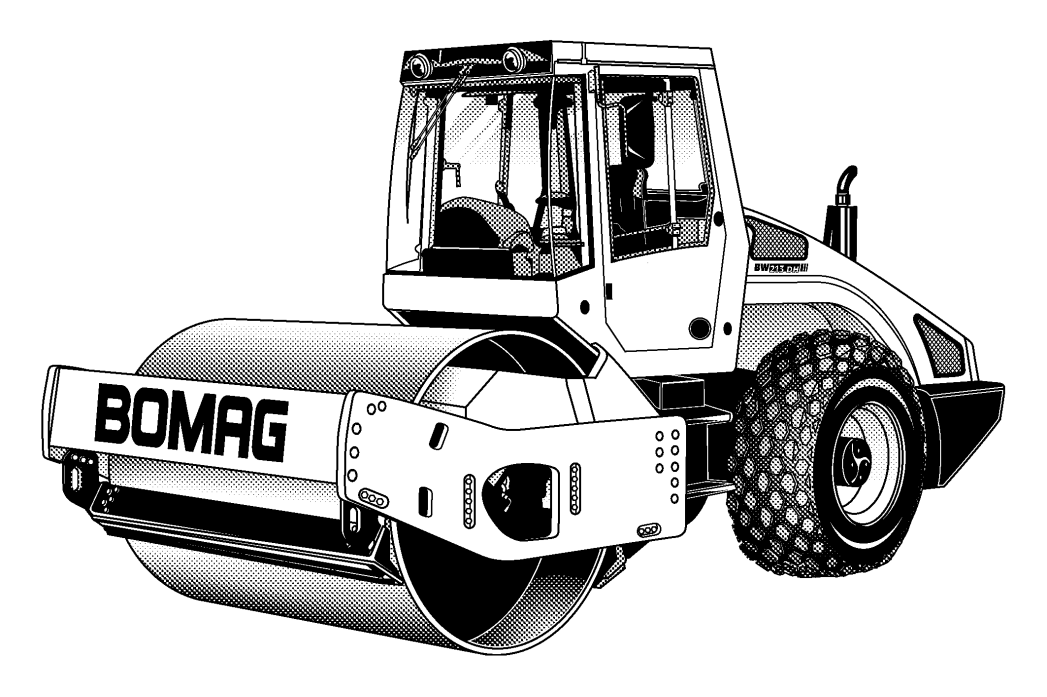
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BOMAG

Service - Manual

BW 219 D-4 / PD-4

S/N 101 582 72 ....> S/N 101 582 73 ....>



Single drum roller

Catalogue number.
008 911 37

05/2007

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1 General

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1.1 Introduction

This manual is intended to support expert mechanics in efficient repair and maintenance work. Whoever wants to do repair work himself should have been sufficiently trained and posses profound expert knowledge, he should limit his work only to those parts and components which will not affect the safety of the vehicle or the passengers. It is highly recommended to have repairs to critical systems, such as steering, brakes and travel drive, sole carried out by a BOMAG workshop. Untrained persons should NEVER UNTERTAKE SUCH REPAIR WORK.

The repair instructions describe the removal or dismantling and assembly of components and assembly groups. The repair of disassembled assembly groups is described as far as this makes sense with respect to available tools and spare parts supply and as far as it can be understood by a skilled mechanic.

Documentation

For the BOMAG machines described in this training manual the following documentation is additionally available:

1. **Operating and maintenance instructions**
2. **Spare parts catalogue**
3. **Wiring diagram***
4. **Hydraulic diagram***
5. **Service Information**

You should only use genuine BOMAG spare parts.

Spare parts needed for repairs can be taken from the spare parts catalogue for the machine.

This manual is not subject of any updating service; we would therefore like to draw your
attention to the additionally published "technical service information".

In case of a new release all necessary changes will be included.

In the course of technical development we reserve the right for technical modifications without prior notification.

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⚠ Danger

Please observe strictly the safety regulations in this manual, in the operating instructions as well as the applicable accident prevention regulations.

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* The applicable documents valid at the date of printing are part of this manual.

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Important notes

These safety regulations must be read and applied by every person involved in the repair of this machine. The applicable accident prevention instructions and the safety regulations in the operating and maintenance instructions must be additionally observed.

Repair work shall only performed by appropriately trained personnel or by the after sales service of BOMAG.

Any suggestions, safety precautions and warnings in this section are intended as a mnemonic aid for well trained and experienced expert mechanics. This manual should not be considered a bible on workshop safety.

Workshop equipment and facilities as well as the use and waste disposal of solvent, fluids, gases and chemicals are subject to legal regulations, which are intended to provide a minimum on safety. It is obviously your own responsibility to know and adhere to these regulations.

This manual contain headers like "Note", "Attention", "Danger" and "Environment", which must be strictly complied with in order to avoid dangers for health and for the environment.

⚠ Danger

Paragraphs marked like this highlight possible dangers for persons.

⚠ Caution

Paragraphs marked like this highlight possible dangers for machines or parts of the machine.

i Note

Paragraphs marked like this contain technical information for the optimal economical use of the machine.

Environment

Paragraphs marked like this point out practices for safe and environmental disposal of fuels and lubricants as well as replacement parts.

Observe the regulations for the protection of the environment.

General

- Before starting repair work stand the machine on level and solid ground.
- Always secure the machine against unintended rolling.
- Secure the engine reliably against unintentional starting.
- Mark a machine that is defective or being repaired by attaching a clearly visible warning tag to the steering wheel.
- On machines with articulated joint keep the articulated joint locked during work.
- Use protective clothes like hard hat, safety boots and gloves.
- Keep unauthorized persons away from the machine during repair work.
- Tools, lifting gear, lifting tackle, supports and other auxiliary equipment must be fully functional and in safe condition.
- Use only safe and approved lifting gear of sifficient load bearing capacity to remove and install parts or components from and to the machine.
- Be careful with cleansing agents. Do not use easily inflammable or harmful substances, such as gasoline or paint thinners for cleaning.
- Cleaning or repair work on the fuel tank is very dangerous. Do not smoke or allow any ignitable sparks or open fire in the vicinity when cleaning or repairing a tank. .
- When performing welding work strictly comply with the respective welding instructions.

Precautions and codes of conduct for welding work

Welding work should only be performed by specially instructed expert personnel.

⚠ Danger

Electric shock!

Sparks, fire hazard, burning of skin!

Infrared or ultraviolet radiation (arc), flashing of eyes!

Health hazard caused by welding work on highly alloyed work pieces, metal coatings, paint coatings, plastic coatings, oil containing dirt deposits, grease or solvent residues, etc.!

- Check welding equipment and cables for damage before use (also the validity of inspection stickers).
- Ensure good conductivity between earth cable and work piece.
- Start the extraction fan before starting work and guide with the progressing work as required.
- Always isolate the burner when laying it down (remove possible electrode residues).
- Protect cables from being damaged, use cables with insulated couplings.
- Ensure sufficient fire protection, keep a fire extinguisher at hand.

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- In case of welding work in fire or explosion endangered environments, you should always ask for a welding permission.
- Remove combustible parts from the vicinity or cover such parts.
- Name a fire watch during and after welding work.
- Do not clamp the welding rod holder and the inert gas welding gun under your arm and lay these parts only on an insulated top.
- Place the inert gas bottles in a safe place and secure them against falling over.
- Use a protective screen or an arcing shield with welding glass, wear welding gloves and clothes, this applies also for assisting persons.
- Switch the welding unit off before connecting welding cables.

Behaviour in case of faults

- Check electrode holders and electric cables at regular intervals.
- In case of deficiencies switch off the welding unit and inform supervising persons.
- In case of an extractor fan failure or any other fault inform the supervising persons.

Maintenance; waste disposal

- Replace damaged insulating jaws and welding rod holders immediately.
- Replace the welding wire reels only in deenergized state.

What to do in case of accidents; First Aid

- Keep calm.
- Call first air helpers.
- Report the accident.
- In case of an electric accident: Interrupt the power supply and remove the injured person from the electric circuit. If breathing and heart have stopped apply reactivation measures and call for an emergency doctor.

Old oils

Prolonged and repetitive contact with mineral oils will remove the natural greases from the skin and causes dryness, irritation and dermatitis. Moreover, used engine oils contain potentially hazardous contaminants, which could cause skin cancer. Appropriate skin protection agents and washing facilities must therefore be provided.

- Wear protective clothes and safety gloves, if possible.
- If there is a risk of eye contact you should protect your eyes appropriately, e.g. chemistry goggles or full face visor; a facility suitable for rinsing the eyes should also be available.
- Avoid prolonged and repetitive contact with oil, especially with old oil. In case of open incisions and injuries seek medical advice immediately.
- Apply protective cream before starting work, so that oil can be easier removed from the skin.
- Wash with soap and water to ensure that all oil has been removed (a skin cleaning agent and a nail brush will help). Lanolin containing agents will replace natural skin oils that were lost.
- Do not use gasoline, kerosene, diesel, thinner or solvents to wash the skin.
- Do not put oil soaked cloths into your pockets.
- Avoid clothes, especially underpants, getting soiled by oil.
- Overalls must be washed at regular intervals. Clothes that cannot be washed, must be disposed of.
- If possible degrease components before handling.

Environment

It is strictly prohibited to drain off oil into the soil, the sewer system or into natural waters. Entrust special companies with the waste disposal of old oil. If in doubt you should consult your local authorities.

Hydraulics

- Hydraulic oil escaping under pressure can penetrate the skin and cause severe injury. You should therefore relieve the pressure in the system before disconnecting any lines.
- Before applying pressure to the system make sure that all line connections and ports have been properly tightened and are in perfect condition.
- Hydraulic oil leaking out of a small opening can hardly be noticed, therefore please use a piece of cardboard or wood when checking for leaks. When being injured by hydraulic oil consult a physician immediately, as otherwise this may cause severe infections.
- Do not step in front of or behind the drums/wheels/ crawler tracks when performing adjustment work in the hydraulic system while the engine is running. Block drums and/or wheels / crawler tracks with wedges.

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Reattach all guards and safety installations after all work has been completed.

Environment

It is strictly prohibited to drain off hydraulic oil into the soil, the sewer system or into natural waters. Entrust special companies with the waste disposal of old oil. If in doubt you should consult your local authorities.

Fuels

Danger

Repair work on fuel systems must only be performed by appropriately trained personnel.

The following notes refer to general safety precautions for danger free handling of fuel. These notes are only general instructions; in case of uncertainties you should consult the person responsible for fire protection.

Fuel vapours not only are easily inflammable, but also highly explosive inside closed rooms and toxic; dilution with air creates an easily inflammable mixture. The vapours are heavier than air and therefore sink down to the ground. Inside a workshop they may easily become distributed by draft. Even the smallest portion of spilled fuel is therefore potentially dangerous.

- Fire extinguishers charged with FOAM, SCHAUM, CO2 GAS or POWDER must be available wherever fuel is stored, filled in, drained off, or where work on fuel systems is performed.
- The vehicle battery must always be disconnected, BEFORE work in the fuel system is started. While working on the fuel system you should not disconnect the battery, because this could generate sparks, which would ignite explosive fuel vapours.
- Wherever fuel is stored, filled, drained off or where work on fuel systems is carried out, all potential ignition sources must be extinguished or removed. Search lights must be fire proof and well protected against possible contact with running out fuel.

Hot fuels

Before draining fuel off the tank for repair work, you must strictly apply the following measures:

- Allow the fuel to cool down, to prevent any contact with a hot fluid.
- Vent the system, by removing the filler cap in a well ventilated area. Screw the filler cap back on, until the tank is finally emptied.

Synthetic rubber

Many O-rings, hoses and similar parts, which are apparently made of natural rubber, are actually made of plastic material, a so-called fluoroelastomer. Under normal operating conditions this material is safe and does not impose any danger to health.

However, if this material becomes damaged by fire or extreme heat, it may decompose and form highly caustic hydrofluoric acid, which can cause severe burns in contact with skin.

- If the material is in such a state it must only be touched with special protective gloves. These gloves must be disposed of directly after use.
- If the material has contacted the skin despite these measures, take off the soiled clothes and seek medical advice immediately. In the meantime wash the affected parts of the skin for 15 to 60 minutes with cold water or lime water.

Poisonous substances

Some of the fluids and substances used are toxic and must under no circumstances be consumed.

Skin contact, especially with open wounds, should be strictly avoided.

These fluids and substances are, amongst others, anti-freeze agents, hydraulic oils, washing additives, lubricants and various bonding agents.

Engine

Danger

Do not work on the fuel system while the engine is running - danger to life!

After the engine has stopped wait until the pressure has dropped (on Commonm Rail engines approx. 5 minutes, other engines 1 minute), because the system is under high pressure - danger to life!

Keep out of the danger zone during the initial test rung. Danger caused by high pressure in case of leaks - danger to life!

When performing work on the fuel system make sure that the motor cannot be started unintentionally - danger to life!

- Maintenance and cleaning work on the engine must onyl be performed with the engine stopped and cooled down. Make sure that the electric system has been switched off (ignition key pulled out).
- Observe the accident prevention regulations for electric systems (e.g. -VDE-0100/-0101/-0104/-0105 Electric precautions against dangerous contact voltages).
- Cover all electric components properly before wet cleaning.

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Air conditioning system

⚠ Caution

Lines in the air conditioning system must only be loosened by trained and explicitly instructed experts.

- Wear safety goggles! Put on your safety goggles. This will protect your eyes against coming into contact with refrigerant, which could cause severe damage by freezing.
- Wear safety gloves and an apron! Refrigerant are excellent solvents for greases and oils. In contact with skin they will remove the protective grease film. However, degreased skin is very sensitive against cold temperatures and germs.
- Do not allow liquid refrigerants to come into contact with skin! Refrigerant takes the heat required for evaporation from the environment. Very low temperatures may be reached. The results may be local frost injuries (boiling point of R134a -26.5°C at ambient pressure).
- Do not inhale higher concentrations of refrigerant vapours! Escaping refrigerant vapours will mix with the ambient air and displace the oxygen required for breathing.
- Smoking is strictly prohibited! Refrigerants may be decomposed by a glowing cigarette. The resulting substances are highly toxic and must not be inhaled.
- Welding and soldering on refrigeration equipment! Before starting welding or soldering work on vehicles, (in the vicinity
  of air conditioning components) all refrigerant must be drawn out and the rests removed by blowing out the system with nitrogen. The decomposition products created from the refrigerant under the influence of heat not only are highly toxic, but also have a strong corrosive effect, so that pipes and system components may be attacked. The substance is mainly fluorohydrogen.
- Pungent smell! In case of a pungent smell the afore mentioned decomposition products have already been created. Extreme care must be exercised not to inhale these substances, as otherwise the respiratory system, the lungs and other organs may be harmed.
- When blowing out components with compressed air and nitrogen the gas mixture escaping from the components must be extracted via suitable exhaust facilities (workshop exhaust systems).

Handling pressure vessels

- Since the fluid container is pressurized, the manufacture and testing of these pressure vessels is governed by the pressure vessel directive. (New edition from April 1989). Paragraph 10 of the pressure vessel directive demands that these pressure containers must be periodically inspected and tested by a specialist, according to paragraph 32. In this case periodically recurring inspections consist of external examinations, normally on containers in operation. The refrigerant container must be visually inspected two times per year, within the frame work of major inspections. Special attention must thereby be paid to signs of corrosion and mechanical damage. If the container is in no good condition, it should be replaced for safety reasons, in order to protect the operator or third parties against the dangers when handling or operating pressure vessels.
- Secure pressure vessels against tipping over or rolling away.
- Do not throw pressure vessels. Pressure vessels may thereby be deformed to such an extent, that they will crack. The sudden evaporation and escape of refrigerant releases excessive forces. This applies also when snapping off valves on bottles. Bottles must therefore only be transported with the safety caps properly installed.
- Refrigerant bottles must never be placed near heating radiators. Higher temperatures will cause higher pressures, whereby the permissible pressure of the vessel may be exceeded. The pressure vessel directive therefore specifies that a pressure vessel should not be warmed up to temperatures above 50 °C.
- Do not heat up refrigerant bottles with an open flame. Excessive temperatures can damage the material and cause the decomposition of refrigerant.
- Do not overfill refrigerant bottles, since any temperature increase will cause enormous pressures.

Environment

In operation, during maintenance and repair work and when taking refrigeration systems our of service it is not permitted to let refrigerant escape into the atmosphere, which would contradict the current status of technology.

Battery

- Wear goggles and face protection (acid).
- Wear suitable clothes to protect face, hands and body (acid).
- Work and store accumulators only well ventilated rooms. (Development of oxyhydrogen gas).
- Do not lean over the battery while it is under load, being charged or tested. (Danger of explosion).
- Burning cigarettes, flames or sparks can cause explosion of the accumulator
- Keep ignition sources away from the battery.

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- Always shield eyes and face towards the battery.
- Do not use battery chargers or jump leads without following the operating instructions.
- Keep the cell plugs closed.
- After an accident with acid flush the skin with water and seek medical advice.
- Do not allow children access to batteries.
- When mixing battery fluid always pour acid into water, never vice-versa.

Special safety regulations

- Use only genuine BOMAG spare parts for repair purposes. Original parts and accessories have been specially designed for this machine.
- We wish to make explicitly clear that we have not tested or approved any parts or accessories not supplied by us. The installation and/or use of such products may therefore have an adverse effect on the specific characteristics of the machine and thereby impair the active and/or passive driving safety. The manufacturer explicitly excludes any liability for damage caused by the use of non-original parts or accessories.
- Unauthorized changes to the machine are prohibited for safety reasons.
- If tests on the articulated joint need to be performed with the engine running, do not stand in the articulation area of the machine, danger of injury!
- Do not perform cleaning work while the engine is running.
- If tests must be performed with the engine running do not touch rotating parts of the engine, danger of injury.
- Exhaust gases are highly dangerous. Always ensure an adequate supply of fresh air when starting the engine in closed rooms.
- Refuel only with the engine shut down. Ensure strict cleanliness and do not spill any fuel.
- Keep used filters in a separate waste container and dispose of environmentally.
- Dispose of oils and fuel environmentally when performing repair or maintenance work.
- Do not refuel in closed rooms.
- Do not heat up oil higher than 160 °C because it may ignite.
- Wipe off spilled oil and fuel.
- Do not smoke when refuelling or when checking the acid level in the battery.
- Do not check the acid level of the battery with a naked flame, danger of explosion!
- Old batteries contain lead and must be properly disposed of.
- There is a danger of scalding when draining off engine or hydraulic oil at operating temperature.
- on machines with rubber tires a tire may busr if incorrectly assembled. This can cause severe injury.
- Do not exceed the specified highest permissible tire pressure.

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General

- Before removing or disassembling and parts, hoses or components mark these parts for easier assembly.
- Before assembly oil or grease all parts, as far as this is necessary.

Electrics

General

The electric and electronic systems in construction equipment are becoming more and more extensive. Electronic elements are increasingly gaining importance in hydraulic and mechanical vehicle systems.

Diagnostics according to plan

A structured approach in trouble shooting saves time and helps to avoid mistakes and expenses, especially in the fields of electrics and electronics. Understanding electronic controls requires the knowledge of some basic terms concerning their general performance. In many cases error logs are just simply read out and control units are replaced without any further trouble shooting. This is in most cases unnecessary and, even more important, very expensive.

Random tests have revealed that purely electronic components or control units only very rarely are the actual cause of failures:

- In approx. 10 % of the examined cases the problems were caused by control units.
- In approx. 15 % sensors and actuators were the cause of the problems.

By far the highest proportion of all faults could be traced back to wiring and connections (plugs, etc.).

General:

- Before changing any expensive components, such as control units, you should run a systematic trouble shooting session to eliminate any other possible fault sources. Electric signals must be checked at the locations to which they are applied, i.e. on control unit or sensor technology. So, if the system had been diagnosed without unplugging the control unit and checking the wiring, one should be alerted.
- Check for good cable and ground contacts, therefore keep all mechanical transition points between electric conductors (terminals, plugs) free of oxide and dirt, as far as this is possible.
- Perform trouble shooting in a systematic way. Do not become confused by the high number and variety of electric cables, current can only flow in a closed circuit. You should first become acquainted with the function of the corresponding electric circuit by following the correct wiring diagram. Detected faults should be rectified immediately. If the system still does not work correctly after this measure, trouble shooting must be continued. Several faults very rarely occur at the same time, but it is not impossible.
- Do not disconnect or connect battery or generator while the engine is running.
- Do not operate the main battery switch under load.

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- Do not use jump leads after the battery has been removed.
- Sensors and electric actuators on control units must never be connected individually or between external power sources for the purpose of testing, but only in connection with the control unit in question, as otherwise there may be a risk of destruction (damage)!
- Disconnecting the control unit plug connectors with the control unit switched on, i.e. with the power supply (terminal 15 "On"), is not permitted. Switch the voltage supply "off" first - then pull out the plug.
- Even with an existing polarity reversal protection incorrect polarity must be strictly avoided. Incorrect polarity can cause damage to control units!
- Plug-in connectors on control units are only dust and water tight if the mating connector is plugged on! Control units must be protected against spray water, until the mating connector is finally plugged on!
- Unauthorized opening of the control electronics (micro controller MC) as well as changes or repairs on the wiring can lead to dangerous malfunctions.
- Do not use any radio equipment or mobile phones inside the driver's cab without an appropriate outside antenna or in the vicinity of the control electronics!

Electrical system and welding work

- Surge voltages in the electric system must be strictly avoided:
- When performing welding work always fasten the earth clamp of the welding unit in the immediate vicinity of the welding location.

⚠ Caution

Switch off the main battery switch, doisconnect the generator and pull the plug out on the control unit before starting welding work.

Battery

Rules for the handling of batteries

Even though it may be conveniently installed in the engine compartment, it should never be used as a rest for tools. When connecting the poles, e.g. by means of a spanner, the battery will become an "electric welder".

As a measure to avoid short circuits you should first disconnect the negative pole during disassembly and reconnect the negative pole last during assembly.

Terminal clamps should be assembled with as little force as possible.

Poles and terminal clamps should always be kept clean to avoid transition resistances during starting and the related development of heat.

You should obviously also pay attention to secure fastening of the battery in the vehicle.

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Hydraulic system

⚠ Caution

Do not open any hydraulic components if you have not been properly trained and without exact knowledge.

Please note

Cleanliness is of utmost importance. Make sure that no dirt or other contaminating substances can enter into the system.

- Clean fittings, filler covers and the area around such parts before disassembly to avoid entering of dirt.
- Before disconnecting hoses, pipes or similar relieve the system pressure with the engine shut down.
- During repair work keep all openings closed with clean plastic plugs and caps.
- Do not run pumps and motors without oil.
- When cleaning hydraulic components take care not to damage any fine machine surfaces.
- Chemical and rubber soluble cleansing agents may only be used to clean metal parts. Do not let such substances come in contact with sealing material.
- Rinse of cleaned parts thoroughly, dry them with compressed air and apply anti-corrosion oil immediately. Do not install parts that show traces of corrosion.
- Avoid the formation of rust on fine machined caused by hand sweat.
- Grease must not used as a sliding agent for assembly work. Use hydraulic oil.
- Do not start the engine after the hydraulic oil has been drained off.
- Use only the specified pressure gauges. Risk of damaging the pressure gauges under too high pressure.
- Clean ports and fittings before removal so that no dirt can enter into the hydraulic system.
- Check the hydraulic oil level before and after the work.
- Use only clean oil according to specification.
- Check the hydraulic system for leaks, find and rectify the cause.
- Fill new hydraulic units with hydraulic oil before starting operation.
- After changing a component thoroughly flush and bleed the entire hydraulic system.
- Perform measurements at operating temperature of the hydraulic oil (approx. 40 ¯C).
- After changing a component perform a high and charge pressure test, if necessary check the speed of the exciter shaft.
- The operating pressure of the exciter shaft to a great extent depends on the base under the vibrating drum. If the soil is too hard place the drums on old rubber tires. Do not activate the vibration on a hard, concreted base, danger of bearing damage.
- After the completion of all tests perform a test run and then check all connections and fittings for leaks with the engine still stopped and the hydraulic system depressurized.

Before commissioning

- After changing a component clean the hydraulic oil tank thoroughly.
- Fill the housings of hydraulic pumps and motors with hydraulic oil.
- Use only hydraulic oils according to the specification in the maintenance instructions.
- After changing a component clean the hydraulic system as described in the flushing instructions in order to prevent all other components from being damaged by abrasion and metal chips remaining in the system.
- Change the hydraulic oil filter.

Commissioning

- Bleed the hydraulic circuits.
- Start up the system without load.
- Check the hydraulic oil level in the tank, fill up oil if necessary.

After commissioning

- Check system pressures and speeds.
- Check fittings and flanges for leaks.
- After each repair check all adjustment data, rotational speeds and nominal values in the hydraulic system, adjust if necessary.
- Do not adjust pressure relief valves and control valves to values above their specified values.

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Air conditioning system

CFC - halon prohibition

The CFC - halon prohibition from May 06, 1991 regulates the withdrawal from the use of CFC and the handling of these refrigerants.

Contents:

Since 1995 CFC (R12) is no longer permitted for use in new systems.

In operation, during maintenance and repair work and when taking refrigeration systems our of service it is not permitted to let refrigerant escape into the atmosphere, which would contradict the current status of technology.

Work on refrigeration systems must only be carried out by persons with well founded knowledge about such systems and who have the necessary technical equipment available.

The use of refrigerant must be documented.

Old systems should be converted to refrigerants harmless to ozone (refrigerant substitutes).

For this reason the Federal Environmental Agency at the end of 1995 published suitable replacement refrigerants for R 12. As a consequence old systems must no longer be filled with R12. As soon as such a system is opened for service, the system must be converted to a suitable replacement or service refrigerant. Old systems may still be used, as long as they are leak tight. R 134a was nominated as replacement for R 12.

Inside the European Union the "EU-Directive 2037/ 2000 on substances causing decomposition of the ozone layer" regulates the production, use and availability of CFC and H-CFC.

- In case of a repair on the refrigeration system you should first evacuate the air conditioning system for at least 45 minutes to remove any moisture from the system, before you start to refill. Moisture bonded in the compressor oil / refrigeration oil (PAG oil) can only be removed from the system by changing the oil.
- During repair work on refrigerant lines and components, these must be kept closed as far as possible, in order to prevent the invasion of air, moisture and dirt, because the operational reliability of the system can only be assured if all components in the refrigerant circuit are clean and dry from inside.
- Make sure that no dirt or foreign parts can enter into the compressor or the air conditioning system. The area around the refrigerant hoses should be cleaned with a gasoline free solvent.
- All parts to be reused should be cleaned with a gasoline free solvent and blow-dried with clean compressed air or dried with a lint-free cloth.
- Before opening all components should have warmed up to ambient temperature, to avoid that damp air is drawn into the component by the difference in temperatures.
- Damaged or leaking parts of the air conditioning must not be repaired by welding or soldering, but must generally be replaced.
- Do not fill up refrigerant, but extract existing refrigerant and refill the system.
- Different types of refrigerant must not be mixed. Only the refrigerant specified for the corresponding air conditioning system must be used.
- Refrigerant circuits with refrigerant type R134a must only be operated with the compressor oil / refrigeration oil approved for the compressor.
- Used compressor oil / refrigeration oil must be disposed of as hazardous waste.
- Due to its chemical properties compressor oil / refrigeration oil must never be disposed of together with engine or transmission oil.
- Compressor oil / refrigeration oil is highly hydroscopic. Oil cans must strictly be kept closed until use. Oil rests should not be used, if the can had been opened over a longer period of time.
- All O-rings as well as pipe and hose fittings must be oiled with compressor/refrigeration oil beforeiassembly.
- When replacing a heat exchanger, e.g. evaporator or condenser, any compressor oil / refrigeration oil lost by exchanging the components, must be replaced with fresh oil.
- A too high compressor oil / refrigeration oil level adversely affects the cooling performance and a too low oil level has a negative effect on the lifetime of the compressor.
- If a air conditioning unit needs to be opened, the dryer must be replaced in any case.
- Always use new O-rings when reassembling the unit.
- Always use two spanners when connecting pipes or hoses, to prevent the pipe end from being damaged .
- Tighten screw fittings with the specified torque.
- Check the connections of pipes, fittings or components thoroughly; do not use if damaged.
- Do not leave the refrigerant circuit unnecessarily open to the atmosphere. Do not attempt to repair bent or burst pipes.
- Compressor valves must only be opened after the system has been properly sealed.
- The use of leak detection colouring matter is not permitted, because its chemical composition is unknown and its effect on compressor oil and rubber elements is not predictable. The use of leak detec-

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tion colouring matter makes any warranty claims null and void.

- Tools used on refrigeration circuits must be of excellent condition, thus to avoid the damage of any connections.
- The dryer is to be installed last, after all connections in the refrigerant circuit have been tightened.
- After completion of repair work screw locking caps (with seals) on all connections with valves and on the service connections. Start up of the air conditioning system. Observe the filling capacity.
- Before start up of the air conditioning system after a new filling: - Turn the compressor approx. 10 revolutions by hand using the clutch or V-belt pulley of the magnetic clutch. - Start the engine with the compressor/control valve switched off. - Once the idle speed of the engine has stabilized switch on the compressor and run it for at least 10 minutes at idle speed and maximum cooling power.
- Never operate the compressor over longer periods of time with high engine speeds without a sufficient amount of refrigerant in the system. This could probably cause overheating and internal damage.

Fuel hoses

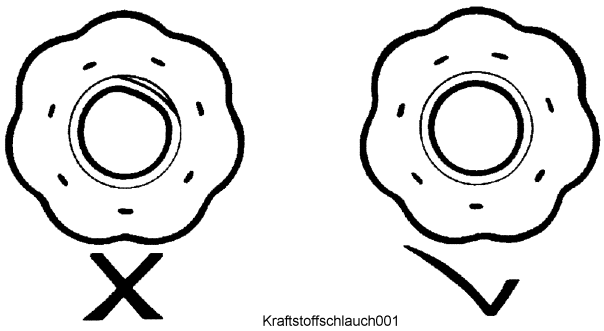


Fig. 1

⚠ Caution

All fuel hoses have two layers of material, a reinforced rubber coating outside and an internal Viton hose. If a fuel hose has come loose one must make absolutely sure that the internal Viton layer has not been separated from the reinforced outer layer. In case of a separation the hose needs to be replaced.

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Gaskets and mating surfaces

Leaking or failing seals and gaskets can in most cases be tracked down to careless assembly, causing damage not only to the seal or gasket, but also to the mating surfaces. Careful assembly work is mandatory if good results are to be achieved.

- Before assembling replacement seals make sure that the running surface is free of pitting, flutes, corrosion or other damage.
- Inappropriately stored or handled seals (e.g. hanging from hooks or nails) must under no circumstances be used.
- Sealing compound should only be used if specially requested in the instructions. In all other cases these joints should be assembled in dry condition.
- Sealing compound must be applied thin and evenly on the corresponding surfaces; take care that the compound does not enter into oil galleries or blind threaded bores.
- Before assembly remove any residues of old sealing compound. Do not use any tools that could damage the sealing surfaces.
- Examine the contact faces for scratches and burrs, remove these with a fine file or an oilstone; take care that no grinding dust and dirt enters into tapped bores or enclosed components.
- Blow lines, ducts and gaps out with compressed air, replace any O-rings and seals that have been dislodged by the compressed air.

Assembly of radial seals

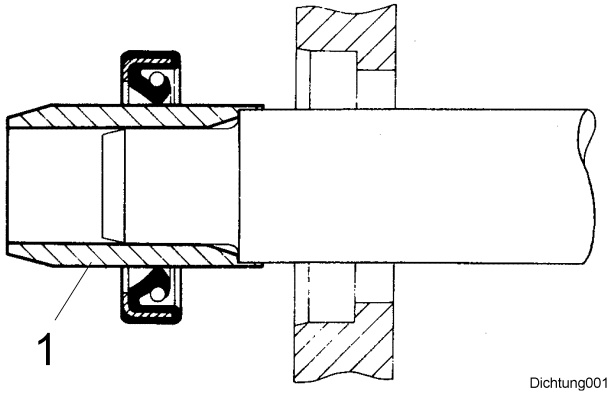


Fig. 2

- Lubricate sealing lips 1 (Fig. 2) with clean grease; in case of double seals fill the space between the sealing lips with a generous amount of grease.
- Slide the seal over the shaft, with the lip facing towards the fluid to be sealed.

i Note

If possible, use an assembly sleeve 1 (Fig. 2), ***to protect the lip from being damaged by sharp edges, threads or splines.*** *If no assembly sleeve is available, you should use a plastic tube or adhesive tape to prevent the sealing lip from being damaged.*

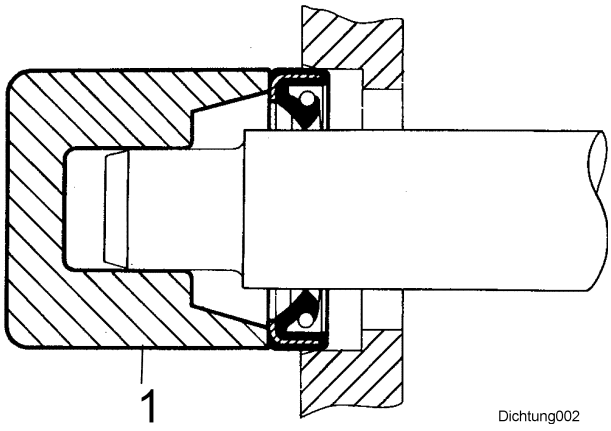


Fig. 3

- Lubricate the outer rim 1 (Fig. 3) of the seal and press it flat on the housing seat.

i Note

If possible, use a "bell" 1 (Fig. 3), to make sure ***that the seal will not skew.*** *In some cases it may be advisable to assemble the seal into the housing first, before sliding it over the shaft. Under no circumstances should the full weight of the shaft rest on the seal.*

If you have no proper service tools at hand, use a suitable drift punch with a diameter which is about 0.4mm smaller than the outer diameter of the seal. Use VERY LIGHT blows with the hammer if no press is available.

- Press or knock the seal into the housing, until it is flush with the housing surface.

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Feather keys and keyways

⚠ Caution

Feather keys must only be reused if they show no differences to new feather keys, any notches must be considered as initial signs of wear.

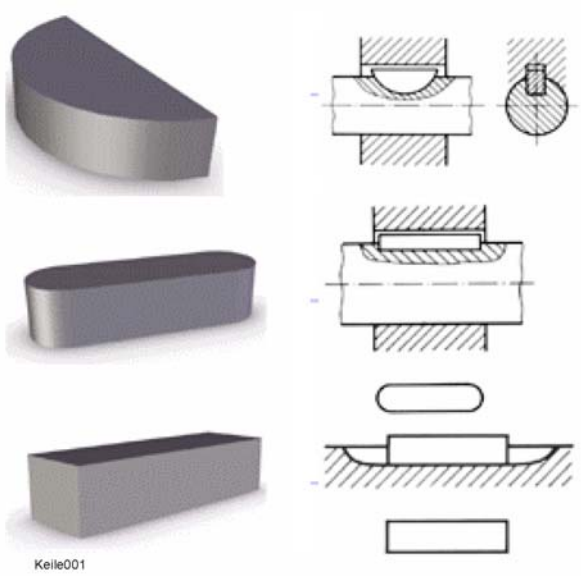


Fig. 4

- Clean and thoroughly examine the feather key.
- Debur and thoroughly clean the edges of the keyway with a fine file before reassembling.

Ball and roller bearings

⚠ Caution

Ball and roller bearings must only be reinstalled after it has been assured that they are in perfect condition.



Fig. 5

- Remove any lubricant residues from the bearing to be examined by washing it with gasoline or any other appropriate degreasing agent. Cleanliness is of utmost importance for all related work.
- Check balls or rollers, running surfaces, outer faces of outer races and inner faces of inner races for visible damage. If necessary replace the bearing with a new one, since these symptoms are first signs of wear.
- Hold the bearing with you thumb and the index finger by the inner race, rotate the outer race and make sure that it runs without friction. Hold the bearing by the outer race and repeat this test with the inner race.
- Move the outer race gently to and fro while holding it by the inner race; check for resistance while rotating and replace the bearing if it does not work correctly.
- Lubricate the bearing with an appropriate lubricant before reinstalling.

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- Check shaft and bearing housing for discolouration or other signs of movement between bearing and seats.
- Make sure that shaft and housing are free of burrs before assembling the bearing.
- If a bearing of a pair of bearings shows any defects, we highly recommend the replacement of both bearings.
- On greased bearings (e.g. wheel bearings) fill the space between bearing and outer seal with the recommended type of grease before assembling the seal.
- Always mark the individual parts of separable bearings (e.g. taper roller bearings) to enable correct reassembling. Never assemble the rollers to an outer race that has already been used, replace the complete bearing instead.

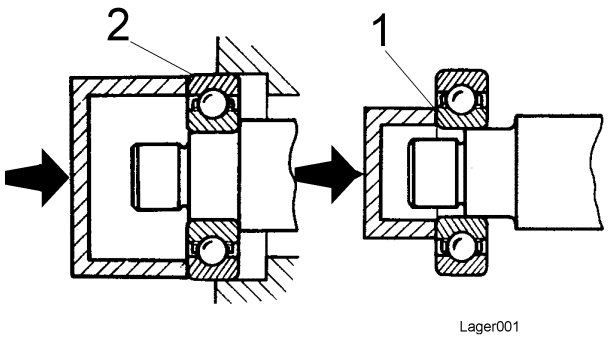


Fig. 6

⚠ Caution

When assembling the bearing to the shaft load must only be applied to the inner race 1 (Fig. 6).

When fitting the bearing into the housing load must only be applied to the outer race (2).

Screws and nuts

Tightening torque

⚠ Caution

Always tighten nuts or screws to the specified tightening torque. Tightening torques deviating from the ones in the table are specially mentioned in the repair instructions.

Damaged screws must under no circumstances be used any longer. Recutting threads with thread cutters or taps adversely affects the strength and leak tightness of the screw joint. Damaged or corroded thread pitches can cause incorrect torque value readings.

Self-locking nuts must be generally renewed.

The use of screws with too high strength can cause damage!

- Nut of a higher strength can generally be used instead of nuts of a lower strength classification.
- When checking or retightening screw joints to the specified tightening torque you should first relieve by a quarter turn and then tighten to the correct torque.
- Before tightening you should lightly oil the thread, in order to ensure low friction movement. **The same applies for self-locking nuts.**
- Make sure that no oil or grease will enter into tapped bores. The hydraulic power generated when turning in the screw could cause breakage of the effected part.

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Strength classes of metric screws

The strength classes (from 3.6 to 12.9) are specified for all strength classes from a nominal diameter of 5mm. The corresponding identification can be found where allowed for by the shape of the screw.

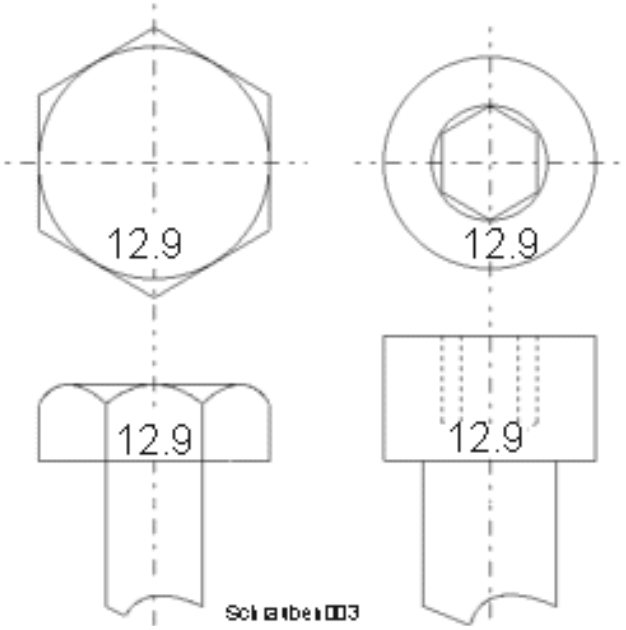


Fig. 7 Identification of screws

Example: A screw is identified with 12.9.

The first number corresponds with 1/100 of the nominal tensile strength (minimum tensile strength) in N/mm^2.

- The nominal tensile strength is 12 X 100N/mm^2 = 1200 N/mm^2.

The second number specifies 10-times the ration between lower yield point and nominal tensile strength (yield point ratio).

i Note

When exceeding the lower yield point, the material will return to its original shape when being relieved (plastic deformation).

When exceeding the upper yield point the material will not restore its original shape after being relieved.

- The lower tensile strength is 9/10 X 1200 N/mm^2 = 1080 N/mm^2.

i Note

However, these values are by no means identical with the tightening torques, which are to be set on a torque wrench. The corresponding calculation requires a higher effort and, in the end, depends on the materials to be bolted together.

Strength classes of metric nuts

Nuts are differentiated by three load groups. Each load group has a special designation system for the strength class assigned, so that the load group can be clearly identified.

Nuts for screw joints with full load capability (4, 5, 6, 8, 10, 12)

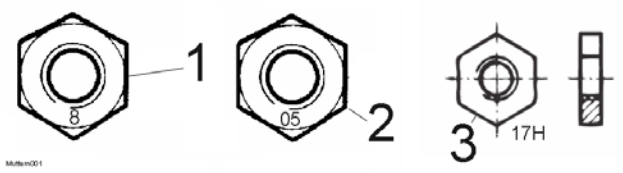


Fig. 8 Identification of nuts

In a connection with a screw, these nuts 1 (Fig. 8) must be able to bear the full pre-load at the yield point.

Nut height above 0.8 d (d = nominal dimension).

Strength class of nut	Strength class of associated screw
4	3.6, 4.6, 4.8
5	3.6, 4.6, 4.8 5.6, 5.8
6	6.8
8	8.8
9	9.8
10	10.8
12	12.8

Nuts for screw joints with limited load factor (04, 05)

The preceding "0" indicates that, due to their low height, nuts 2 (Fig. 8) in this group are only able to withstand the force of a screw to a limited extent.

Nut height below 0.8 d (d = nominal dimension).

Nuts for screw joints without specified load factor (11H, 14H, 17H, 22H)

This standard contains strength classes (hardness classes) for nuts 3 (Fig. 8), for which no load values can be specified, e.g. because of their shape and dimensions, but which can only be classified by their hardness.

Nut height below 0,5 d (d = nominal dimension).

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Identification in clock system

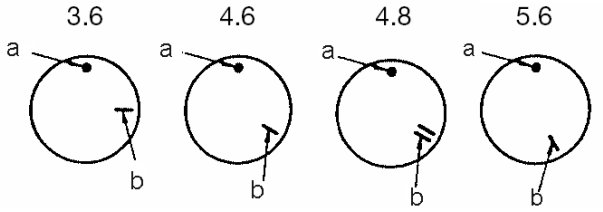


Fig. 9 Identification of nuts in clock system

For small nuts (Fig. 9) the clock system can be used for identification.

- The 12 o'clock position is identified by a dot or the manufacturer's symbol.
- The strength class is identified by a dash (b).

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The values specified in the table apply for screws:

- black oiled
- with surface protection A4C
- with surface protection DACROMET

i Note

DACROMET is a surface protection that mainly consists of zinc and aluminium in a chromium oxide matrix. DACROMETIZATION provides excellent corrosion protection for metal surfaces by applying a mineral coating with metallic-silver appearance.

Tightening torques for screws with metric unified thread[1]

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
M4	3	5	5
M5	6	9	10
M6	10	15	18
M8	25	35	45
M10	50	75	83
M12	88	123	147
M14	137	196	235
M16	211	300	358
M18	290	412	490
M20	412	578	696
M22	560	785	942
M24	711	1000	1200
M27	1050	1480	1774
M30	1420	2010	2400

1 Coefficient of friction μ tot. = 0,14

Tightening torques for screws with metric unified fine thread[1]

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
M8 x 1	26	37	48
M10 x 1.25	52	76	88
M12 x 1,25	98	137	126
M12 x 1.5	93	127	152
M14 x 1.5	152	216	255
M16 x 1.5	225	318	383
M18 x 1.5	324	466	554
M20 x 1.5	461	628	775
M22 x 1.5	618	863	1058
M24 x 2	780	1098	1294
M27 x2	1147	1578	1920
M30 x 2	1568	2254	2695

1 Coefficient of friction μ tot. = 0,14

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Tightening torques for screws treated with anti-seizure paste OKS 240[1] (copper paste)

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
M16	169	240	287
M16 x 1.5	180	255	307
M18	232	330	392
M18 x 1.5	260	373	444
M20	330	463	557
M20 x 1.5	369	502	620
M22	448	628	754
M22 x 1.5	495	691	847
M24	569	800	960
M24 x 2	624	879	1036
M27	840	1184	1520
M27 X 2	918	1263	1536
M30	1136	1608	1920
M30 x 2	1255	1804	2156
3/4“ - 10 UNC	276	388	464
3/4“ - 16 UNC	308	432	520

1 Anti-seizure paste (copper paste) is used for the assembly of screw connections, which are exposed to high temperatures and corrosive effects. Prevents seizure and corrosion.

Tightening torques for wheel nuts (fine thread) [1] [2]

Thread diameter	Tightening torques Nm
	10.9
M12x1.5	100
M14x1.5	150
M18x1.5	300 - 350
M20x1.5	400 - 500
M22x1.5	500 - 600

1 Coefficient of friction μ tot. = 0,14

2 These values result in a 90% utilization of the yield point

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The values specified in the table apply for screws:

- black oiled
- with surface protection A4C
- with surface protection DACROMET

i Note

The difference between Withworth and UNF/UNC threads is the fact that UNF and UNC threads have 60° flanks, as the metric ISO-thread, whereas Withworth has a flank of only 55°.

DACROMET is a surface protection that mainly consists of zinc and aluminium in a chromium oxide matrix. DACROMETIZATION provides excellent corrosion protection for metal surfaces by applying a mineral coating with metallic-silver appearance.

Tightening torques for screws with UNC thread, [1] UNC Unified Coarse Thread Series, American Unified Coarse Thread

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
1/4“ - 20	11	15	19
5/16“ - 18	23	32	39
3/8“ - 16	39	55	66
7/16“ - 14	62	87	105
1/2“ - 13	96	135	160
9/16“ - 12	140	200	235
5/8“ - 11	195	275	330
3/4“ - 10	345	485	580
7/8“ - 9	560	770	940
1“ - 8	850	1200	1450
1 1/8“ - 7	1200	1700	2000
1 1/4“ - 7	1700	2400	2900
1 3/8“ - 6	2200	3100	3700
1 1/2“ - 6	3000	4200	5100

1 Coefficient of friction μ tot. = 0,14

Tightening torques for screws with UNF thread, [1] UNF Unified National Fine Thread Series, American Unified Fine Thread

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
1/4“ - 28	13	18	22
5/16“ - 24	25	35	42
3/8“ - 24	45	63	76
7/16“ - 20	70	100	120
1/2“ - 20	110	155	185
9/16“ - 18	155	220	260
5/8“ - 18	220	310	370
3/4“ - 16	385	540	650
7/8“ -14	620	870	1050

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Tightening torques for screws with UNF thread, [1] UNF Unified National Fine Thread Series, American Unified Fine Thread

Screw dimension	Tightening torques Nm		
	8.8	10.9	12.9
1“ - 12	930	1300	1600
1 1/8“ - 12	1350	1900	2300
1 1/4“ - 12	1900	2700	3200
1 3/8“ - 12	2600	3700	4400
1 1/2“ - 12	3300	4600	5600

1 Coefficient of friction μ tot. = 0,14

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2 Maintenance

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2.1 General notes on maintenance

When servicing the machine pay careful attention to all applicable safety instructions.

Thorough maintenance of the machine ensures maximum reliability and prolongs the lifetime of important components. The necessary effort can by no means be compared with the problems and malfunctions that could occur if this is not observed.

The terms left/right are always related to travel direction forward.

- Clean machine and engine thoroughly before starting maintenance work.
- For maintenance work park the machine on level ground.
- Maintenance work must generally be carried out with the engine shut down.
- Depressurize hydraulic lines before working on them.
- Disconnect the battery and cover it with insulation material before starting to work on electrical components.
- Always attach the articulation lock (transport lock) before starting to work in the articulation area of the machine.

Environment

Catch running out oils, coolant and fuel and do not let them seep into the ground or into the sewage system. Dispose of oils, coolant and fuels environmentally.

Notes on the fuel system

The lifetime of the diesel engine is decisively depending on the cleanliness of the fuel.

- Keep the engine free of dirt and water as this could damage the injection elements of the engine.
- Zinc lined drums are not suitable for storing fuel.
- The fuel drum should rest for a longer period of time before drawing off fuel.
- Do not let the suction hose disturb the sludge on the bottom of the drum.
- Do not draw off fuel from near the bottom of the fuel drum.
- Fuel left in the fuel drum is not suitable for the engine and should only be used for cleaning purposes.

Notes on the engine performance

Combustion air and fuel injection rates of the diesel engine have been carefully adjusted and determine the engine's performance and temperature level as well as the quality of the exhaust gas.

If your machine has to operate permanently in "thin air" (at high altitudes) and with full power, you should consult the after sales service of BOMAG or the service department of the engine manufacturer.

Notes on the hydraulic system

During maintenance work in the hydraulic system cleanliness is of utmost importance. Make sure that no dirt or other impurities can enter into the system. Small particles can flute valves, cause pumps to seize and block restrictors and pilot bores, thereby causing costly repairs.

- If during the daily oil level check the oil level is found to have dropped, check all lines, hoses and components for leakages.
- Seal external leaks immediately. If necessary inform the responsible service department.
- Do not store drums with hydraulic oil outside, or at least keep them under a cover. During weather changes water may penetrate through the bunghole.
- Always fill the hydraulic system using the filling and filtering unit (BOMAG part-no. 007 610 01). This unit is equipped with a fine filter, which filters the hydraulic oil and prolongs the lifetime of the system filter.
- Clean fittings, filler caps and their immediate surrounding area before removing them, so that no dirt can fall in.
- Do not leave the tank opening unnecessarily open, cover it so that no dirt can fall in.

Notes on the cooling system

On water cooled engines the preparation and monitoring of the coolant is of utmost importance, as otherwise engine failures caused by corrosion, caviation and freezing may occur.

The coolant is a mixture of water and a cooling system protection agent.

The cooling system must be permanently monitored. Apart from the coolant level inspection this includes also the inspection of the concentration of cooling system protection agent.

The concentration of the cooling system protection agent can be checked with commercially available test instruments (glycomat).

⚠ Danger

Health hazard!

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The mixing of nitride based cooling system protection agents with amine based agents will cause the generation of highly toxic nitrosamines.

Environment

Cooling system protection agents must be disposed of environmentally.

2.2 Fuels and lubricants

Engine oil

Quality

Lubrication oils are classified according to their performance and quality class. Oils according to other comparable specifications may be used.

Approved engine oils		
Deutz	DQC II	DQC III
ACAE	E3/96/E5-02	E4-99
API	CH-4/CG-4	-
DHD	DHD-1	-

The exact assignment of the approved oil qualities and oil change intervals can be taken from the following section "Lubrication oil change intervals".

Consult your local service station if in doubt.

Oil viscosity

Multi-purpose oils should be generally used.

Since lubrication oil changes its viscosity with the temperature, the ambient temperature at the operating location of the engine is of utmost importance when choosing the viscosity class (SAE-class) .

Optimal operating conditions can be achieved by using the opposite oil viscosity chart (Fig. 10) as a reference.

Occasionally falling short of the temperature limits will impair the cold starting ability, but will not cause any engine damage. In order to keep the occurring wear as low as possible, occassional exceeding of the limits should not happen over a longer period of time.

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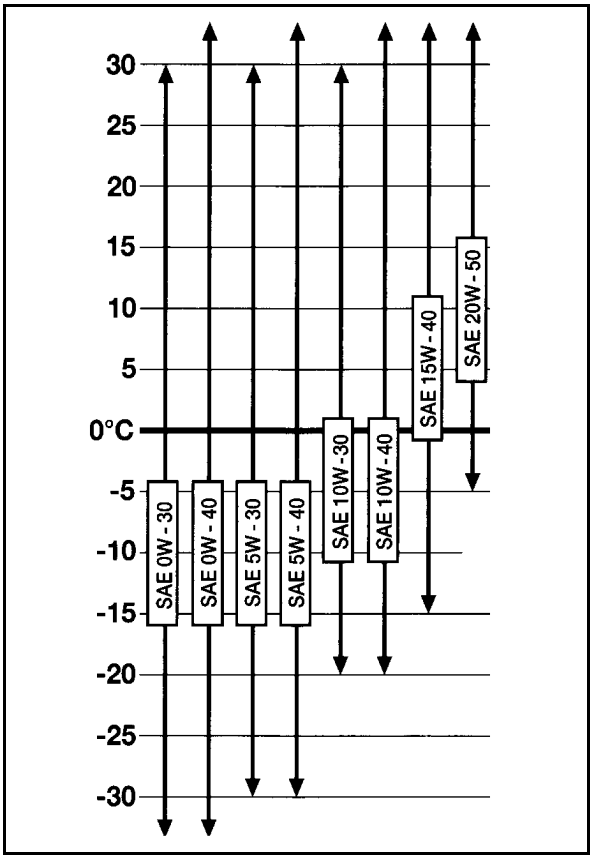


Fig. 10

With their better temperature and oxidation stability synthetic lubrication oils offer quite a few benefits.

Oil change intervals

The longest permissible time a lubrication oil should remain in an engine is 1 year. If the following oil change intervals are not reached over a period of 1 year, the oil change should be performed at least once per year, irrespective of the operating hours reached.

ACEA[1]

E3-96/E5-02
E4-99 = 500 operating hours

API[2]

CG-4/CH-4 = 500 operating hours

⚠ Caution

These intervals apply only when using a diesel fuel with maximum 0.5 % sulphur by weight and for ambient temperatures higher than -10 °C.

When using fuels with a sulphur content of more than 0.5% to 1% or under ambient temperatures below -10 °C the oil change intervals specified in the table must be halved. For fuels with a sulphur content of more than 1% you should consult the responsible service agency.

1 European Engine Oil Sequences
2 American Petroleum Institute

Fuels

Quality

You should only use commercially available brand diesel fuel with a sulphur content below 0.5% and ensure strict cleanliness when filling in. A higher sulphur content has a negative effect on the oil change intervals. Use only winter-grade diesel fuel under low ambient temperatures. The fuel level should always be topped up in due time so that the fuel tank is never run dry, as otherwise filter and injection lines need to be bled.

When using fuels with a Cetan number < 49 poor starting and white smoke can be expected, in particular in connection with low ambient temperatures.

The following fuel specifications are permitted: DIN/EN 590; DIN 51 601; Nato Codes: F-54, F-75; BS 2869: A1 and A2; ASTM D 975-78: 1-D and 2-D.

- DIN/EN 590
- BS 2869
- ASTM D 975-78: 1-D and 2-D.
- Nato Codes: F-54, F-34, F44 und XF63

Winter fuel

⚠ Danger

Fire hazard!

Diesel fuels must never be mixed with gasoline.

For winter operation use only winter diesel fuel, to avoid clogging because of paraffin separation. At very low temperatures disturbing paraffin separation can also be expected when using winter diesel fuel.

In most cases a sufficient cold resistance can also be achieved by adding flow enhancing fuel additives. Consult the engine manufacturer.

Operation with rape seed oil methyl ester (RME „Bio Diesel“)

Due to the extreme quality differences of RMEW-fuels available on the market, which are caused by the non-existence of a standardization, BOMAG does generally not approve any RME-fuels. If this is neglected the warranty will become null and void!

However, if you still intend to operate the machine with RME-fuels you should observe the following information:

- Reduced engine power (approx. 7%), higher fuel consumption.
- The quality of RME-fuel should be in compliance with DIN draft 51606.
- Avoid longer periods of standstill (formation of resin, corrosion in injection system)
- RME-fuel can damage the paint finish of the machine.

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- Fuel dilution of engine oil, therefore shortening of oil change intervals to half.
- Rubber parts, such as leak fuel return lines, seats will be damaged in the long run and need to be replaced on a regular basis or should be replaced by parts made of fluorinated rubber. However, fluorinated rubber is not resistant against normal diesel fuel.
- If the fuel filter is clogged the filter change intervals must be shortened accordingly.

Coolant, anti-freeze agent

Use only soft tap water (drinking water) to prepare the coolant mix.

As a protection against frost, corrosion and boiling point anti-freeze agents must be used under any climatic conditions.

The proportion of cooling system protection agent must be between min. 35% and max. 45% to the water.

⚠ Caution

Do not mix different coolants and additives of any other kind.

Environment

Cooling system protection agents must be disposed of environmentally.

Hydraulic oil

The hydraulic system is operated with hydraulic oil HV 46 (ISO) with a kinematic viscosity of
46 mm^2/s at 40°C. For topping up or for oil changes use only high-quality hydraulic oil, type HVLP according to DIN 51524, part 3, or hydraulic oils type HV according to ISO 6743/3. The viscosity index (VI) should be at least 150 (observe information of manufacturer).

Bio-degradable hydraulic oil

On request the hydraulic system can also be filled with ester based biodegradable hydraulic oil (Panolin HLP Synth. 46). The biologically quickly degradable hydraulic oil meets all demands of a mineral oil based hydraulic oil according to DIN 51524.

In hydraulic systems filled with Panolin HLP Synth. 46 always use the same oil to top up. When changing from mineral oil based hydraulic oil to an ester based biologically degradable oil, you should consult the lubrication oil service of the oil manufacturer for details.

Check the filter more frequently after this change.

⚠ Caution

Oil change bio-degradable hydraulic oil:

Perform regular oil analyses for content of water and mineral oil.

Replace the hydraulic oil filter element every 500 operating hours.

Oil for drive axle

For the drive axle use only multi-purpose transmission oil of API-class GL5 with viscosity class SAE 90.

The additives in this oil ensure low wear lubrication under all operating conditions.

Lubrication grease

For lubrication use only EP-high pressure grease, lithium saponified (penetration 2).

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2.3 Table of fuels and lubricants

Assembly	Fuel or lubricant		Quantity approx. Attention Observe the level marks
	Summer	Winter	
Engine	Engine oil ACEA: E3-96/E5-02 or API: CG-4/CH-4 SAE 10W/40 (-20 °C to +40 °C) SAE 15W/40 (-15 °C to +40 °C) Fuel		approx. 12.5 litres without oil filter
	Diesel	Winter diesel fuel	approx. 340 litres
Hydraulic system	Hydraulic oil (ISO), HV46, kinem. viscosity 46 mm^2/s at 40 °C		approx. 60 litres
Vibration bearings	Engine oil SAE 15W/40		approx. 2 x 1,8 litres
Drive axle	Gear oil SAE 90, API GL5		approx. 12.5 litres
Wheel hubs	Gear oil SAE 90, API GL5		approx3.5 l per side
Axle reduction gear	Gear oil SAE 90, API GL5		approx. 1.9 litres
Drum drive gear	Gear oil SAE 90, API GL5		approx. 3.2 litres
Air conditioning system	Refrigerant R134A		1400
Engine cooling system	Cooling system protection agent		approx. 16 litres
Tires	Water		approx. 295 litres
	Calcium chloride ($CaCl_2$) or magnesium chloride ($MgCl_2$)		approx. 100 kg

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2.4 Running-in instructions

The following maintenance work must be performed when running in new machines or overhauled engines:

⚠ Caution

Up to approx. 250 operating hours check the engine oil level twice every day.

Depending on the load the engine is subjected to, the oil consumption will drop to the normal level after approx. 100 to 250 operating hours.

After a running-in time of 30 minutes

- Retighten the V-belt

After 250 operating hours

- Retighten bolted connections on intake and exhaust tubes, oil sump and engine mounts.
- Retighten the bolted connections on the machine.
- Retighten all wheel fastening screws with the specified tightening torque.
- 1. Oil change vibration bearings
- Oil change in drive axle
- Oil change in wheel hubs
- Oil change, axle reduction gear
- 1. Oil change, drum drive reduction gear

After 500 operating hours

- 2. Oil change vibration bearings
- 2. Oil change, drum drive reduction gear

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2.5 Maintenance chart

No.	Maintenance work	Remark	Running-in instructions after 250 operating hours	every 10 operating hours, daily	every 250 operating hours	every 500 operating hours	every 1000 operating hours	every 2000 operating hours	every 3000 operating hours	as required
5.6	Check the engine oil level	Dipstick mark		X						
5.7	Check the water separator			X						
5.8	Check the fuel level			X						
5.9	Check the hydraulic oil level	Inspection glass		X						
5.10	Check the coolant level	Inspection glass		X						
5.11	Check the dust separator			X						
5.12	Check the tire pressure				X					
5.13	Clean the cooling fins on engine and hydraulic oil cooler				X					
5.14	Check the oil level in the drive axle				X					
5.15	Check the oil level in the wheel hubs				X					
5.16	Check the oil level in the axle reduction gear				X					
5.17	Check the oil level in the drum reduction gear				X					
5.18	Check the oil level in the vibration bearings				X					
5.19	Change engine oil and oil filter cartridge[1]	min. 1x per year				X				
5.20	Change the fuel filter cartridge					X				
5.21	Drain the sludge from the fuel tank					X				
5.22	Service the battery	Pole grease				X				
5.23	Change the fuel pre-filter cartridge					X				
5.24	Check, replace the refrigerant compressor V-belt					X				
5.25	Service the air conditioning					X				
5.26	Check, adjust the valve clearance	Intake = 0,3 mm Exhaust = 0,5 mm					X			
5.27	Check, replace the ribbed V-belt						X			

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No.	Maintenance work	Remark	Running-in instructions after 250 operating hours	every 10 operating hours, daily	every 250 operating hours	every 500 operating hours	every 1000 operating hours	every 2000 operating hours	every 3000 operating hours	as required
5.28	Check the engine mounts		X				X			
5.29	Oil change in drive axle	min. 1x per year	X				X			
5.30	Oil change in wheel hubs	min. 1x per year	X				X			
5.31	Oil change, axle reduction gear	min. 1x per year	X				X			
5.32	Oil change in drum drive reduction gear**	min. 1x per year	X				X			
5.33	Oil change vibration bearings[2]	see foot note, min. 1 x per year	X				X			
5.34	Retighten the fastening of the axle on the frame						X			
5.35	Tighten the wheel nuts		X				X			
5.36	Check the ROPS						X			
5.37	Clean the oil bath air filter	min. 1x per year					X			
5.38	Change hydraulic oil and breather filter[3]	at least every 2 years						X		
5.39	Change the hydraulic oil filter[4]	at least every 2 years						X		
5.40	Change the coolant	at least every 2 years						X		
5.41	Check the injection valves								X	
5.42	Service the combustion air filter	min. 1x per year, safety cartridge at least every 2 years								X
5.43	Adjusting the scrapers									X
5.44	Adjust the parking brake									X
5.45	Change the tires									X
5.46	Change the fresh air filter in the cabin									X
5.47	Tightening torques									X
5.48	Engine conservation									X

1 Oil change intervals depend on quality of oil and fuel (sulphur content)
2 Oil change intervals after 50 h, after 500 h, after 1000 h, and then every 1000 h.
3 Also in case of repair in the hydraulic system.
4 Also in case of repair in the hydraulic system.

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3 Technical data

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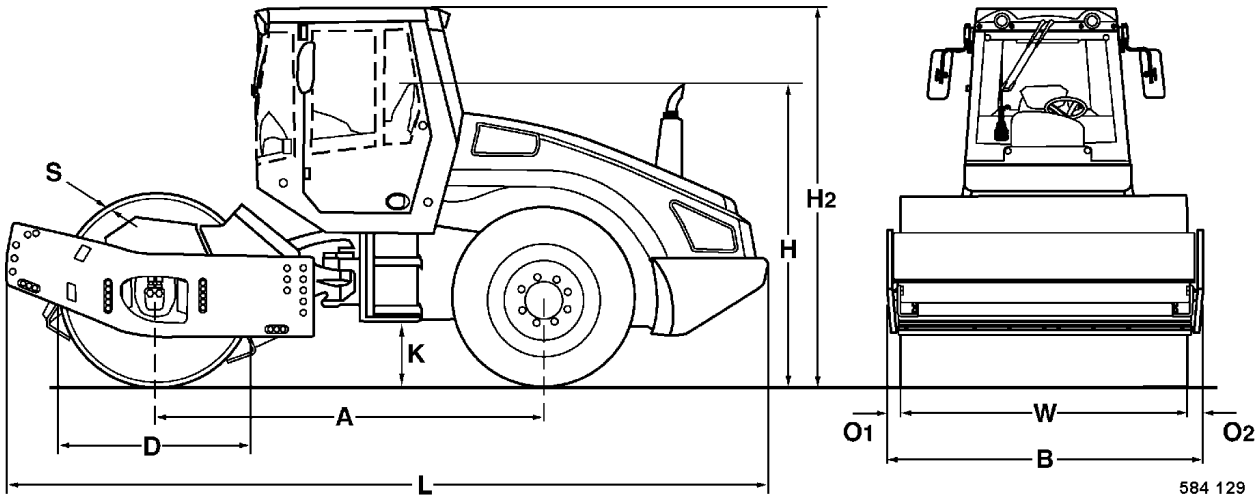


Fig. 11

Dimensions in mm	A	B	D	H	H2	K	L	O1	O2	S	W
BW 219 D-4	3255	2300	1600	2288	3022	450	6338	85	85	40	2130
BW 219 PD-4	3255	2300	1500	2288	3022	450	6338	85	85	35	2130

1		**BW 219 D-4**	**BW 219 PD-4**
Weights			
Operating weight (CECE) with ROPS and cabin	kg	19050	19390
Axle load, drum (CECE)	kg	12800	13140
Axle load, wheels (CECE)	kg	6250	6250
Static linear load	kg/cm	60,1	-
Travel characteristics			
Travel speed 1	km/h	0 ... 3	0 ... 3
Travel speed 2	km/h	0 ... 4	0 ... 4
Travel speed 3	km/h	0 ... 6,5	0 ... 6,5
Travel speed 4	km/h	0 ... 10,5	0 ... 10,5
Max. gradability (depending on soil)	%	50	50
Engine			
Engine manufacturer		Deutz	Deutz
Type		BF6M 2012 C	BF6M 2012 C
Cooling		Water	Water
Number of cylinders		6	6
Rated power ISO 3046	kW	147	147
Rated speed	rpm	2300	2300
Electrical equipment	V	12	12
Drive system		hydrostatic	hydrostatic
Driven axles		2	2
Brakes			
Service brake		hydrostatic	hydrostatic
Parking brake		hydr.-mech.	hydr.-mech.

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1		BW 219 D-4	BW 219 PD-4
Steering			
Type of steering		articulated	articulated
Steering operation		hydrostatic	hydrostatic
Vibration			
Vibrating drum			
Drive system		hydrostatic	hydrostatic
Frequency 1	Hz	31	31
Frequency 2	Hz	26	26
Amplitude 1	mm	1,1	1,1
Amplitude 2	mm	2,02	2,02
Tires			
Tire size		23.1-26/12 TL R3	23.1-26/12 TL R1
Air pressure	bar	1,6	1,5
Filling capacities			
Engine	Litres	12,5	12,5
Fuel	Litres	340	340
Hydraulic oil	Litres	60	60

1 The right for technical modifications remains reserved

Additional engine data		
Combustion principle		4-stroke diesel
Low idle speed	rpm	850 ± 150
High idle speed	rpm	2475 ± 125
Specific fuel consumption	g/kWh	222
Injection valve opening pressure	bar	250
Valve clearance intake	mm	0,3
Valve clearance exhaust	mm	0,5
Starter power	kW	3,1
Travel pump		
Manufacturer		Sauer
Type		90R075
System		Axial piston/swash plate
Max. displacement	cm^3/rev.	75
Max. flow capacity	l/min	163,65
High pressure limitation	bar	400 + 26
Charge pressure, high idle	bar	26
Drum reduction gear		
Type		CR31
Transmission ratio		45,6
Drum drive motor		
Manufacturer		Sauer
Type		51C 110
System		Axial piston – bent axle
Displacement (stage 1)	cm^3/rev.	110
Displacement (stage 2)	cm^3/rev.	55
Perm. leak oil rate	l/min	2
Flushing rate	l/min	10
Flushing limitation	bar	16

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Axle drive motor

Manufacturer		Sauer
Type		51D 110
System		Axial piston – bent axle
Max. displacement (stage 1)	cm^3/rev.	110
Min. displacement (stage 2)	cm^3/rev.	69
Perm. leak oil rate	l/min	2
Flushing rate	l/min	16
Flushing limitation	bar	16

Vibration pump

Manufacturer		Sauer
Type		90R 055
System		Axial piston/swash plate
Max. displacement	cm^3/rev.	55
Start up pressure	bar	345+ 26
Operating pressure (soil dependent)	bar	approx. 100

Vibration motor

Manufacturer		Sauer
Type		90M 055
System		Axial piston/swash plate
Displacement	cm^3/rev.	55
Flushing rate	l/min	6
Flushing pressure limitation	bar	13

Check steering/

Type		HY/ZFFS11/16
System		Gear pump
Displacement	cm^3/rev.	16
Max. steering pressure	bar	175 + 26

Steering valve

Manufacturer		Danfoss
Type		OSPC 500 ON
System		Rotary spool

Rear axle

Manufacturer		Dana
Type		CHC 193/55
Differential		No-Spin
Degree of locking	%	100
Reduction ratio		93,74

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The following noise and vibration values according to the EC-directive for machines, edition (91/368/ EEC) were measured at nominal engine speed and with the vibration switched on. The machine was standing on an elastic base.

During operation these values may vary because of the existing operating conditions.

Noise value

The sound level according to enclosure 1, paragraph 1.7.4. f of the EC-machine regulation is

sound pressure level at the work place of the operator (with cabin):

L_{pA} = 72,1 dB(A)

sound capacity level:

L_{WA} = 105 dB(A)

These sound values were determined according to ISO 3744 for the sound capacity level (L_{wA}) and ISO 6081 for sound pressure level (L_{pA}) at the place of the operator.

Vibration value

The vibration values according to enclosure 1, paragraph 3. 6. 3. a of the EC-machine regulation are:

Vibration of the entire boy (driver's seat)

The weighted effective acceleration value determined according to ISO 2631 part 1, is <= 0,5 m/sec^2.

Hand-arm vibration values

The weighted effective acceleration value determined according to ISO 8662 part 1, is <= 2,5 m/sec^2.

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4 Connection overview

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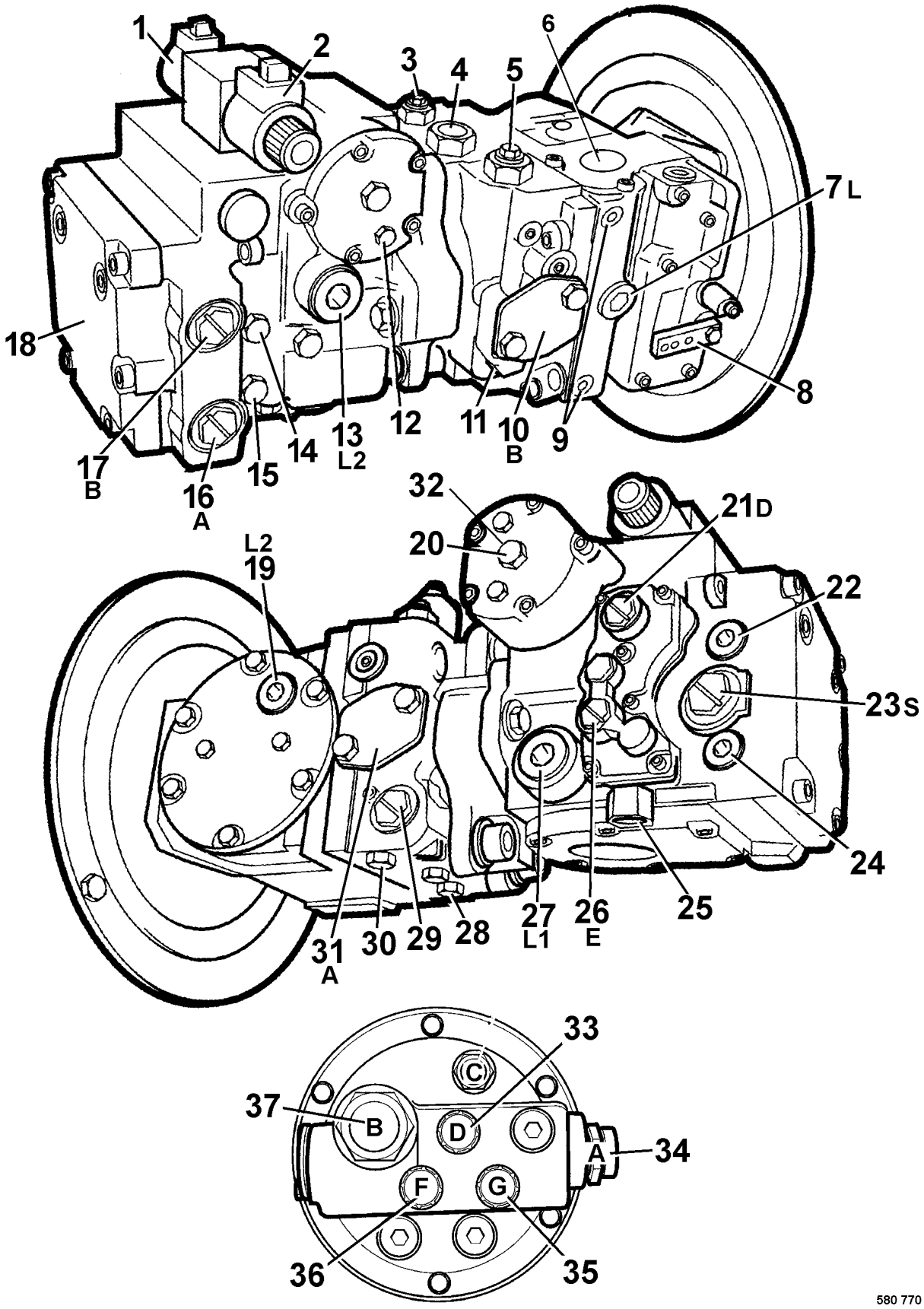


Fig. 1 Travel pump

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1 Control solenoid, high frequency
2 Control solenoid, low frequency
3 Multi-function valve 400 bar (boost check and pressure relief valve), travel system
4 Connection, charge pressure to brake solenoid valve, travel speed range selection and charge oil supply for vibration pump
5 Multi-function valve 400 bar (boost check and pressure relief valve), travel system
6 Setscrew, mechanical neutral position
7 Connection L, leak oil connection to vibration pump
8 Lever, travel control
9 Pilot pressure test port
10 High pressure port B, high pressure reverse
11 Charge pressure relief valve, 26 bar
12 Adjustment screw, low frequency
13 Connection L2, leak oil to tank
14 Pressure test port MB, high frequency
15 High pressure test port MA, low frequency
16 High pressure port A, low frequency
17 High pressure port B, high frequency
18 Charge pump, internal
19 Connection L2, to drum drive motor (flushing)
20 Adjustment screw, high frequency
21 Connection D, charge pressure to filter
22 Multi function valve 345 bar (boost check and pressure relief valve), vibration drive high frequency
23 Connection S, suction line charge pump from hydraulic oil tank
24 Multi function valve 345 bar (boost check and pressure relief valve), vibration drive low frequency
25 Charge pressure relief valve, vibration pump (blocked)
26 Connection E, charge oil from travel pump
27 Connection L1, leak oil connection to travel pump
28 Pressure test port MB, high pressure reverse
29 Charge oil from filter
30 Pressure test port MA, high pressure forward
31 High pressure port A, high pressure forward
32 Setscrew, mechanical neutral position, vibration
33 Leak oil connection D, leak oil from axle drive motor
34 Leak oil connection A, leak oil from travel pump
35 Leak oil connection G, leak oil from drum drive motor
36 Leak oil connection F, leak oil from vibration motor
37 Radiator inlet

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5 Tests and adjustments

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5.1 Special tools, tests and adjustments

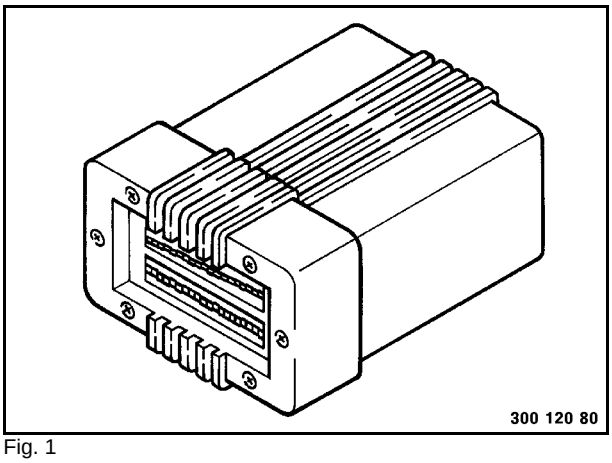


Fig. 1

1. Vibration reed frequency meter

   1000 - 4000 rpm

   17 - 67 Hz

   BOMAG part-no.: 300 120 80


Fig. 2

2. Sirometer (frequency meter)

   800 - 50.000 rpm

   14 - 750 Hz

   BOMAG part-no.: 059 710 02



Fig. 3

3. Anti-freeze tester, quick and accurate measuring, sturdy plastic housing, automatic temperature correction, no after-dripping, instructions for use on unit, reading down to -40 °C. Material: Plastic, Temperature range: down to -40 °C

   BOMAG part-no.: 050 100 75

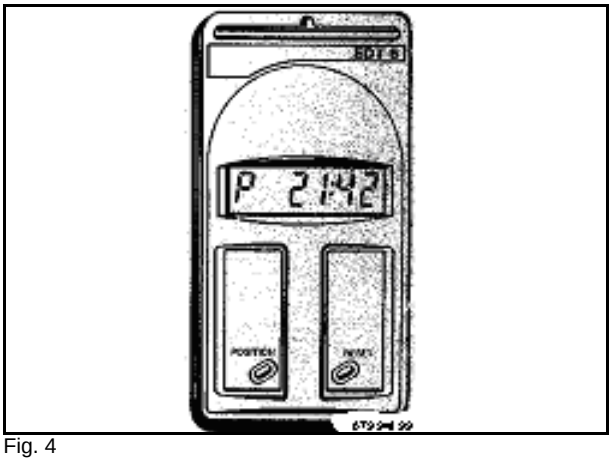


Fig. 4

4. Digital rpm-meter for petrol engines

   BOMAG part-no.: 079 948 99

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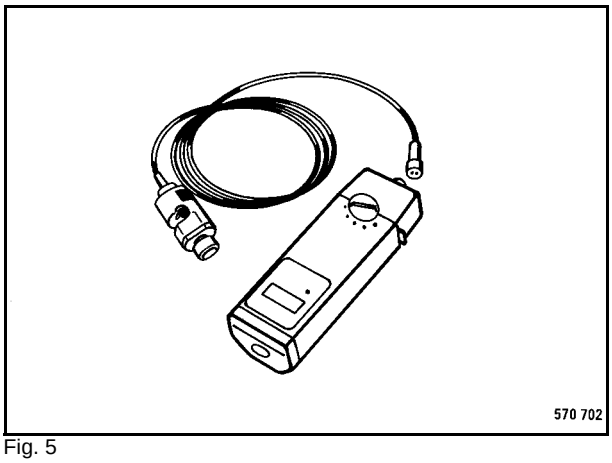


Fig. 5

5. Digital rpm-meter for petrol engines

   BOMAG part-no.: 059 711 12



Fig. 6

6. Digital rpm-meter, optical/mechanical, universal use

   BOMAG part-no.: 079 948 98



Fig. 7

7. Infrared manual thermometer, -18 to 275°C

   BOMAG part-no.: 057 668 06

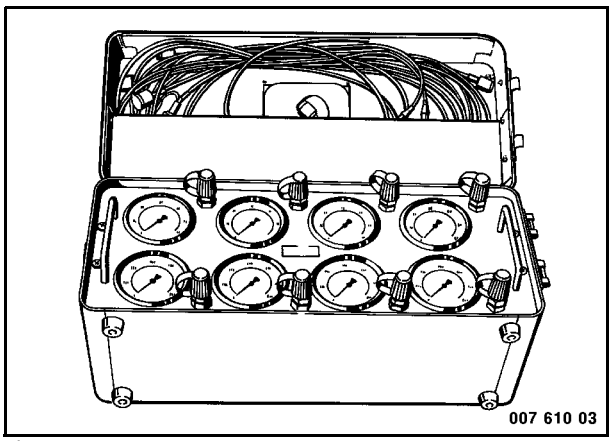


Fig. 8

8. Hydraulic test case, large

   BOMAG part-no.: 007 610 03

i Note

4 X 600 bar pressure gauges

4 X 60 bar pressure gauges

8 pressure test hoses

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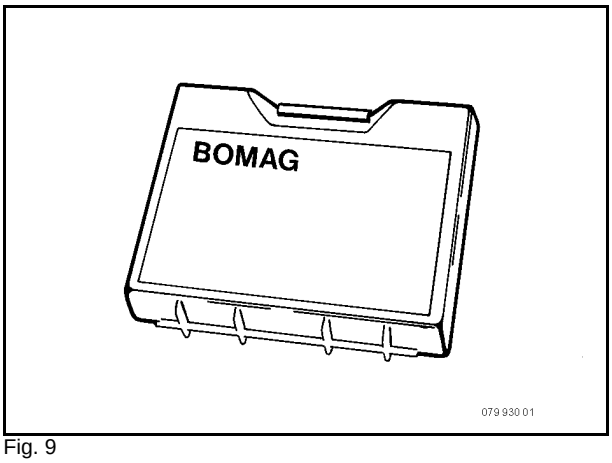


Fig. 9

9. Hydraulic test case, small

BOMAG part-no.: 079 930 01

i Note

1X 25 bar pressure gauge

1X 150 bar pressure gauge

2X 400 bar pressure gauges

4 pressure test hoses

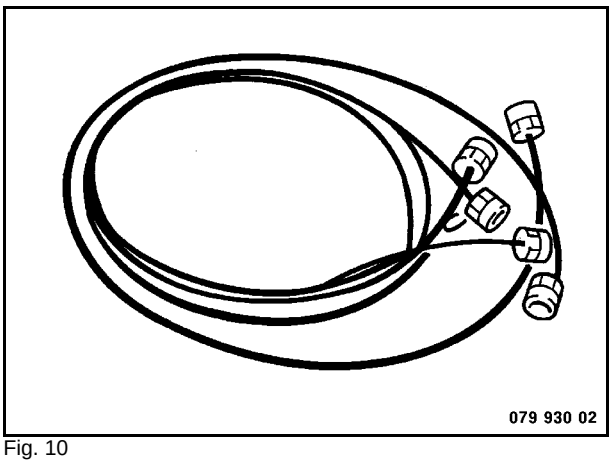


Fig. 10

10. Pressure test hoses

1000 mm BOMAG part-no.: 079 930 02

2500 mm BOMAG part-no.: 079 930 03

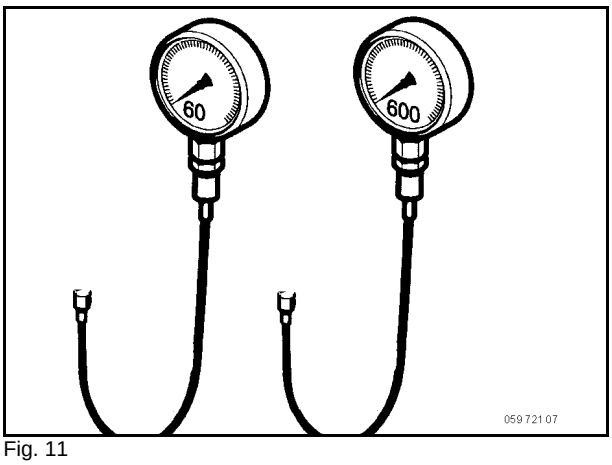


Fig. 11

11. Pressure gauge

60 bar BOMAG part-no.: 059 721 07

600 bar BOMAG part-no.: 059 721 04

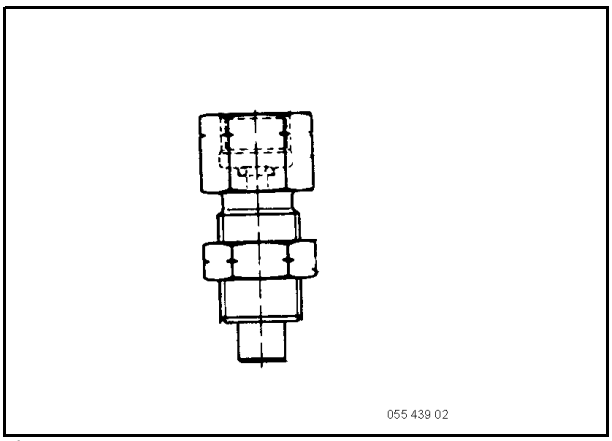


Fig. 12

12. Adapter for pressure test hose

BOMAG part-no.: 055 439 02

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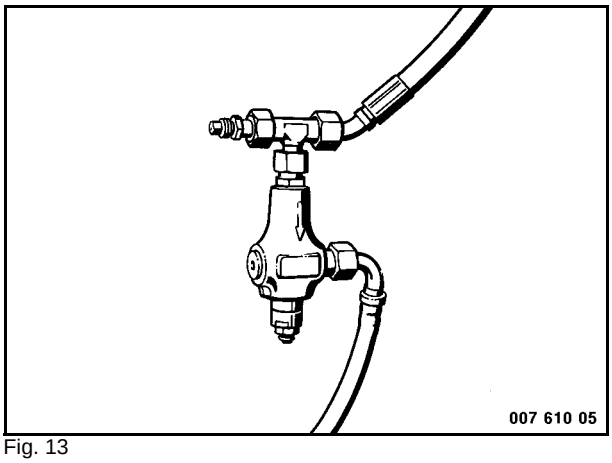


Fig. 13

13. Gear pump testing device

    BOMAG part-no.: 007 610 05

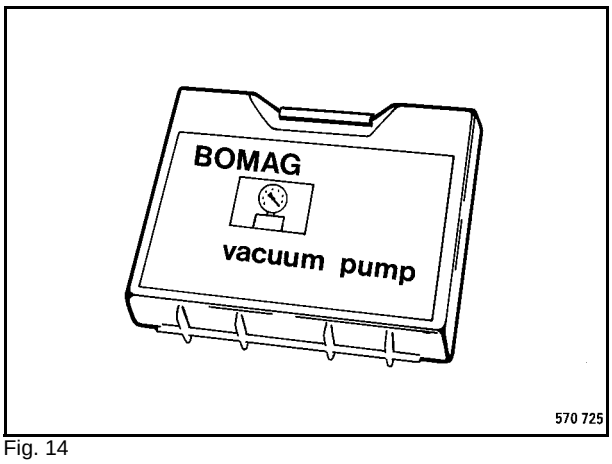


Fig. 14

14. Vacuum pump for hydraulic oil tank

    BOMAG part-no.: 007 610 04 (12 Volt)

    BOMAG part-no.: 007 610 24 (24 Volt)

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5.2 Checking the rotation speeds

Special tools

Vibration reed frequency meter, RPM-meter for diesel engines.

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

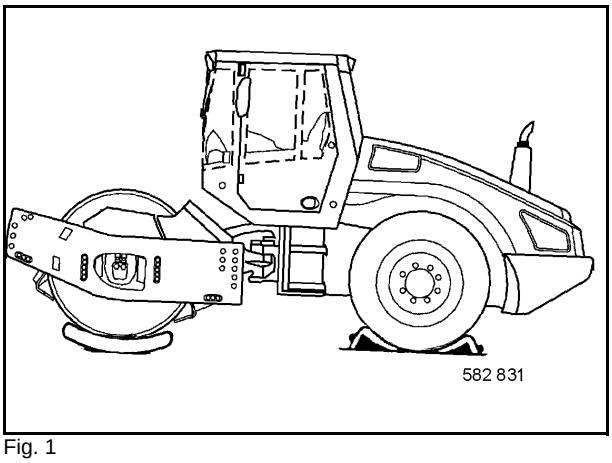


Fig. 1

1. Drive the machine with both drums on an elastic base (rubber buffers) (Fig. 1).
2. Block the wheels with suitable chocks.

Check the engine speed

i Note

If necessary, the engine speed may also be checked with the vibration Reed frequency meter.

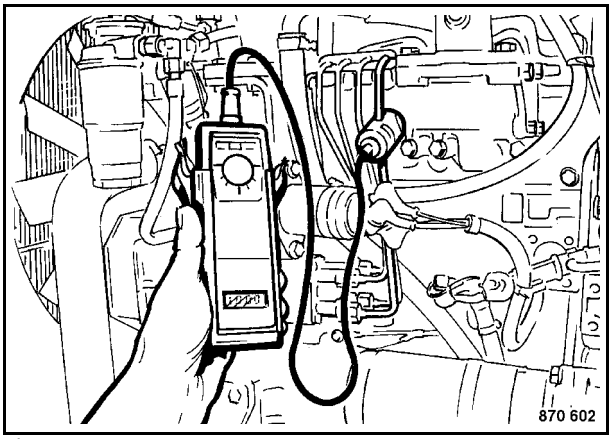


Fig. 2

1. Connect the RPM-meter to the injection line (Fig. 2).
2. Run the engine with maximum speed.
3. Apply the brake.
4. Measure the rotation speeds.

   Nominal value idle speed:

   Low idle speed, see technical data.

   High idle speed, see technical data.
5. Switch the vibration on .

   Nominal value nominal speed:

   See technical data.

   Evaluation of test

   If the nominal value is not reached, perform trouble shooting for the engine.

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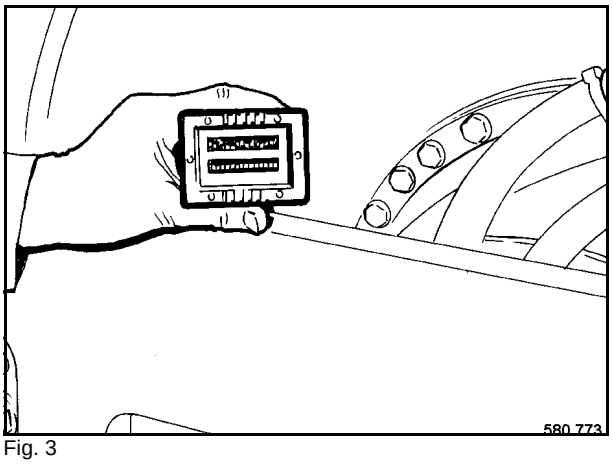


Fig. 3

Checking the exciter shaft speed

1. Switch the vibration on at max. engine speed.
2. Apply the brake.
3. Measure the speed of the vibrator shaft, rest the tester on your thumb (Fig. 3).

Nominal value:

See technical data.

Evaluation of test

If the nominal value is not reached, perform trouble shooting in the vibration circuit.

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5.3 Checking / adjusting the neutral positions of the travel pump

Special tools

Hydraulic test case

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

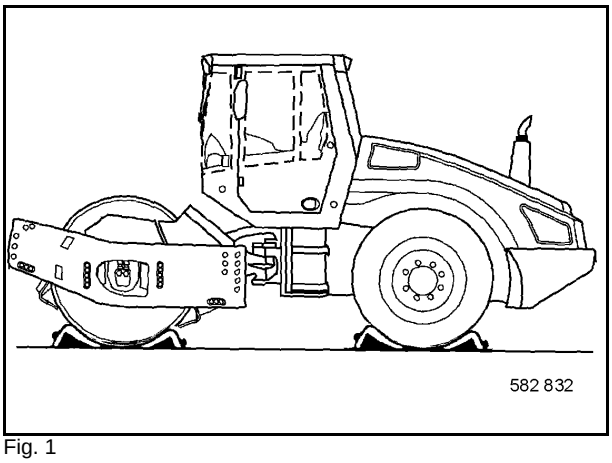


Fig. 1

1. Block drums and wheels with suitable chocks (Fig. 1).

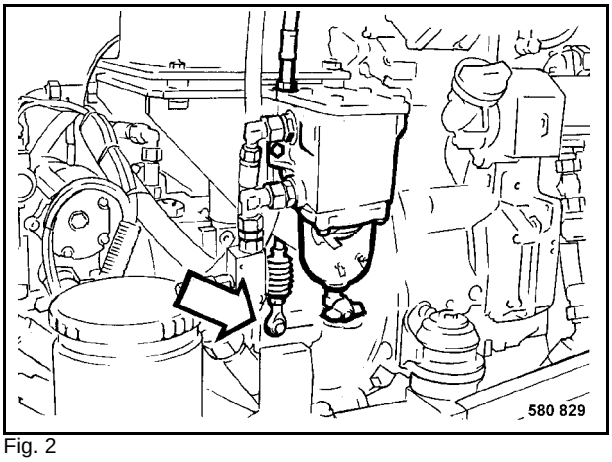


Fig. 2

2. Unhook the travel cable (Fig. 2) from the pump.

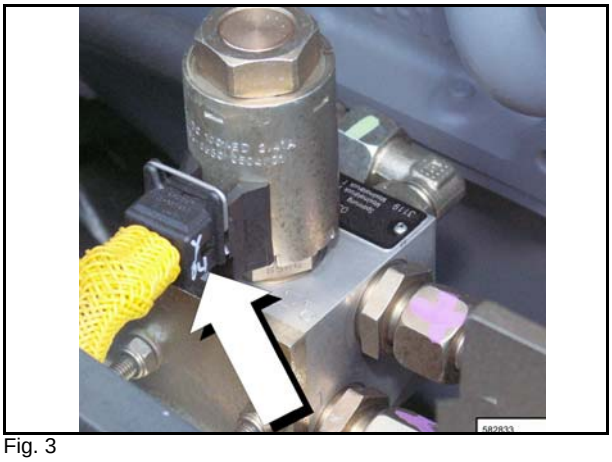


Fig. 3

3. Pull the plug (Fig. 3) off the brake solenoid valve to close the brake.

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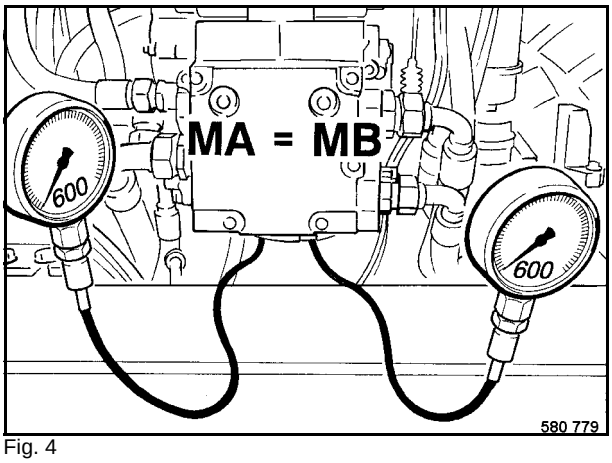


Fig. 4

4. Connect 600 bar pressure gauges to high pressure test ports MA and MB (Fig. 4).

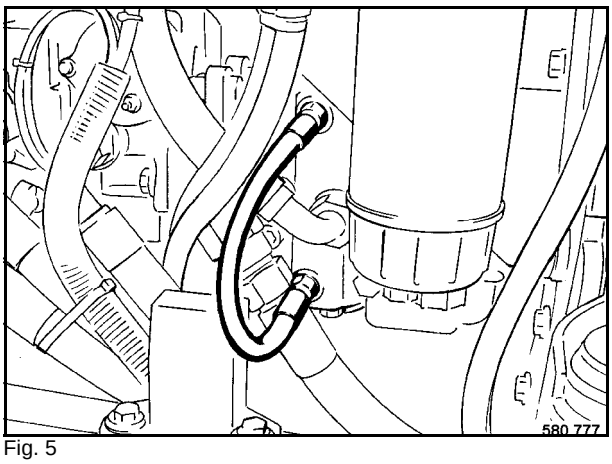


Fig. 5

5. Connect the control chamber ports X3 and X4 (Fig. 5) with a hose

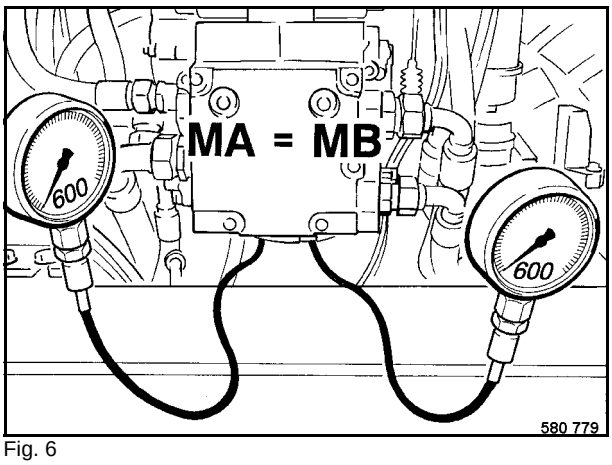


Fig. 6

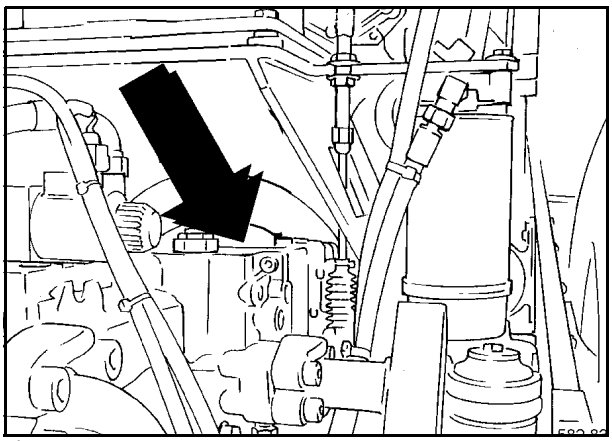
6. Start the engine and run it with maximum speed.

Nominal value

Both pressure gauges (Fig. 6) must show equal pressure (charge pressure).

i Note

If necessary repeat the pressure test with 60 bar pressure gauges, for more accurate readings.


Fig. 7

Evaluation of test

If pressure builds up on one side, adjust the mechanical neutral position (Fig. 7), until the pressures on both pressure gauges are identical.

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5.4 Pressure tests in the travel circuit

Special tools

Hydraulic test case

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

1. Block drums and wheels with suitable chocks (Fig. 1).

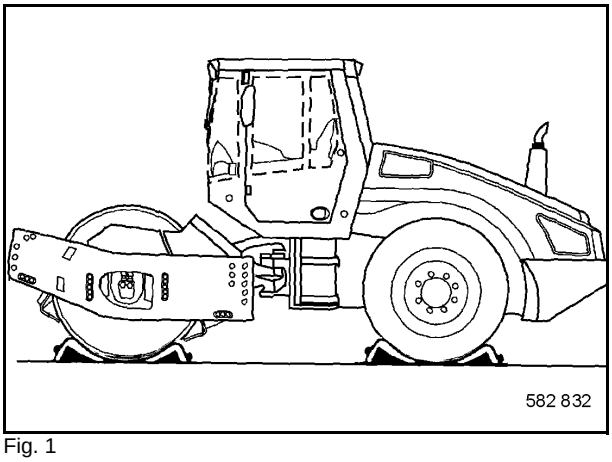


Fig. 1

2. Pull the plug (Fig. 3) off the brake solenoid valve to close the brake.

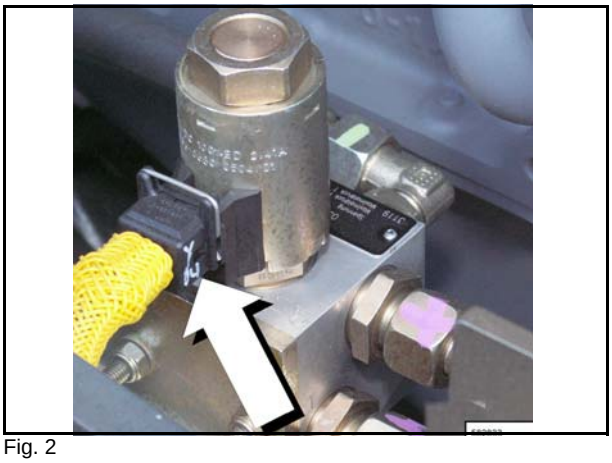


Fig. 2

3. Connect 600 bar pressure gauges to the high pressure test ports for "forward travel" and "reverse travel" and a 60 bar pressure gauge to the charge pressure test port (Fig. 2).
4. Start the engine and run it with maximum speed.
5. Read charge and high pressure gauges.

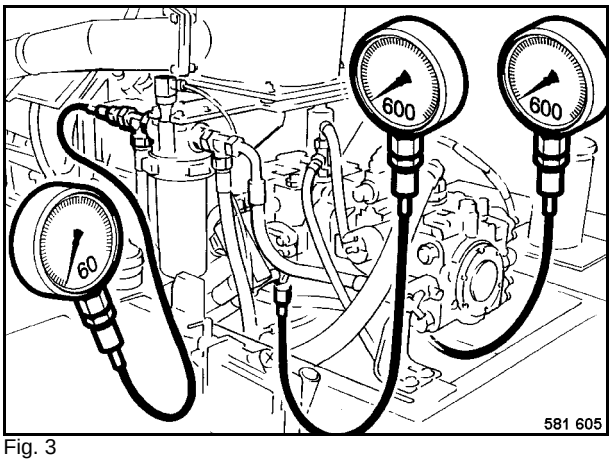


Fig. 3

Nominal value

see technical data of travel pump:

Charge pressure gauge = charge pressure at high idle

High pressure gauge = charge pressure at high idle

Evaluation of test

If the nominal value is not reached, check the steering/charge pump.

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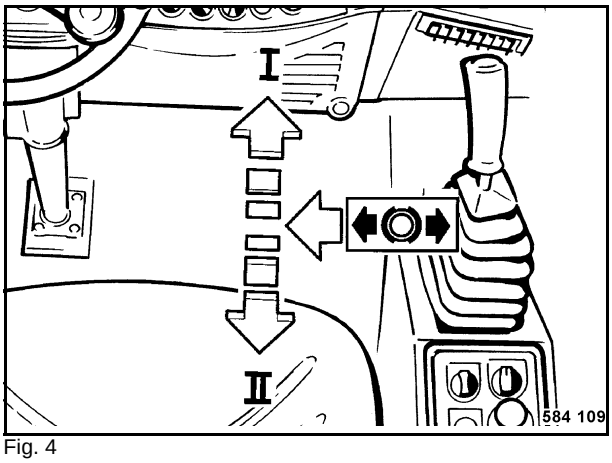


Fig. 4

Measurement with quickly operated travel lever

6. Move the travel lever (Fig. 4) quickly forward, read the pressure gauge.

Nominal value

see technical data of travel pump:

Charge pressure gauge = charge pressure at high idle

High pressure gauge = pressure override

Evaluation of test

If the specified high pressure is not reached, check the travel pump.

If the charge pressure drops considerably during the high pressure test, check the components individually.

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5.5 Checking / adjusting the vibrator shaft speeds

Special tools

Vibration reed frequency meter

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

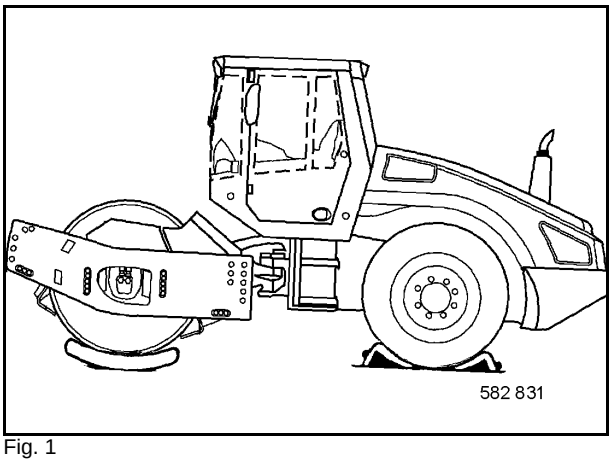


Fig. 1

1. Drive the machine on an elastic base (rubber buffers) (Fig. 1).
2. Apply the parking brake and block the wheels additionally with suitable chocks.
3. Start the engine and run it with maximum speed.
4. Switch on vibration high frequency / low amplitude or low frequency / high amplitude.

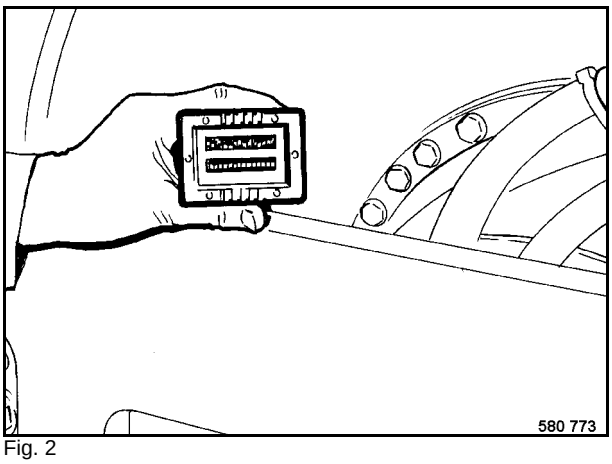


Fig. 2

5. Measure the speed (Fig. 2), rest the tester on your thumb.

Nominal value

high amplitude/
low frequency = see technical data

low amplitude/
high frequency = see technical data

Evaluation of test

In case of deviations exceeding 10% determine the cause, perform trouble shooting for engine / vibration circuit and check vibration motor.

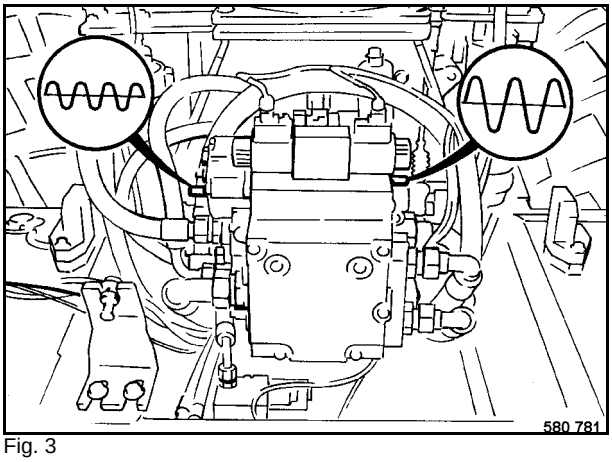


Fig. 3

6. Adjust the speed on the corresponding adjustment screw (Fig. 2).

i Note

Turning the adjustment screw in reduces the speed, turning the screw out increases the speed.

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5.6 Pressure measurements in the vibration circuit

Special tools

Hydraulic test case

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

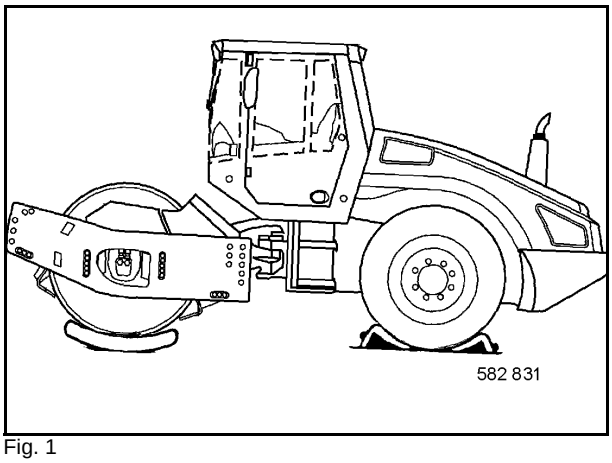


Fig. 1

1. Drive the machine with both drums on an elastic base (rubber buffers) (Fig. 1).
2. Block the wheels with suitable chocks.
3. Apply the brake.

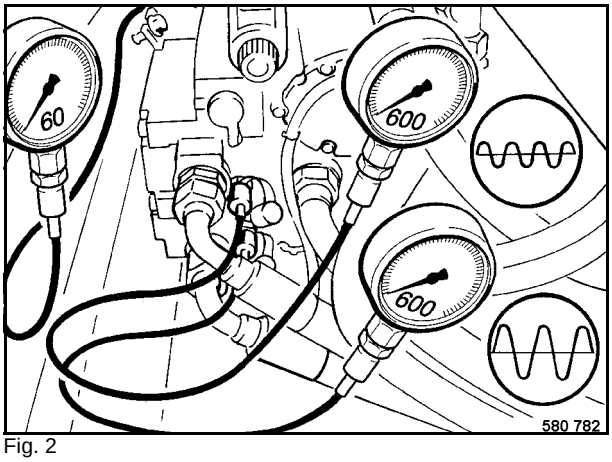


Fig. 2

4. Connect a 60 bar pressure gauge (Fig. 2) to the charge pressure test port.
5. Connect a 600 bar pressure gauge each to the high pressure test ports for "high amplitude" and "low amplitude".
6. Start the engine and run it with maximum speed.
7. Switch on vibration with high or low frequency.

Nominal value

Charge pressure = charge pressure at high idle (see technical data of travel pump).

Start-up pressure = vibration pump start-up pressure (see technical data of vibration pump).

Operating pressure = vibration pump operating pressure (see technical data of vibration pump).

Evaluation of test

If the charge pressure drops, check the components individually.

If the starting pressure is not reached, check the vibration pump.

If the starting pressure is only reached for one frequency, check the high pressure relief valves.

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5.7 Check the leakage rate of the vibration motor

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (50 °C).

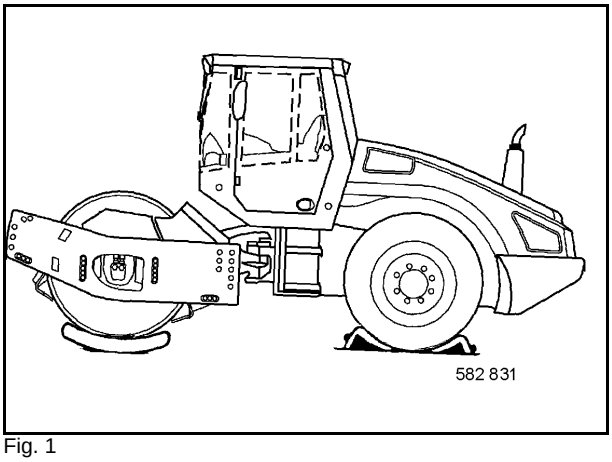


Fig. 1

1. Drive the drum of the machine on an elastic base (rubber buffers) (Fig. 1) and block the wheels additionally with suitable chocks.
2. Apply the brake.

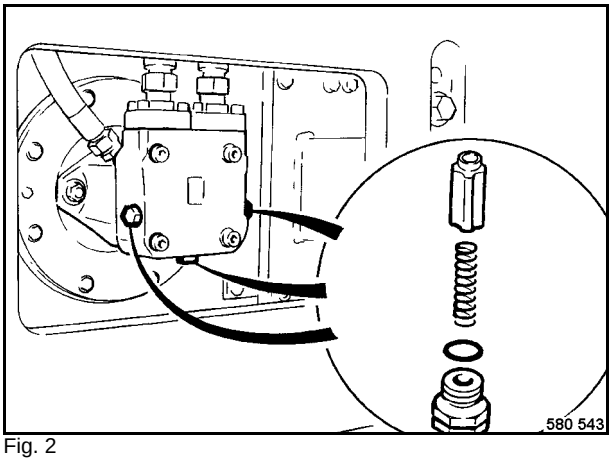


Fig. 2

3. Block the flushing valve (Fig. 2) with washers.

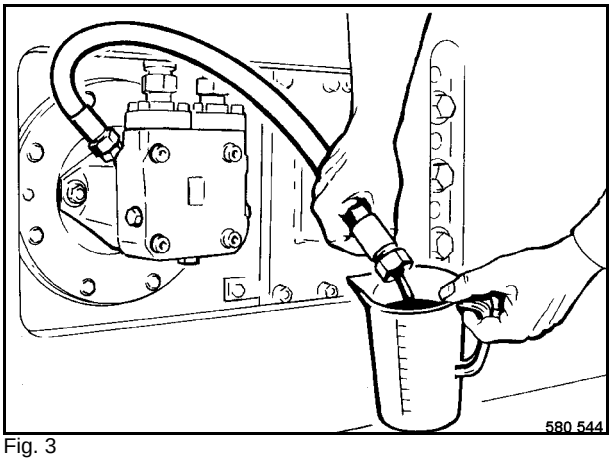


Fig. 3

4. Disconnect the leak oil hose (Fig. 3), connect a measuring hose and hold it into a measuring beaker.
5. Start the engine and run it with maximum speed.
6. Switch the vibration on and measure the running out leak oil during one timed minute.

Nominal value

max. 1.5 litre/min

Evaluation of test

If the permissible leak oil rate is exceeded, replace the vibration motor.

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5.8 Pressure test in steering circuit

Special tools

Hydraulic test case, gear pump testing equipment

⚠ Caution

Perform measurements at operating temperature of the hydraulic oil (approx. 50 °C).

Measurement 1

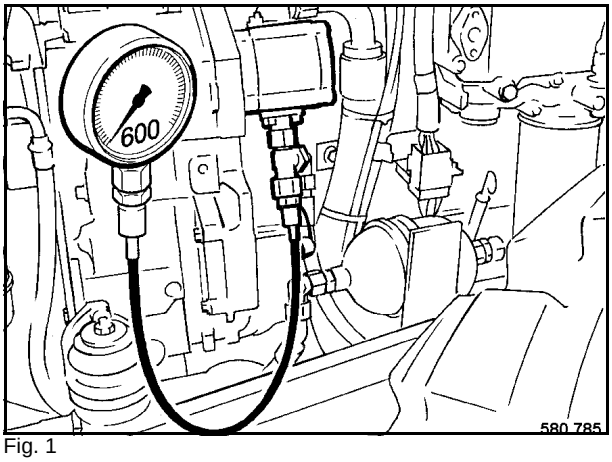


Fig. 1

1. Connect a 600 bar pressure gauge to the steering pressure test port (Fig. 1).
2. Start the engine and run it at idle speed.

⚠ Danger

Danger of crushing, do not access the articulation area of the machine!

3. Turn the steering against an end stop.
4. Read the pressure gauge.

Nominal value

see technical data, max. steering pressure of steering/charge pump.

Evaluation of test 1

If the nominal value is reached, check the steering cylinder.

Measurement 2

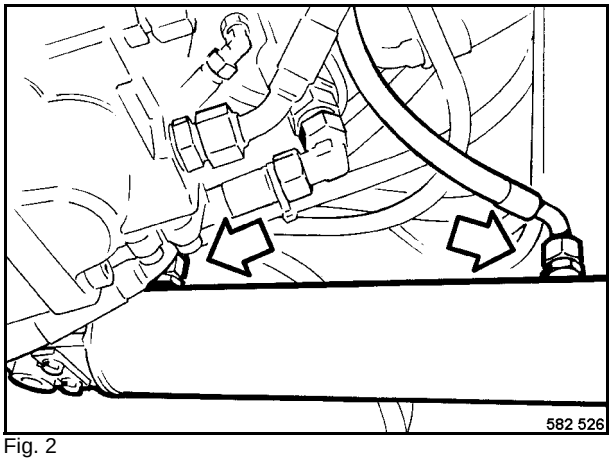


Fig. 2

5. Disconnect the hydraulic hoses from ports L and R (Fig. 2) (machines with one steering cylinder) on the steering cylinder and close them with plugs.

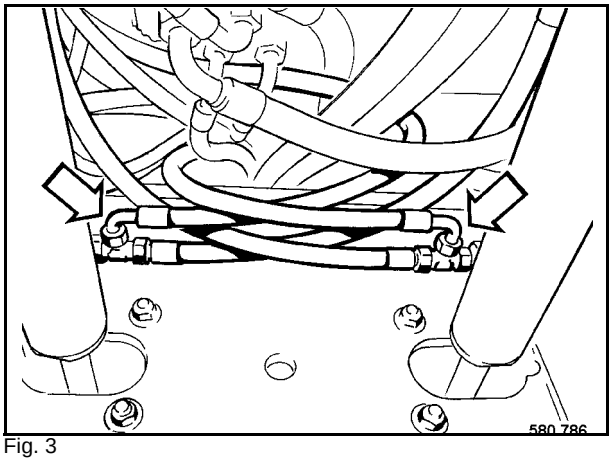


Fig. 3

6. Disconnect the hydraulic hoses from ports L and R (Fig. 3) (machines with two steering cylinder) on the steering cylinders and close them with plugs.
7. Start the engine and run it at idle speed.
8. Turn the steering wheel.
9. Read the pressure gauge.

Nominal value

see technical data for steering/charge pump.

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Evaluation of test 2

If the nominal value is reached, replace the steering cylinder.

If the nominal value is not reached, check the steering/charge pump.

10. Reconnect the hydraulic hoses to the steering cylinders.

Measurement 3

11. Actuate the emergency stop switch.

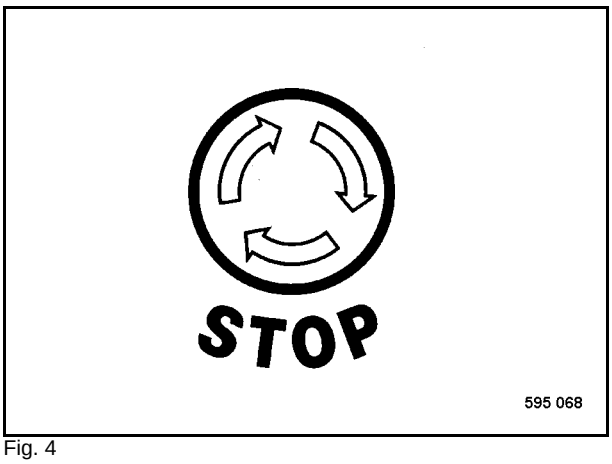


Fig. 4

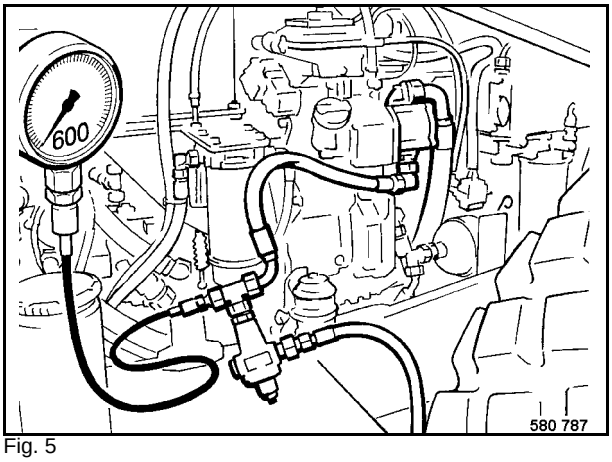


Fig. 5

12. Close the pump outlet port (Fig. 5) with the gear pump test equipment.
13. Crank the engine with the starter

Nominal value

see technical data for steering/charge pump.

Evaluation of test 3

If the nominal value is reached, replace the steering valve.

If the nominal value is not reached, replace the steering/charge pump.

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6 Flushing and bleeding

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6.1 Special tools for flushing

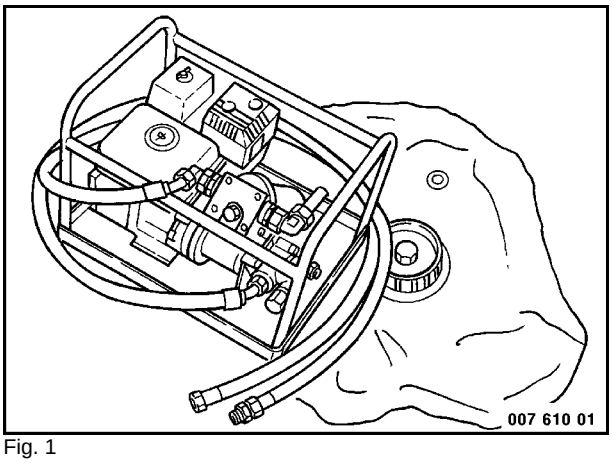


Fig. 1

1. Filling and filtering unit with oil bag

   BOMAG part-no.: 007 610 01

2. Filter element

   BOMAG part-no.: 079 930 35

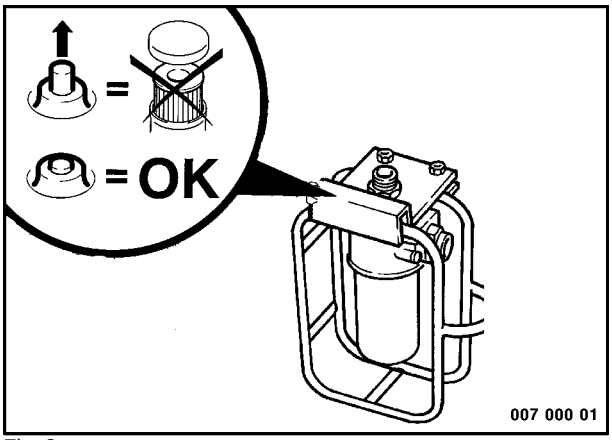


Fig. 2

3. Flushing filter (S connection)

   BOMAG part-no.: 007 000 01

4. Filter element 1µ

   BOMAG part-no.: 079 930 52

5. Flushing hose 20S - 25S (2 pieces)

   BOMAG part-no.: 055 509 19

6. Screw socket R1“ - 25S (2 pieces)

   BOMAG part-no.: 055 400 52

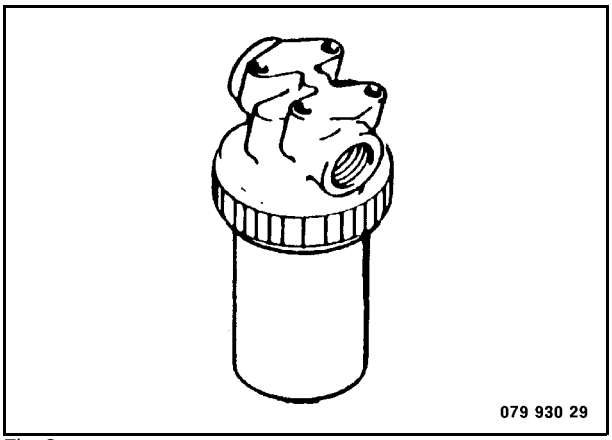


Fig. 3

7. Flushing filter (L connection)

   BOMAG part-no.: 079 390 29

8. Filter element

   BOMAG part-no.: 079 390 14

9. Flushing hose 15L (2 pieces)

   BOMAG part-no.: 055 510 09

10. Screw socket R3/4“ -- 15L (2 pieces)

    BOMAG part-no.: 055 400 89

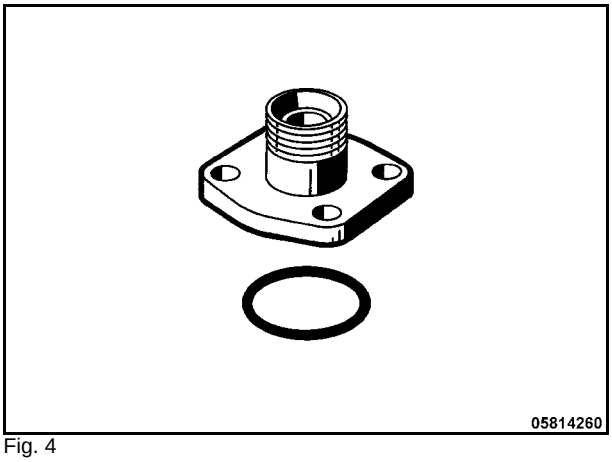


Fig. 4

11. SAE-flange 1“ - 20S

    BOMAG part-no.: 058 142 60

12. O-ring

    BOMAG part-no. 062 203 30

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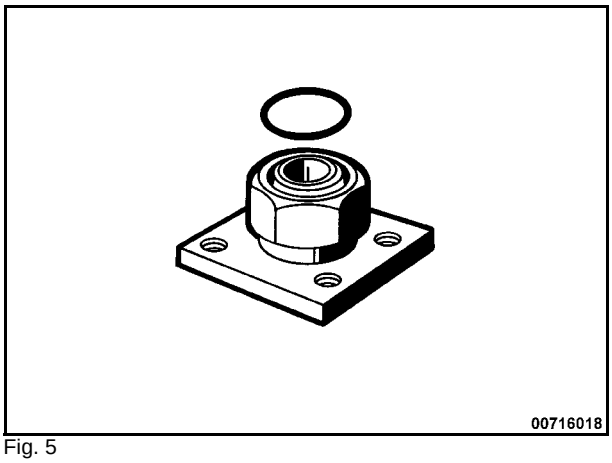


Fig. 5

13. Flanged plate 1“ - 25S

    BOMAG part-no.: 007 160 18

14. O-ring

    BOMAG part-no. 062 202 22

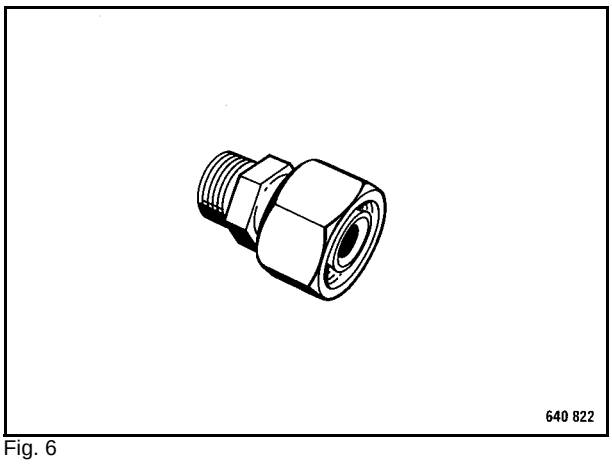


Fig. 6

15. Reducing fitting 18L - 15L

    BOMAG part-no.: 055 422 92

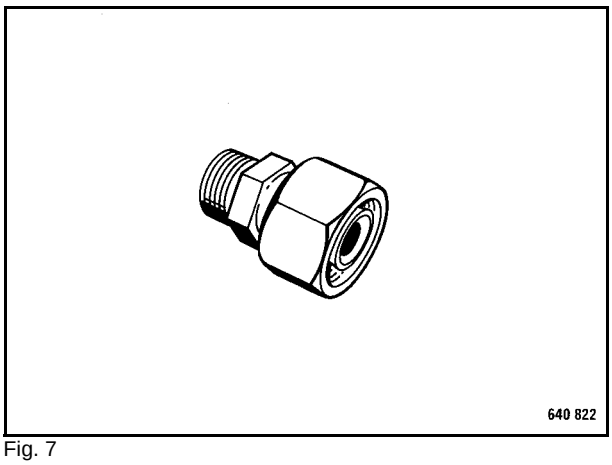


Fig. 7

16. Reducing fitting 25S - 20S

    BOMAG part-no.: 055 422 98

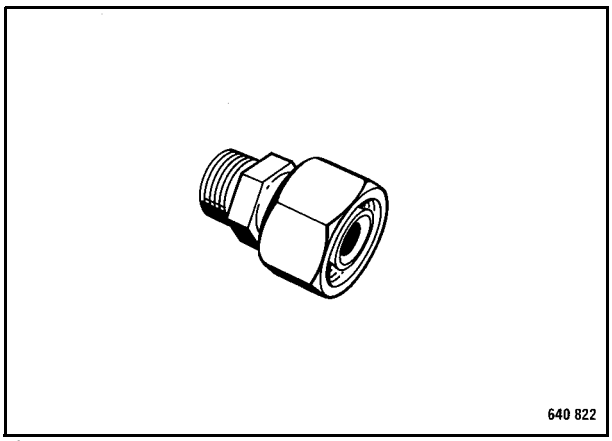


Fig. 8

17. Reducing fitting 20S - 16S

    BOMAG part-no.: 055 423 26

https://truckmanualshub.com/

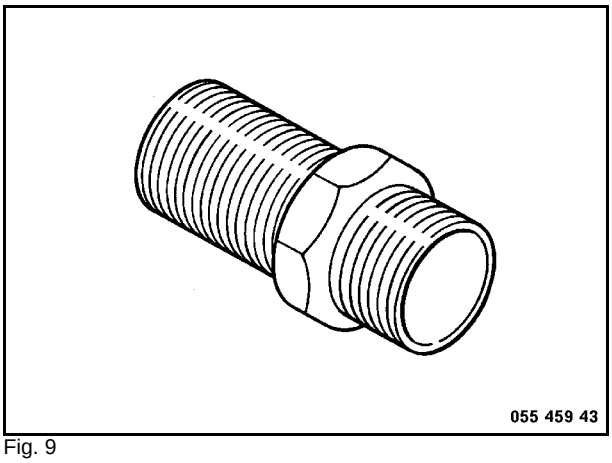


Fig. 9

18. Connecting socket 15L

BOMAG part-no.: 055 426 55

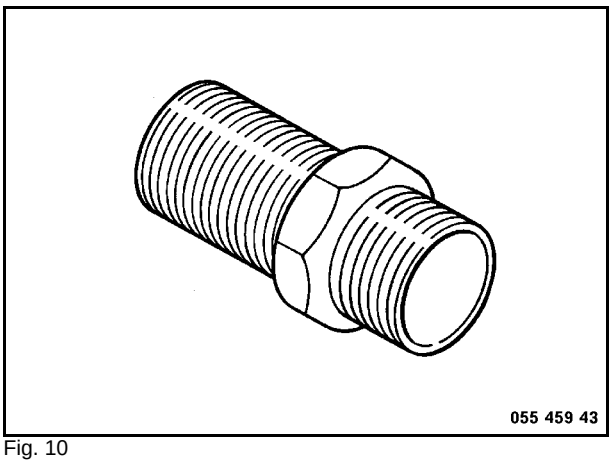


Fig. 10

19. Connecting socket 18L

BOMAG part-no.: 055 426 06

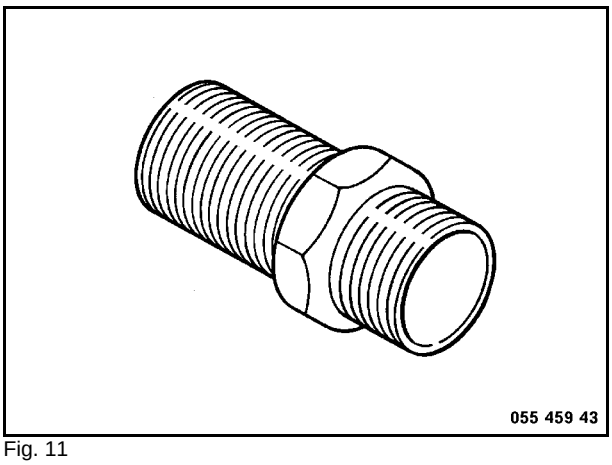


Fig. 11

20. Connecting socket 16S

BOMAG part-no.: 055 459 43

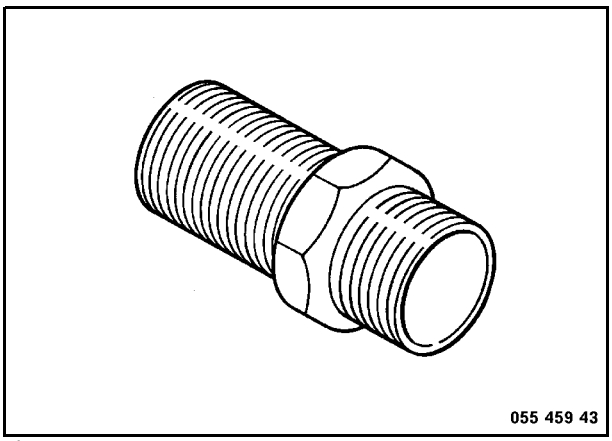


Fig. 12

21. Connecting fitting 20S

BOMAG part-no.: 055 459 44

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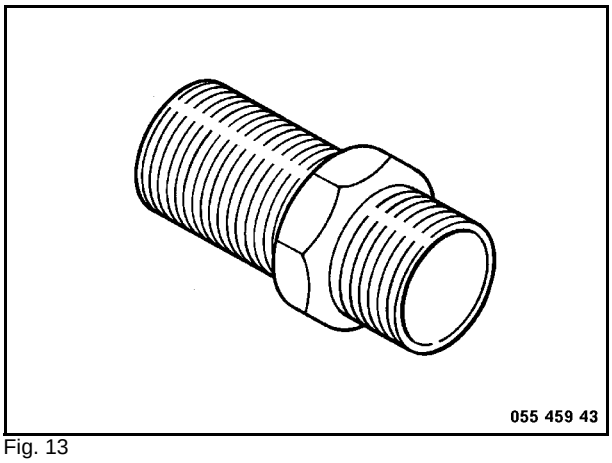


Fig. 13

22. Connecting fitting 25S

BOMAG part-no.: 055 459 45

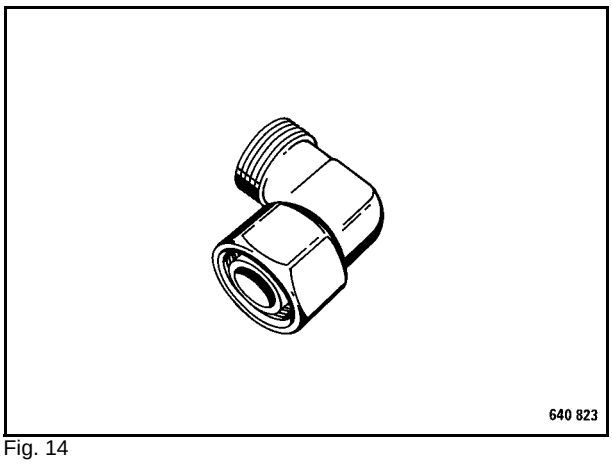


Fig. 14

23. Angular fitting 18L

BOMAG part-no.: 055 421 26

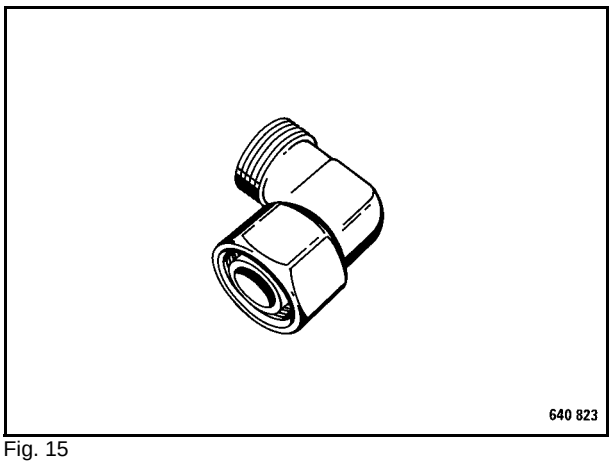


Fig. 15

24. Elbow fitting 16L

BOMAG part-no.: 055 421 36

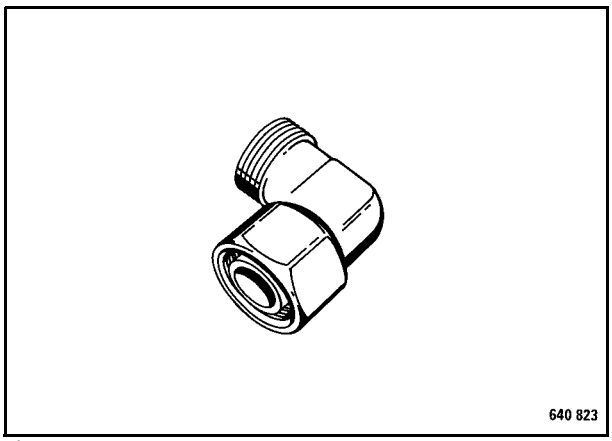


Fig. 16

25. Elbow 20S

BOMAG part-no.: 055 421 37

https://truckmanualshub.com/

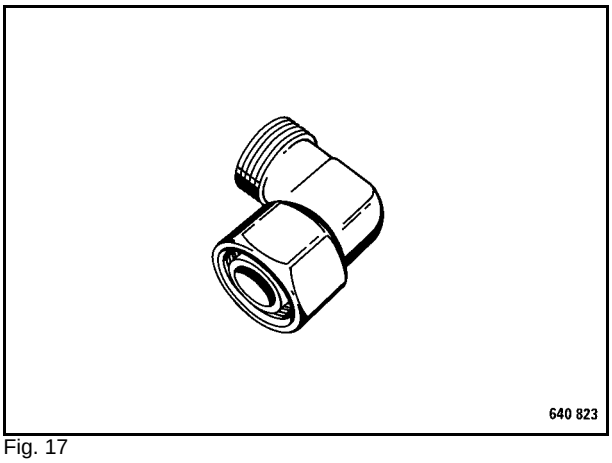


Fig. 17

26. Elbow 25S

BOMAG part-no.: 055 421 38

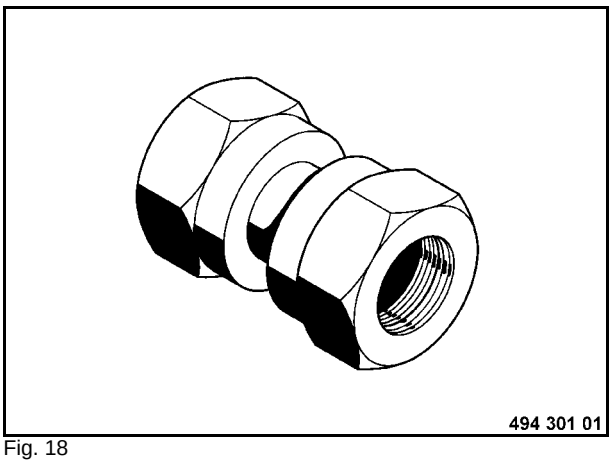


Fig. 18

27. Pipe connection 16S - 16S

BOMAG part-no.: 493 301 01

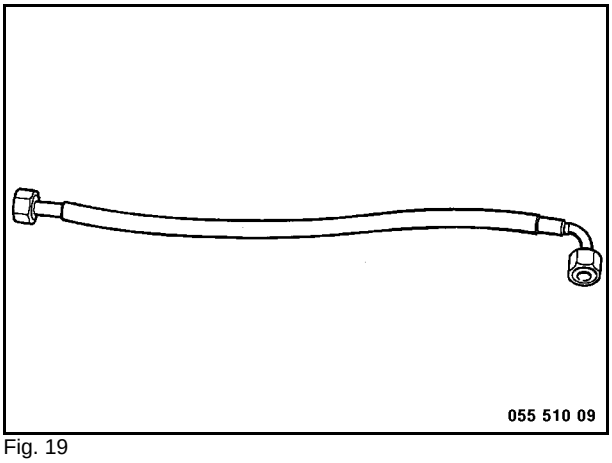


Fig. 19

28. Connecting hose 15L

BOMAG part-no.: 055 510 09

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6.2 Flushing - general

⚠ Caution

Solid particles in the circuit will very quickly cause damage to machine components.

Environment

Environmental damage

Catch running out hydraulic oil and dispose of environmentally.

Changing a component

⚠ Caution

Always flush the complete oil circuit after you have replaced a component.

Chips (abrasion) in the oil

- Open and clean all components in the oil circuit, replace if necessary.
- Clean all high pressure hoses in the oil circuit, replace if necessary.
- If abrasion is found in the travel circuit you should also flush the vibration circuit.
- If abrasion is found in the vibration circuit you should also flush the travel circuit.

Before flushing

Change the filter element

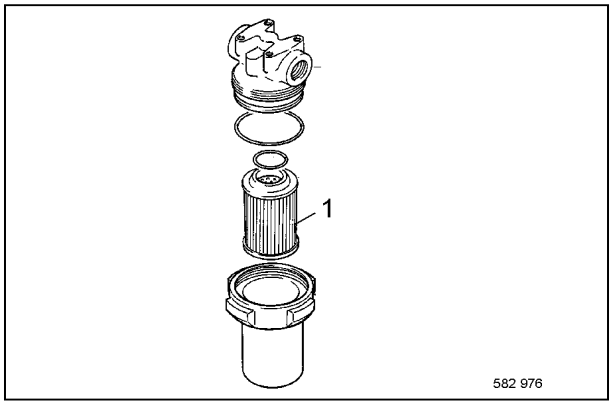


Fig. 1

- Change the hydraulic oil filter element (1).

Clean the hydraulic tank

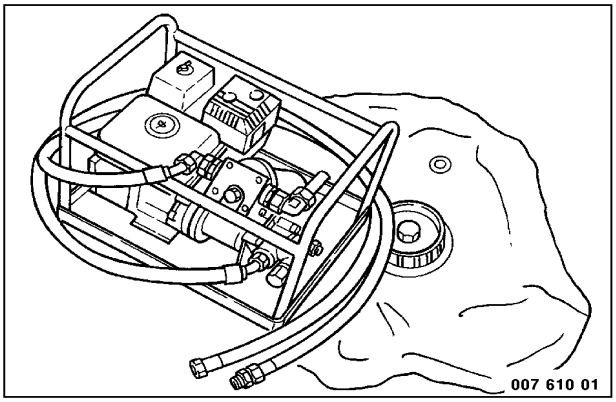


Fig. 2

⚠ Caution

Change the oil in case of excessive contamination, oil discoloration or if the oil change interval is almost due.

- Filter the tank content with the filling and filtering unit and pump it into the oil bag.
- Mark all hoses and disconnect them from the hydraulic oil tank.
- Clean the oil tank thoroughly from inside, if necessary remove the complete tank cover.
- Reconnect all hoses.
- Fill the hydraulic oil tank again with the filling and filtering unit.

Bleeding

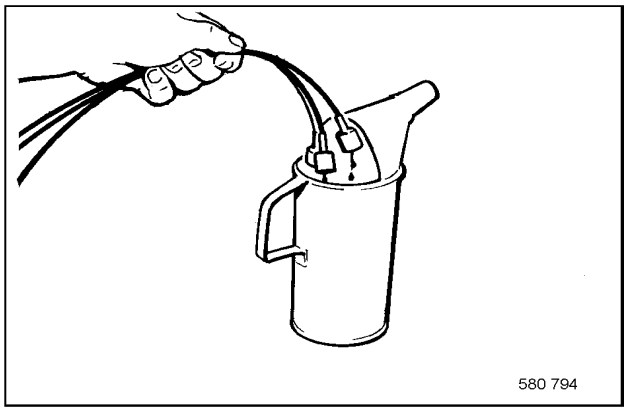


Fig. 3

- Always bleed closed hydraulic circuits if lines had been removed or connected.

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Servicing the flushing filter kit

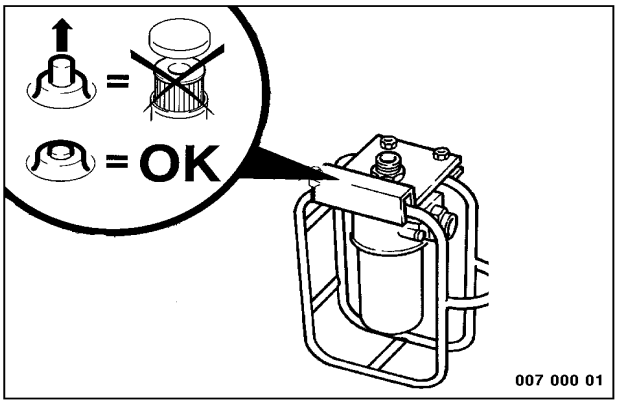
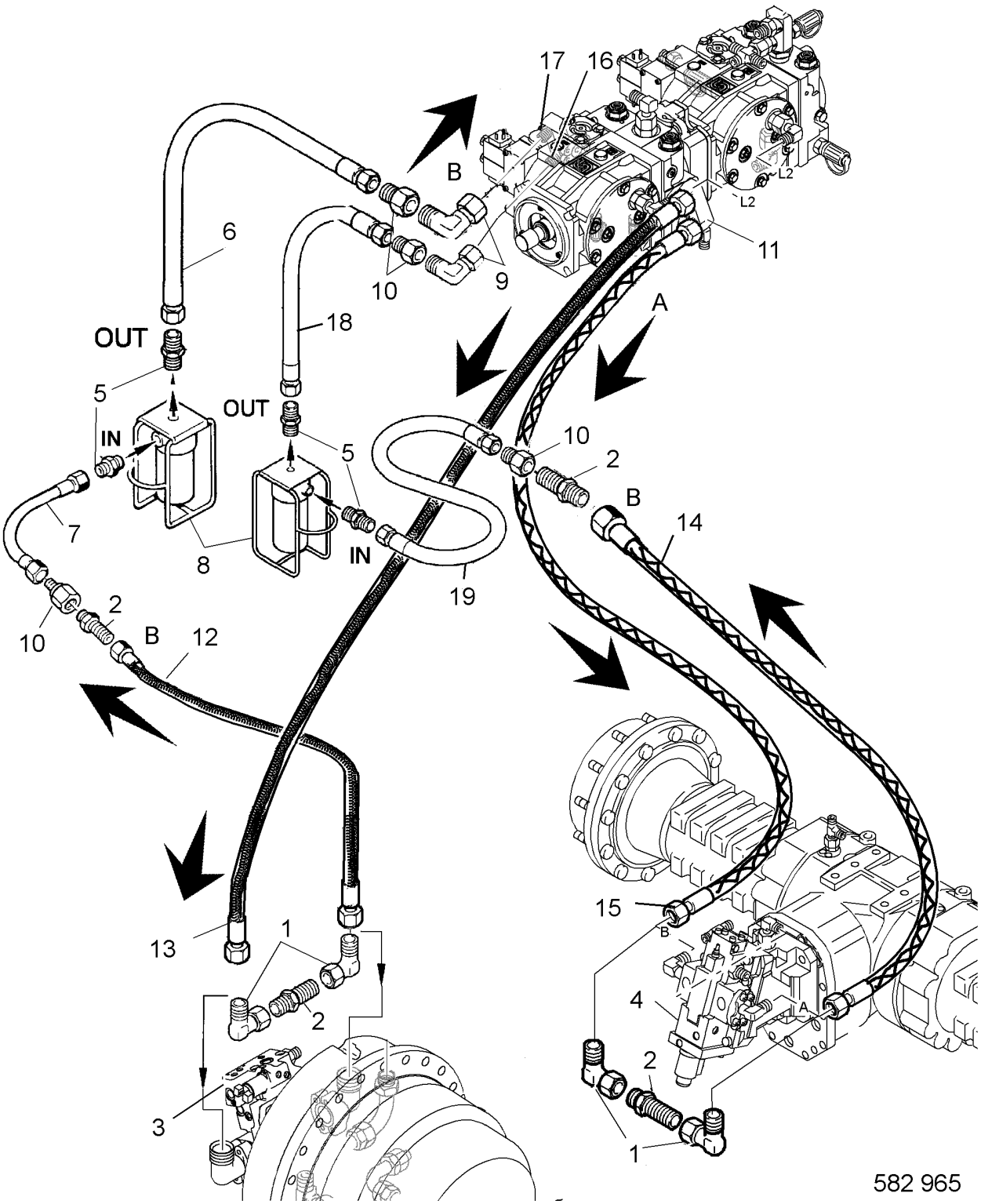


Fig. 4

- Replace the filter element of the flushing filter when the red control pin of the contamination indicator is pressed out during the filtering process.
- Clean hoses and connections and store the flushing kit in a clean and protected environment.

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1 Elbow union (tool)
2 Connecting union (tool)
3 Drum drive motor
4 Axle motor
5 Screw socket R1 - 25S (tool)
6 Flushing hose 25S - 20S (tool)
7 Flushing hose 25S - 20S (tool)
8 Flushing filter with filter element 1µ (tool)
9 Elbow union (tool)
10 Reducing fitting (tool)
11 Travel pump
12 High pressure hose (B, drum drive motor reverse)
13 High pressure hose (A, drum drive motor forward)
14 High pressure hose (B, axle motor reverse)
15 High pressure hose (A, axle motor forward)
16 High pressure hose (B, axle motor reverse)
17 High pressure port (B, drum drive motor reverse)
18 Flushing hose 25S - 20S (tool)
19 Flushing hose 25S - 20S (tool)

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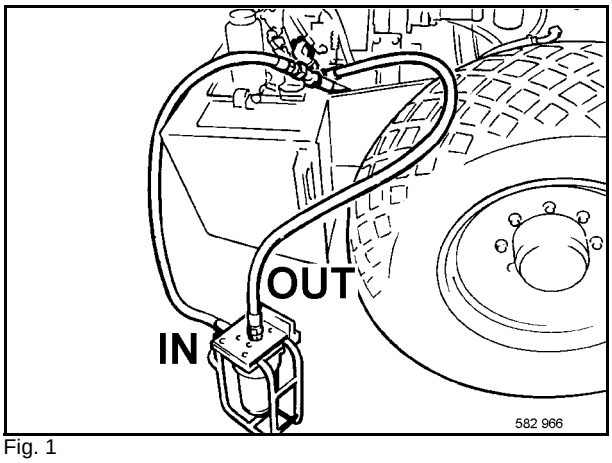


Fig. 1

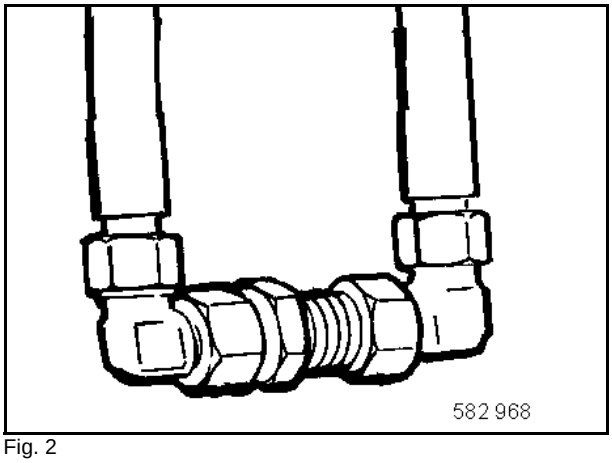


Fig. 2

6.4 Flushing the travel circuit (travel pump distribution)

Flushing the drum drive

Replacing the hydraulic oil filter element

Cleaning the hydraulic oil tank

i Note

Observe the chapter "Flushing - General"

Installing the flushing filter

⚠ Caution

Before the installation of the filters check hoses and connections for cleanliness.

The flushing filter must be installed in the low pressure side in the return flow to the pump, so that only cleaned oil will enter the travel pump in forward travel.

With the connection shown in the illustration the travel pump must therefore be actuated to forward direction.

1. Disconnect the high pressure hose 12 (see chapter "Flushing schematic - travel circuit") from the travel pump (high pressure port 17) and connect it with the flushing hose (7) (flushing filter inlet "IN").
2. Connect the flushing hose (6) (flushing filter outlet "OUT") to the (high pressure port 17) on the travel pump.

Disconnect the drum drive motor

3. Take the drum drive motor out of the hydraulic circuit by joining the high pressure hoses (12 and 13) on the drum drive motor together.

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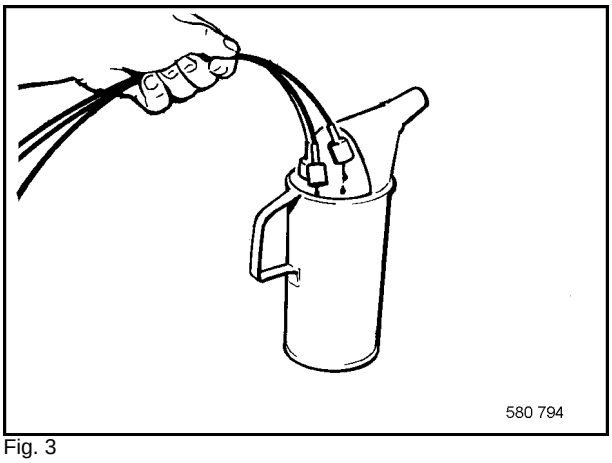


Fig. 3

Bleeding the travel circuit

i Note

Bleeding the travel circuit, see chapter "Bleeding the travel circuit".

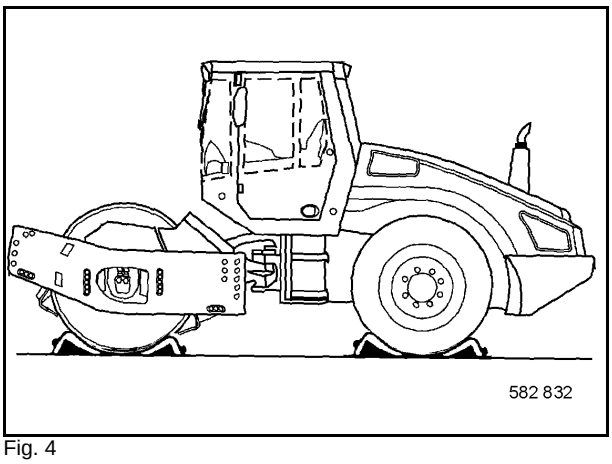


Fig. 4

Flushing the hoses

4. Block drums and wheels with suitable chocks.

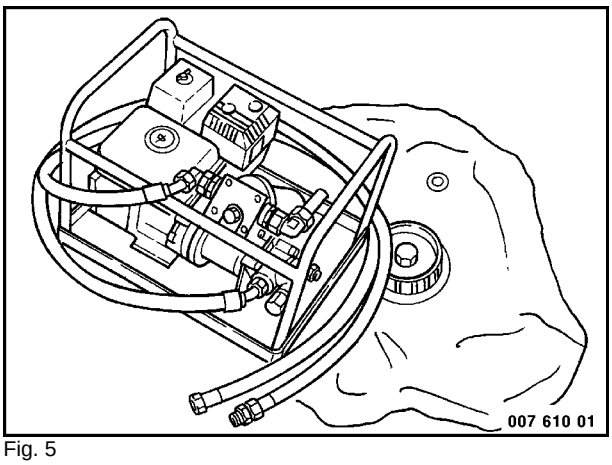


Fig. 5

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

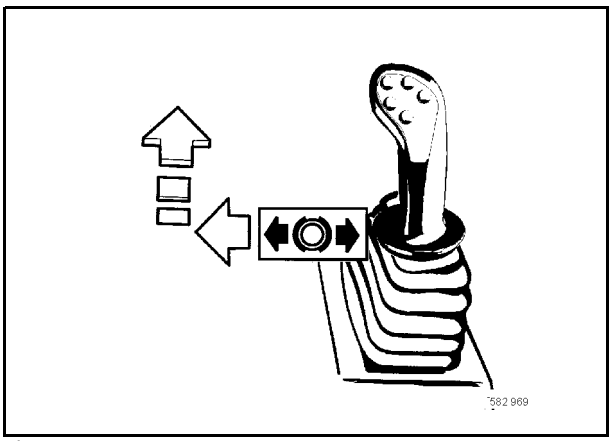


Fig. 6

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

5. Start the engine and shift the travel lever to travel direction forward.
6. Perform the flushing process at various engine speeds for approx. 10 minutes.
7. Shut down the engine.
8. Reconnect the hydraulic hoses (12 and 13) to the drum drive motor.

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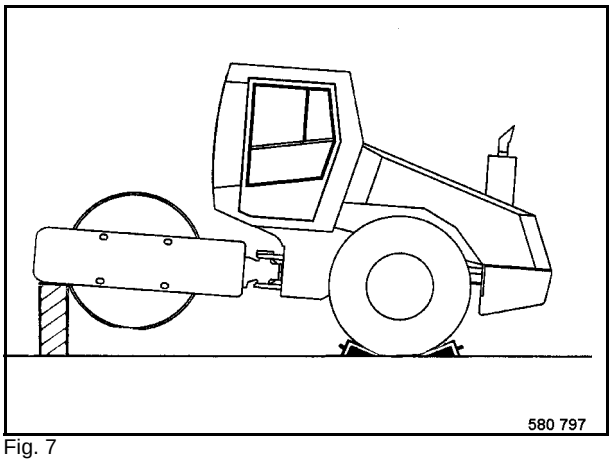


Fig. 7

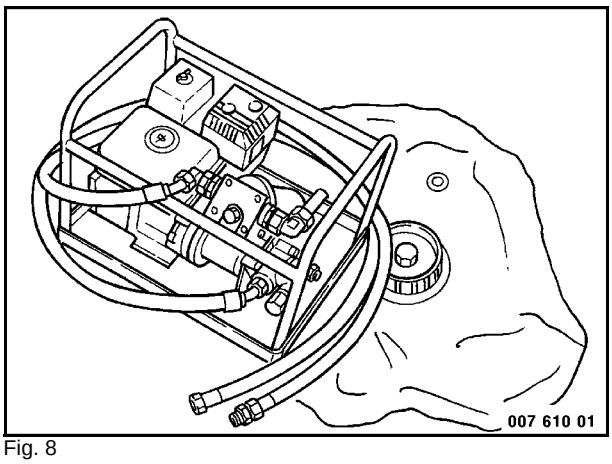


Fig. 8

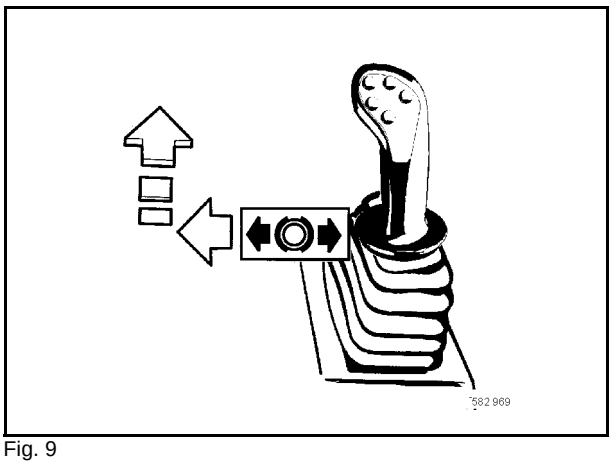


Fig. 9

Flushing the drum drive motor

⚠ Danger

Danger of accident!

The drum must rotate freely.

9. Jack up the front of the machine, so that the drum can rotate freely.
10. Secure the rear wheels with chocks.
11. Pre-select the slow speed range.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

12. Start the engine, run it with maximum speed and shift the travel lever to travel direction forward.
13. Run the flushing procedure for approx. 10 minutes. During this process keep changing the pump flow by shifting the travel lever several times between full and halve forward travel.
14. Shut down the engine.
15. Remove the flushing filter and reconnect the high pressure lines.

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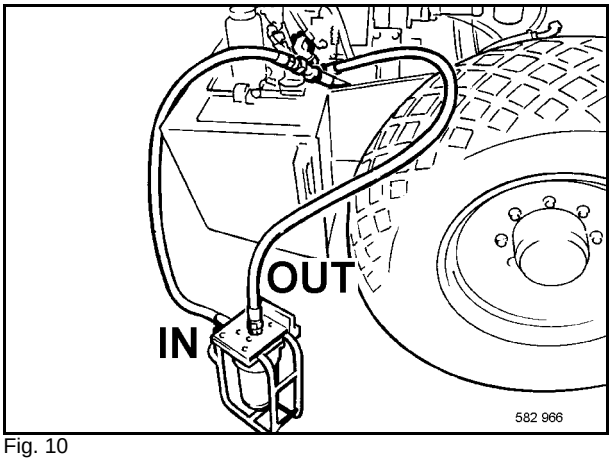


Fig. 10

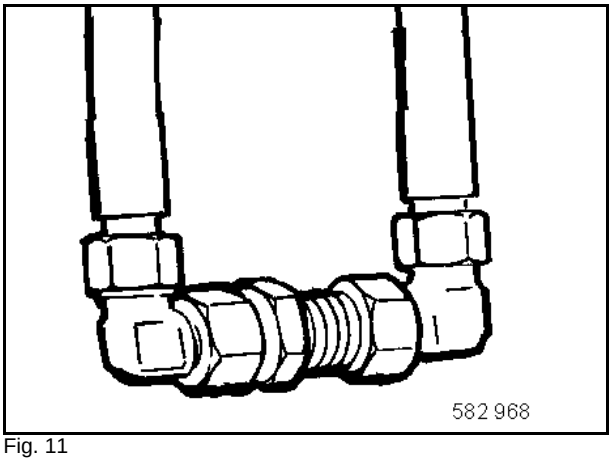


Fig. 11

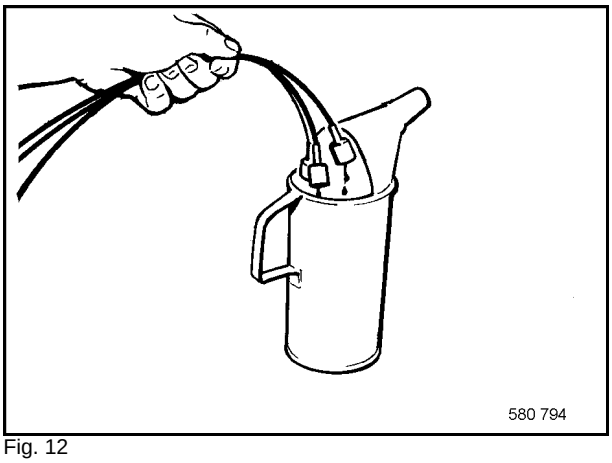


Fig. 12

Flushing the axle drive

Installing the flushing filter

16. Disconnect the high pressure hose 14 (see chapter "Flushing schematic - travel circuit") from the travel pump (high pressure port 16) and connect it with the flushing hose (18) (flushing filter inlet "IN").
17. Connect the flushing hose (19) (flushing filter outlet "OUT") to the (high pressure port 16) on the travel pump.

Disconnecting the axle motor

18. Take the axle drive motor out of the hydraulic circuit by joining the high pressure hoses (14 and 15) on the axle drive motor together.

Bleeding the travel circuit

i Note

Bleeding the travel circuit, see chapter "Bleeding the travel circuit".

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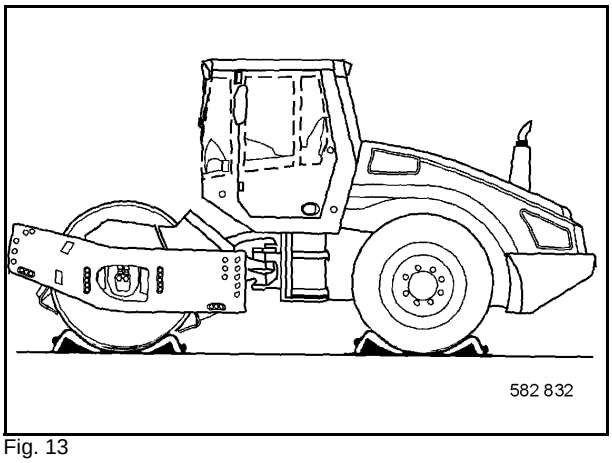


Fig. 13

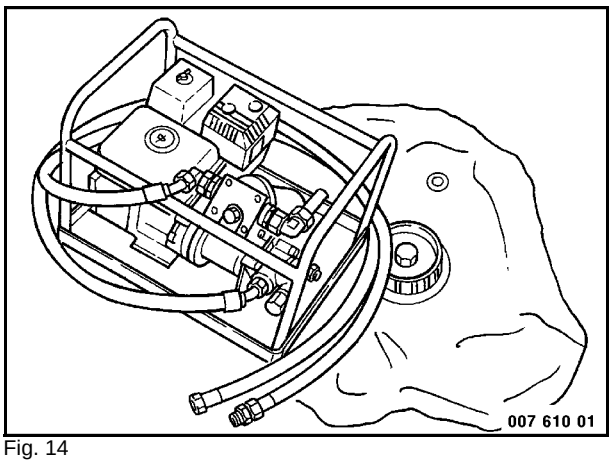


Fig. 14

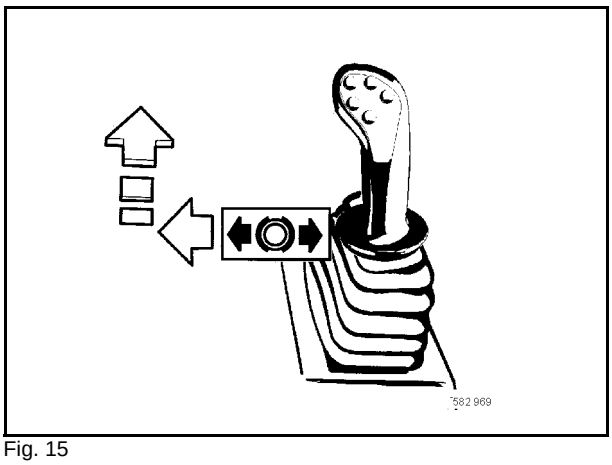


Fig. 15

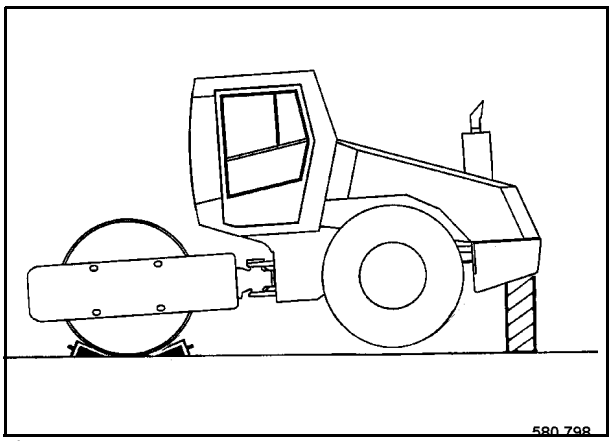


Fig. 16

Flushing the hoses

19. Block drums and wheels with suitable chocks.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

20. Start the engine and shift the travel lever to travel direction forward.
21. Perform the flushing process at various engine speeds for approx. 10 minutes.
22. Shut down the engine.
23. Reconnect the hydraulic hoses (14 and 15) to the axle drive motor.

Flushing the axle motor

⚠ Danger

Danger of accident!

Both wheels must be off the ground. The wheels must be able to rotate freely.

24. Jack up the rear of the machine, so that the wheels can rotate freely.
25. Secure the drum with wheel chocks.
26. Pre-select the slow speed range.

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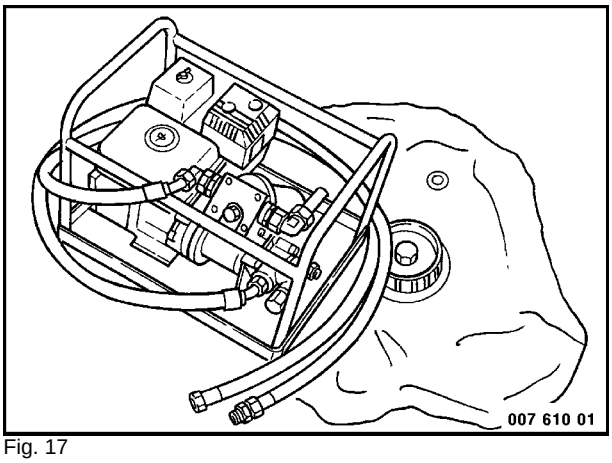


Fig. 17

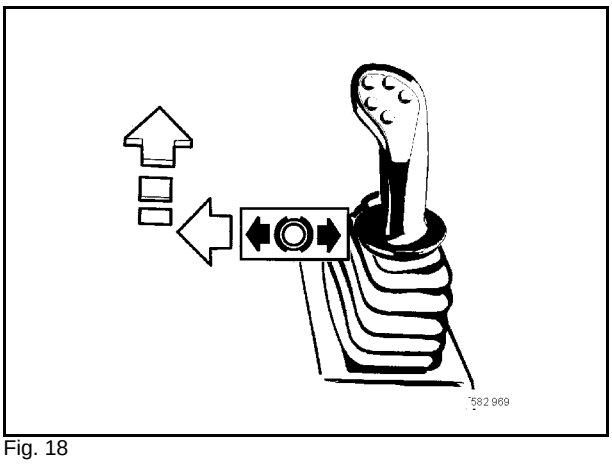


Fig. 18

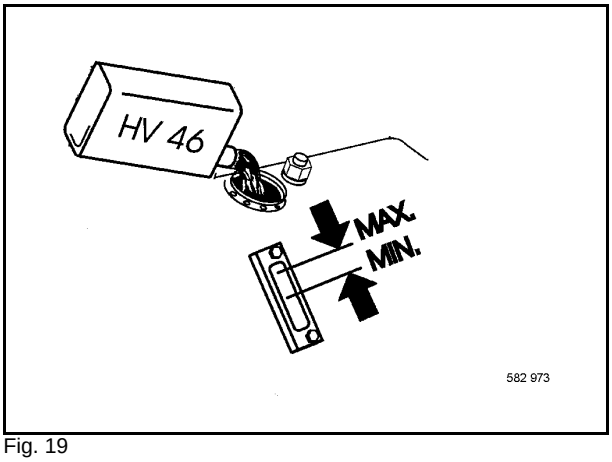


Fig. 19

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

27. Start the engine, run it with maximum speed and shift the travel lever to travel direction forward.
28. Run the flushing procedure for approx. 10 minutes. During this process keep changing the pump flow by shifting the travel lever several times between full and halve forward travel.
29. Shut down the engine.
30. Remove the flushing filter and reconnect the high pressure lines.

Bleeding the travel circuit

31. Bleed the travel circuit (see corresponding chapter).

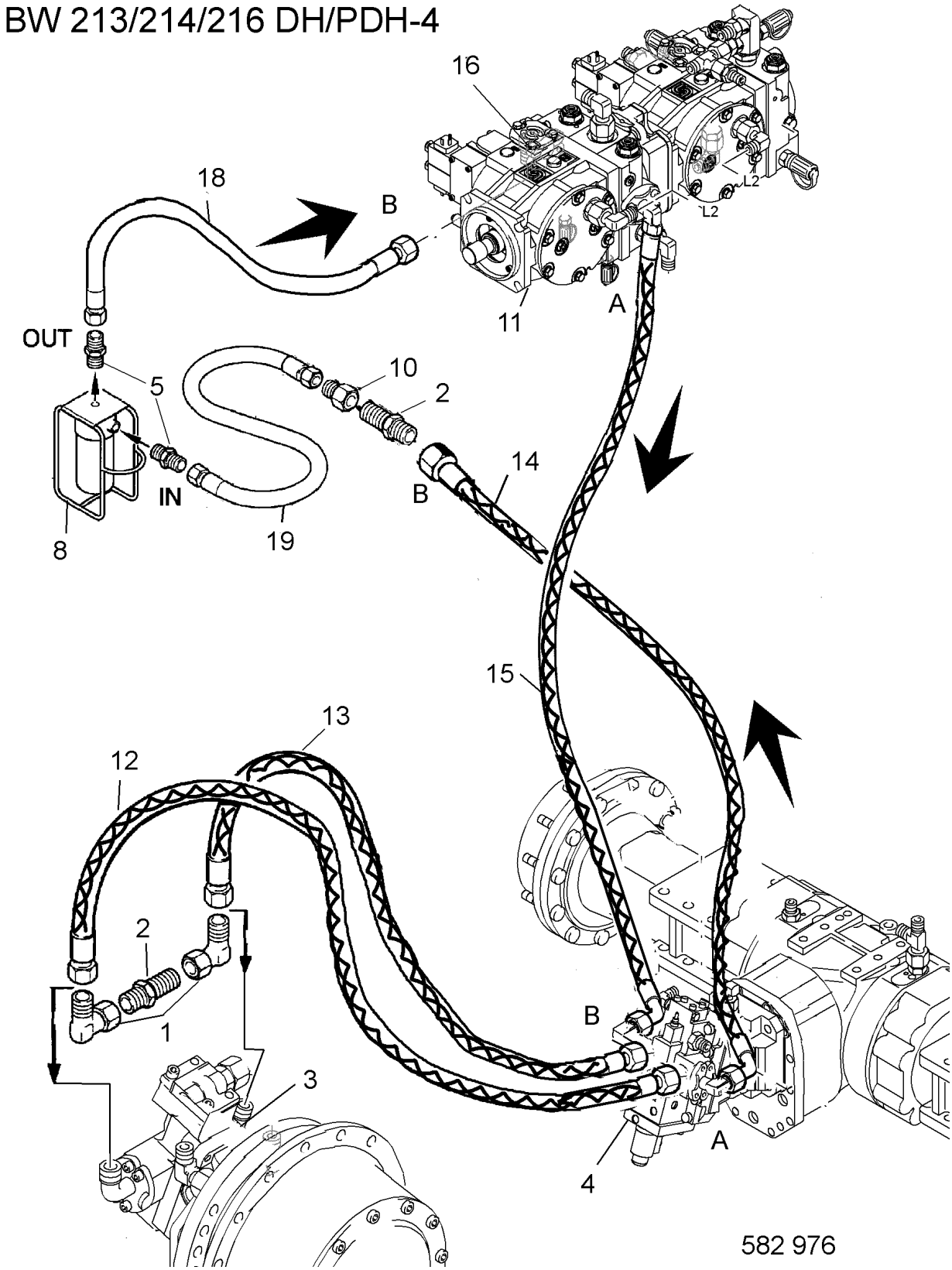
Keep circulating the tank content.

32. After completing the bleeding process circulate the tank content with the filtering unit for another 15 minutes.

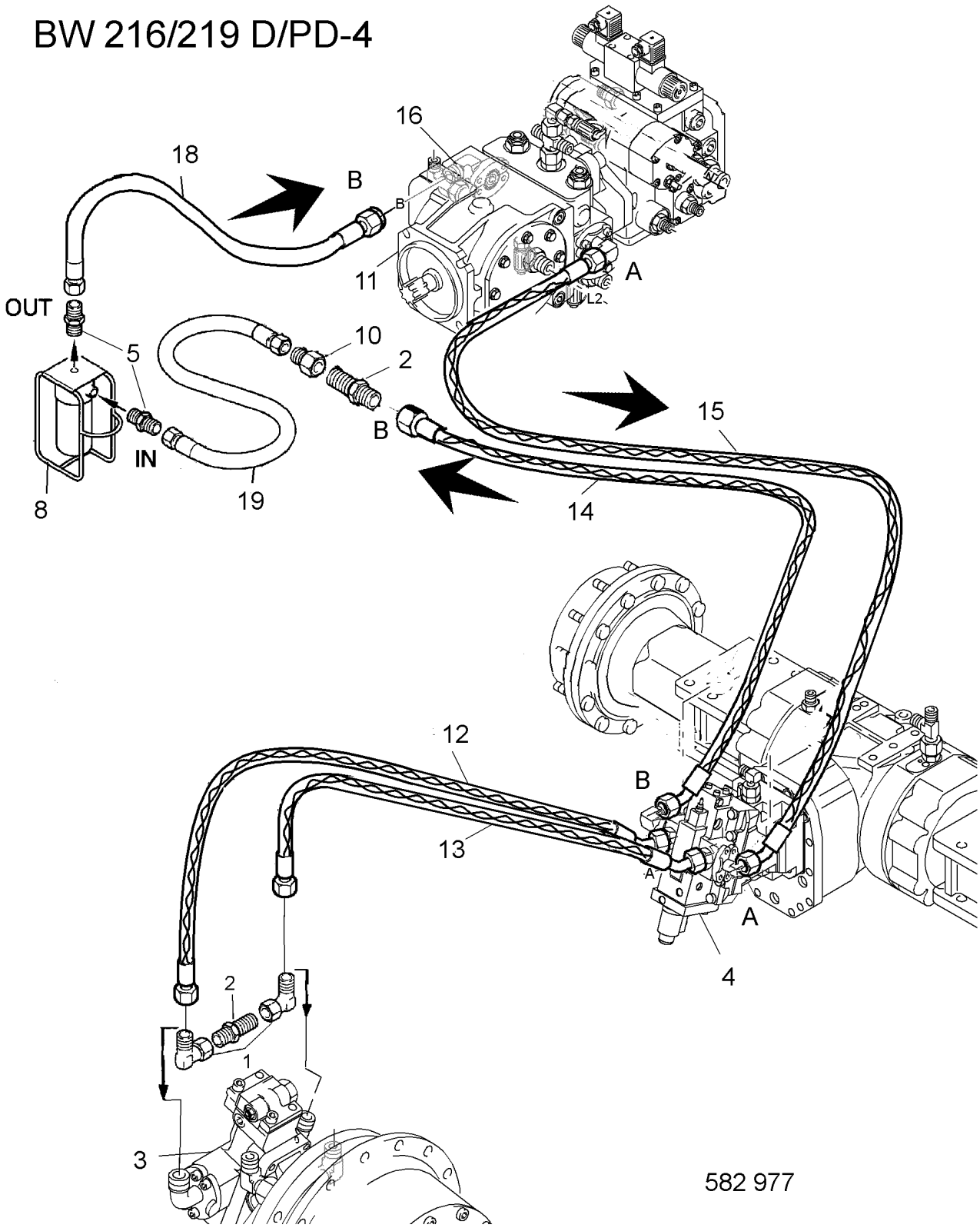
Function test

33. Check the hydraulic oil level in the tank, fill up if necessary.
34. Check all connections for leaks with the engine running (visual inspection).
35. Perform a test drive, load the travel system in forward and reverse, e.g. by driving uphill or starting on a gradient.
36. Check all ports and connections for leak tightness (visual inspection).

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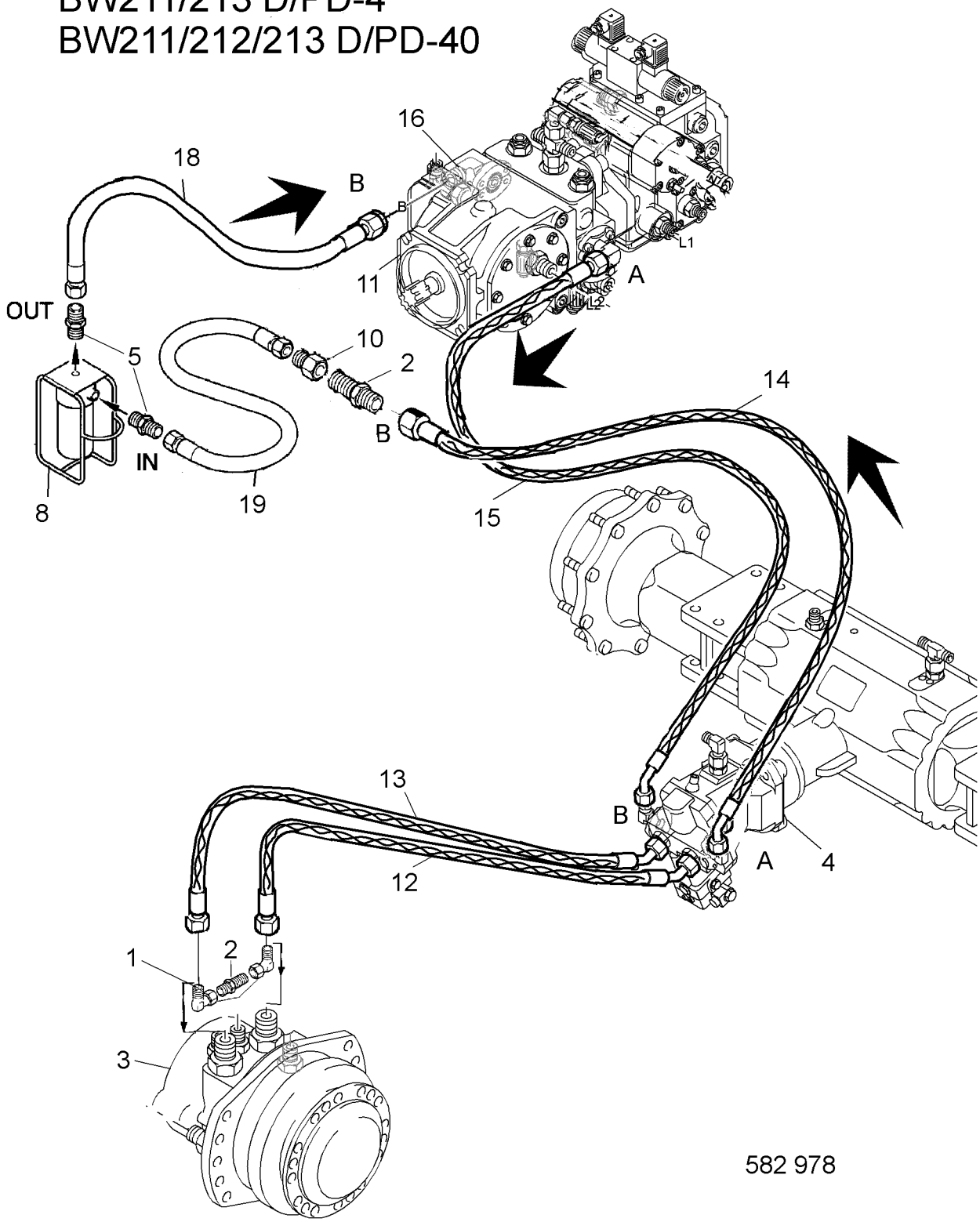


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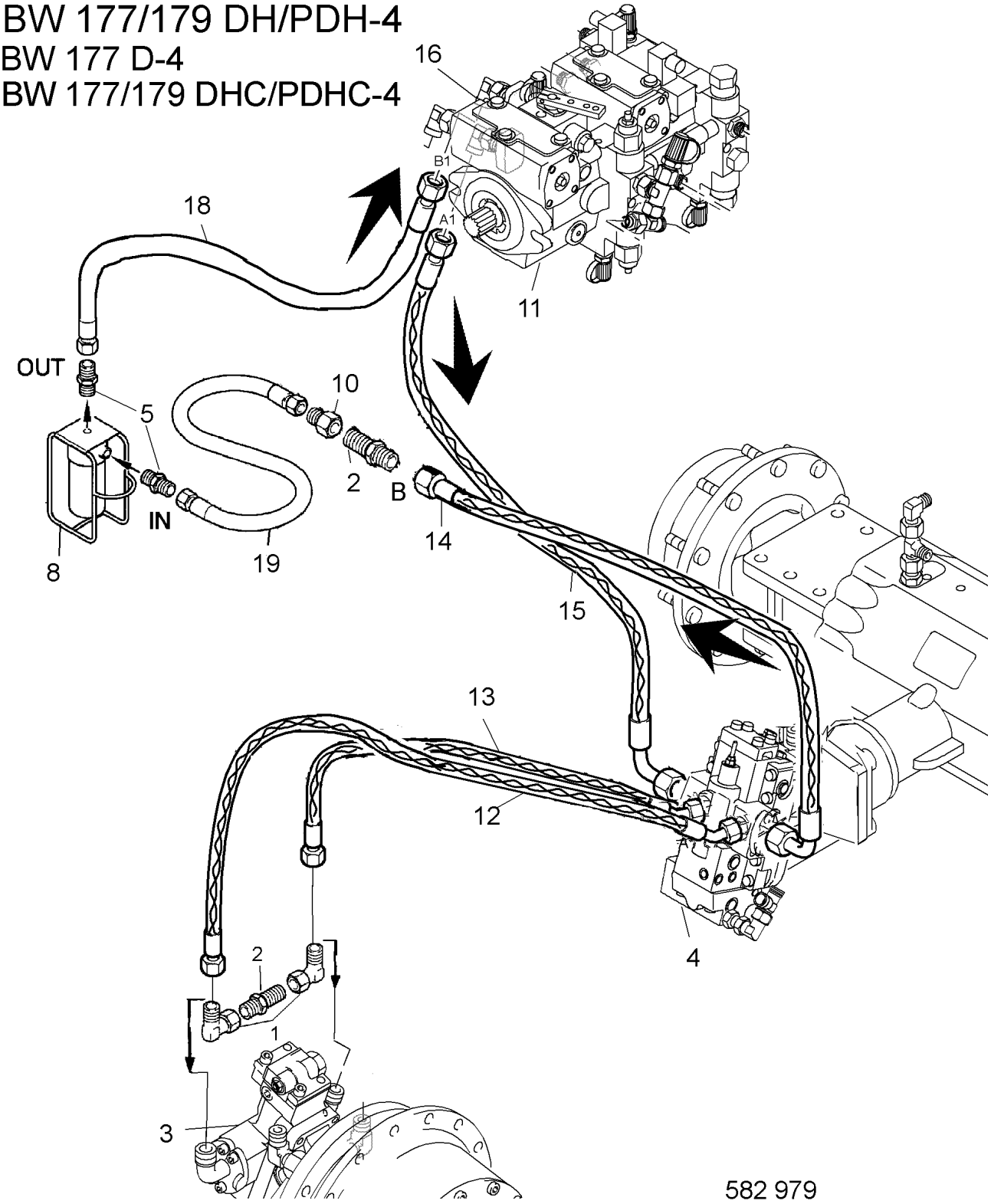
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BW 177 D-4
BW 177/179 DHC/PDHC-4



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1 Elbow union (tool)
2 Connecting union (tool)
3 Drum drive motor
4 Axle motor
5 Screw socket R1 - 25S (tool)
6 not used
7 not used
8 Flushing filter with filter element 1µ (tool)
9 not used
10 Reducing fitting (tool)
11 Travel pump
12 High pressure hose (drum drive motor reverse)
13 High pressure hose (drum drive motor forward)
14 High pressure hose (B, axle motor reverse)
15 High pressure hose (A, axle motor forward)
16 High pressure hose (B, axle motor reverse)
17 not used
18 Flushing hose 25S - 20S (tool)
19 Flushing hose 25S - 20S (tool)

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6.6 Flushing the travel circuit (axle motor distribution)

Flushing the drum drive

Replacing the hydraulic oil filter element

Cleaning the hydraulic oil tank

i Note

Observe the chapter "Flushing - General"

Installing the flushing filter

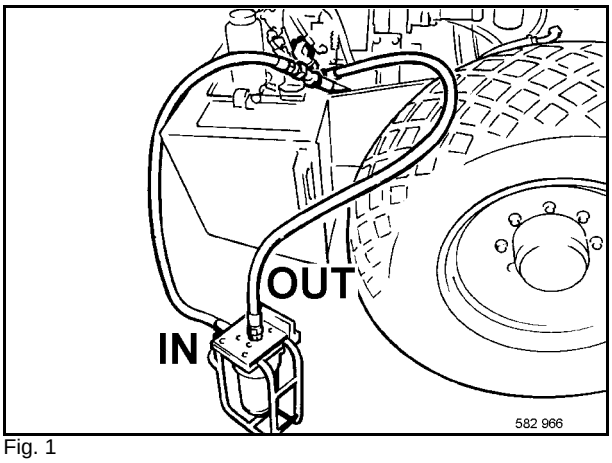


Fig. 1

⚠ Caution

Before the installation of the filters check hoses and connections for cleanliness.

The flushing filter must be installed in the low pressure side in the return flow to the pump, so that only cleaned oil will enter the travel pump in forward travel.

With the connection shown in the illustration the travel pump must therefore be actuated to forward direction.

1. Disconnect the high pressure hose 14 (see chapter "Flushing schematic - travel circuit") from the travel pump (high pressure port 16) and connect it with the flushing hose (19) (flushing filter inlet "IN").
2. Connect the flushing hose (18) (flushing filter outlet "OUT") to the (high pressure port 16) on the travel pump.

Disconnect the drum drive motor

3. Take the drum drive motor out of the hydraulic circuit by joining the high pressure hoses (12 and 13) on the drum drive motor together.

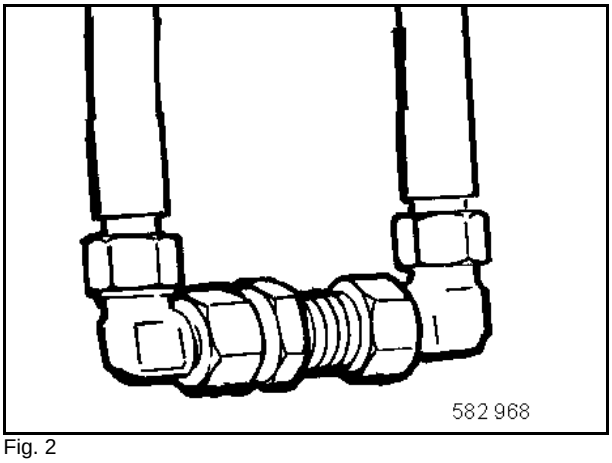


Fig. 2

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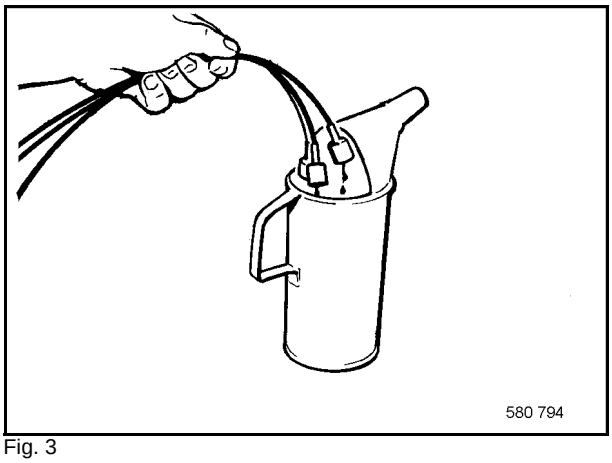


Fig. 3

Bleeding the travel circuit

i Note

Bleeding the travel circuit, see chapter "Bleeding the travel circuit".

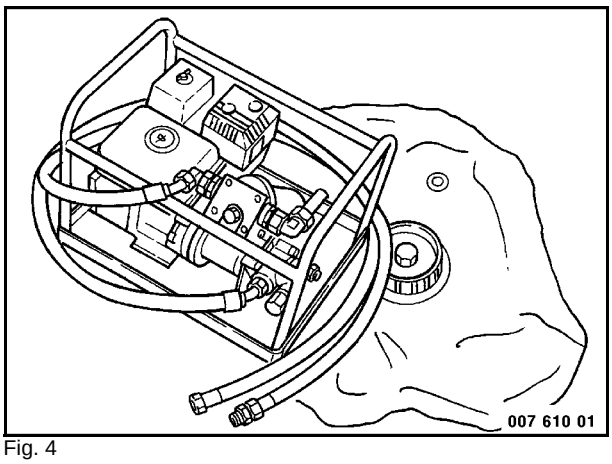


Fig. 4

Flushing the hoses

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

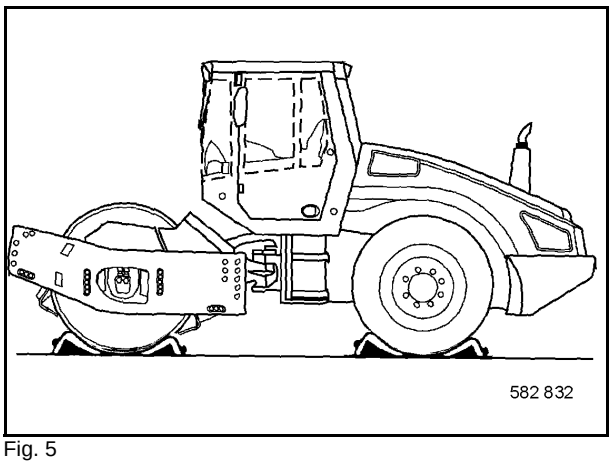


Fig. 5

4. Block drums and wheels with suitable chocks.

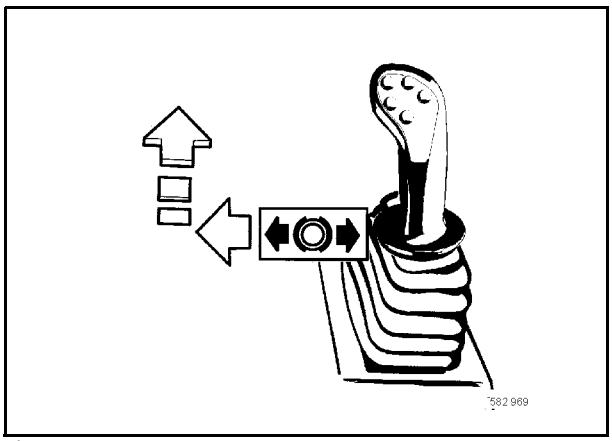


Fig. 6

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

5. Start the engine and shift the travel lever to travel direction forward.
6. Perform the flushing process at various engine speeds for approx. 10 minutes.
7. Shut down the engine.
8. Reconnect the hydraulic hoses (12 and 13) to the drum drive motor.

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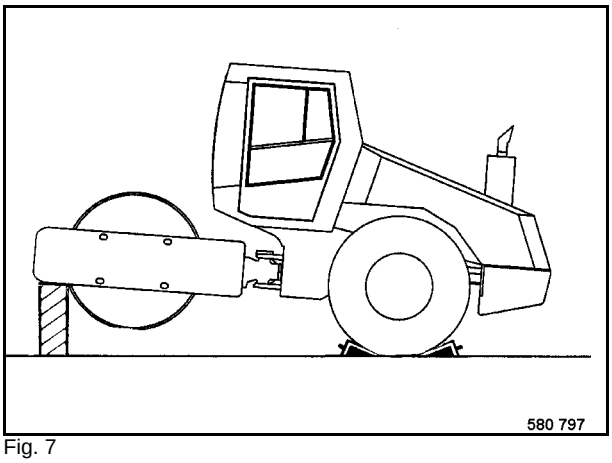


Fig. 7

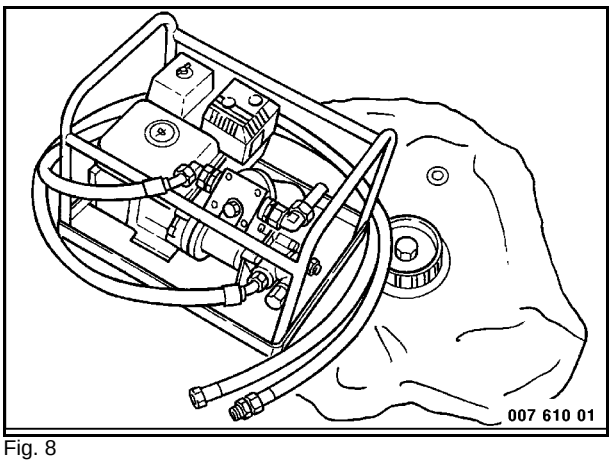


Fig. 8

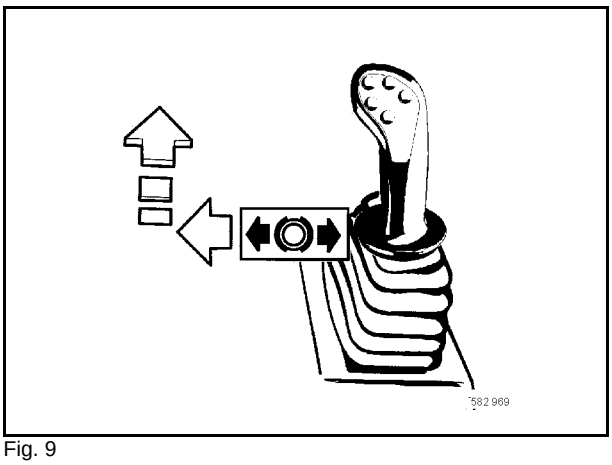


Fig. 9

Flushing the drum drive motor

⚠ Danger

Danger of accident!

The drum must rotate freely.

9. Jack up the front of the machine, so that the drum can rotate freely.
10. Secure the rear wheels with chocks.
11. Pre-select the slow speed range.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

12. Start the engine, run it with maximum speed and shift the travel lever to travel direction forward.
13. Run the flushing procedure for approx. 10 minutes. During this process keep changing the pump flow by shifting the travel lever several times between full and halve forward travel.
14. Shut down the engine.

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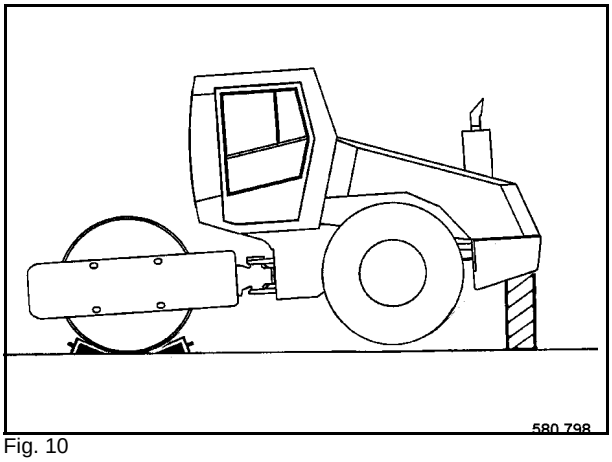


Fig. 10

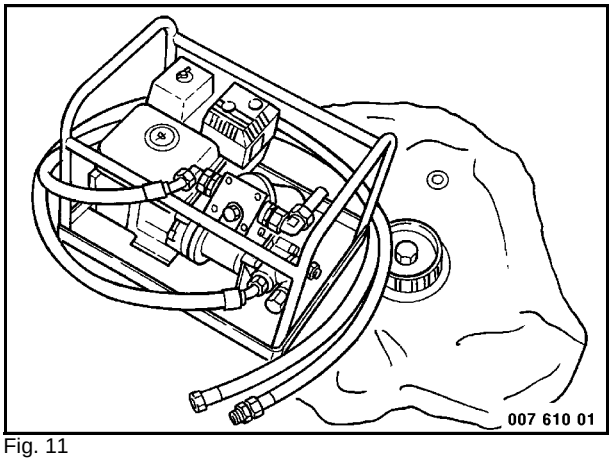


Fig. 11

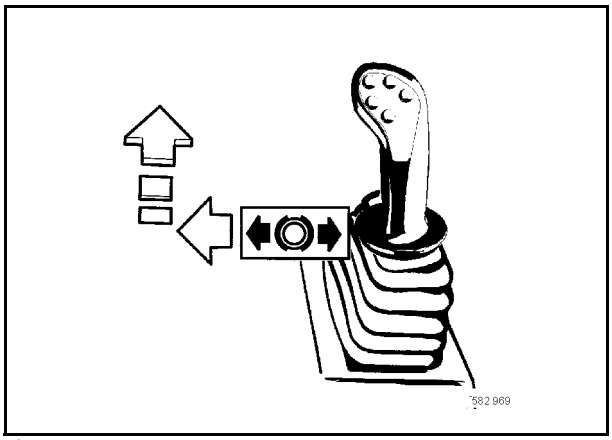


Fig. 12

Flushing the axle motor

⚠ Danger

Danger of accident!

Both wheels must be off the ground. The wheels must be able to rotate freely.

15. Jack up the rear of the machine, so that the wheels can rotate freely.
16. Secure the drum with wheel chocks.
17. Pre-select the slow speed range.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Move the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

18. Start the engine, run it with maximum speed and shift the travel lever to travel direction forward.
19. Run the flushing procedure for approx. 10 minutes. During this process keep changing the pump flow by shifting the travel lever several times between full and halve forward travel.
20. Shut down the engine.
21. Remove the flushing filter and reconnect the high pressure lines.

Bleeding the travel circuit

22. Bleed the travel circuit (see corresponding chapter).

Keep circulating the tank content.

23. After completing the bleeding process circulate the tank content with the filtering unit for another 15 minutes.

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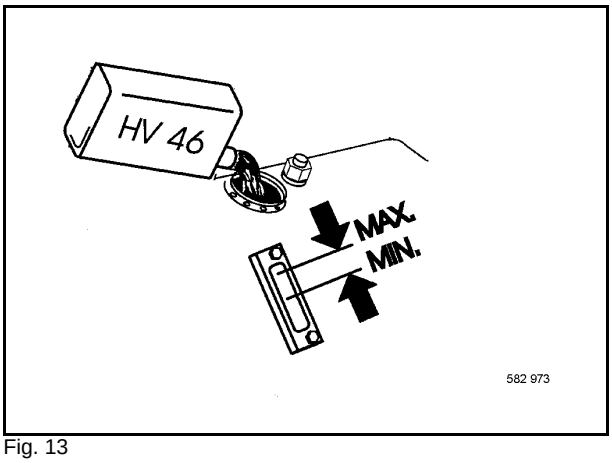
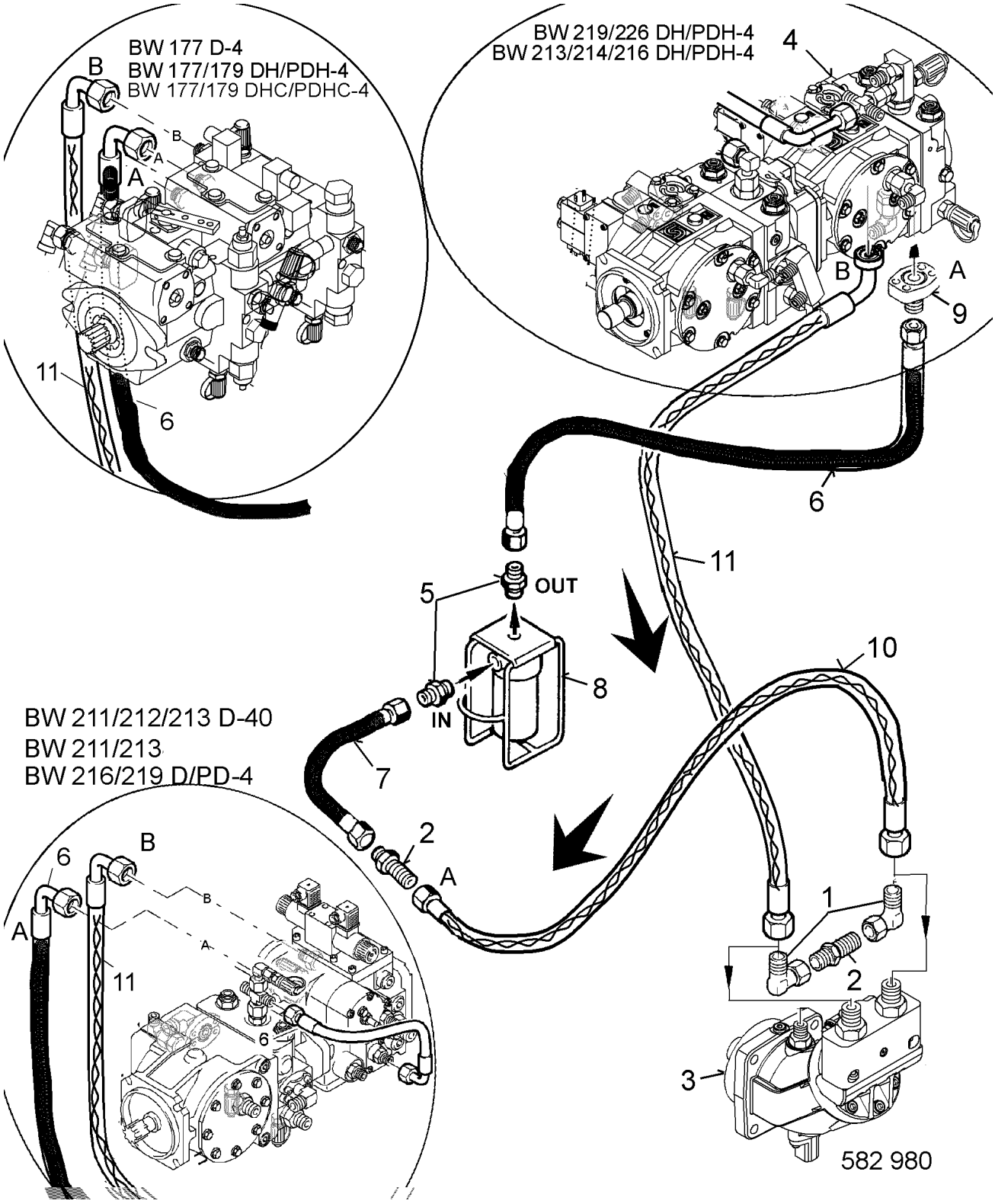


Fig. 13

Function test

24. Check the hydraulic oil level in the tank, fill up if necessary.
25. Check all connections for leaks with the engine running (visual inspection).
26. Perform a test drive, load the travel system in forward and reverse, e.g. by driving uphill or starting on a gradient.
27. Check all ports and connections for leak tightness (visual inspection).

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1 Elbow union (tool)
2 Connecting union (tool)
3 Vibration motor
4 Vibration pump
5 Screw socket R1 - 25S (tool)
6 Flushing hose 25S - 20S (tool)
7 Flushing hose 25S - 20S (tool)
8 Flushing filter with filter element 1µ (tool)
9 SAE flange (tool)
10 High pressure hose (B, high frequency)
11 High pressure hose (A, low frequency)

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6.8 Flushing the vibration circuit

Replacing the hydraulic oil filter element

Cleaning the hydraulic oil tank

i Note

Observe the chapter "Flushing - General"

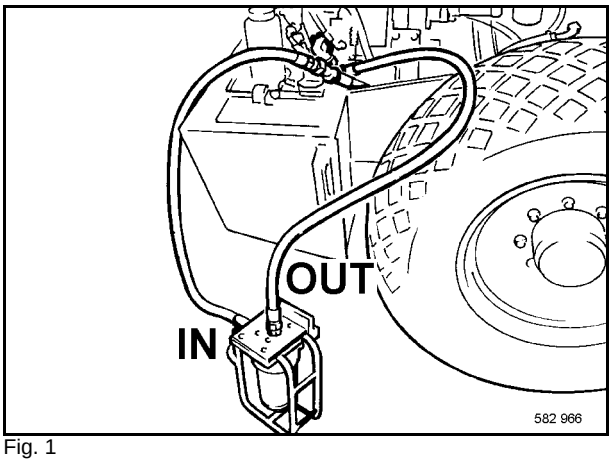


Fig. 1

Installing the flushing filter

⚠ Caution

Before the installation of the filters check hoses and connections for cleanliness.

The flushing filter must be installed in the low pressure side in the return flow to the pump, so that only cleaned oil will enter the vibration pump in high frequency.

For the connection schematic shown here the vibration must always be filtered with "high frequency / low amplitude".

1. Disconnect the high pressure hose 10 (see chapter "Flushing schematic - vibration circuit") from the vibration pump (4) and connect it with the flushing hose (7) (flushing filter inlet "IN").
2. Connect the flushing hose (6) (flushing filter outlet "OUT") to the (high pressure port A) on the vibration pump.

Disconnect the vibration motor

3. Take the vibration motor out of the hydraulic circuit by joining the high pressure hoses (10 and 11) on the vibration motor together.

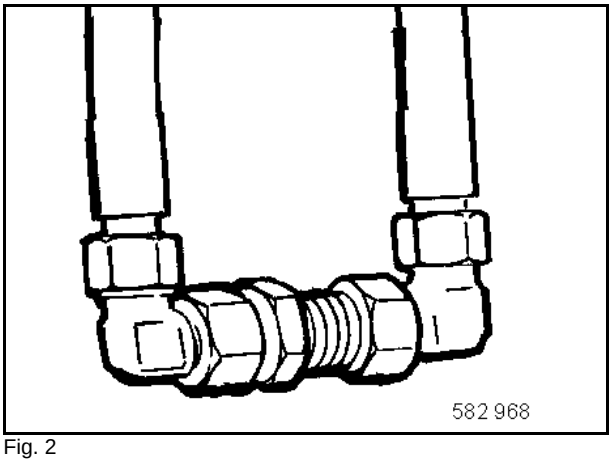


Fig. 2

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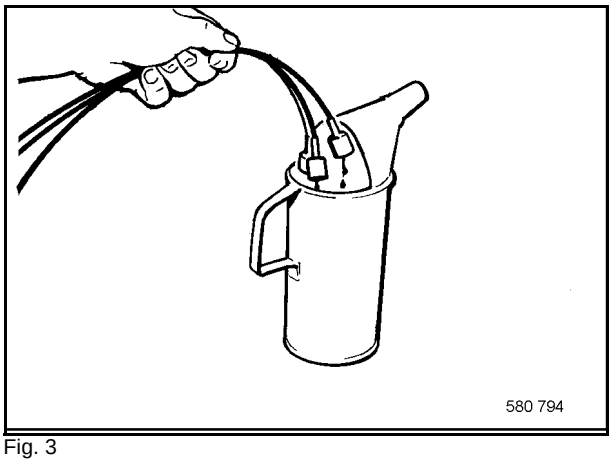


Fig. 3

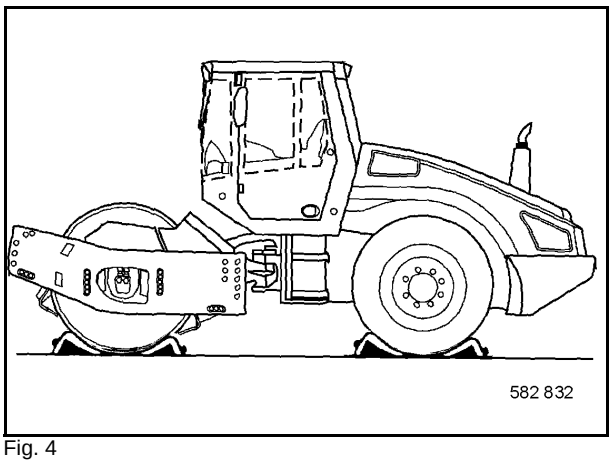


Fig. 4

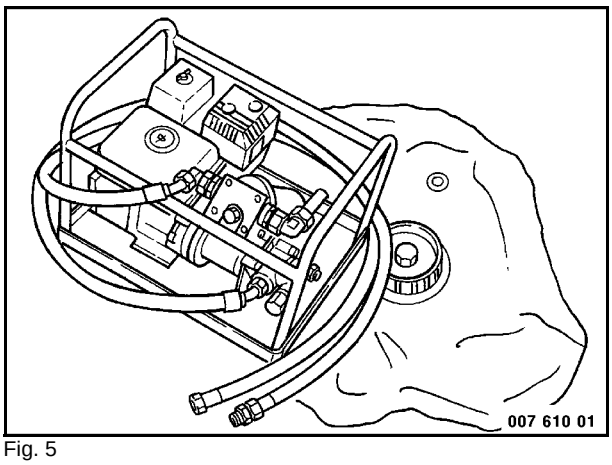


Fig. 5

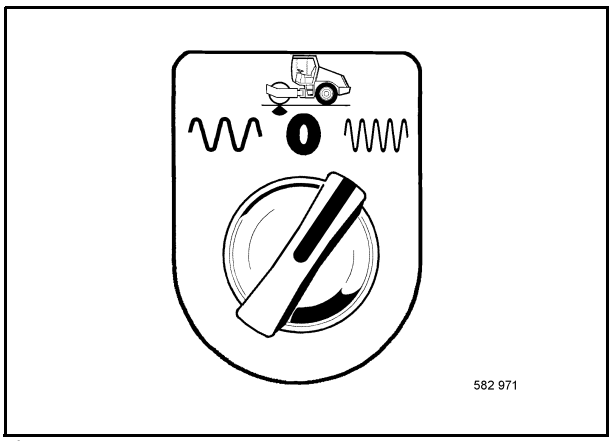


Fig. 6

Bleeding the vibration circuit

i Note

Bleeding the vibration circuit, see chapter "Bleeding the vibration circuit".

Flushing the hoses

4. Block drums and wheels with suitable chocks.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Use only high frequency, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

5. Switch on vibration with high frequency.
6. Start the engine and run it with maximum speed.
7. Flush the circuit for approx. 10 minutes, thereby switch the vibration on and off at intervals of approx. 30 seconds.
8. Shut down the engine.
9. Reconnect the hydraulic hoses (10 and 11) to the vibration motor.

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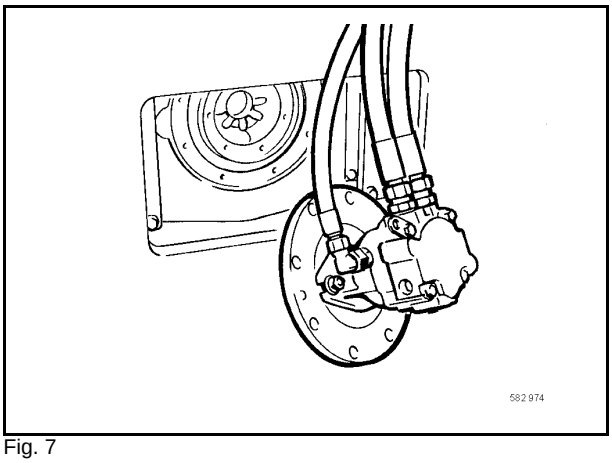


Fig. 7

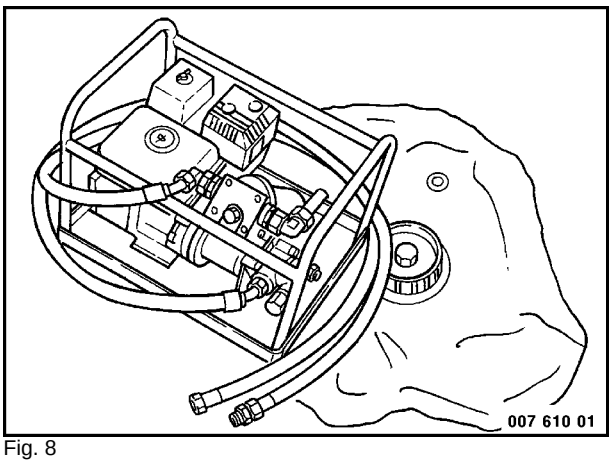


Fig. 8

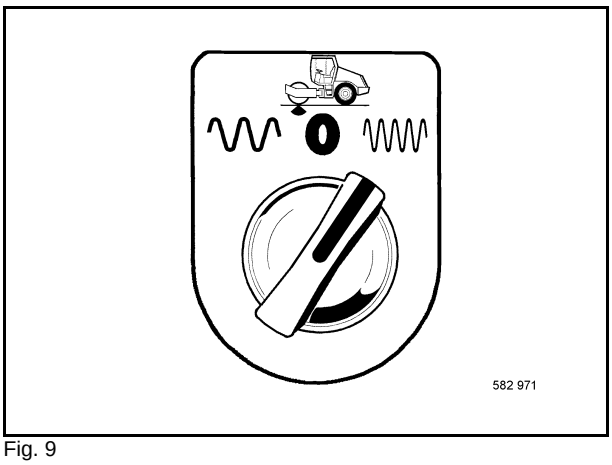


Fig. 9

Flushing the vibration motor

10. Unscrew the fastening screws for the vibration motor and pull the motor out of the coupling.

i Note

Keep circulating the complete tank content with the filling and filtering unit throughout the entire flushing process.

⚠ Caution

Use only high frequency, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

11. Start the engine and run it with maximum speed.
12. Run the flushing procedure for approx. 10 minutes. Switch the vibration on and off at intervals of approx. 30 seconds.
13. Shut down the engine.
14. Remove the flushing filter and reinstall the vibration motor.

Bleeding the vibration circuit

15. Bleed the vibration circuit (see corresponding chapter).

Keep circulating the tank content.

16. After completing the bleeding process circulate the tank content with the filtering unit for another 15 minutes.

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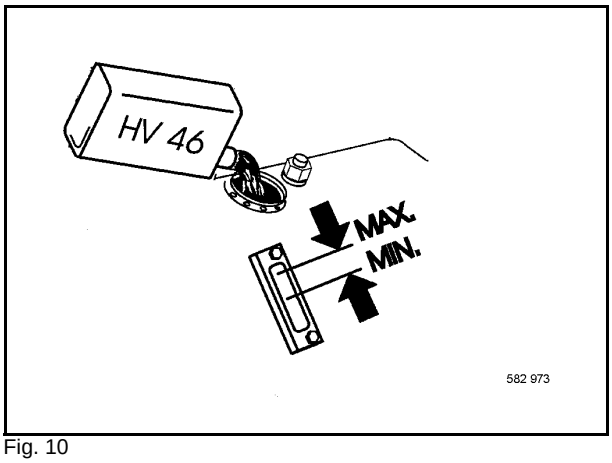


Fig. 10

Function test

17. Check the hydraulic oil level in the tank, fill up if necessary.
18. Test drive.
19. Check all ports and connections for leak tightness (visual inspection).

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6.9 Bleeding the travel circuit

Environment

Catch hydraulic oil and dispose of environmentally.

1. Install a pressure test hose to the charge pressure test port.
2. Install a pressure test hose each to the high pressure test ports.
3. Actuate the emergency stop switch.

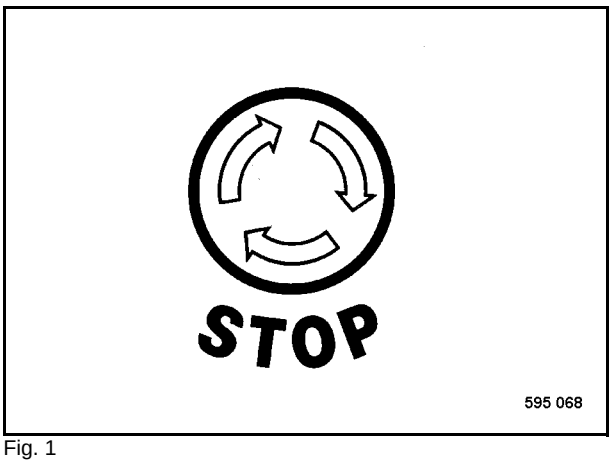


Fig. 1

Danger

The engine should not start.

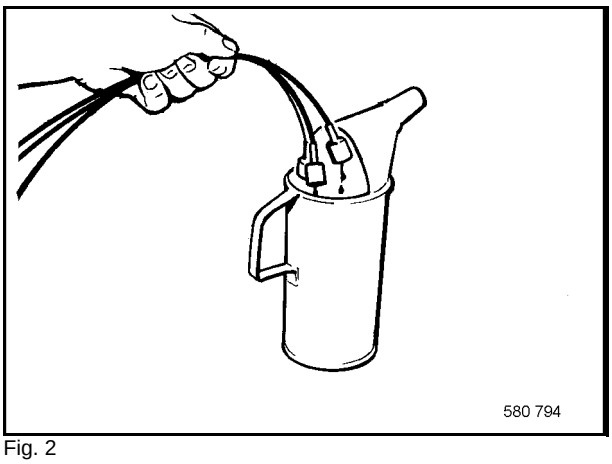


Fig. 2

4. Hold the open ends of the pressure test hoses (Fig. 2) into a container.
5. Operate the starter motor for approx. 30 seconds. Wait one minute and repeat this procedure, until oil starts to run out from the pressure test hoses.
6. Remove the pressure test hoses.

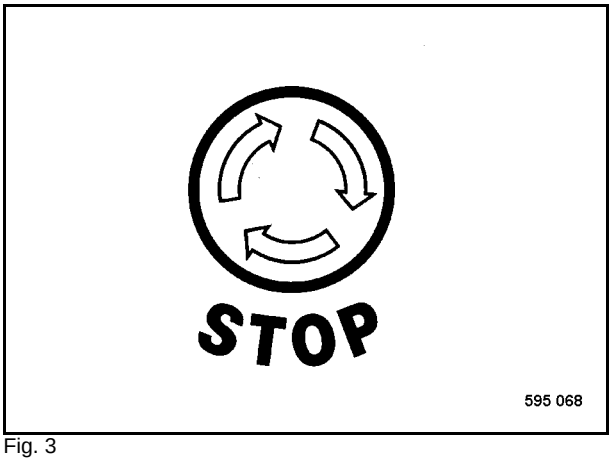


Fig. 3

7. Unlock the emergency stop switch

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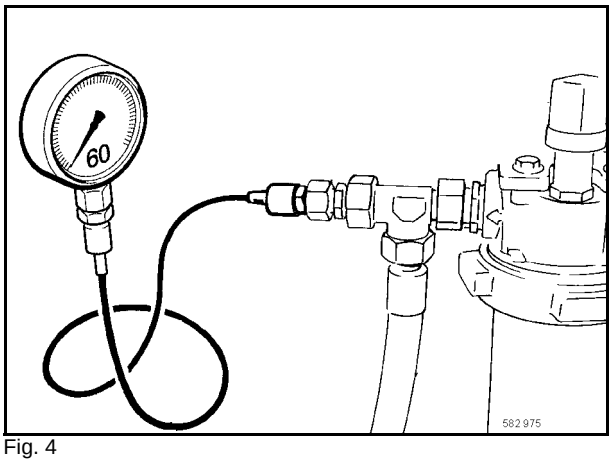


Fig. 4

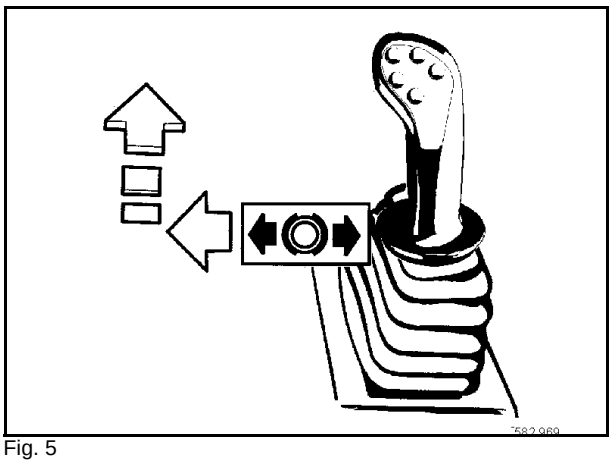


Fig. 5

8. Connect a 60 bar pressure gauge to the charge pressure test port (Fig. 4) and run the engine max. 15 seconds at idle speed.
9. Pause for approx. 30 seconds and keep repeating this procedure, until the gauge shows a constant charge pressure reading.

⚠ Caution

With the flushing filter installed shift the travel lever only to travel direction forward, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

⚠ Danger

Run the engine with idle speed.

10. Start the engine.
11. Shift the travel lever (Fig. 5) approx. 1/3 to forward direction.
12. After approx. 1 to 2 minutes shut down the engine for a minute.

i Note

This waiting time is necessary to allow air bubbles to escape through the leak oil return line.

13. After a waiting time of approx. 1 minute keep repeating this procedure, until the indicated charge pressure drops directly to zero when shutting down the engine.

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6.10 Bleeding the vibration circuit

Environment

Catch hydraulic oil and dispose of environmentally.

1. Install a pressure test hose to the charge pressure test port.
2. Install a pressure test hose each to the high pressure test ports.
3. Actuate the emergency stop switch.

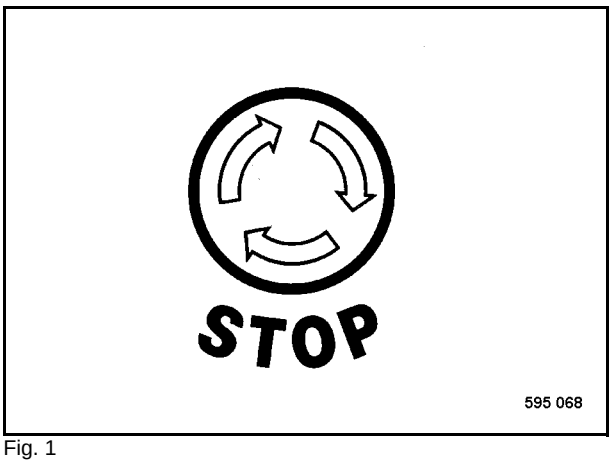


Fig. 1

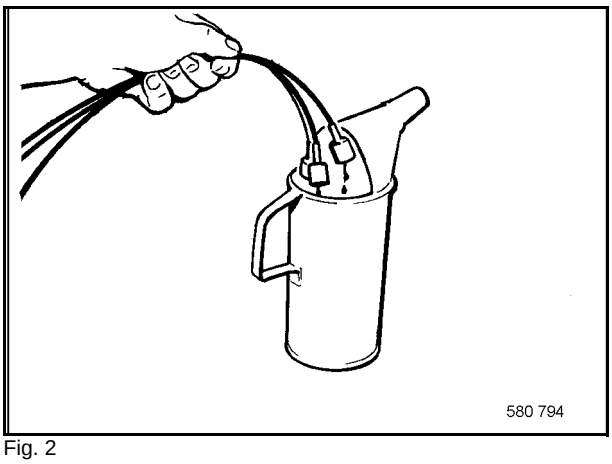


Fig. 2

4. Hold the open ends of the pressure test hoses (Fig. 2) into a container.
5. Crank the engine approx. 10 seconds with the starter motor. Wait one minute and keep repeating this procedure, until oil starts to run out from the pressure test hoses.
6. Remove the pressure test hoses.

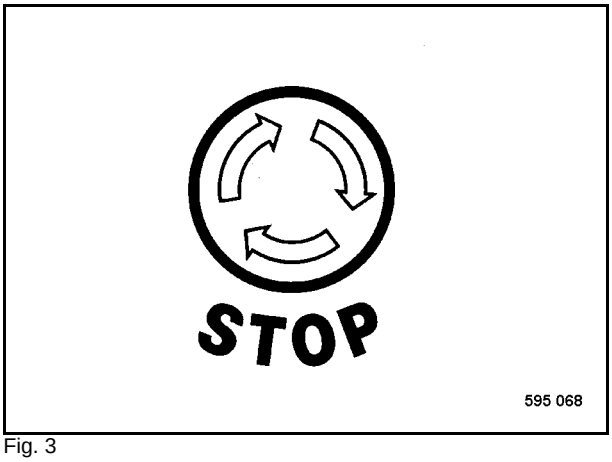


Fig. 3

7. Unlock the emergency stop switch

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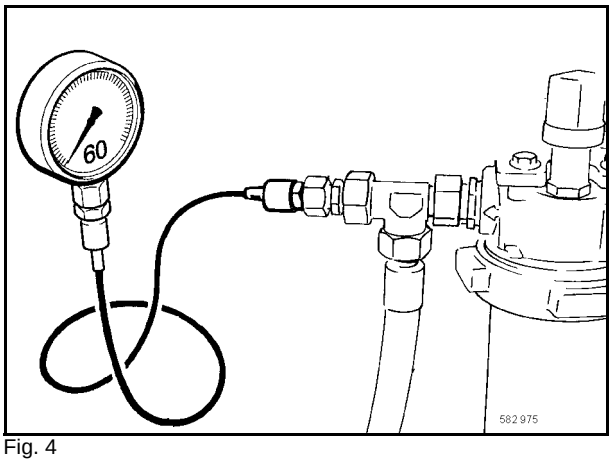


Fig. 4

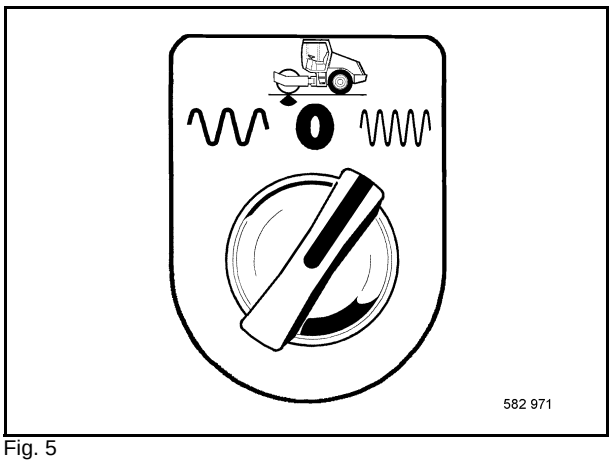


Fig. 5

8. Connect a 60 bar pressure gauge to the charge pressure test port (Fig. 4) and run the engine max. 15 seconds at idle speed.
9. Wait for approx. 30 seconds and repeat the procedure, until the pressure gauge shows a constant charge pressure.

⚠ Caution

With the flushing filter installed use only high frequency, as otherwise the flushing filter will be subjected to oil flow from the wrong direction.

10. For bleeding switch on vibration with high frequency (Fig. 5).
11. Start the engine.
12. After running the engine 1 to 2 minutes pause for approx. one minute.

i Note

This waiting time is necessary to allow air bubbles to escape through the leak oil return line.

13. After a waiting time of approx. 1 minute keep repeating this procedure, until the indicated charge pressure drops directly to zero when shutting down the engine.

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7 Fundamental electrics

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7.1 Understanding circuit diagrams

Wiring diagrams are graphical representations of circuitry conditions, related to the electrical system. They do not contain any information about the actual type of wiring, they only serve the purpose of visualizing the circuitry logics.

The wiring diagram is indispensable for effective and systematic trouble shooting in the vehicle wiring system. This plan provides the following information:

- Number and type of individual elements in the examined electric circuit, such as plug connectors, fuses, switches, consumers, relays, ...
- The sequence in which current flows through the individual elements in the electric circuit.
- Connections between the examined, faulty electric circuit and other circuits in the vehicle wiring system.
- Pin assignment of plug-and-socket connections.

Structure:

- Table of contents
- Function groups
- List of components

Table of contents

The table of contents lists all function groups.

Standardverkabelung; standard wireing: dicke Linien, thick lines

Platinenverdrahtung; connection on printed circuit board: dünne Linien, thin lines

Inhaltsverzeichnis: table of contents:

Blatt Nr.: sheet no.:	Zeichnungsnummer drawing - no.	Funktionsgruppe	function unit
001		Stromlaufplan	curcuit diagram
002		Versorgung	supply
003		Starten	starting unit
004		Überwachung	monitoring unit
006		Bremse	brake
007		Vibration	vibration
008	XXX XX	Warneinrichtungen	warning equipment
013		Arbeitsbeleuchtung StVZO	working head lights (road traffic)
014		Blinkbegrenzung	illumination
015		Kabine	cab
016		Heizung	heating unit
101		Bauteilliste	component listing
201		Kontrollmodul	monitoring board

1 2 3 4 5 6 7 8 9 10

Datum: Name:

Stromlaufplan circuit diagram

E0001

Seite: page: von: 001 from: 001

Ers.f.: Replaces:

Blatt Nr.: sheet no.: 001

Fig. 6 Table of contents

Example:

Function group "Warning systems“, drawing number XXX XX can be found on page no. 8.

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Function groups

On the individual pages the electric circuits are combined to function groups.

Arrangement of current paths

The individual current paths must be read as follows:

- From top (plus potential) to bottom (minus potential).
- From left to right.
- From function group to function group.
- Via cross references for potentials and relays.

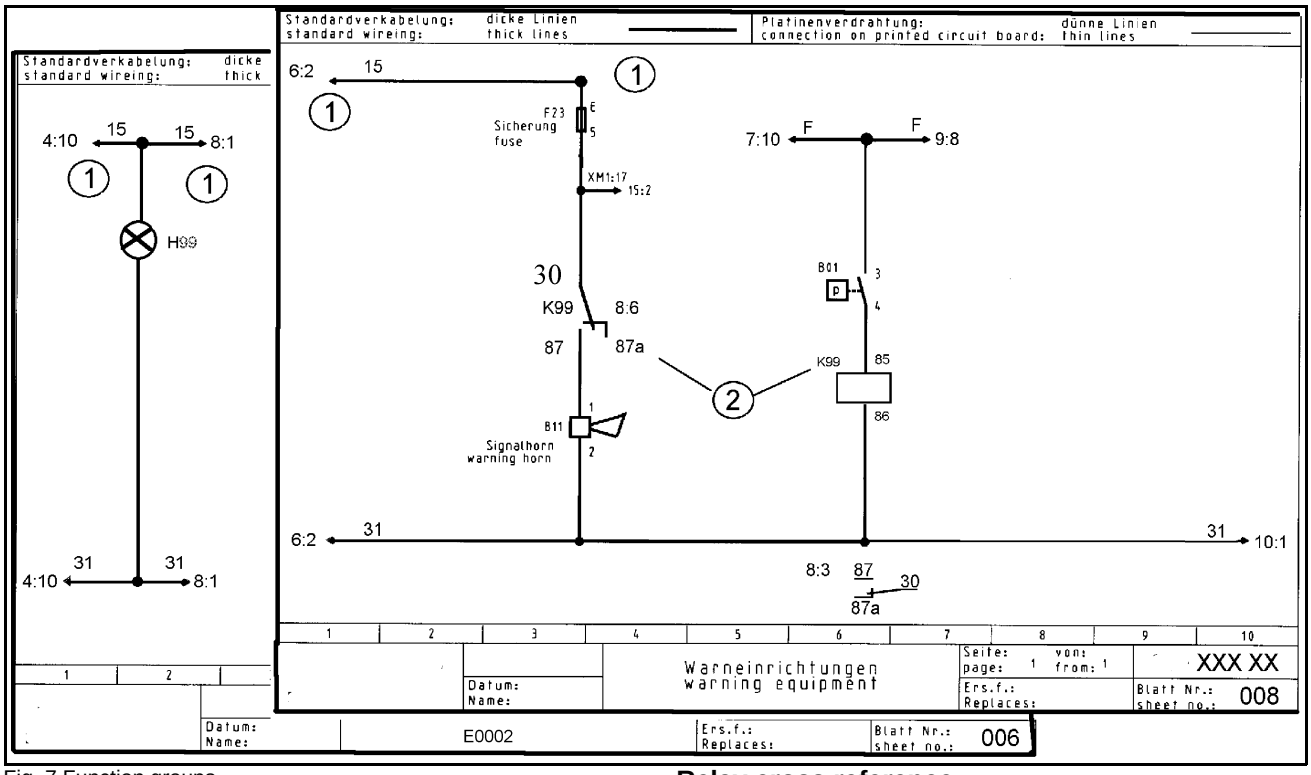


Fig. 7 Function groups

Potential cross references

Potential cross references serve the purpose of tracking signals, which are transmitted from one function group to another.

Example:

Potential "15" on page no. 6 is continued to the left on page no. 4 in current path "10" and to the right on page no. 8 in current path "1“.

Relay cross reference

Relay cross references serve the tracking of signals, which need to be tracked for components with outgoing contacts.

A mimic diagram with information about the contact types of a relay and their positions in the wiring diagram is additionally attached to the bottom of each contactor coil.

Example:

The coil of relay (K99) is located on page no. 8 in current path "6".

The mimic diagram under the relay informs that a change-over switch with contact types 30, 87 and 87a is triggered.

The changeover contact can be found on page no. 8 in current path "3".

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Current paths

The pages of a circuit diagram are sub-divided into current paths (Fig. 8) (0 ..... 20).

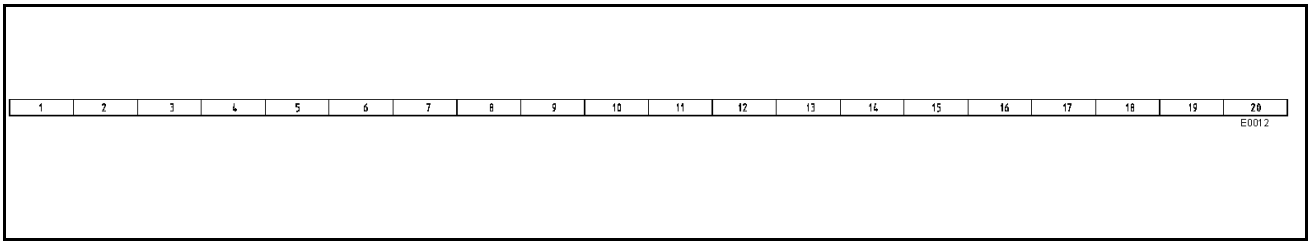
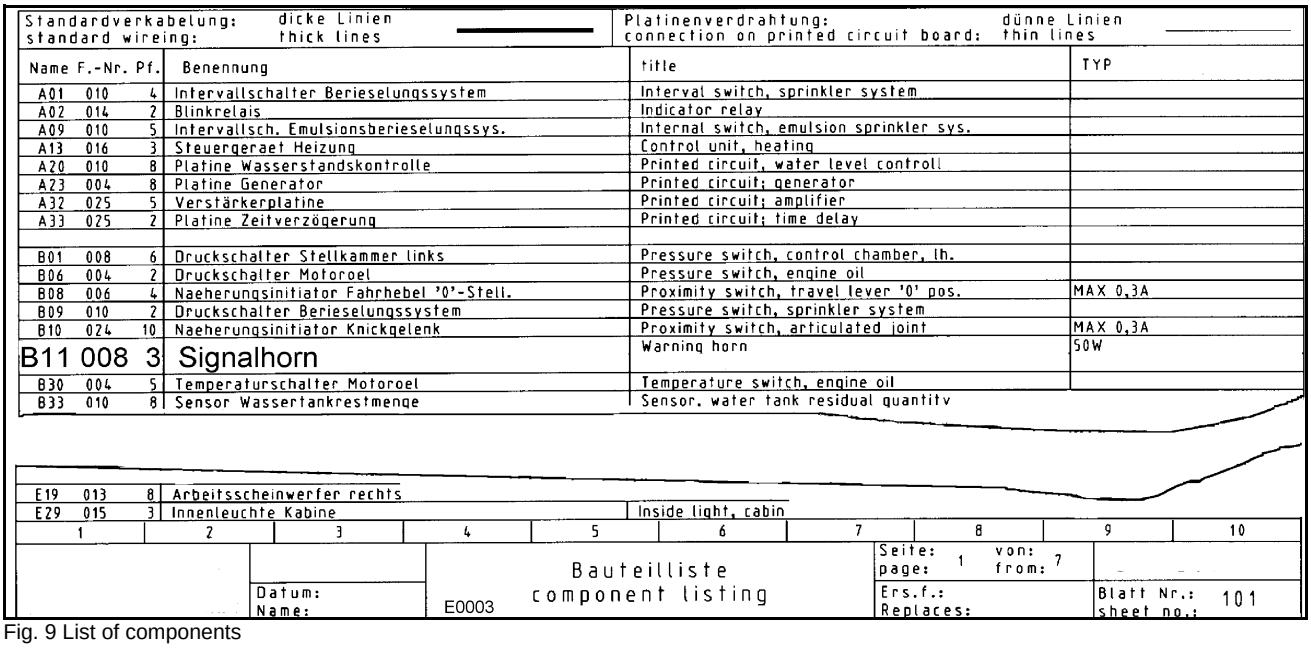


Fig. 8 Current paths

List of components

Here you find all components used in alphabetical order, related to the name of the component (A01, A02....).



Standardverkabelung: dicke Linien — standard wireing: thick lines

Platinenverdrahtung: dünne Linien — connection on printed circuit board: thin lines

Name	F.-Nr.	Pf.	Benennung	title	TYP
A01	010	4	Intervallschalter Berieselungssystem	Interval switch, sprinkler system	
A02	014	2	Blinkrelais	Indicator relay	
A09	010	5	Intervallsch. Emulsionsberieselungssys.	Internal switch, emulsion sprinkler sys.	
A13	016	3	Steuergeraet Heizung	Control unit, heating	
A20	010	8	Platine Wasserstandskontrolle	Printed circuit, water level controll	
A23	004	8	Platine Generator	Printed circuit; generator	
A32	025	5	Verstärkerplatine	Printed circuit; amplifier	
A33	025	2	Platine Zeitverzögerung	Printed circuit; time delay	
B01	008	6	Druckschalter Stellkammer links	Pressure switch, control chamber, lh.	
B06	004	2	Druckschalter Motoroel	Pressure switch, engine oil	
B08	006	4	Naeherungsinitiator Fahrhebel '0'-Stell.	Proximity switch, travel lever '0' pos.	MAX 0,3A
B09	010	2	Druckschalter Berieselungssystem	Pressure switch, sprinkler system	
B10	024	10	Naeherungsinitiator Knickgelenk	Proximity switch, articulated joint	MAX 0,3A
B11	008	3	Signalhorn	Warning horn	50W
B30	004	5	Temperaturschalter Motoroel	Temperature switch, engine oil	
B33	010	8	Sensor Wassertankrestmenge	Sensor, water tank residual quantity	
E19	013	8	Arbeitsscheinwerfer rechts		
E29	015	3	Innenleuchte Kabine	Inside light, cabin	

1 2 3 4 5 6 7 8 9 10

Datum: Name:

Bauteilliste
component listing
E0003

Seite: page: 1 von: from: 7

Ers.f.: Replaces:

Blatt Nr.: sheet no.: 101

Fig. 9 List of components

Component cross references

Example:

The warning horn "B 11" is located on page no. 8 in current path 3.

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Graphic symbol

Graphic symbols are standardized representations for electrical appliances. They serve the purpose of a simplified representation of complete systems, from which, however, the function can be clearly identified. This standardization is in compliance with the globally valid regulations of the IEC (International Electrical Commission). For Germany these symbols were included in the DIN-Standard. The standardization serves the purpose of global understanding and fault free connection of appliances, especially in automobile repairs.

Since the wiring diagram is intended to show only the most essential aspects, the graphic symbol only shows as much of the function, as is needed for easy recognition and for the avoidance of mistakes.

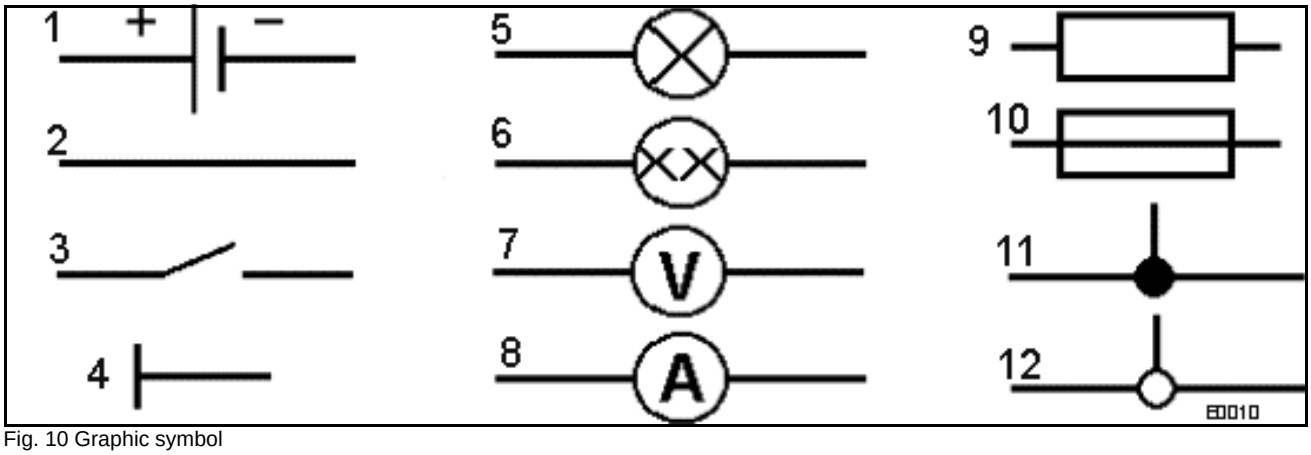


Fig. 10 Graphic symbol

1 Current source
2 Conductor
3 Switch
4 Ground
5 Filament lamp
6 Filament lamp with two luminous elements
7 Voltmeter
8 Amperemeter
9 Resistance
10 Backup
11 Line connection (fixed)
12 Line connection (separable)

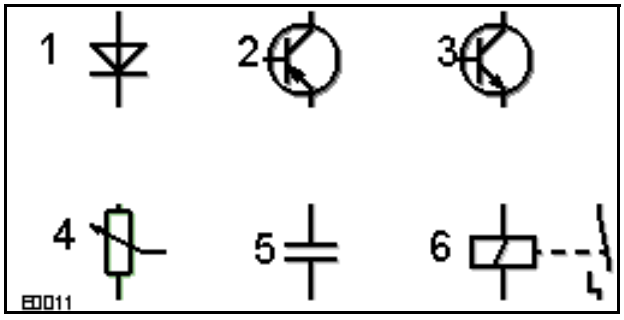


Fig. 11 Graphic symbol

1 Diode
2 Transistor
3 NPN-Transistor
4 changeable resistance
5 Condenser
6 Working current relay

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7.2 Terminal designations

For easier connection work almost every connection on a consumer or switch used in a motor vehicle has a terminal designation. In Germany the designation of the individual connection terminals is determined by the standard DIN 72552. The following table represents a section with the most important terminals from this standard.

Terminal designation	Meaning
1	Ignition coil, ignition distributor low voltage
1a	Ignition distributor with 2 separate electric circuits, to ignition timer 1
1b	Ignition distributor with 2 separate electric circuits, to ignition timer 2
2	Short circuit terminal (magneto ignition)
4	Ignition coil, ignition distributor high voltage
4a	Ignition distributor with 2 separate electric circuits, from ignition coil 1, terminal 4
4b	Ignition distributor with 2 separate electric circuits, from ignition coil 2, terminal 4
15	Switch plus (after battery) : Output of ignition-travel switch
15a	Output from dropping resistor to ignition coil and starter
17	Preheating starter switch, preheating
19	Preheating starter switch, starting
30	Battery plus direct
30a	Battery changeover relay 12V / 24V, input from battery 2 plus
31	Battery minus direct or ground
31a	Battery changeover relay 12V / 24V return line to battery 2 minus
31b	Return line to battery minus or ground via switch or relay (switched minus)
31c	Battery changeover relay 12V / 24V return line to battery 1 minus
32	Electric motors, return line
33	Electric motors, main connection
33a	Electric motors, limit shut down
33b	Electric motors, shunt field
33f	Electric motors, for 2nd lower speed range
33g	Electric motors, for 3rd lower speed range
33h	Electric motors, for 4th lower speed range
33L	Electric motors, counter-clockwise rotation
33R	Electric motors, clockwise rotation
45	Starter, separate starter relay output; starter: Input (main current)
45a	2-starter parallel operation, start relay for engagement current, output starter 1
45b	2-starter parallel operation, start relay for engagement current, output starter 2
48	Terminal on starter and on start repeat relay, monitoring of starting process
49	Input flasher relay
49a	Output flasher relay
49b	Flasher relay output 2nd flasher circuit
49c	Flasher relay output 3rd flasher circuit
50	Starter, starter control
50a	Battery changeover relay, output for starter control
50b	Starter control, parallel operation of 2 starters with sequence control

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Terminal designation	Meaning
50c	Start relay for sequence control of engagement current in parallel operation of 2 starters, input in starter relay for starter 1 Start relay for sequence control of engagement current in parallel operation of 2 starters, input in starter relay for starter 2
50d	Start locking relay, input
50f	Start locking relay, output
50g	Start repetition relay, input
50h	Start repetition relay, output
51	A.C.-generator, direct voltage on rectifier
51a	A.C.-generator, direct voltage on rectifier with reactance coil for day travel
52	Trailer signals: further signals from trailer to towing vehicle
53	Wiper motor input (+)
53a	Wiper motor (+) end limit shut down
53b	Wiper shunt winding
53c	Electric windscreen washer pump
53e	Wiper, braking effect
53i	Wiper motor with permanent magnet and 3rd brush for higher speed
54	Trailer signals, trailer plug device and lamp combination, brake light
54g	Trailer signals, compressed air valve for permanent brake in trailer, electromagnetically operated
55	Fog light
56	Head light
56a	Head light, travel light and travel light control
56b	Head lights, dimmed head light
56d	Head lights, flash light
57	Parking light for motor cycles (abroad also for cars and trucks)
57a	Parking light
57L	Parking light left
57R	Parking light right
58	Side lights, tail light, number plate light, dashboard light
58b	Tail light changeover for single axle trailers
58c	Trailer plug for single core wired and trailer fused tail light
58d	Adjustable dashboard light, tail light and side light
58L	Side light, left
58R	Side light, right
59	A.C.-generator (magneto generator), alternating voltage output or rectifier input
59a	A.C.-generator, charging armature output
59b	A.C.-generator, tail light armature output
59c	A.C.-generator, brake light armature output
61	Generator control
71	Intermittent tone control unit, input
71a	Intermittent tone control unit, output to horn 1 + 2 (low)
71b	Intermittent tone control unit, output to horn 3 + 4 (high)
72	Alarm switch (flashing beacon)

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Terminal designation	Meaning
75	Radio, cigarette lighter
76	Loudspeaker
77	Door valve control
81	Switch (breaker and two-way contact), input
81a	Switch (breaker and two-way contact), output 1
81b	Switch (breaker and two-way contact), output 2
82	Switch (maker), input
82a	Switch (maker), output 1
82b	Switch (maker), output 2
82z	Switch (maker), input 1
82y	Switch (maker), input 2
83	Switch (multi-position switch), input
83a	Switch (multi-position switch), output position 1
83b	Switch (multi-position switch), output position 2
83L	Switch (multi-position switch), output position left
83R	Switch (multi-position switch), output position right
84	Current relay, input drive and relay contact
84a	Current relay, output drive
84b	Current relay, output relay contact
85	Switching relay, output drive winding end (minus or ground)
86	Switching relay, input drive winding start
86a	Switching relay, input drive winding start 1st winding
86b	Switching relay, input drive winding start 2nd winding
87	Relay contact on breaker and two-way contact, input
87a	Relay contact on breaker and two-way contact, output 1 (breaker side)
87b	Relay contact on breaker and two-way contact, output 2
87c	Relay contact on breaker and two-way contact, output 3
87z	Relay contact on breaker and two-way contact, input 1
87y	Relay contact on breaker and two-way contact, input 2
87x	Relay contact on breaker and two-way contact, input 3
88	Relay contact for maker
88a	Relay contact on maker and two-way contact, (maker side) output 1
88b	Relay contact on maker and two-way contact, (maker side) output 2
88c	Relay contact on maker and two-way contact, (maker side) output 3
88z	Relay contact on maker, input 1
88y	Relay contact on maker, input 2
88x	Relay contact on maker, input 3
B+	Battery Plus
B-	Battery Minus
D+	Dynamo Plus
D-	Dynamo Minus
DF	Dynamo field (generator excitation current)
DF1	Dynamo field 1 (generator excitation current)

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Terminal designation	Meaning
DF2	Dynamo field 2 (generator excitation current)
U	Three-phase generator, three-phase terminal
V	Three-phase generator, three-phase terminal
W	Three-phase generator, three-phase terminal
C	Travel direction indicator (flasher relay) control light 1
C0	Main connection for control light separated from flasher relay
C2	Travel direction indicator (flasher relay) control light 2
C3	Travel direction indicator (flasher relay) control light 3 (e.g. for 2 trailer operation)
L	Indicator left
R	Indicator right

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7.3 Current and voltage

General

If one wants to describe electric current, this can most simply be accomplished by means of a comparison:

One simply compares electric current with water.

Voltage

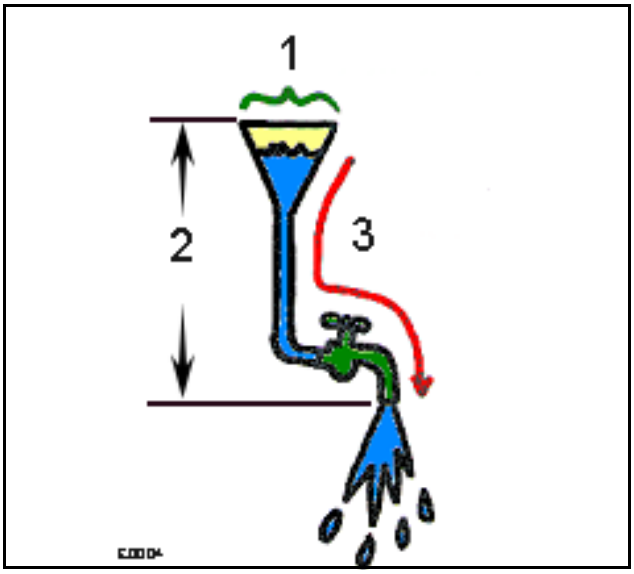


Fig. 1

1 (Fig. 1) Charge

2 Voltage

3 Current

The equalization attempt between different electric charges is referred to as electric voltage.

Voltage sources have two poles of different charge. On the one side we have the plus pole with a lack of electrons, on the opposite side the minus pole with a surplus of electrons. This electric "pressure" is known as electric voltage.

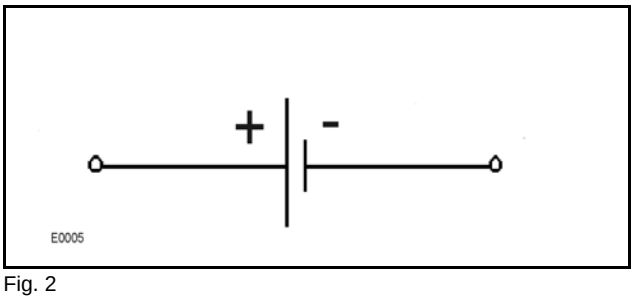


Fig. 2

If there is a connection between these two poles a discharge will take place, resulting in the flow of an electric current.

Plus pole= lack of electrons

Minus pole = excess of electrons

The following statements concerning electric voltage can be made

- electric voltage is the pressure or force applied to free electrons.
- the electric voltage is the cause of electric current
- electric voltage is a result of the equalization attempt of electric charges.

Voltage is measured with a Voltmeter.

Unit, Volt

The electric voltage (U) is measured in Volt (V).

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Current

Electric current generally describes the directed movement of charge carriers.

- The charge carriers may either be electrons or ions.
- Electric current can only flow if there is a sufficient amount of free moving charge carriers.
- The higher the number of electrons flowing through a conductor per second, the higher the amperage.

Current is measured with an ammeter.

Unit, Ampere

The electric amperage (I) is measured in Ampere (A).

The technical flow direction is specified from PLUS to MINUS.

i Note

Current actually flows from minus to plus, because the current flow is made up of negatively charged electrons.

But since this was only discovered after the poles of a current source had already been designated, the assumption that current flows from plus to minus was maintained for historic reasons.

Circuit

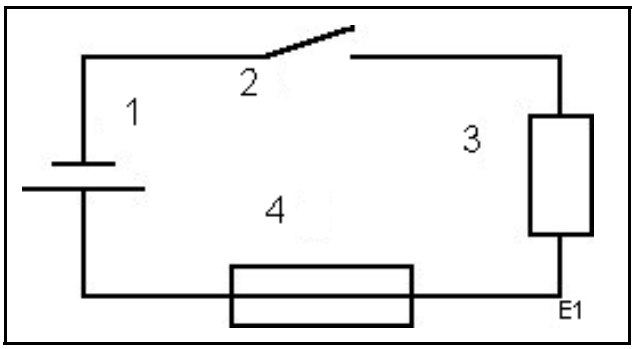


Fig. 3 Circuit

A simple circuit consists of a current source 1 (Fig. 3), a consumer (3) and the connecting wiring.

When the circuit is closed, current can flow.

The circuit can be interrupted or closed with a switch (2).

The system is protected by a fuse (4).

Types of current

Direct current (D.C.)

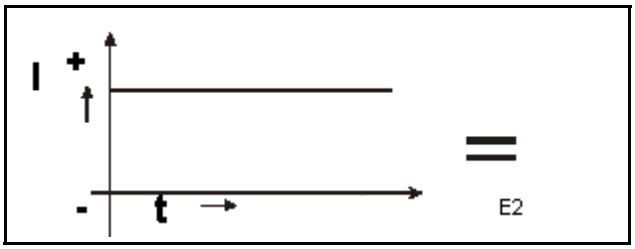


Fig. 1 Direct current (D.C.)

Direct current flows with steady voltage and amperage from the plus to the minus pole.

Pure D.C.-voltages are only delivered by accumulators or batteries.

The voltage in the vehicle wiring system is no pure D.C.-voltage. Even without the generator running, but the consumers switched on, the voltage is not constant, but drops gradually according to the battery charge condition.

The internal resistance of the battery also causes permanent changes in the vehicle voltage, as soon as consumers are switched on or off.

Alternating current (A.C.)

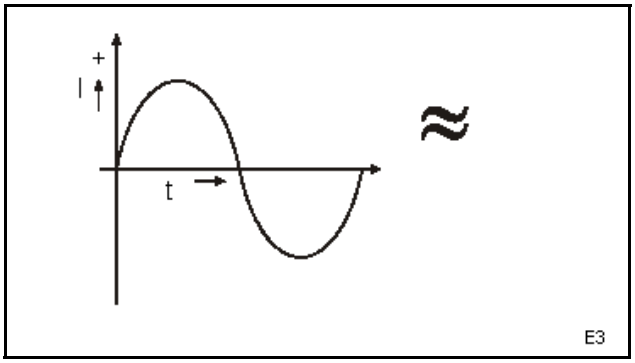


Fig. 2 Alternating current (A.C.)

Alternating current not only changes its direction, but also its amperage.

Pulsating direct current

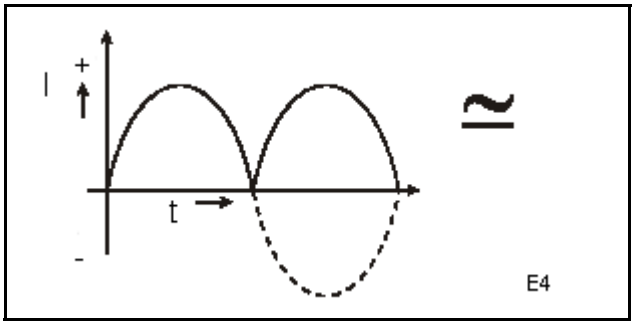


Fig. 3 Pulsating direct current

Converting alternating current into a direct current signal by means of a rectifier results in an pulsating direct current.

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Pulse width modulation (PWM)

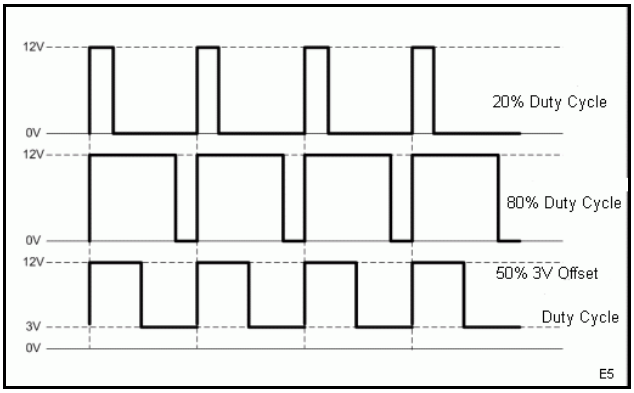


Fig. 4 PWM

The PWM signal is in most cases generated by a control and can be used to trigger proportional valves. The signal (square wave signal) is changed in its pulse control factor, the period, however, remains unchanged.

The following applies:

- The signal voltage cannot be measured.
- The current can be measured.

⚠ Caution

Solenoid valves must not be interference suppressed with suppressor diodes.

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Controller Area Network (CAN)

created by Bosch at the end of the eighties for automobile applications.

Development objectives:

Real-time critical, robust and low price communication of control units, such as transmission and engine control, but also less time critical applications in the field of convenience electronics, such as air conditioning.

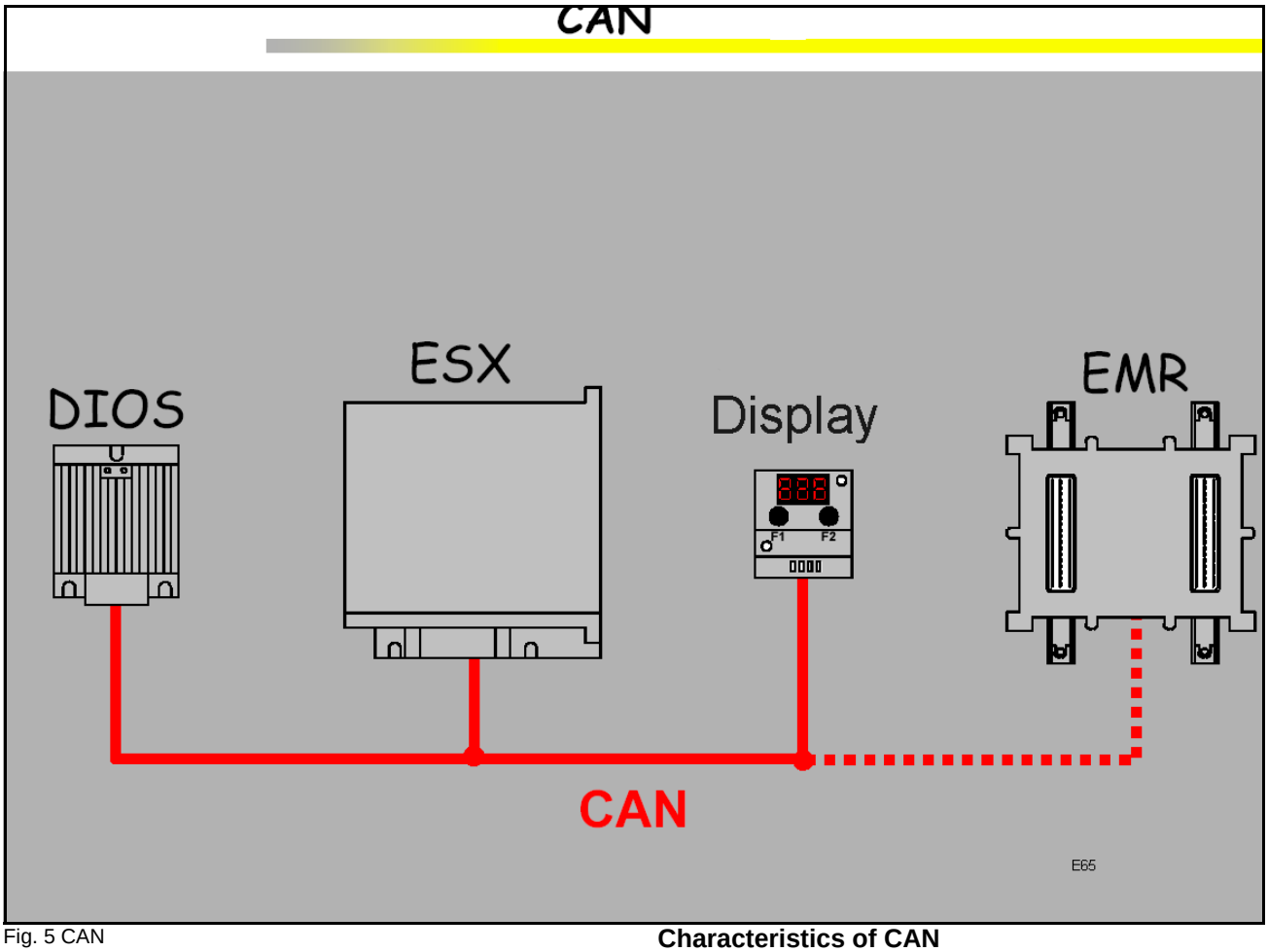


Fig. 5 CAN

Why CAN?

- Networking of control units for the realization of complex functions.
- Reduction of the extend of wiring and plug connections.
- Better diagnostic possibilities (central diagnostics socket).

Characteristics of CAN

It is a kind of serial data transmission. The individual bits are transmitted one after the other, only 2 lines are required.

CAN lines are twisted together 30 to 40 times per metre. Electromagnetic interferences therefore always occur simultaneously in both lines, the software is thus able to filter out interfering signals more easily.

Wire (+) = cable colour blue

Wire (-) = cable colour yellow

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7.4 Resistance

Resistance and voltage drop

While current flows through a conductor the current flow is more or less inhibited by the conductor, this inhibitation is referred to as Resistance.

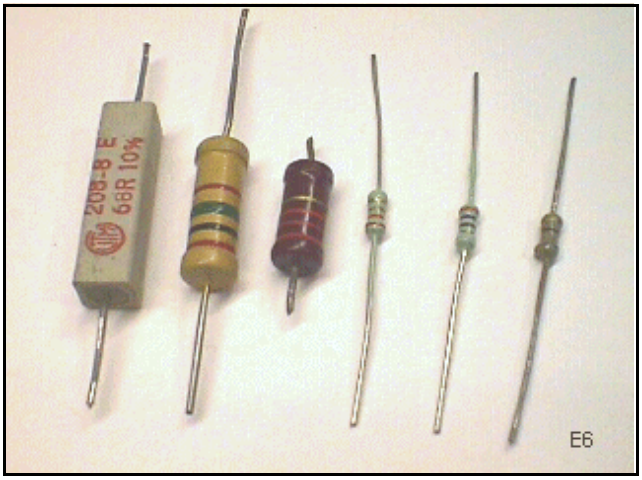


Fig. 1 Various size resistors

Each conductor has its specific resistance, which is characteristic for the corresponding material. A good conductor has a low resistance, a poor conductor has a high resistance.

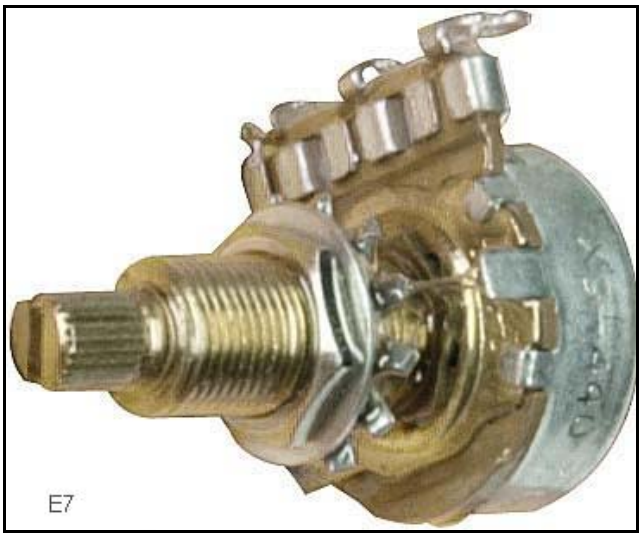


Fig. 2 Potentiometer, infinitely adjustable resistor

The resistance can only be measured with a Multimeter.

Symbol, R

Unit, Ohm Ω

The electric resistance (R) is measured in Ohm Ω

Rule of thumb:

- The thicker the cable cross-section, the lower the voltage loss.
- The shorter the cable, the better the current.
- The cleaner the contacts, the better the current.
- The quality of the ground cable is of the same importance as the supply line.

Unnecessary resistances

Unnecessary resistances are frequently caused by mechanical connections, even clean ones, but mainly soiled and oxidizes terminals, too thin cables, material with poor conductivity or bent open cable lugs.

Bad

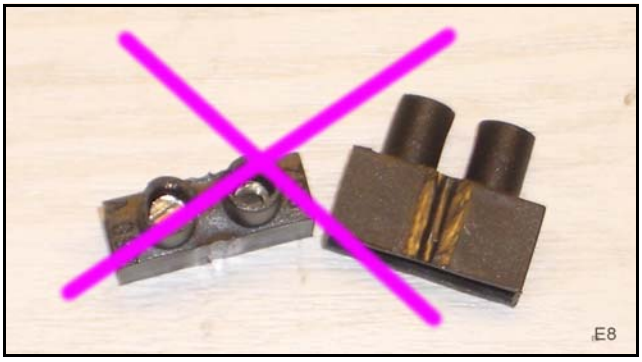


Fig. 1 Screw-type terminals

Copper wires are squashed and thus become faulty.

Better



Fig. 2 Spring clamps

Connecting clamps for flexible conductors

BOMAG No. 057 565 72

Ampacity up to 20 Amp.

Cable cross-section 0.08 to 2.5 qmm

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Fig. 3

In many cases it is better to replace the contact. Soiled or oxidized contacts should be cleaned with Ballistol (Fig. 4) and subsequently wetted with copper paste.

Copper paste is a heat resistant grease, which has been mixed with copper powder. The paste protects electric contacts against oxidation. Copper paste keeps water away.



Fig. 4 Balistol oil

Sometimes the flanks of flat plugs bend open. If these are closed again with the help of pliers the flanks will be excessively strained at the bend and will definitely break sooner or later. It is better to place a small nail under the bottom of the cable lug before bending.

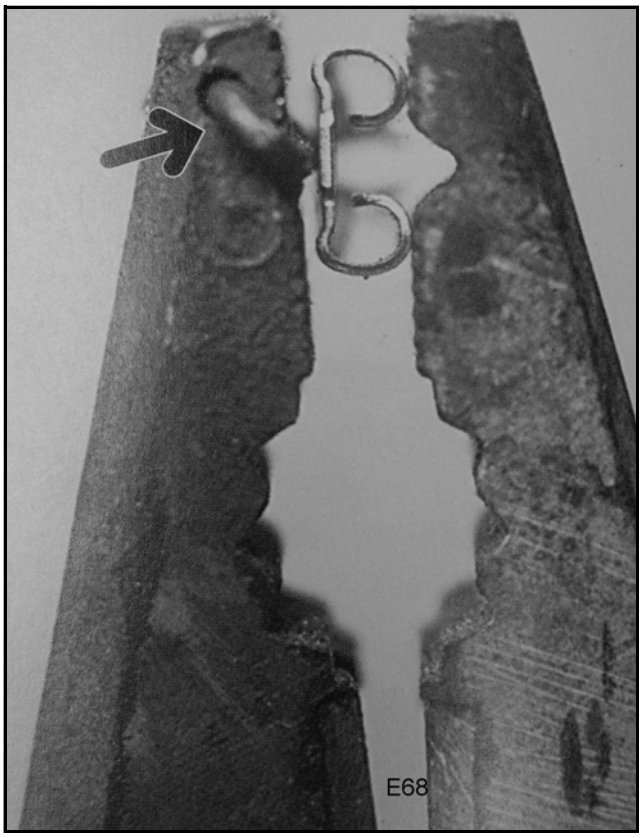


Fig. 5

Hint for practice:

A tool you cannot buy. The pliers were converted, the nail is permanently present.

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7.5 Series / parallel connection

Series connection

In a series circuit the resistors (consumers) are lined up one after the other and the same current (I) passes through each of the consumers However, series connection of consumers is not suitable in practice, as each resistance causes a voltage drop. In the vehicle wiring system all consumers are designed for the same vehicle voltage (e.g. 12 Volt).

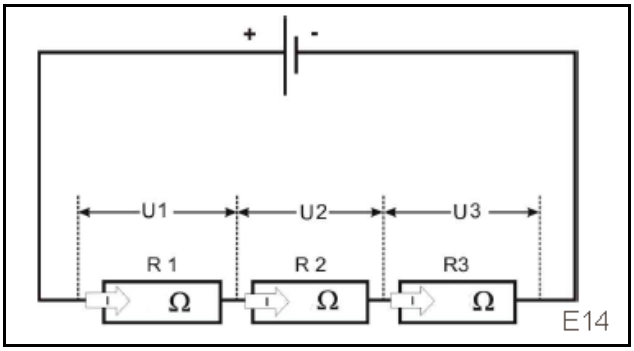


Fig. 1 Series connection

Current

In series connection the current is identical at every point.

Itotal = I1 = I2 = I3

Voltage

The sum of all partial voltages is identical with the total voltage.

Utotal = U1 + U2 + U3

Resistance

The sum of all partial resistances is identical with the total resistance.

Rtotal = R1 + R2 + R3

Series connection of batteries

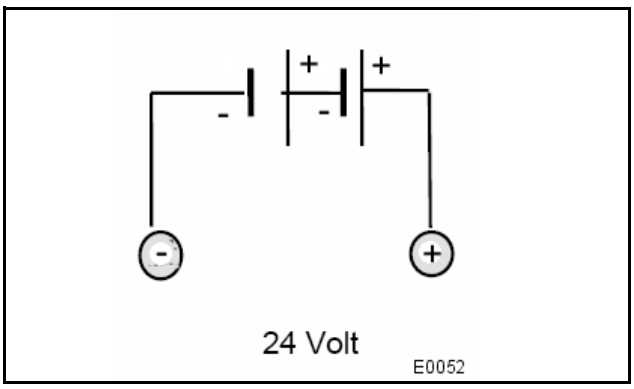


Fig. 2

In order to achieve a vehicle voltage of 24 V two batteries of the same type and capacity must be connected in series mode.

- In series connection the plus pole of the first battery must be connected with the minus pole of the second battery.
- The sum of all individual voltages is applied to the free poles.
- The total capacity (Ah) is identical with the capacity of the individual battery.

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Parallel connection

In parallel connection all resistances (consumers) are connected between feed and return line.

- All resistances (consumers) are supplied with the same voltage.
- Each of the resistances (consumers) draws as much current as required.

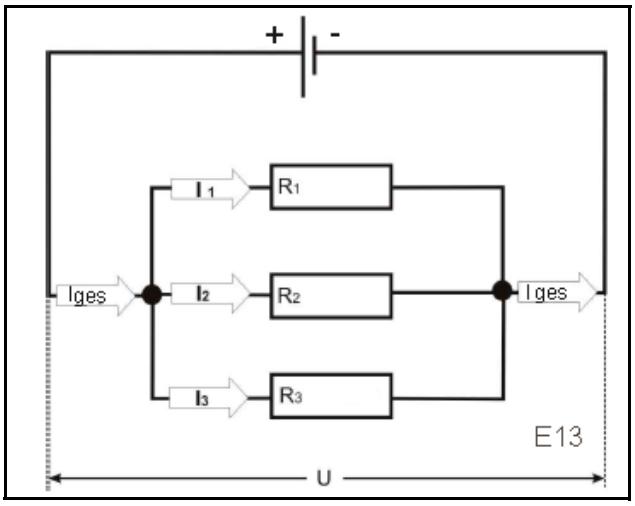


Fig. 3 Parallel connection

Current

The total current is the sum of all currents.

Itotal = I1 + I2 + I3

Voltage

The voltage values are identical at every resistance (consumer).

Utotal = U1 = U2 = U3

Resistance

The total resistance is less than the lowest individual resistance.

Parallel connection of batteries

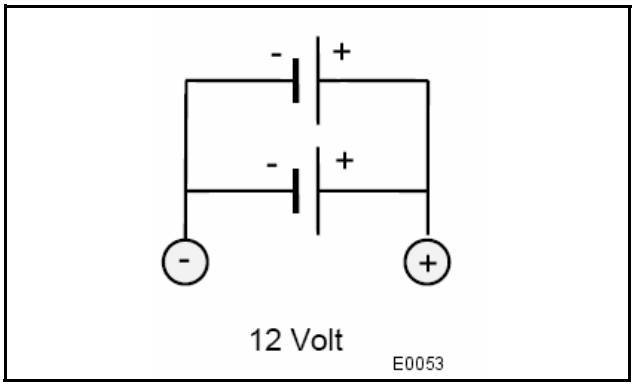


Fig. 4

By connecting 2 batteries of same type and capacity in parallel mode the capacity can be doubled, because the individual capacities add up to the total capacity.

- In parallel connection the plus pole of the first battery is connected with the plus pole of the second battery and the minus pole of the first battery with the minus pole of the second battery.
- Plus and minus poles have the voltage of the single battery applied.
- The total capacity (Ah) is identical with the sum of all battery capacities.

The disadvantage of a parallel connection becomes apparent, by equalizing currents flowing between parallel batteries, if the batteries have different states of charging.

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7.6 Ohm's law

In a closed electric circuit voltage, current and resistance must always be considered in close relation. This relation is represented by Ohm's Law.

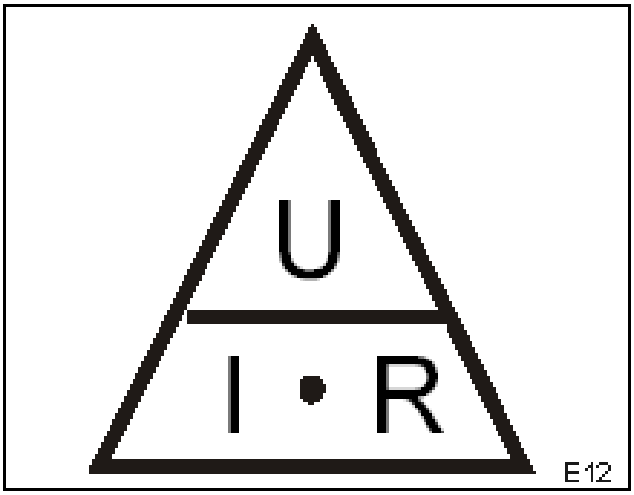


Fig. 1

According to this law a voltage of 1V is required to let 1A (ampere) flow through a conductor with a resistance of 1 (Ohm Ω).

Advice

By means of this triangle the formula can be easily rearranged, the value you are looking form must just be blanked off with a finger.

Voltage U = I multiplied with R

Resistance R = U divided by I

Amperage I = U divided by R

U = Voltage in Volt

I = Current in Ampere

R = Resistance in OHM Ω

7.7 Electrical energy

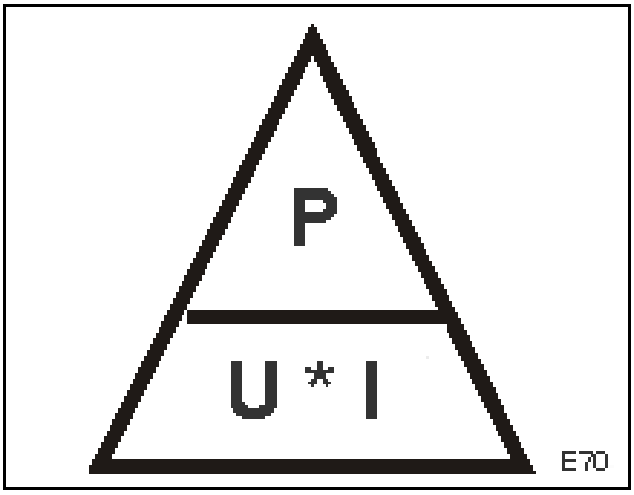


Fig. 1

In a closed electric circuit current and voltage generate energy.

If a current of 1 Ampere flows at a voltage of 1 Volt, energy of 1 Watt is produced.

Advice

By means of this triangle the formula can be easily rearranged, the value you are looking form must just be blanked off with a finger.

Energy P = I multiplied with U

Amperage I = P divided by U

Voltage U = P divided by I

U = Voltage in Volt

I = Current in Ampere

P = Power in Watt

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7.8 Formula diagram

Description:

- Select the desired value from the inner circle.
- Determine the formula variables in the quarter circle
- Calculate

Example:

P = 150 Watt

U = 24 Volt

Sought for = Current in Ampere

I = P : U = 150 W : 24 Volt = 6.25 Ampere

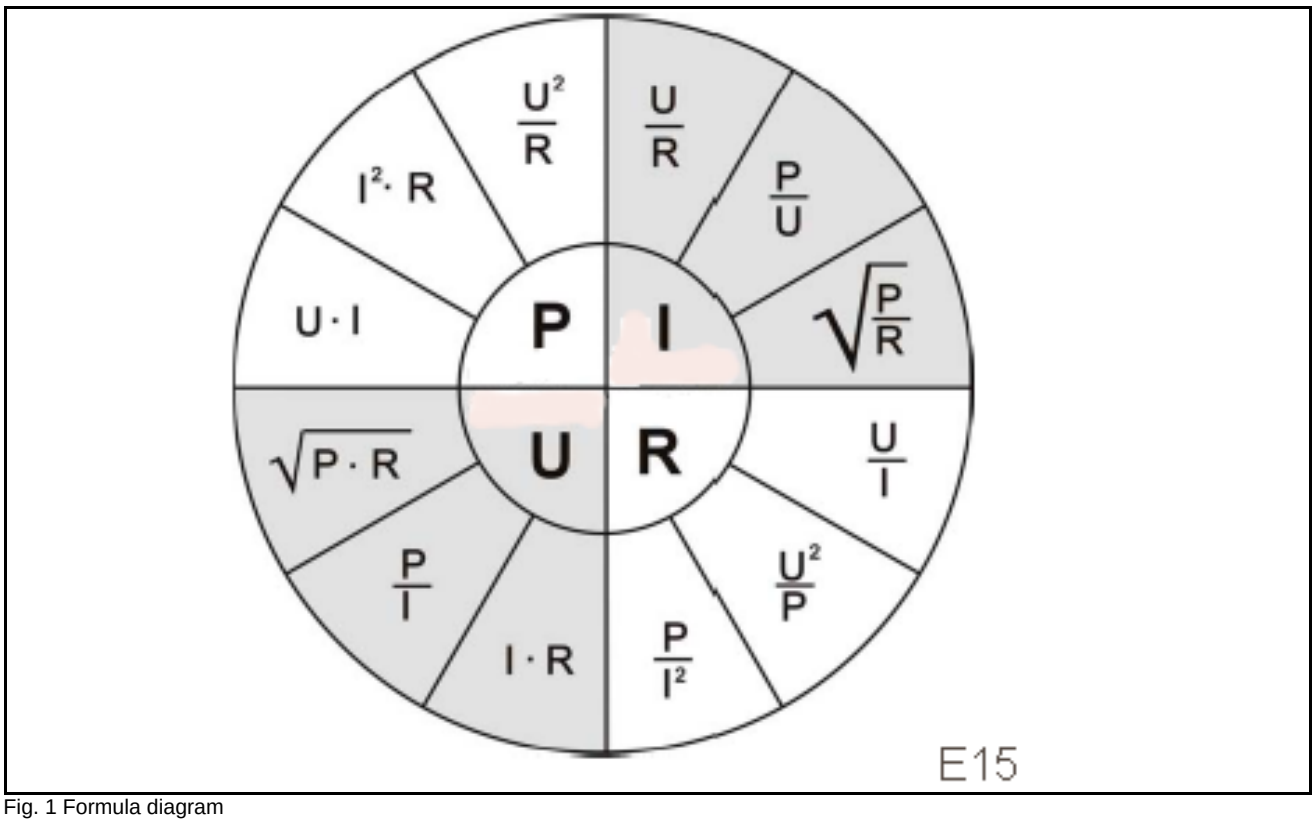


Fig. 1 Formula diagram

Resistance, R Ohm Ω

Voltage, U Volt

Current, I Ampere

Power, P Watt

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7.9 Metrology

Test lamps

Test lamp

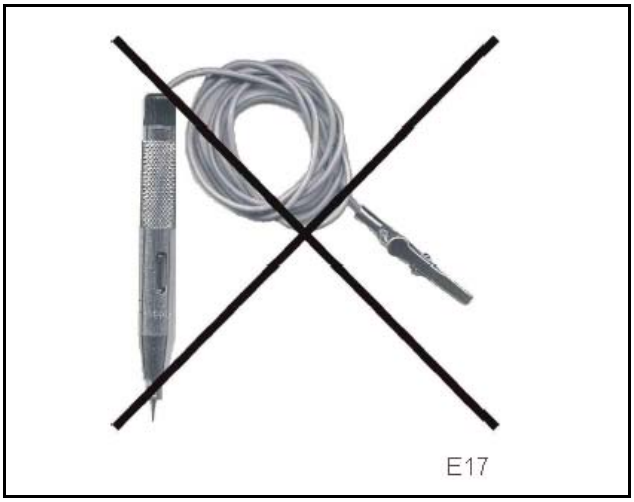


Fig. 1 Test lamp

⚠ Caution

This type of tester must not be used for testing on electronic components. The high power consumption of the test lamp may destroy electronic components in the control units.

Diode test lamp

This instrument is used for simple voltage measurements. The test lamp consists of two test points. The negative measuring cable is connected to ground and the positive measuring cable to the corresponding measuring location.



Fig. 2 Diode test lamp

If voltage is present, the corresponding light emitting diode will light up.

Multimeter

This tester is a multimeter and can be used to measure e.g. current, voltage and resistance. Depending on the design it may also be suitable for transistor and frequency.

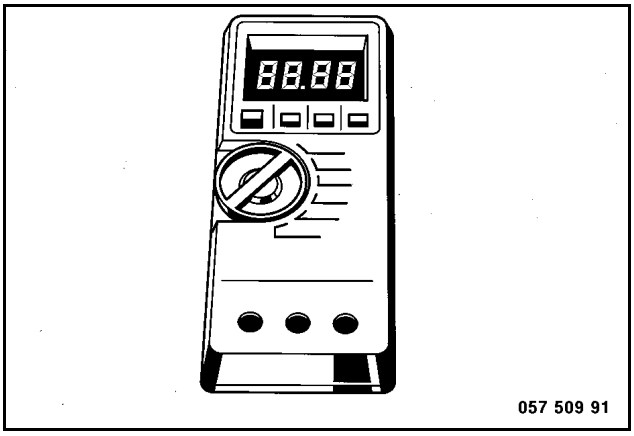


Fig. 1 Multimeter

In order to avoid damage:

- the range selector switch must be correctly set for the corresponding measurement.
- the test cable must be plugged into the correct socket.
- the voltage type (AC/DC) must be set.
- In case of direct voltage the correct polarity must be assured.
- the measuring range should be chosen higher at the beginning of the test.
- In order to avoid any influence on the circuitry to be measured, the internal resistance of the voltage tester should be as high as possible.

Resistance and continuity measurement with multimeter

The continuity tester of the multimeter can be used to measure whether there is a connection between 2 measuring points. The following information should be observed when measuring resistance and continuity:

- The component to be measured must not be connected to the power supply during the measurement.
- At least one side of the component to be measured must be disconnected from the circuitry, as otherwise the measuring result may be influenced by parallel components.
- Polarity is of no significance.

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Voltage and voltage drop measurement with multimeter

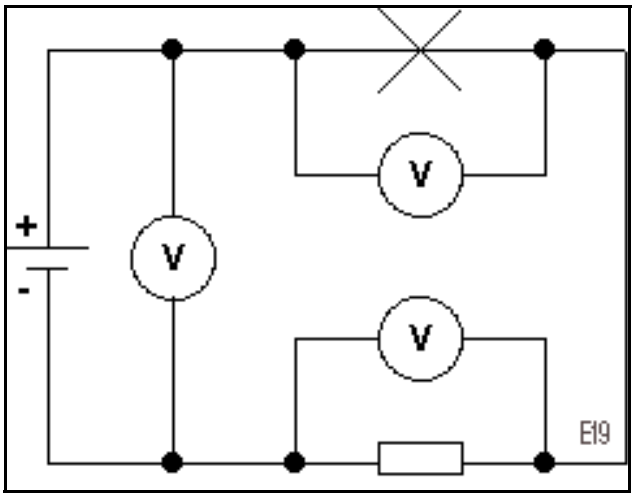


Fig. 2 Voltage measurement

- The meter is always connected parallel to consumer, component or power source.
- Measurement at the voltage source measures the currently available Voltage.
- A measurement at the consumer measures the voltage drop at this component.

Current measurement with the multimeter

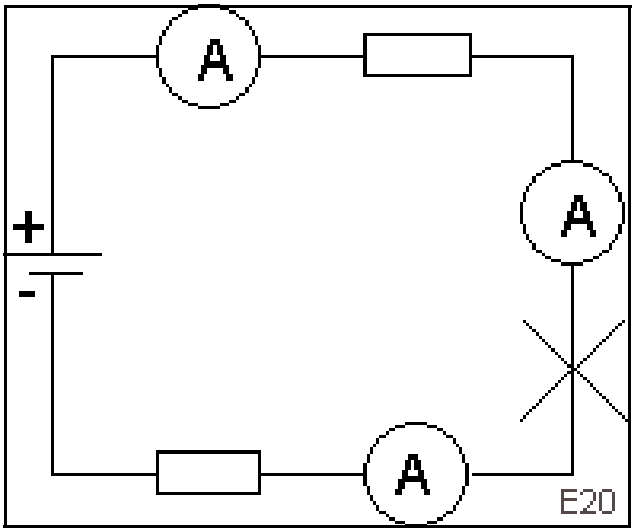


Fig. 3 Current measurement

- During the measurement the current must be able to flow through the meter, i.e. the electric circuit must be opened. The meter is connected in series with the consumer.

Advice

If the electric circuit is difficult to access and the internal resistance of the consumer is known, the voltage may also be measured at the consumer.

The current value can then be calculated with the help of Ohm's law.

Clip-on measuring instrument

The clip-on measuring instrument can be used to measure current, voltage and resistance.



Fig. 1 Clip-on measuring instrument

- For measuring current the individual conductor must be fully enclosed by the measuring tongs, the actual measurement takes place without contact.

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Magnet tester



Fig. 1 Magnet tester

The magnet tester is used to test solenoid valves and magnetic coils.

The test lamp responds to the magnetic fields of A.C-voltage, D.C.-voltage and permanent magnets.

- The component to be tested does not need to be removed.
- The magnetic coil can also be tested under a protective cap.

7.10 Diodes, relays, fuses

Diodes

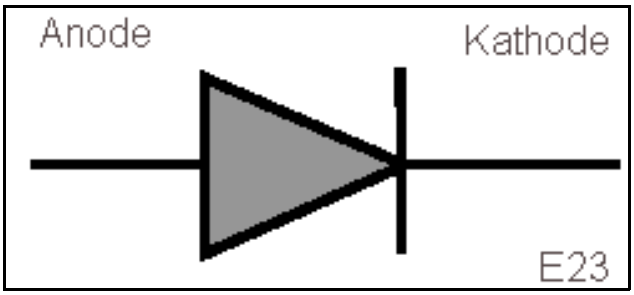


Fig. 1

A diode consists of two different semi-conductors, which are connected by a separating layer. The max. conducting state current must not be exceeded.

Plus-voltage on diode:

- At 0.6 – 0.7 Volt (silicium diode) the diode becomes conductive.

Negative voltage on diode:

- The diode does not allow current to pass through.



Fig. 2 Marking of the cathode

Diodes are used:

- For rectifying A.C. voltage.
- For absorbing voltage peaks (free-wheeling diode).
- For construction of logical circuits.

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Diode logics and free-wheeling diode

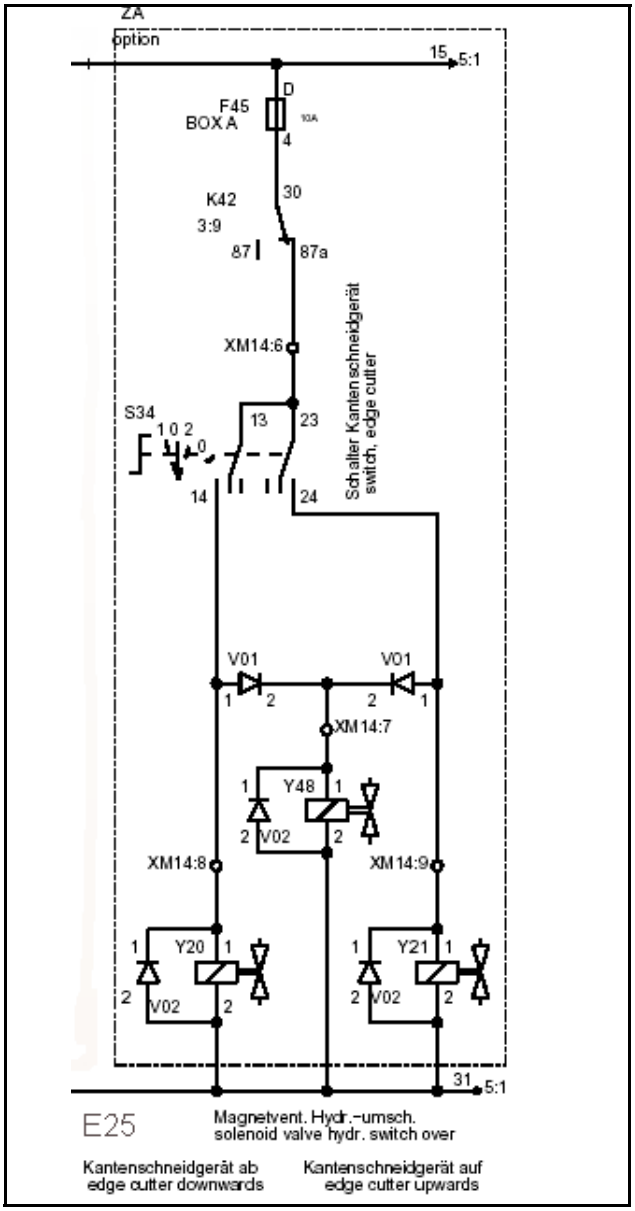


Fig. 3 Diode circuitry

- The solenoid valve Y48 (Fig. 3) is supplied with electric current when switch S34 is switched to position "1" or "2".
- Solenoid valve Y20 is supplied, if the switch is in position "1".
- Solenoid valve Y21 is supplied, if the switch is in position "2".

The three diodes V02 serve as free-wheeling diodes with the function of of eliminating voltage peaks.

Light emitting diodes

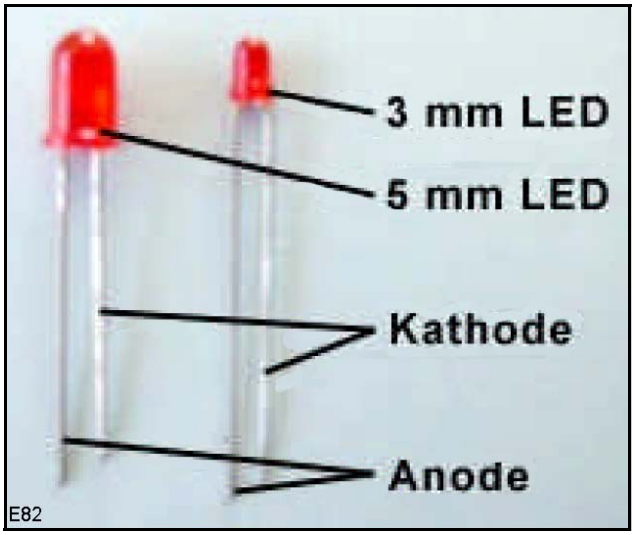


Fig. 4 LED

The light emitting diode, also referred to as LED, is a semi-conductor diode, which generates (emits) light during operation in forward direction. A semi-conductor crystal thereby emits a light signal, which is converged or scattered by the lenticular shape of the head. Light emitting diodes are available in various colours, sizes and shapes. They are for this reason used as signal lamps. This component is constructed of different semi-conductor crystals, depending on its colour. It works like any other semi-conductor diode.

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Relays

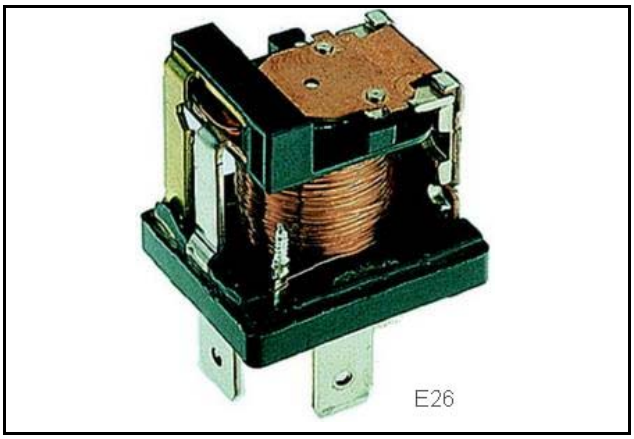


Fig. 1 Relays

Relays are commonly used to realize switching processes.

A free-wheeling diode prevents induction voltage from flowing back from the coil into the vehicle wiring system, which would cause interference with electronic components (control units).

With the possibility of using breaker - maker contacts the effect of an information can be reversed.

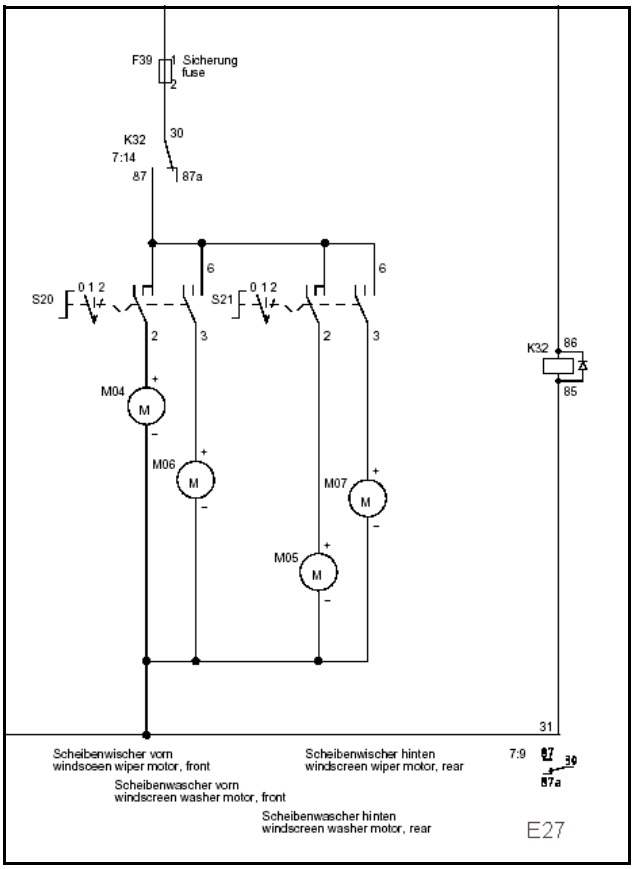


Fig. 2 Relay circuitry

The windscreen wiper and washer motors can only be operated via switches S20 and S21, when relay K32 is supplied with electric current (Fig. 2).

86 = Positive supply for coil

85 = Ground supply for coil

30 = Supply voltage

87 = Normally open contact

87a= Normally closed contact

Fuses



Fig. 1

Fuses are used to protect lines and equipment against overloads and short circuit. If the fuse is overloaded the fusible wire heats up with increasing current, until it finally melts.

⚠ Caution

Fuses must not be repaired or bridged.

The melting time at 23 °C is:

- approx. 1 hour with 1.5 times the rated current
- approx. 1 minute with 2.5 times the rated current.

A 5 Amp fuse loaded with 1.5 times the rated current (7.5 Amp) will finally melt after approx. 1.5 hours.

Yellow = 5 A

Brown = 7.5 A

White = 8 A

Red = 16 A

Blue = 25 A

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7.11 Batteries

Battery – accumulator

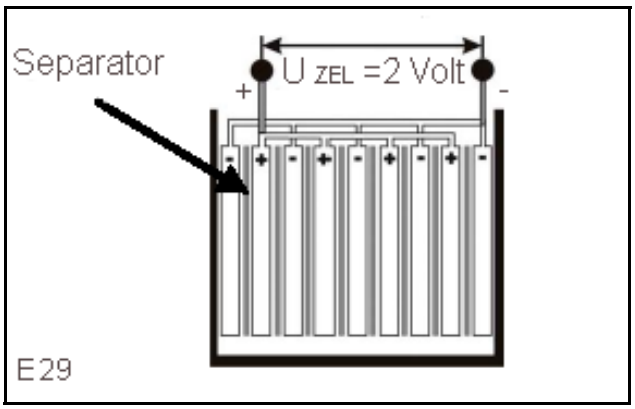


Fig. 1

In vehicles batteries are used to start the engine. The ability to start the engine depends on the charge condition of the batteries.

Lead collectors or accumulators are secondary elements, i.e they can be recharged after discharging electric current.

The basic element of a lead accumulator is the cell. It contains the plate blocks consisting of positive and negative plates. These plates are separated from each other by separators.

All positive plates are arranged parallel to the plus pole, the negative plates parallel to the minus pole of the cells.

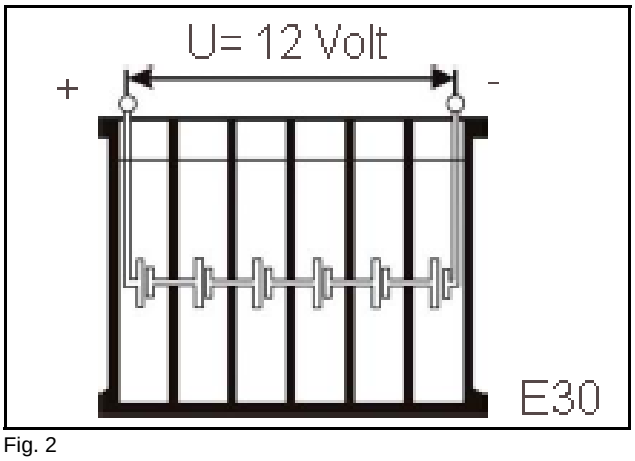


Fig. 2

All cells are filled with a conductive fluid, the electrolyte. For a 12 Volt battery 6 cells are connected in series.

Capacity

is a synonym for the amount of current taken up and discharged by a battery over a specified period of time.

Battery maintenance

i Note

Maintenance free batteries are gaining more and more significance, this freedom from maintenance, however, is only limited to the fact that no water needs to be added.

If the battery is not charged and discharged over a longer period of time, the battery will slowly discharge by itself.

The accumulator may only be discharged down to a final discharging voltage of 10.5 Volt, as otherwise there is a risk of sulphation, i.e. the generated lead sulphate forms increasingly coarser crystals, which will finally not react at all or only very sluggishly during a subsequent charging process.

In the worst case the accumulator can only be disposed of after such an exhaustive discharge.

The following therefore applies for longer downtimes:

- Remove the battery and store it in a cool, dry and frost protected room.
- Check the open circuit voltage on the battery at regular intervals (at least once every month).
- Recharge immediately if the open circuit voltage has dropped to 12.25 Volt (no rapid charging).

i Note

The open circuit voltage of batteries occurs approx. 10 h after the last charging or approx. 1 h after the last discharge.

Battery test in general

- Is the battery leaking? Can traces of impact, shock or compression be found in the leaking area?
- Check for e.g. incorrect fastening, foreign bodies on the battery mounting surface and similar.

Testing batteries with screw plugs

Checking the acid density:

- The cells are filled with diluted sulphuric acid as electrolyte (approx. 25 Vol% sulphuric acid in distilled water), also referred to as accumulator acid, which has a density of 1.285 kg/dm^3 at a temperature of +27° Celsius. This means that one litre of electrolyte has a weight of 1.285 kg. As the cell is being discharged lead sulphate (PbSO4) will form on both electrodes and the electrolyte will increasingly change to water. Since water has a lower specific weight than diluted sulphuric acid the density of the electrolyte will also drop during the discharge and with a fully discharged cell and a temperature of 27°C it will only be 1.18 kg/dm^3.
- With a lead cell the acid density is therefore a measure for the charge condition. This characteristic is used to determine the charge condition of a lead

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battery. The so-called acid tester (hydrometer) is used for this purpose. In a battery of good condition the acid density should be the same in all cells.

Acid density at 27 °C in kg/dm^3

- 1.25 -1.28, open-circuit voltage approx. 12.7 Volt. Battery is charged.
- 1.20 -1.24, open circuit voltage approx.12.4 to 12.5 Volt, is 50% discharged. Charging is necessary.
- 1.19 and less, open circuit voltage less than 12.3 Volt. Battery is insufficiently charged. Battery needs to be recharged immediately.

i Note

If the current consumption during charging is not 1/20 of the nominal capacity (example 100 Ah battery: 100Ah x 1/20 = 5 A) or full charging of the battery results in a final acid density of only 1.24 kg/dm^3 or less, the battery shows normal wear by aging. The battery was insufficient charging or exhaustive discharge.

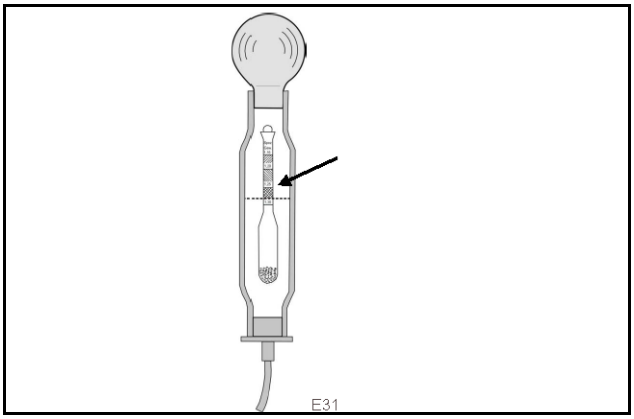


Fig. 3 Reading the acid level

- Maximum permissible tolerance between highest and lowest measuring value of the 6 cells: 0.03 kg/dm^3.

Testing batteries without screw plugs

On closed batteries the acid density cannot be measured, we therefore recommend testing with the following mobile tester:



Fig. 4 Battery and generator tester

The battery and generator tester comes with an 8-line LC display with background illumination and is able to print out test results via an (optional) integrated thermal printer.

i Note

Before testing clean the poles and ensure good connection between clamps and poles.

The test program calculates the text messages "good" or "replace" on the basis of the charge condition (derived from the battery voltage) and the currently available starting power of the battery. A battery with 45% starting power may thus be rated good and another one with 75% starting power as poor ("replace").

The starting power represents the ratio of detected cold testing current to the entered cold testing current of the battery.

The starting power can exceed 100%.

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Charge condition with hydrometer

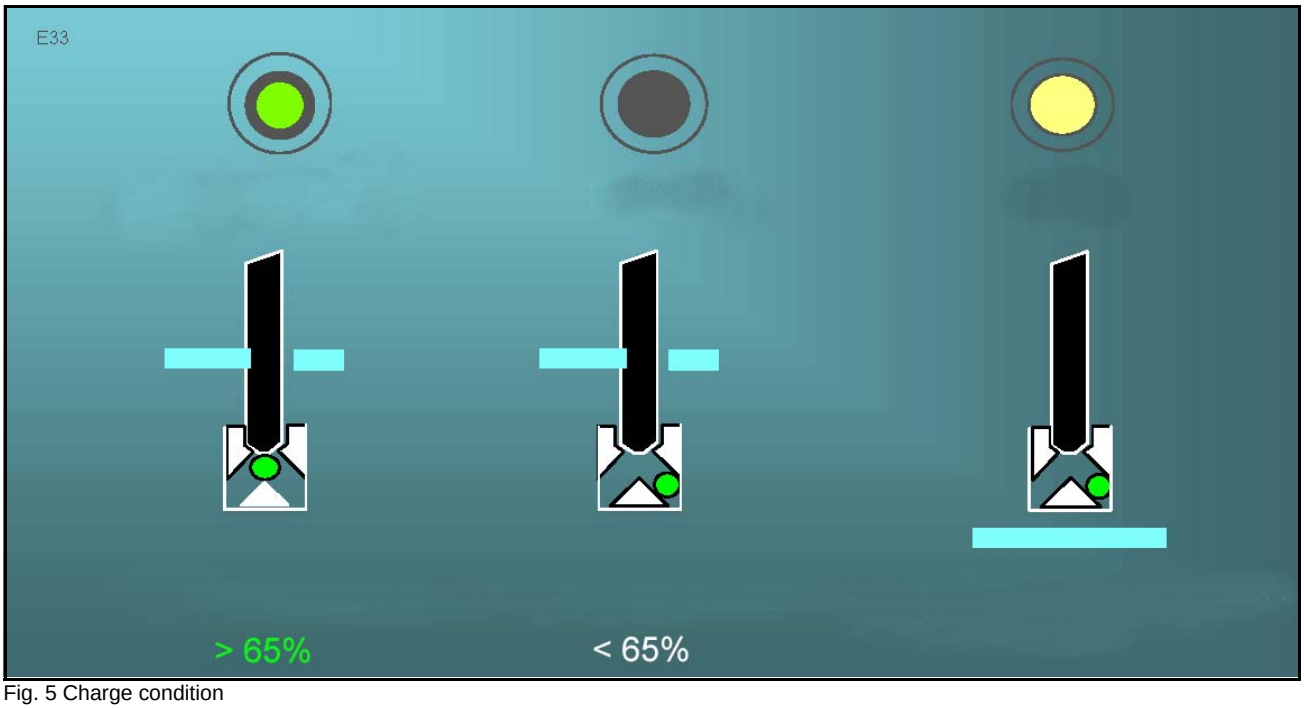


Fig. 5 Charge condition

Green = Charge condition >65%

Dark = Charge condition <65%

Light = Electrolyte level too low

⚠ Danger

Danger of explosion!!! If the electrolyte level is too low, the battery must no longer be charged.

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7.12 Three-phase generator

General

The generator should be of light weight, have a high rate of efficiency and supply all consumers in the vehicle with electric current at a steady voltage already at idling speed.

i Note

Three-phase generators must only be operated in combination with regulator and battery.

Batteries must not be connected with reversed polarity.

Plus and minus cables must be disconnected during rapid charging of the battery or electric welding on the vehicle.

⚠ Caution

Before removing the generator you must disconnect the ground cable from the minus pole of the battery while the ignition is switched off. Do not disconnect the generator while the engine is running, because this may cause extremely high voltage peaks in the vehicle wiring system ("Load Dump"), which could possibly damage control units, radios or other electronic equipment.

When disassembling the battery cable, the B+-nut underneath on the generator side may also be loosened. This nut must in this case be retightened.

When connecting e.g. the battery cable to the terminal of the generator you must make sure that the polarity is correct (generator B+ to the + pole of the battery). Mixing up the polarities by mistake causes short circuit and damage to the rectifier elements - the generator will be out of function.

The generator can only be operated with the battery connected. Under special conditions emergency operation without battery is permitted, the lifetime of the generator is in such cases especially limited.

Plus and minus cables must be disconnected during rapid charging of the battery or electric welding on the vehicle.

When cleaning the generator with a steam or water jet make sure not to direct the steam or water jet directly on or into the generator openings or ball bearings. After cleaning the generator should be operated for about 1 - 2 minutes to remove any deposits of water from the generator.

In the generator the armature windings are located inside the stationary stator, whereas the exciter winding is arranged on the internally revolving rotor (Fig. 6).



Fig. 6 Rotor with claw poles

The three stator windings (Fig. 7) are electrically offset to each other by 120°. The excitation of the magnetic field requires direct current, which is fed to the rotor via two carbon brushes and slip rings.

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Fig. 7 Stator with 3 windings

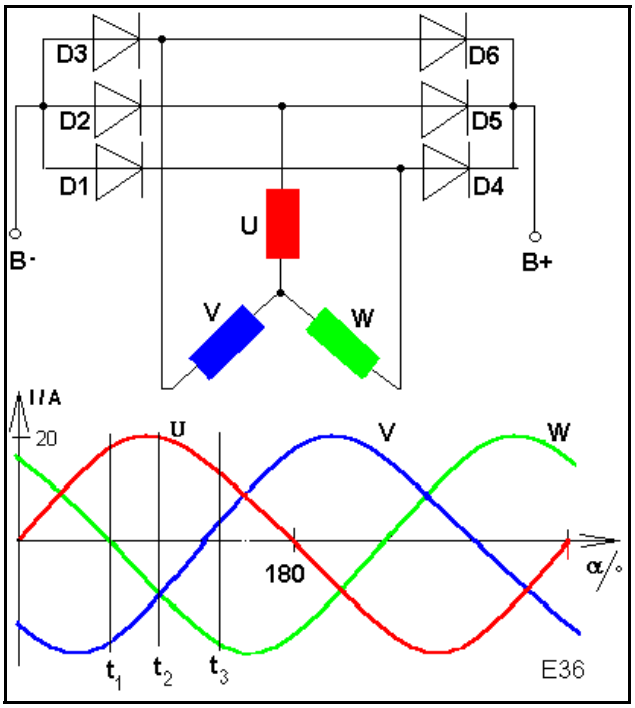


Fig. 8 3-phase current

The generator first of all produces three-phase voltage / three-phase current.

The wiring diagram (Fig. 8) shows the 3 windings in Y-connection and the 6 associated rectifier diodes.

The diodes D1, D2, D3 are also referred to as minus diodes, because they have B- as common connection (minus plate).

The other diodes are the plus diodes.

The rectifier diodes have the effect that the negative half-wave is suppressed and only the positive section of the wave is allowed to pass, resulting in a pulsating D.C. voltage.

Reverse current protection

The rectifier diodes also prevent discharging of the battery via the stator windings. The current can only flow from the generator to the battery.

Why does three-phase current need to be rectified and how does this work?

There are a few components for which can either be operated with alternating current or direct current, because they work independently from the current flow direction.

This includes :

- Incandescent lamps
- Fluorescent lamps
- Glow lamps
- Electric heating elements.

There are also a few components that could be operated either with alternating current, direct current or three-phase current, if the components were designed accordingly.

This includes :

- Electric motors
- Relays

Finally, a variety of important components solely require direct current. These will under no circumstances work with alternating or three-phase current.

This includes :

- Accumulators
- Control units
- All electronics
- Communication equipment.

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Charge control light

It has by no means the function to show whether the ignition is switched on or off. It has the function of indicating that the generator works correctly. Under normal operating conditions the generator should work and the charge control light should be off. The charge control lamp receives (+) from the battery at one pole. The other pole is connected to (D+), i.e. the (+) carbon of the generator. If the generator is working correctly, (+) is attached to both connections on the charge control lamp. Since there is no difference in voltage, no current can flow, the lamp does not light up. If the generator does not work, current flows via the (+) carbon through the armature winding, via the (-) carbon to ground and from there back to the battery. The electric circuit is closed, battery voltage is applied to the charge control lamp and the lamp lights up. Since the generator does not work when the engine is not running, the charge control lamp is not connected directly to the battery, but via the ignition switch. When the ignition is off, the charge control lamp is dead.

Voltage regulator

A generator without regulator would just work light a bicycle dynamo. The power output would increase with rising speed. The voltage output would fluctuate with the load. (In case of a bicycle dynamo the tail light bulb is overloaded when the head light does not consume any power). The function of the regulator is the provision of a uniform vehicle voltage, almost completely independent from speed and load of the generator.

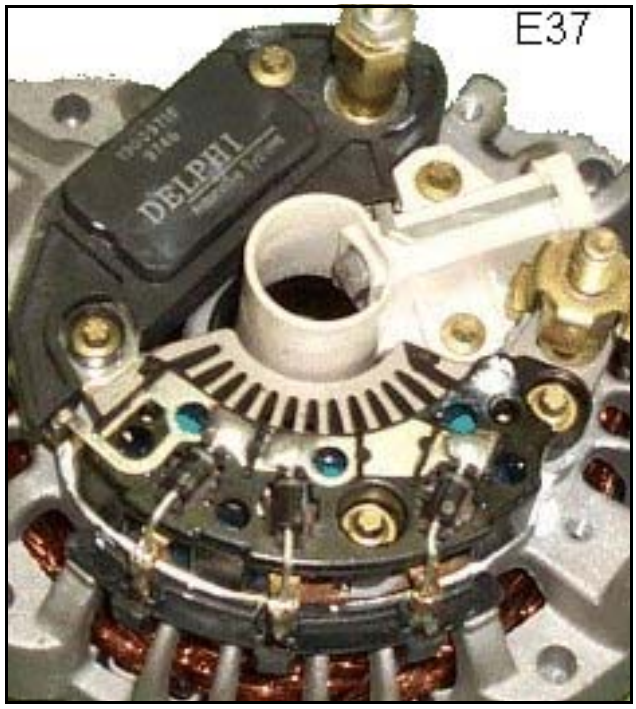


Fig. 9 Regulator with diode plate and rectifier diodes

In most cases voltage regulators (Fig. 9) with carbon brushes form a compact component. The voltage regulator is maintenance free and the wear of carbon brushes is only so little, that they hardly ever need to be replaced during the lifetime of a machine.

The regulator has the following function:

- To maintain the vehicle voltage under any operating conditions below 14.4 V.
- To match the regulator voltage to the temperature.
- Smooth rising of generator current when switching loads (convenience function to avoid jerking of the engine).

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Checking the generator

First one must check whether the generator is actually defective.

- This can be easily found out by checking whether the charge control light in the dashboard lights up. If the light does not go out, even at higher speeds, there must be a defect on the generator, the regulator, the wiring or the V-belt.
- When the engine is at rest, the charge control light must light up. If not, the lamp may probably be defective. Defects on generator or wiring are obviously also possible.

The following points allow to contain faults in the voltage supply within certain limits.

- Cable connections on the generator OK?
- V-belt OK?
- Generator ground (engine ground) OK?
- Pre-excitation from vehicle electronics OK?

Only if all criteria mentioned above are OK, the fault must be in the generator itself. In this case it must be replaced or the following trouble shooting procedure must be performed.

Measuring the charge current

- All plug-and-socket connectors must be free of corrosion and intermittent contact.
- The generator ground connection must be OK.
- During the measurement switch on as many consumers as possible.

1 Attach the clip-on ammeter around the B+ line.

2 Gradually increase the engine speed.

3 The generator current must be at least as high as the total current of all consumers.

Checking the rotor

i Note

The rotor coils can only be measured in disassembled state.



Fig. 10 Rotor

- Remove the regulator with carbon brush.
- Contact the rotor slip ring with the tester points.
- The resistance should be between 3 and 6 OHM Ω
- The rotor coils should not have continuity to ground.

Checking the stator



Fig. 11 Stator

i Note

The stator coils can only be measured in disassembled state.

- Measure the resistance of all three coils.
- The coils should not have contact among each other.

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Checking the regulator voltage with the generator tester

The battery and generator tester comes with an 8-line LC display with background illumination and is able to print out test results via an (optional) thermal printer.



Fig. 12

The generator test assesses the regulator voltage and the ripple factor of the generator voltage.

- All plug-and-socket connectors must be free of corrosion and intermittent contact.
- The generator ground connection must be OK.
- The battery should be in good condition – the idle speed voltage of the battery should be at least 12.6 Volt.
- If possible switch off all consumers.
- Perform the measurement at raised engine speed.

Checking the regulator voltage with the multimeter

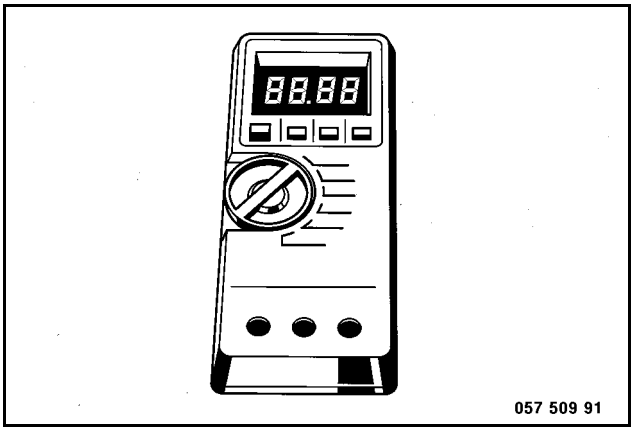


Fig. 13

- All plug-and-socket connectors must be free of corrosion and intermittent contact.
- The generator ground connection must be OK.
- The battery should be in good condition – the idle speed voltage of the battery should be at least 12.6 Volt.
- If possible switch off all consumers.
- Perform the measurement at raised engine speed.
- The voltage (B+) should adjust itself at 13 to 14 Volt.

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Checking the regulator in disassembled state

On a **Bosch generator** unscrew two fastening screws for the regulator and lift the regulator off. For this work the generator does not need to be removed.

The **Delco-Remy generator** needs to be removed and partly dismantled, if the regulator needs to be disassembled. Unscrew the housing screws to do so. Pull rotor with drive bearing and V-belt pulley out of the stator. Unscrew the ends of the stator winding from the diode carrier and separate the stator from the collector ring bearing. Disassemble exciter diodes and brush holders and remove also the regulator.

i Note

When testing the regulator one should be aware that there are 2 different types of regulators:

- If the carbon brush is not connected to ground the regulator is a so-called minus controlled regulator. The exciter winding is positioned between D+ and DF, the regulator therefore regulates the exciter winding on the ground side. The other carbon brush is connected with the cathodes of the exciter diodes, terminal D+. This leaves one further terminal, this is DF.

D+ (vehicle wiring system)

D- (ground contact, mostly located on one of the fastening screws)

DF (Dynamo Field)

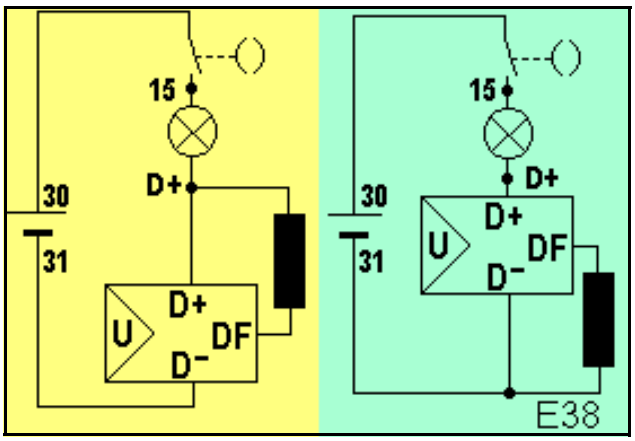


Fig. 14

- If the carbon brush is connected to ground the regulator is a so-called plus controlled regulator. The exciter winding is positioned between DF and D-, the regulator therefore regulates the exciter winding on the plus side. The other carbon brush is then connected with terminal DF. This leaves one further terminal, this is D+.

The basic function of a disassembled regulator can be easily tested with a 12V lamp and an adjustable D.C. power supply unit (0V ... 20V).

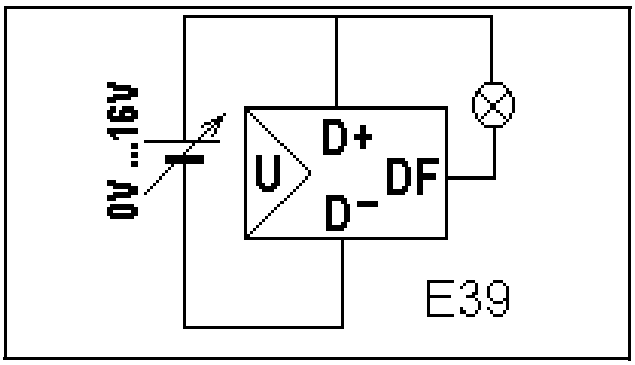


Fig. 15

E.g minus controlled regulator

One connects the regulator (Fig. 15) with D+ and D- to the power source, as shown in the illustration, and the lamp to both carbon brushes, instead of the exciter winding. When slowly increasing the voltage the lamp will first become brighter, because the regulator allows all lamp current (= exciter current) to flow at voltage values up to 14.4V. Once the regulator voltage is reached, the regulator switches the lamp current off. When returning the voltage back below the control voltage, the regulator will switch the lamp back on.

With this test the major difficulty is the problem to remove the regulator an identify terminals D+, DF and D-.

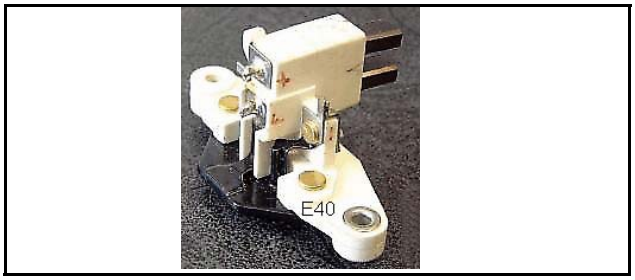


Fig. 16



Fig. 17

The illustrations (Fig. 16) and (Fig. 17) show two different regulator types.

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Replacing the carbon brushes

- On a **Bosch generator** unscrew two fastening screws for the regulator and lift the regulator off. Pull out the carbon brushes from underneath. Their minimum length is **5 mm**, shorter carbon brushes need to be replaced, unsolder both connection litz wires. Solder the litz wires of the new carbon brushes, insert these and fasten the regulator again. For this work the generator does not need to be removed.
- For replacing the carbon brushes in the **Delco-Remy generator** the generator needs to be disassembled and partly dismantled. The carbon brush holder is located inside the collector ring bearing.

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7.13 Electric starter

The starter converts the electric energy stored in the battery into mechanical energy. The starter can only generate its power when a battery with appropriate capacity is available.

Duties of the starter:

- to accelerate the combustion engine to start speed with lowest possible current consumption.
- establish the gear connection between starter and combustion engine.
- to maintain this connection.
- to switch on the starter current.

After starting the engine:

- to return the starter pinion to initial position.
- to switch off the starter current.

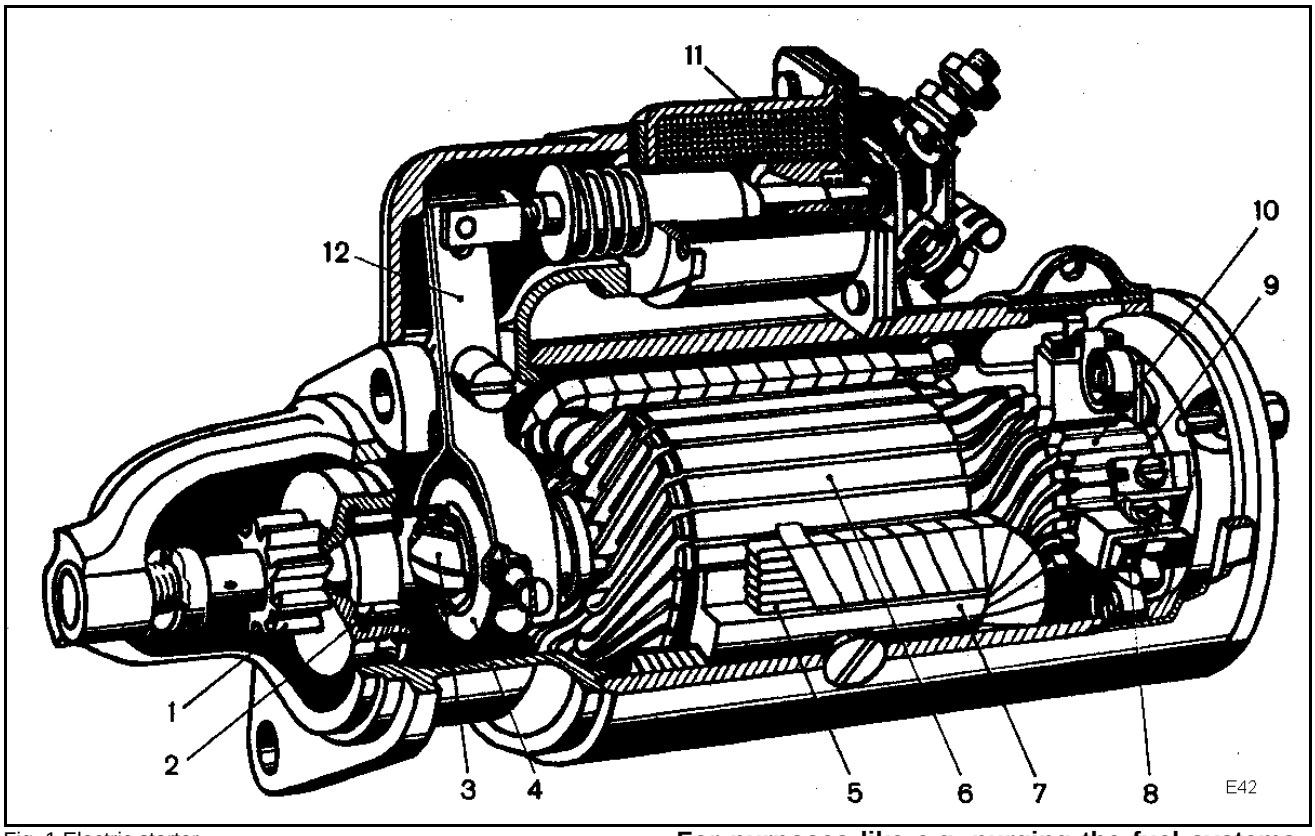


Fig. 1 Electric starter

1 Pinion
2 Roller free-wheeling
3 Steep thread
4 Guide ring
5 Spring winding
6 Armature
7 Pole shoe
8 Carbon brushes
9 Armature brake
10 Collector
11 Magnetic switch
12 Engagement lever

⚠ Caution

So-called jump starting (using an additional external battery) without the battery connected is dangerous. When disconnecting the cables from the poles high inductivities (arcs, voltage peaks) may occur and destroy the electrical installation.

For purposes like e.g. purging the fuel systems, starters may be operated for maximum 1 minute without interruption. Then you should wait for at least 30 minutes (cooling down) until trying again. During the 1 minute starting period this process should not be interrupted.

Starter motors must not be cleaned with high pressure steam cleaning equipment.

The contacts on starter terminals 30, 45, 50 must be protected against unintended shorting (jump protection).

When replacing the starter the ring gear on the engine flywheel must be checked for damage and its number of teeth - if necessary replace the ring gear.

Always disconnect the battery before starting assembly work in the starter area of the engine or on the starter itself.

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Function of pre-engaged-drive starting motor

This type of starter uses a solenoid to engage the pinion with the ring gear. The engaging solenoid contains switching contacts for the starting current. When closing the starter switch, the relay holding winding is active and current flows also through the series connection of pick-up winding and electric motor. The engaging solenoid picks up and moves the free-wheeling with the pinion forward via the engaging lever and the engaging spring. In case of a favourable position of the pinion to the ring gear a tooth of the pinion will directly engage in a tooth gap. In this case the pinion will engage over the entire length of the screw path, until the contact bridge in the engaging relay touches the relay contacts. The starter motor is no switched on. However, if the pinion does not directly find a tooth gap, the ring gear will block any further engaging movement. The engaging lever in this case compresses the engaging spring and the main contact closes, even though the pinion and the ring gear are not engaged. The electric motor keeps rotating the pinion in front of the ring gear face, until a pinion tooth gap matches a tooth on the ring gear and the preloaded engaging spring moves pinion and free-wheeling forward. When switching the relay winding off, the return spring forces the relay armature and the pinion with free-wheeling back to rest position. This disengagement is supported by the steep thread.

Magnetic switch

The magnetic switch is normally arranged directly above the starter.

With the starter switch switched on, both the pickup winding and the holding winding are energized and shift the iron core in axial direction. With a lever this iron core pulls the starter pinion towards the engine flywheel.

Once the gears are engaged the starter current is applied to the back through a large cross-section. At the same time the pickup winding is shorted via the starter current and thus switched off as a measure to reduce the load on the energy household.

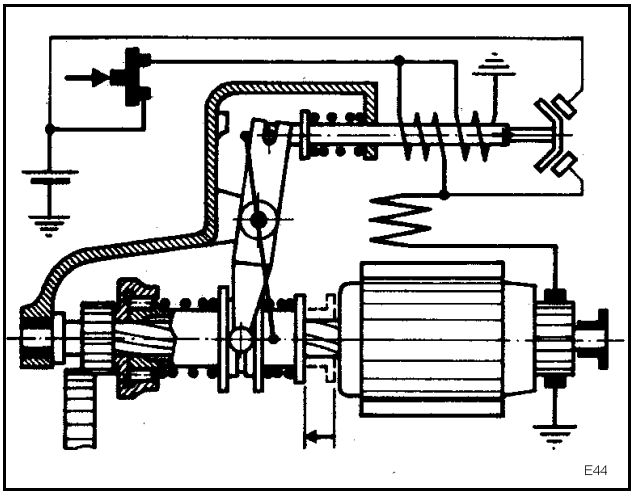


Fig. 2 Switching position during engagement

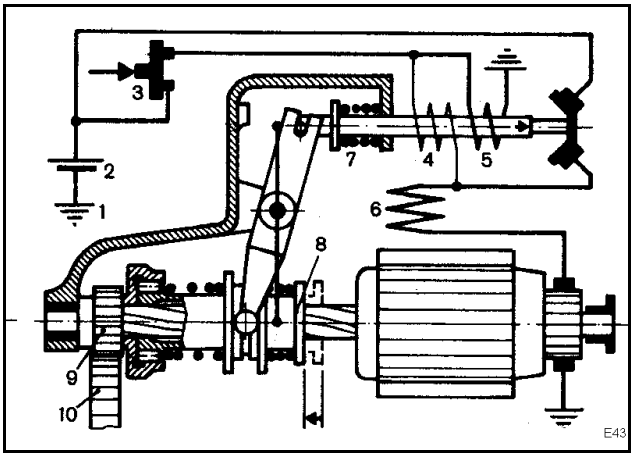


Fig. 3 Switching position during starting

1 Ground
2 Battery
3 Starter switch
4 Pull-in winding
5 Holding winding
6 Exciter winding
7 Restoring spring
8 Driver
9 Pinion
10 Flywheel

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Trouble shooting "Starter"

The most frequent fault is definitely a fully discharged battery.

If the starter rotates too slowly, either the brushes are partly worn off, or parts of the exciter or armature winding is shorted. In some cases oxidized electric contacts or a soiled ground connection causing extremely high voltage losses in the overall starter system are the cause of problems.

If the starter only emits a clicking sound,- either the magnetic switch is defect / soiled (dismantle and clean))- the main contacts on the magnetic switch are worn off / soiled (scrape off carefully with a file and clean)- the starter motor is defective / soiled (remove armature and clean), cover cleaned, moveable parts with grease.

Frequently a jammed return mechanism is the reason for a starter failure.

Occasionally worn contacts are found on the magnetic return switch

Defects on the actual starter motor including pinion and carbon brushes are very rare.

With a trouble shooting chart the faults in the starter system can be narrowed down. The starter system can only work when many conditions are fulfilled at the same time.

- Immobilizer deactivated?
- Ignition switch OK?
- Travel lever in correct position?
- Emergency stop not actuated?
- Battery sufficiently charged?
- Battery poles OK?
- Main battery fuse OK?
- Main battery switch closed?
- Main starter cable (terminal 30) OK?
- Starter control cable (terminal 50) OK, voltage drop?
- Ground cable OK?
- Switching of magnetic switches OK?

The sequence of these tests is generally of no significance. It mainly depends on:

- the experience of the specialist
- the failure probability of the component to be tested and the testing effort for the respective part.

Only if all criteria mentioned above are OK, the fault must be in the starter itself. In this case it can be repaired or replaced.

Testing and measuring the electric starter

i Note

The highest current flows when the starter is blocked! (Short circuit current in starter). This is the case when the pinion is engaged and the starter has the duty to accelerate the flywheel to starting speed.

Function test with starter installed

- Initiate the starting process and measure the voltage on the pickup solenoid switch (50a). At least 10.8 Volt should be applied.
- When operating the starter switch the magnetic switch must engage in the flywheel ring gear (noticeable clicking sound) and release the starting current to the starter. On most magnetic switches the voltage can be measured with the multimeter. If this does not happen even though voltage is applied, replace the magnetic switch.

Function tests with disassembled starter

⚠ Caution

Before removing the starter you must disconnect the ground cable from the minus pole of the battery while the ignition is switched off.

- Check the wear on the carbon brushes and their contact pressure.
- Check the collector, it must not have electrical contact with the rotor shaft.
- Check the drive pinion for excessive wear.
- The return mechanism should not be tight, if necessary grease amply with silicon grease (Bosch PZ 2 V3) or a comparable grease.
- Measure the resistance of the magnetic switch main contact in disengaged condition. Maximum value 0.2 OHM Ω

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7.14 Telemecanique switch

Example of terminal designations

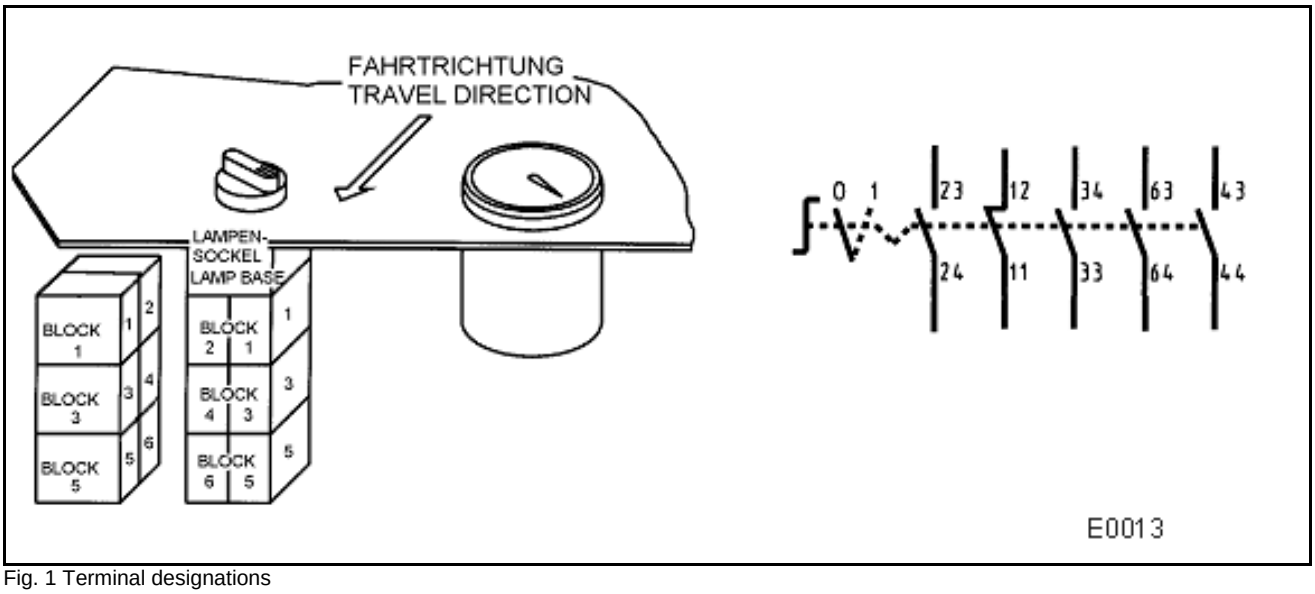


Fig. 1 Terminal designations

- Normally open contact 23 located on block 2
- Normally open contact 24 located on block 2
- Normally closed contact 12 located on block 1
- Normally closed contact 11 located on block 1
- Normally open contact 34 located on block 3
- Normally open contact 33 located on block 3
- Normally open contact 63 located on block 6
- Normally open contact 64 located on block 6
- Normally open contact 43 located on block 4
- Normally open contact 44 located on block 4

i Note

If e.g. block 5 is not needed to design a switch, the numbering for blocks 1,2,3,4 and 6 remains unchanged.

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Disassembly

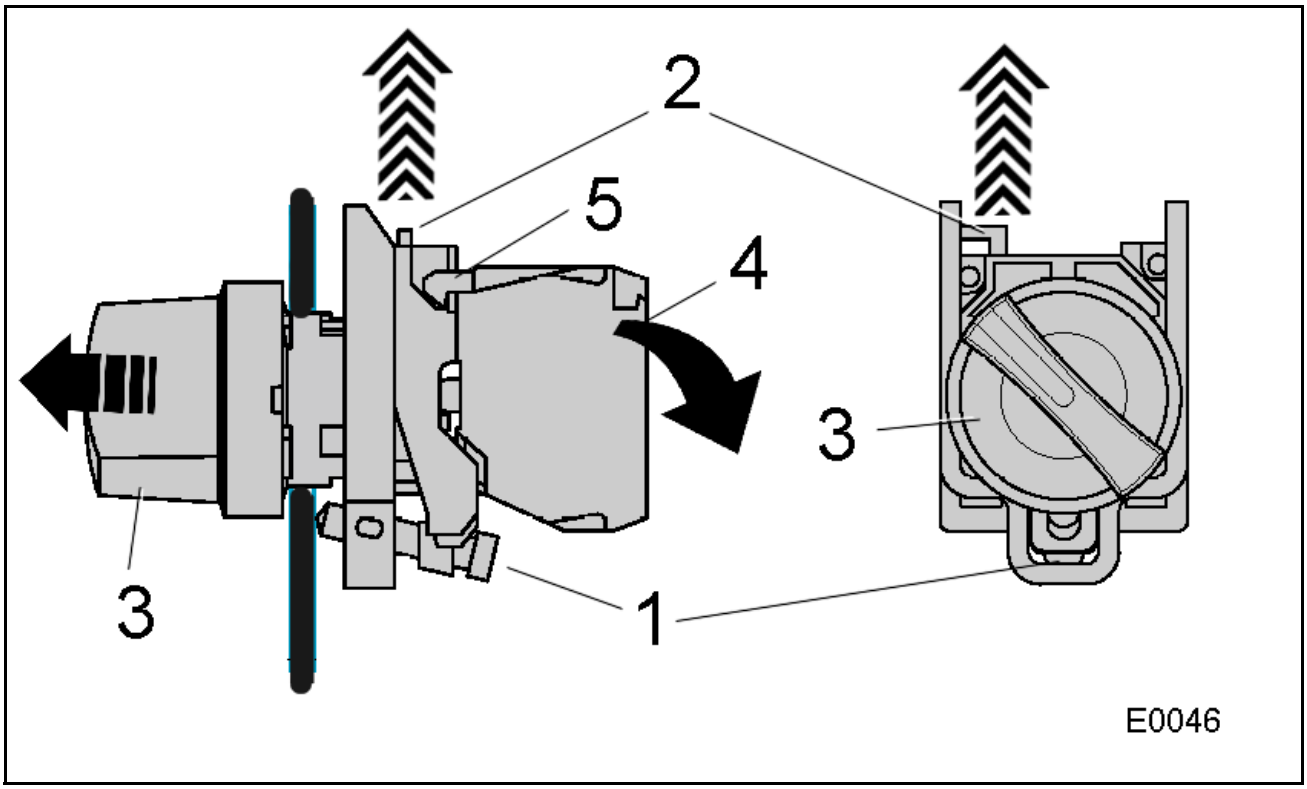


Fig. 2 Disassembly

- Lift up the interlock (5).

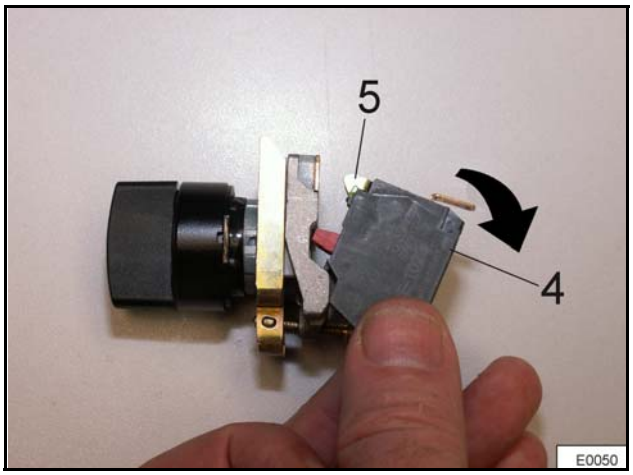


Fig. 3 Folding down the switch block

- Fold down the switch block (4).
- Loosen screw (1).

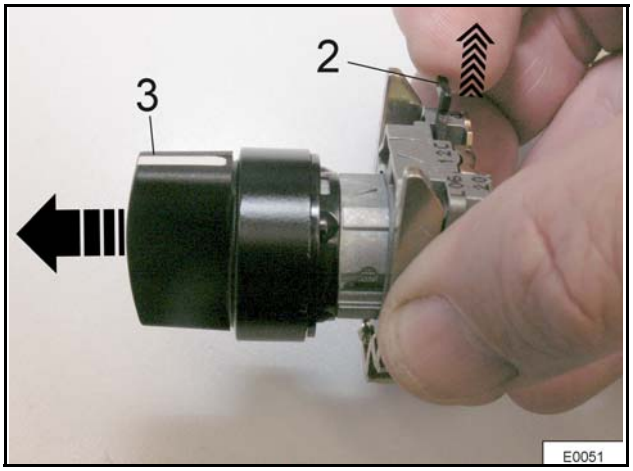


Fig. 4 Pulling out the front element

- Lift up the interlock (2) and pull out the front element (3).

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Assembly

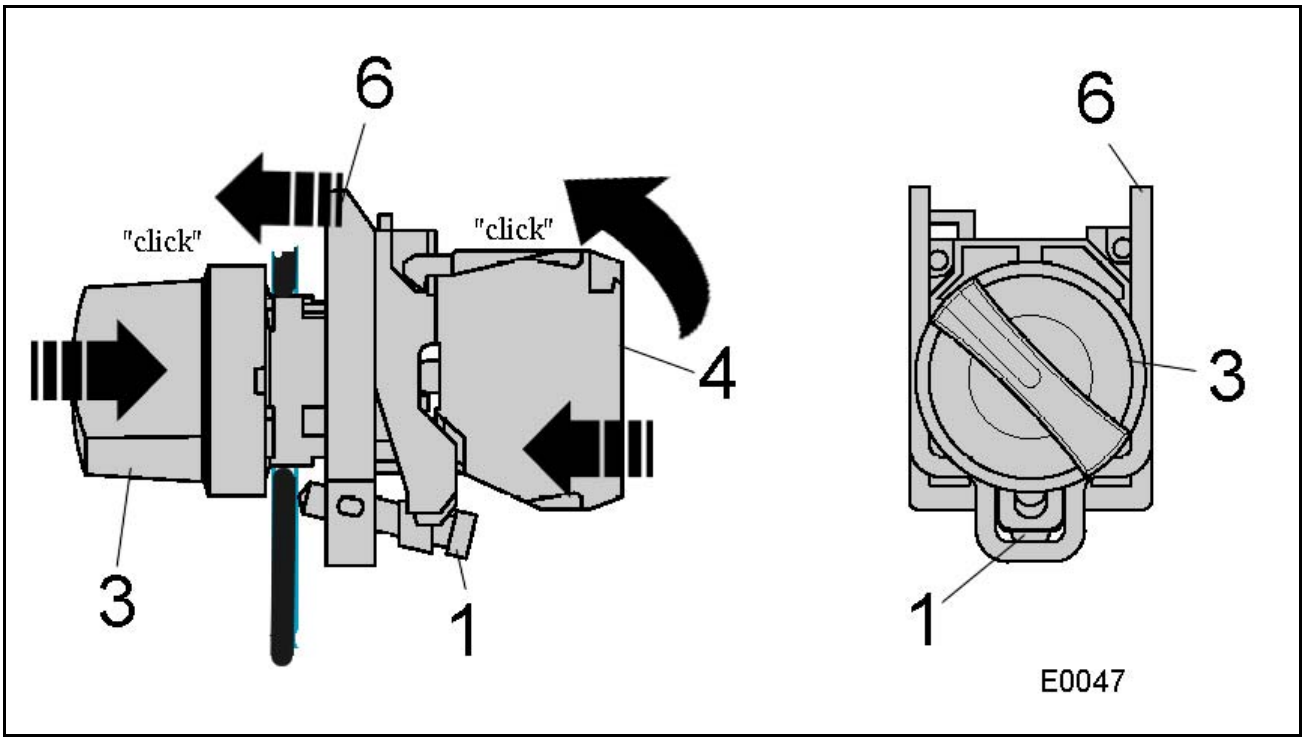


Fig. 5 Assembly

- Insert the front element (3) into the bore in the control panel.

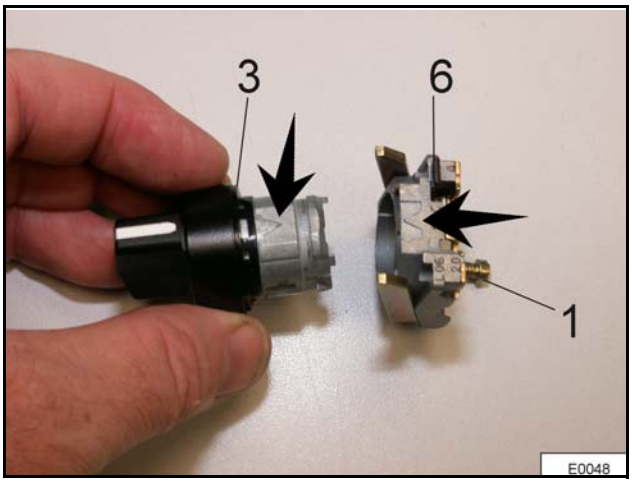


Fig. 6 Observe the marks.

- Clip the fastening adapter (6) onto the front element (3).

i Note

Watch the marls on front element (Fig. 6) and fastening flange.

- Tighten the screw (1) with a tightening torque of 0.6 Nm.

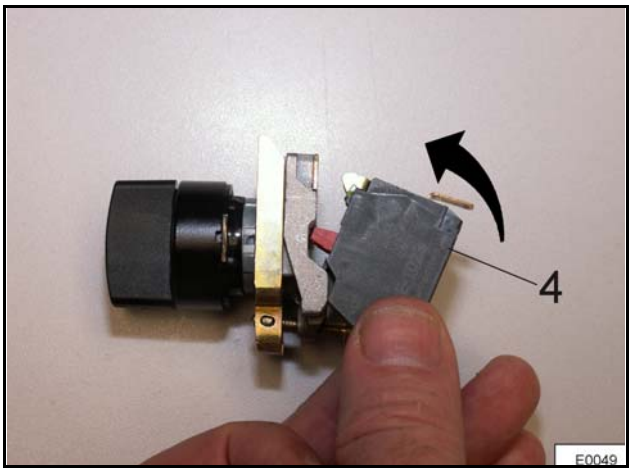


Fig. 7 Assemble the switch block

- Clip on the switch block (4).

i Note

Hook in the switch block at the bottom first (Fig. 7).

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7.15 Inductive proximity switches

General

In all automated sequences the use of sensors as a source of information for the electronic control is indispensable. The sensors deliver the necessary signals about positions, end positions, filling levels or serve as pulse transducers for counting tasks or speed detection. In industrial applications inductive and capacitive proximity switches are today indispensable. Compared with mechanical switches, they offer almost ideal prerequisites: non-contact, wear free operation, high switching frequencies and switching accuracies, as well as high protection against vibration, dust and moisture. Inductive sensors detect all metals without contact, capacitive sensors detect almost all solid and liquid media, such as metal, glass, wood, plastic, water, oil, etc.

Working principle

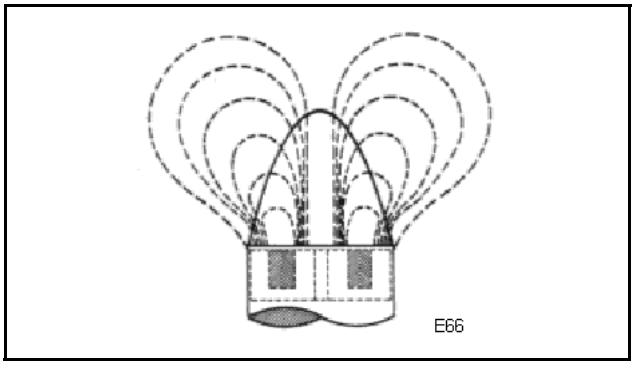


Fig. 8

The working principle is based on the principle of the dampened LC-oscillator. The coil of the oscillation circuit forms a high-frequency magnetic stray field.

This stray field leaks out from the active area of the proximity switch. If metal or non-ferrous metal enters into the response range energy is absorbed. The oscillator is thus dampened and the resulting change in current consumption is evaluated.

PNP circuitry

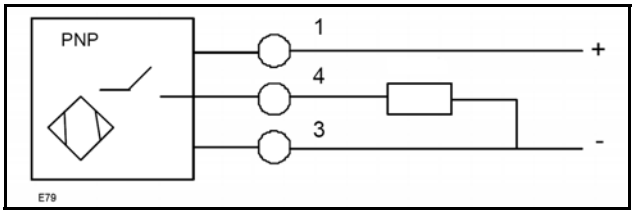


Fig. 9 PNP circuitry

On sensors with PNP-circuitry the output stage contains a PNP-transistor, which switches the load against the positive operating voltage. The load is connected between the output and the negative operating voltage. The switch is designed with a normally open contact, i.e. the contact closes when the initiator comes in "contact" with metal.

NPN circuitry

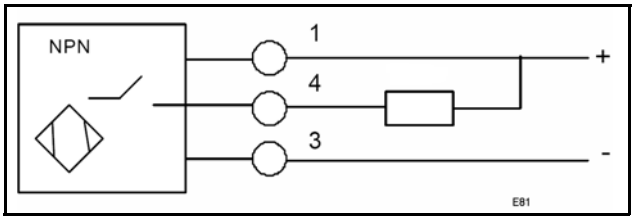


Fig. 10 NPN circuitry

On sensors with NPN-circuitry the output stage contains a NPN-transistor, which switches the load against the negative operating voltage. The load is connected between the output and the positive operating voltage.

Breaking and making contacts

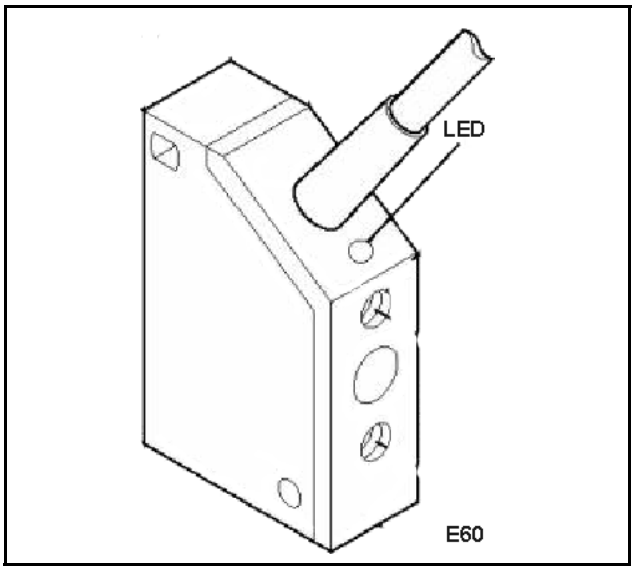


Fig. 11

Proximity switches are used as breaking or making contacts. Depending on the design the switching distances are 2 or 4 mm. The maximum amperage is 300 mA.

The LED (Fig. 11) lights up, when the initiator has detected metal in its stray field.

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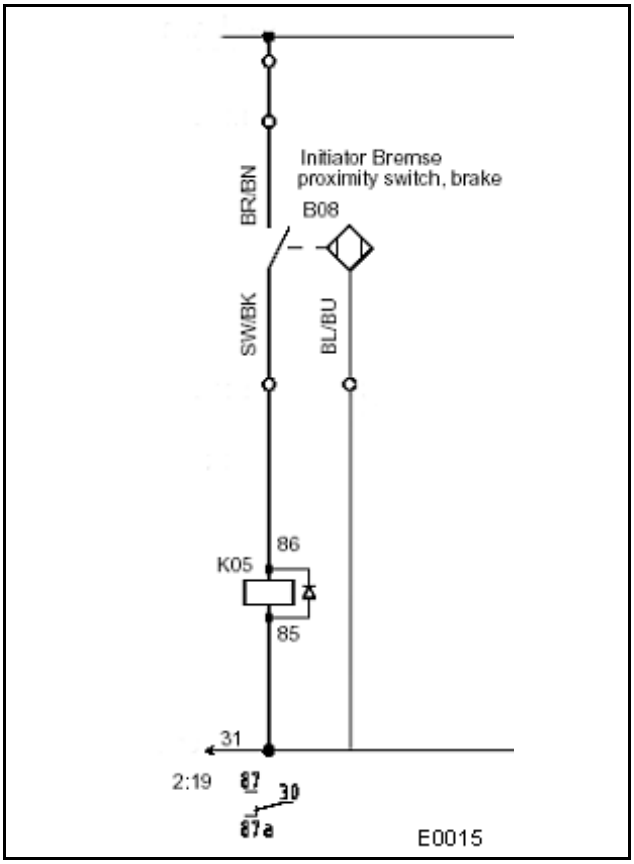


Fig. 12 Circuit diagram, making contact

The circuit diagram (Fig. 12) shows a proximity switch with normally open contact.

Brown = voltage supply

Blue = ground supply

Black = switching output

The initiator switches the relay (K05)

7.16 Angle sensor with current output

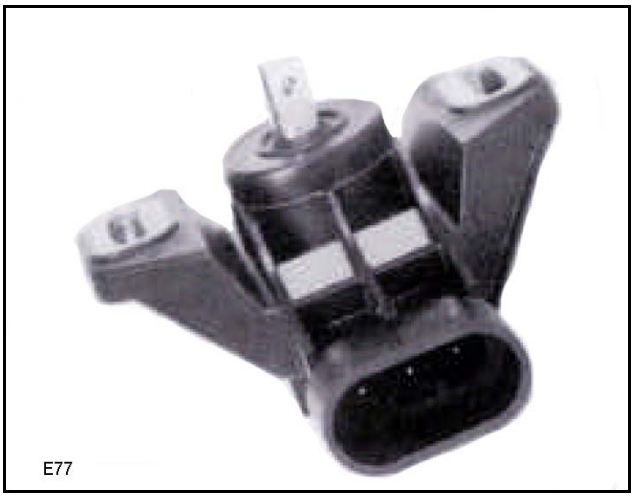


Fig. 1 Sensor

The the function of the angle sensor (Fig. 1) is based on the so-called "Hall-Effect". Named after the American physicist E.H. Hall. Due to the fact that moving electrons are deflected in a magnetic field, a voltage transverse to the flow direction of the primary current can be expected on a current conducting conductor in the magnetic field. Since the electrons are deflected in transverse direction by the magnetic field, they must enrich on the one side and reduce on the opposite side. If a very thin circuit board is now subjected to a current that is uniformly distributed across its cross section, no voltage will be measured between two points A and B, which have an identical distance to the current supply lines and are connected by a highly sensitive galvanometer. When generating a magnetic field vertical to the circuit board, voltage will be present between A and B and a current will flow through the galvanometer connected to these points. This is referred to as "Hall-Effect". The cause for this effect is the warping of the originally parallel electron orbits in the board by the magnetic field.

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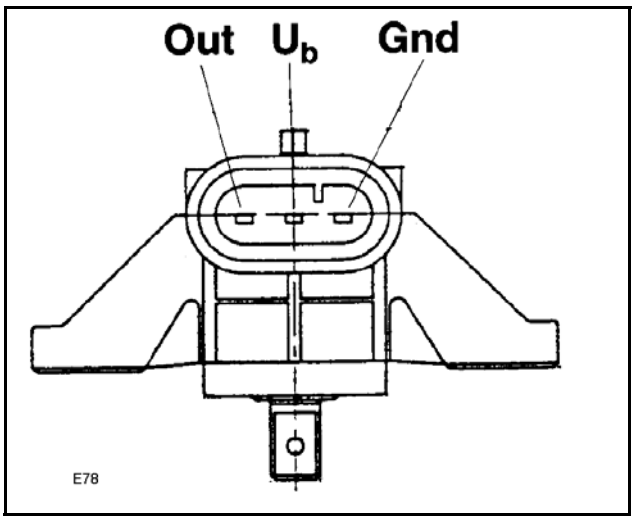


Fig. 2 Connection diagram

The angle sensor has 3 electric connections (Fig. 2).

Ub, supply voltage (+ 8.5 Volt)

Gnd, ground

Out, output current 4-20 mA.

- at -35° = 4 mA output current
- at 0° = 12 mA output current
- at +35° = 20 mA output current.

7.17 Plug connectors

Duties and requirements

Electric plug connectors must provide a reliable connection between different system components and thus ensure the safe function of the systems under any operating condition. There design ensures that they will withstand the applied loads throughout the lifetime of the machine.

Examples for these loads are:

- Vibration acceleration
- Temperature fluctuations, high and low temperatures
- Dampness
- Micro movements of the contact with resulting friction corrosion.

These loads may increase the transition resistances of the contacts, up to total interruption. Even the insulation resistances may drop and thus cause short circuits in neighbouring lines. Electric plug connectors must therefore have the following properties:

- Low transition resistances of the conductive parts.
- High insulation strength between conductive parts with different voltage potentials.
- Excellent leak tightness against water and moisture.

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7.18 Deutsch plug, series DT and DTM

General

Plug connectors DT and DTM have a wedge to hold the pins and sockets in their position. This wedge can be removed and replaced, without having to cut any leads.

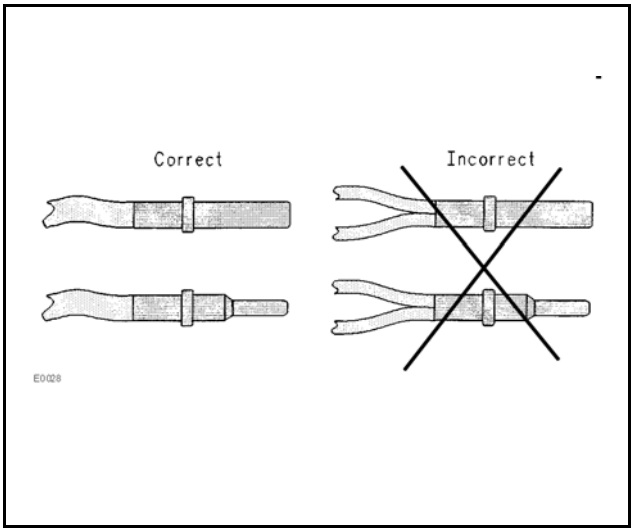


Fig. 3 Crimp connections

⚠ Caution

Do not crimp more than one lead per pin or per socket.

Sockets and pins must not be soldered to leads, they may only be crimped (see special tools for electrics).

When connecting sockets and plugs these must engage with a noticeable click when both halves interlock.

The plug connection should not be separable (without loosening the interlock).

Pulling test

This pulling test ensures that the lead is perfectly crimped and the contact has correctly engaged in the housing.

- Perform a pull test on each lead, each of the terminals and connections must withstand a pulling force of 45 N without any difficulties.

DT Series



Fig. 1 DT plug connection

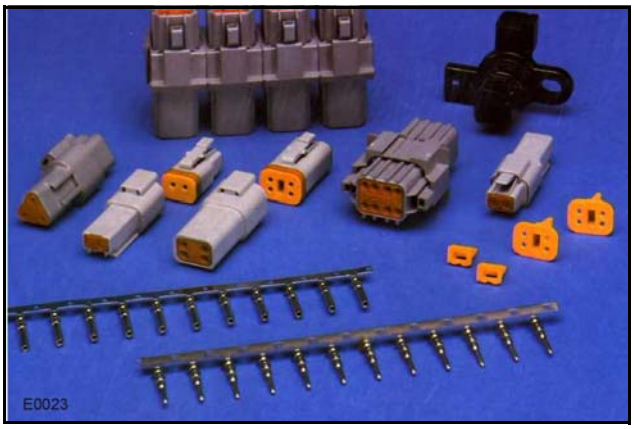


Fig. 2 DT Series

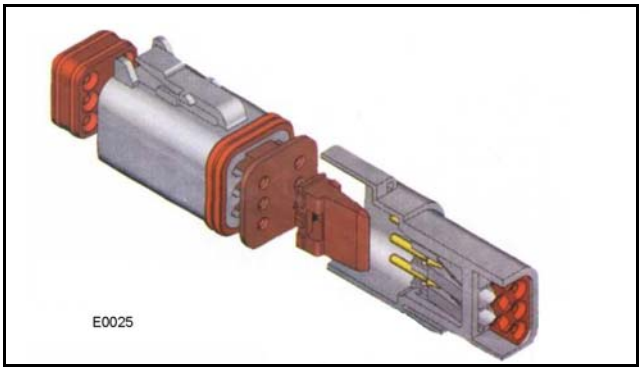


Fig. 3 Sectional drawing

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Installing DT contacts

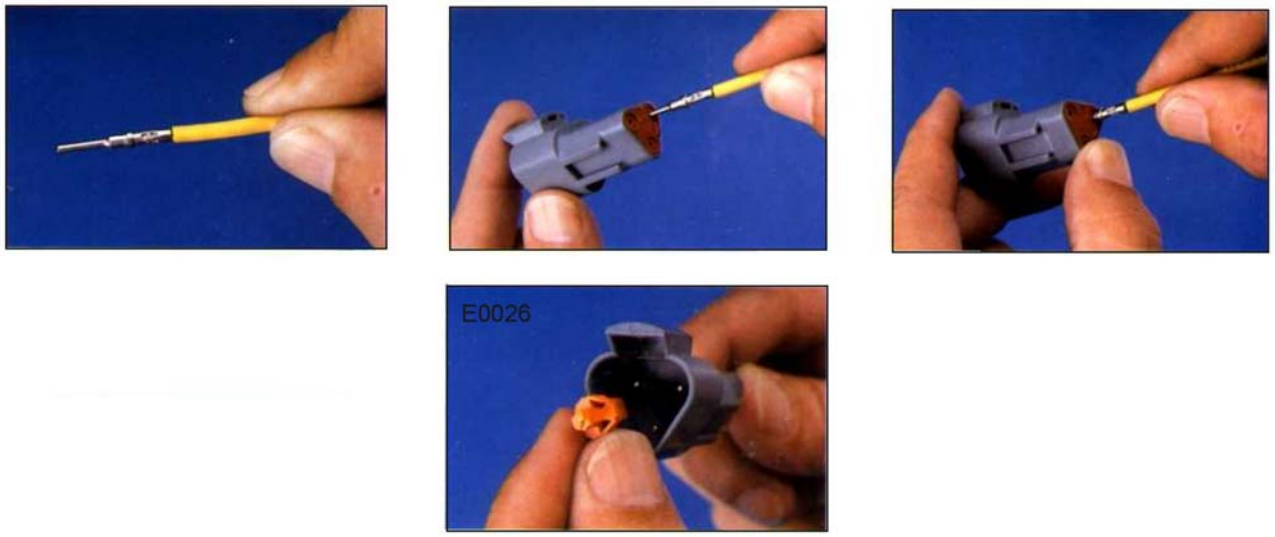


Fig. 4

- Insert the contacts through the rubber grommet until they click into place.
- Insert the orange wedge in direction of arrow.

⚠ Caution

Perform a pull test on each lead, each of the terminals and connections must withstand a pulling force of 45 N without any difficulties.

i Note

Use the same method when assembling the socket.

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Disassembling DT contacts



Fig. 5

- Pull the orange wedge out with long nose pliers.
- Slightly pull the lead and unlock the interlocking hook with a screw driver.
- Pull the contact out of the socket.

i Note

Use the same method when assembling the socket.

In this case the interlock disassembly tool (see special tools for electrics) serves as an aid to remove the wedges.

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DTM Series

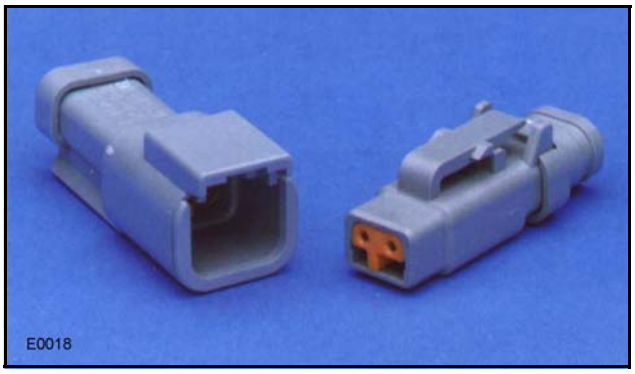


Fig. 1 DTM plug connection

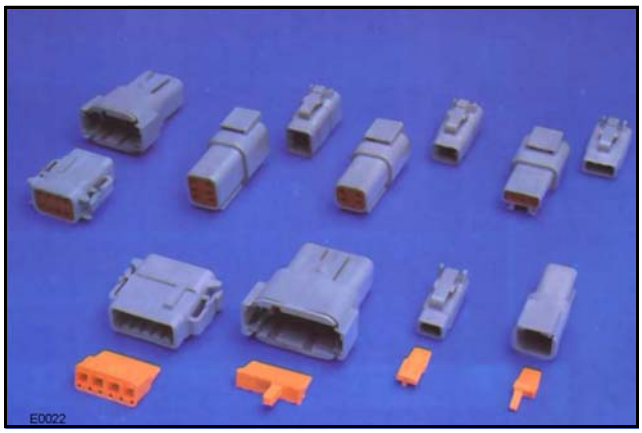


Fig. 2 DTM Series

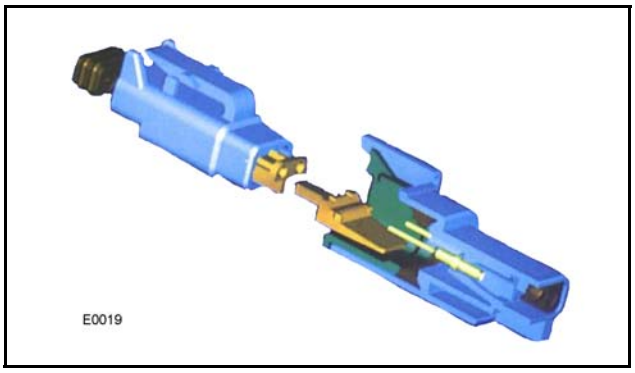


Fig. 3 Sectional drawing

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Installing DTM contacts

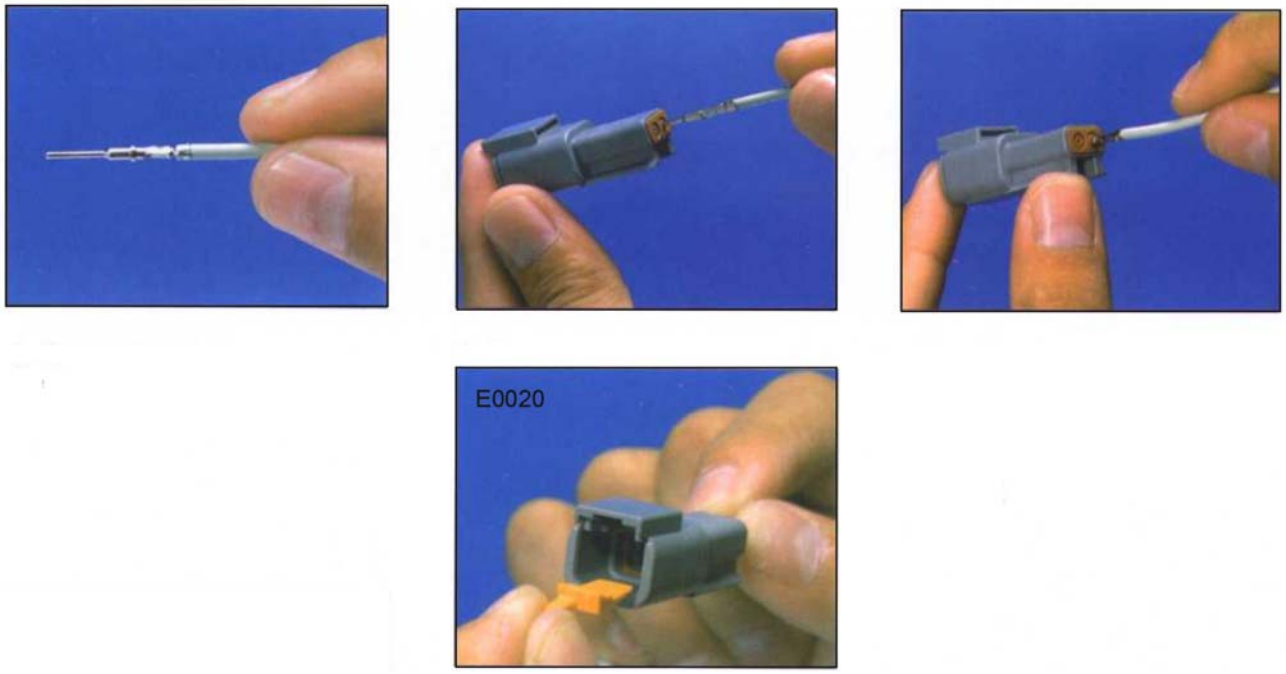


Fig. 4

- Insert the contacts through the rubber grommet until they click into place.
- Insert the orange wedge, until it clicks into place.

⚠ Caution

Perform a pull test on each lead, each of the terminals and connections must withstand a pulling force of 45 N without any difficulties.

i Note

Use the same method when assembling the socket.

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Disassembling DTM contacts

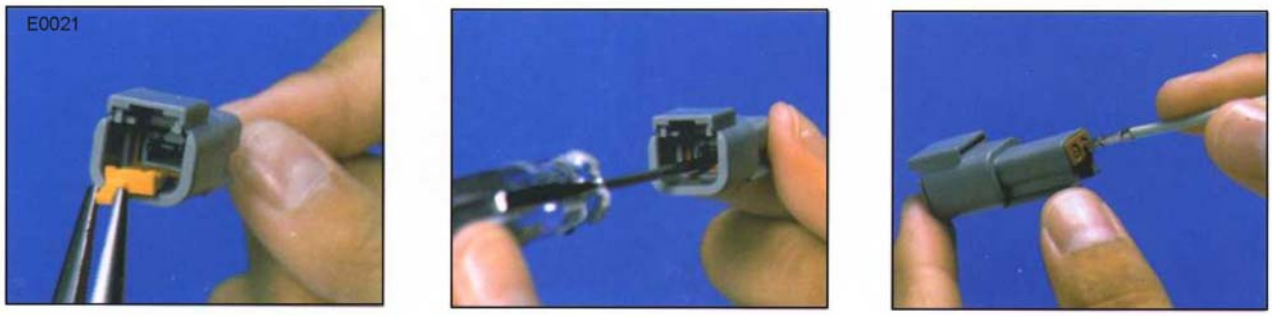


Fig. 5

- Pull the orange wedge (interlock) out with long nose pliers.
- Slightly pull the lead and unlock the interlocking hook with a screw driver.
- Pull the contact out of the socket.

i Note

Use the same method when assembling the socket.

In this case the interlock disassembly tool (see special tools for electrics) serves as an aid to remove the wedges.

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7.19 Plugs and terminals in spring clamping technology

General

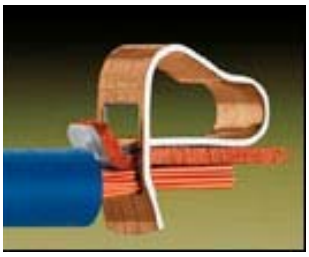


Fig. 1

Spring clamp technology (Fig. 1) for quick, vibration resistant and maintenance-free connection of all conventional copper conductors (single, multiple or fine stranded) with or without wire and ferrule.

⚠ Caution

The spring clamp technology is not suitable for extra fine conductors. Extra fine conductors can be easily pulled out of the spring clamp!

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Connecting terminal for quick repairs

BOMAG part-no.: 057 565 72



Fig. 1 That's how it works

The connecting clamp clamps up to 3 or 5 stripped fine conductors of 0.08 qmm bis 4 mm², single or multiple strand up to 2.5 mm². And this even without tools (Fig. 2).

That's how it works

- Strip 9-10 mm of the lead.
- Open the actuating lever and insert the strand.
- Return the actuating lever to initial position.

⚠ Caution

Perform a pull test on each lead, each of the terminals must withstand a pulling force of 45 N without any difficulties.

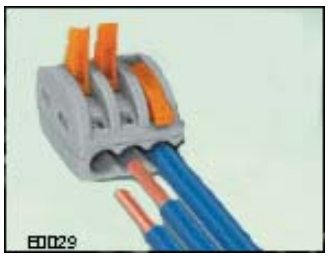


Fig. 2 Connecting clamp

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Series clamp



Fig. 1 That's how it works

That's how it works

- Insert a screw driver into the actuating opening until it bottoms.
- Strip 9-10 mm of the lead and insert it into the clamp.
- Pull out the screw driver.

⚠ Caution

Perform a pull test on each lead, each of the terminals must withstand a pulling force of 45 N without any difficulties.

Measuring signals

On these terminal blocks the bridge slot is most suitable for tapping off and measuring signals. Here you may directly insert a 4 mm test adapter (see special tools for electrics) for connecting a measuring lead. This test adapter is standard in the central electrics of heavy equipment machines.

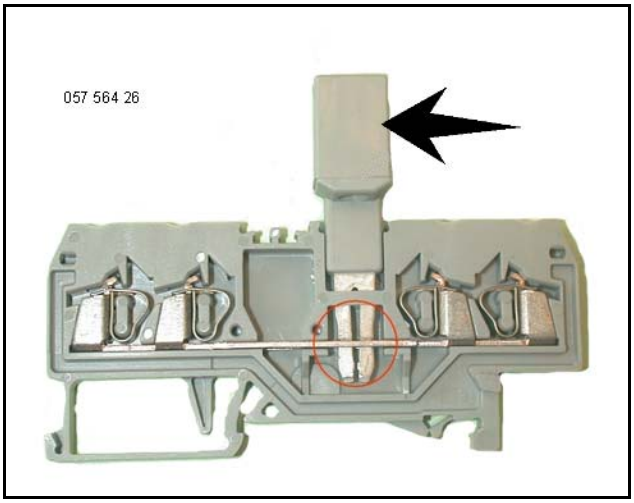


Fig. 2 Test adapter

https://truckmanualshub.com/

X-COM System

The X-COM-SYSTEM, a synthesis of plug connector and series clamp, has grown up to a construction kit for universal system wiring, ever since it was introduced in 1997. All the familiar series clamping functions have thus become pluggable.

X-COM plug clamp

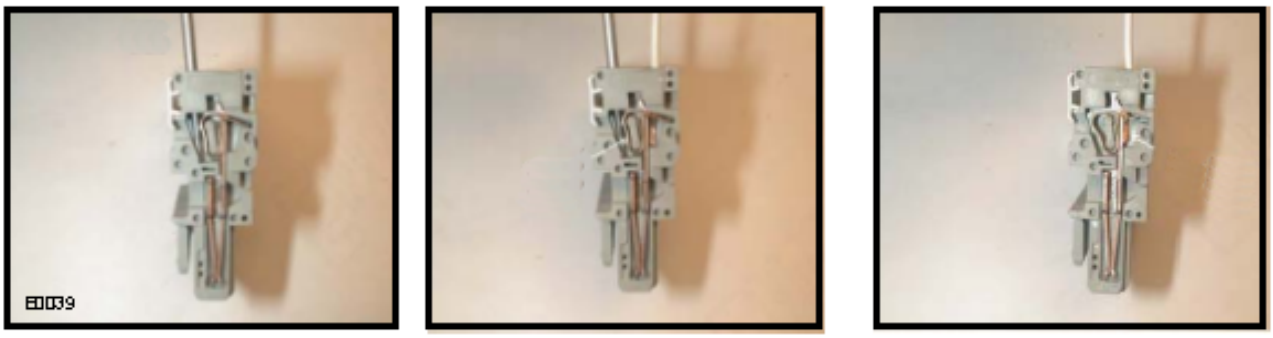


Fig. 1 That's how it works

That's how it works

- Insert a screw driver into the actuating opening until it bottoms.
- Strip 9-10 mm of the lead and insert it into the plug.
- Pull out the screw driver.

⚠ Caution

Perform a pull test on each lead, each of the terminals must withstand a pulling force of 45 N without any difficulties.

Measuring signals

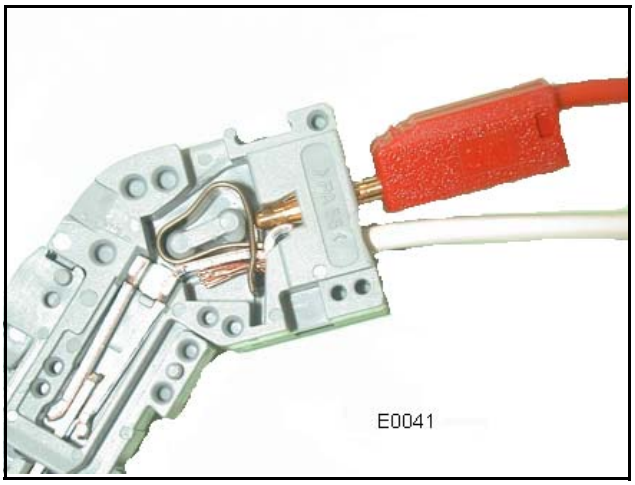


Fig. 2 X-COM plug with measuring cable

- The most reliable measurements on the plug can be made when using the measuring and connecting cable with 2mm plug (see special tools for electrics).

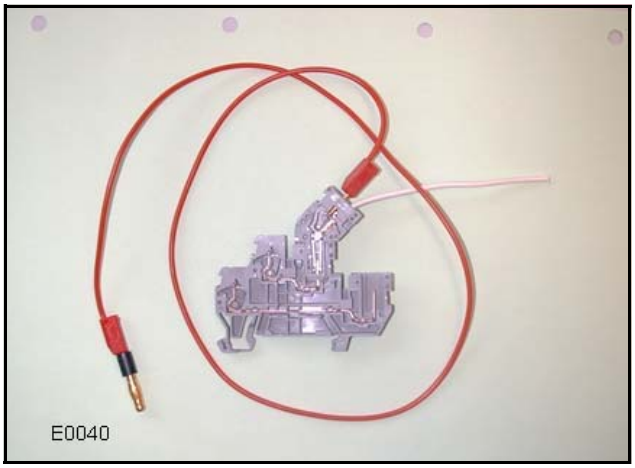


Fig. 3 X-COM plug plugged onto the series clamp

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8 Special tools, electrics

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8.1 Special tools, electrics

Measuring equipment

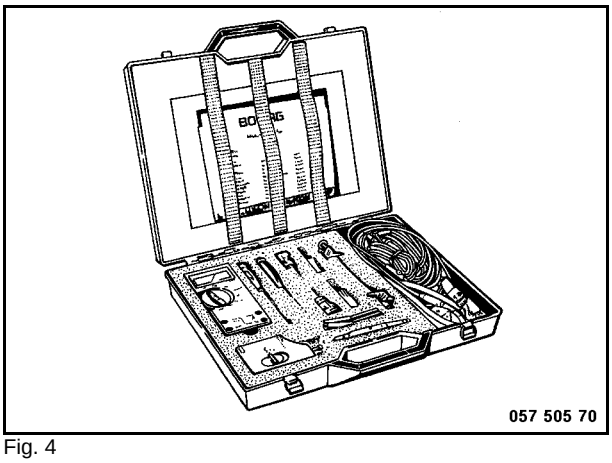


Fig. 4

14. Electric test case

    BOMAG part-no.: 057 505 70

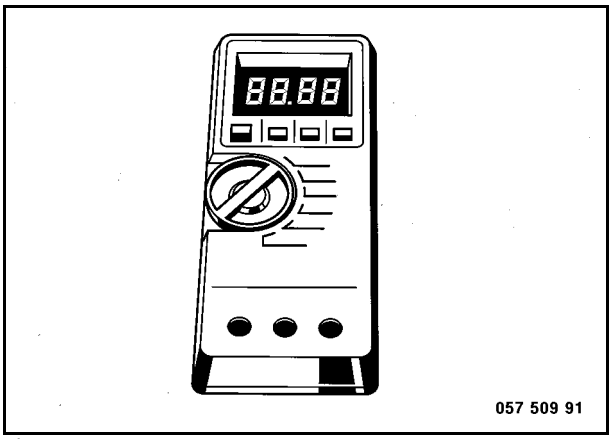


Fig. 5

15. Multimeter

    BOMAG part-no.: 057 509 91

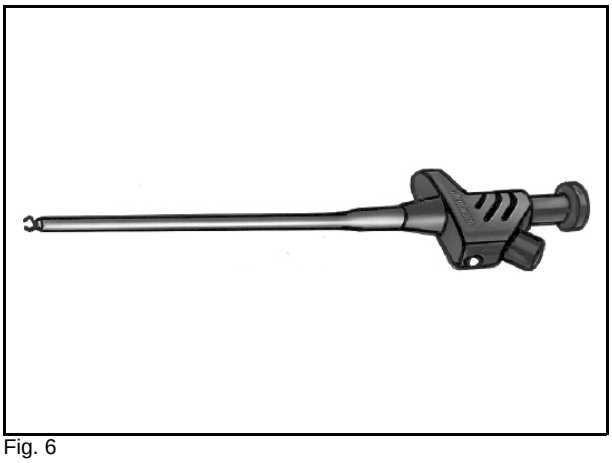


Fig. 6

16. Test prod black, with flexible insulated shaft and button operated gripper with 4 mm bushing, length 157 mm.

    BOMAG part-no.: 079 900 53

17. Test prod red, with flexible insulated shaft and button operated gripper with 4 mm bushing, length 157 mm.

    BOMAG part-no.: 079 900 54

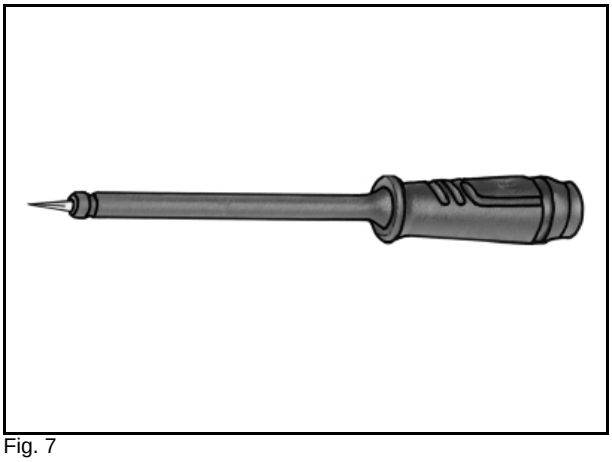


Fig. 7

18. Test prod black, with elastic insulated shaft 4 mm bushing, length 97.5 mm.

    BOMAG part-no.: 079 900 51

19. Test prod red, with elastic insulated shaft 4 mm bushing, length 97.5 mm.

    BOMAG part-no.: 079 900 52

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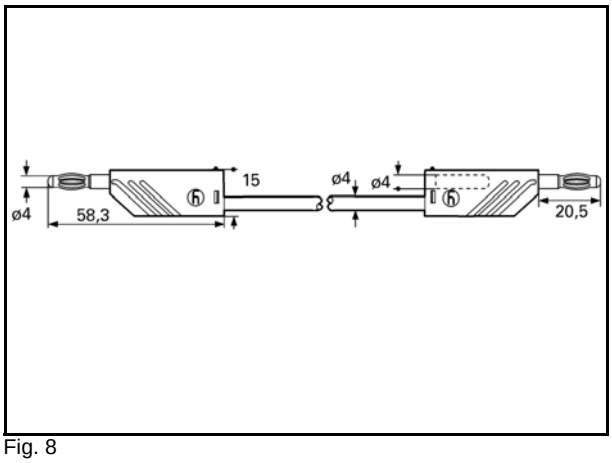


Fig. 8

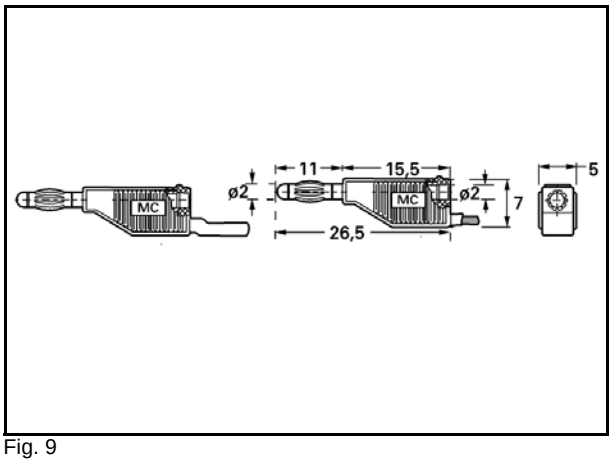


Fig. 9

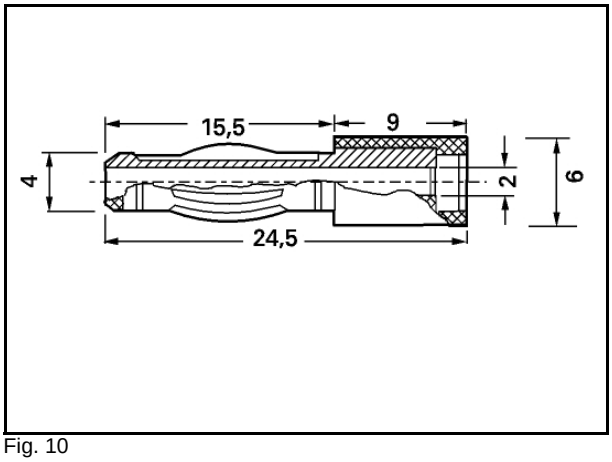


Fig. 10

20. Measuring and connecting lines with 4mm plug, high flexible design, black, length 0.5 m.

    BOMAG part-no.: 079 900 58

21. Measuring and connecting lines with 4mm plug, high flexible design, black, length 1 m.

    BOMAG part-no.: 079 900 59

22. Measuring and connecting lines with 4mm plug, high flexible design, black, length 2 m.

    BOMAG part-no.: 079 900 60

23. Measuring and connecting lines with 4mm plug, high flexible design, red, length 0.5 m.

    BOMAG part-no.: 079 900 55

24. Measuring and connecting lines with 4mm plug, high flexible design, red, length 1 m.

    BOMAG part-no.: 079 900 56

25. Measuring and connecting lines with 4mm plug, high flexible design, red, length 2 m.

    BOMAG part-no.: 079 900 57

26. Measuring and connecting lines with 2 mm plug and gold plated lamella plugs, high flexible design, black, length 300 mm.

    BOMAG part-no.: 079 900 63

27. Measuring and connecting lines with 2 mm plug and gold plated lamella plugs, high flexible design, black, length 600 mm.

    BOMAG part-no.: 079 900 64

28. Measuring and connecting lines with 2 mm plug and gold plated lamella plugs, high flexible design, red, length 300 mm.

    BOMAG part-no.: 079 900 61

29. Measuring and connecting lines with 2 mm plug and gold plated lamella plugs, high flexible design, red, length 600 mm.

    BOMAG part-no.: 079 900 62

30. Transition plug connector, with 4 mm plug on one side and 2 mm socket on the other, insulated design

    BOMAG part-no.: 079 900 65

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Fig. 11

31. Magnetic coil tester

BOMAG part-no.: 057 555 54



Fig. 12

32. Clip-on measuring instrument

BOMAG part-no.: 079 900 50



Fig. 13

33. Battery - generator tester

BOMAG part-no.: 079 900 91

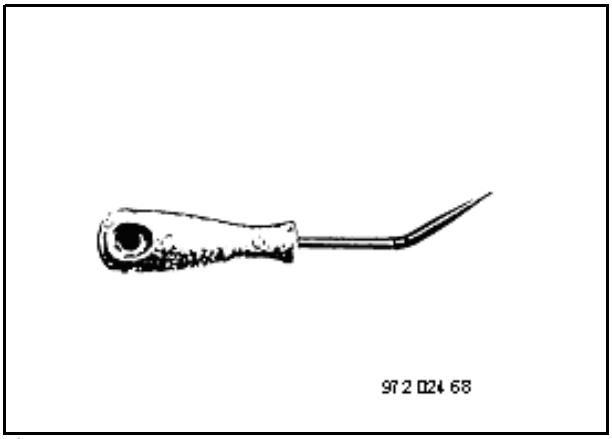


Fig. 14

Spring clamps (Wago or Weidmüller)

34. Cranked screwdriver (Fig. 14) to open spring clamps (Fig. 15).

BOMAG part-no.: 972 024 68

https://truckmanualshub.com/

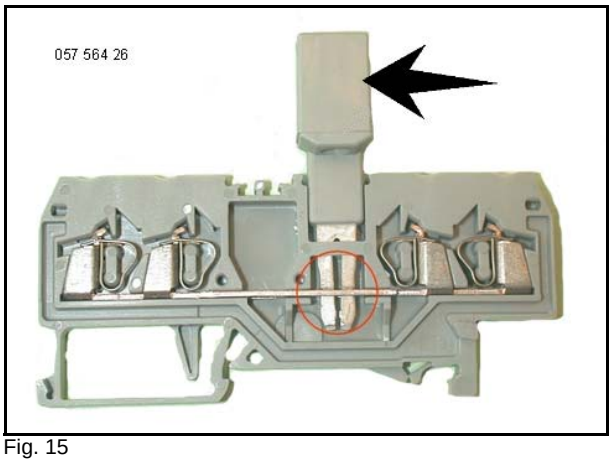


Fig. 15

35. Testing adapter to measure the signals from the series spring clamps (Wago).

BOMAG part-no.: 057 564 26

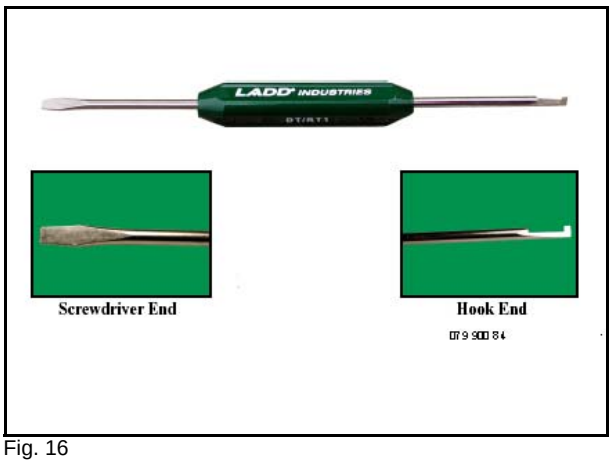


Fig. 16

Deutsch contacts

36. Tool to disassemble the interlocking on Deutsch plugs (series DT and DTM).

BOMAG part-no.: 079 900 84

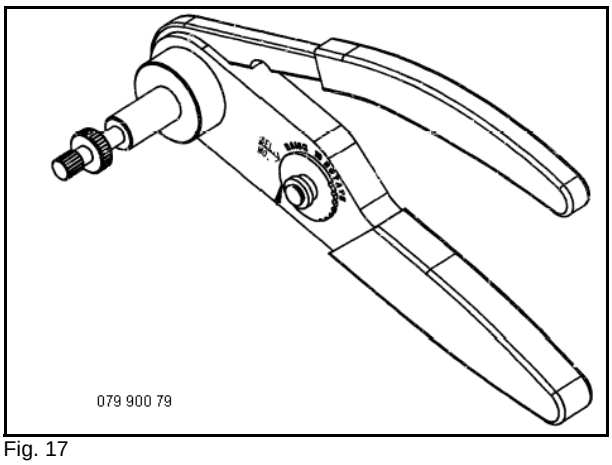


Fig. 17

37. Crimping pliers for Deutsch contacts of series DT and DTM, size AWG 20,16 and 12.

AWG 20 = 0.5 mm^2 cable cross-section

AWG 16 = 1,5 mm^2 cable cross-section

AWG 12 = 4,0 mm^2 cable cross-section

BOMAG part-no.: 079 900 79

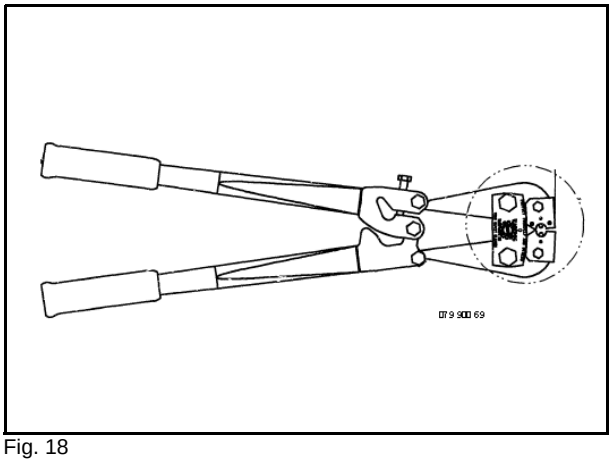


Fig. 18

38. Crimping pliers for Deutsch contacts of series HDT, size AWG 6 and 8.

AWG 8 = 10,0 mm^2 cable cross-section

AWG 6 = 16,0 mm^2 cable cross-section

AWG 6 = 16,0 mm2 cable cross-section

BOMAG part-no.: 079 900 69

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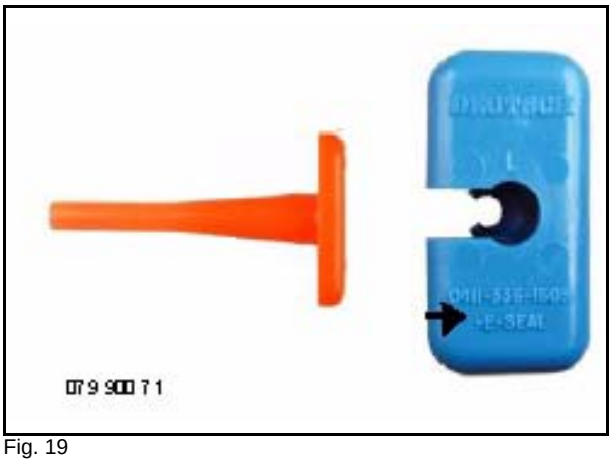


Fig. 19

39. Disassembly tool for Deutsch contacts of series HDP.

AWG 20, BOMAG part-no.: 079 900 78

AWG 16, BOMAG part-no.: 079 900 71

AWG 12, BOMAG part-no.: 079 900 72

AWG 8, BOMAG part-no.: 079 900 73

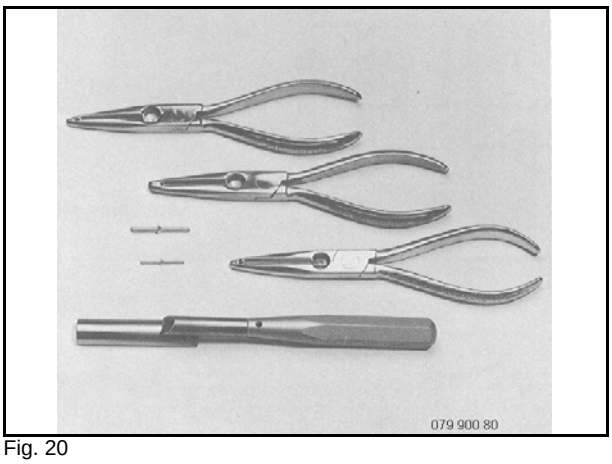


Fig. 20

ITT contacts

40. Installation tool for ITT crimp contacts of series CA-COM, contact size 15S/16S/15/16.

BOMAG part-no.: 079 900 80

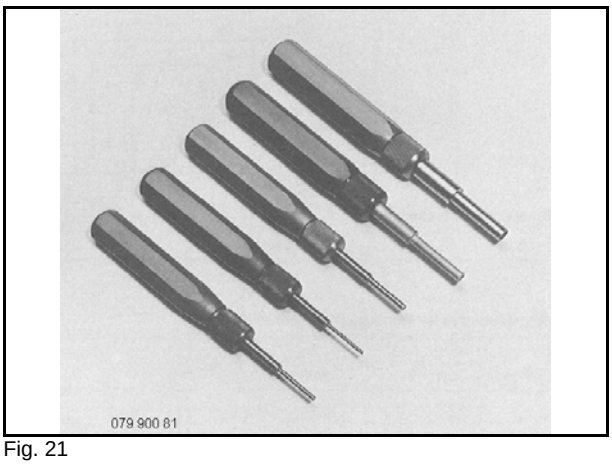


Fig. 21

41. Disassembly tool for ITT male contacts of series CA-COM, contact size 15S/16S/15/16.

BOMAG part-no.: 079 900 81

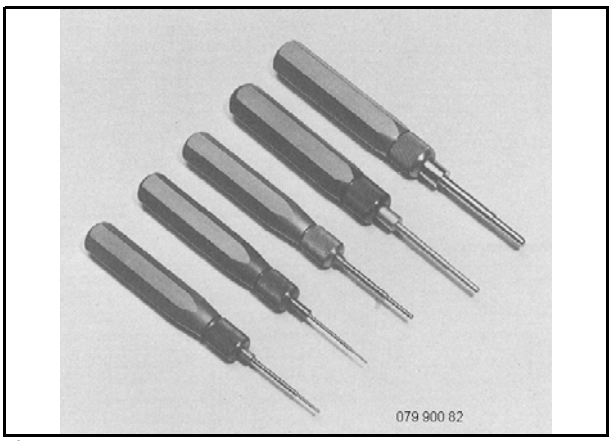


Fig. 22

42. Disassembly tool for ITT female contacts of series CA-COM, contact size 15S/16S/15/16.

BOMAG part-no.: 079 900 82

https://truckmanualshub.com/

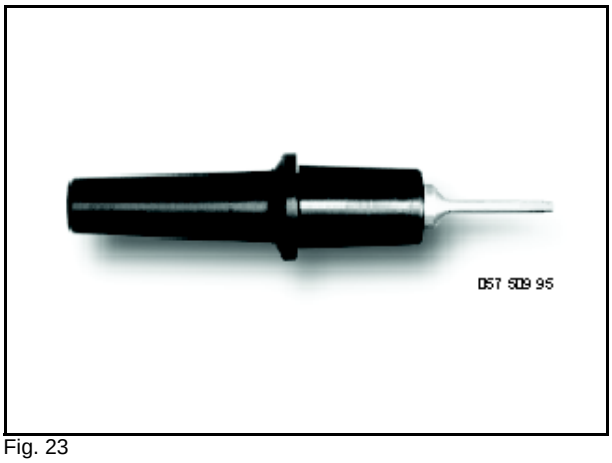


Fig. 23

Schaltbau contacts

43. Disassembly tool for Schaltbau contacts of series M1, M2.

BOMAG part-no.: 057 509 95

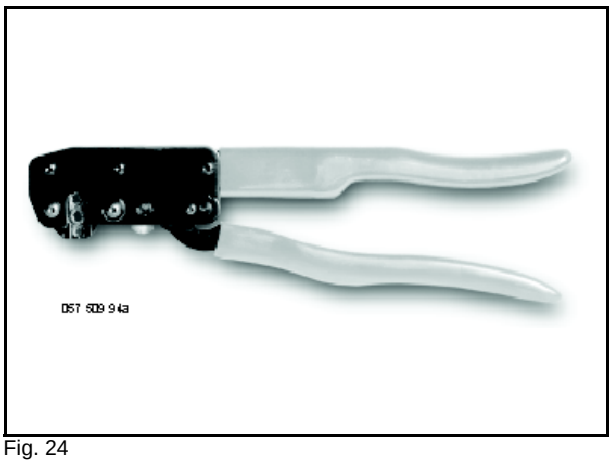


Fig. 24

44. Crimping pliers for Schaltbau contacts of series M1, M2 with connecting cross-section 0.14 - 6.0 mm^2.

BOMAG part-no.: 057 509 94



Fig. 25

FCI Burndy contacts

45. Disassembly tool for FCI Burndy contacts of series TRIM TRIO

BOMAG part-no.: 079 900 00



Fig. 26

AMP contacts

46. Crimping pliers for AMP-contacts of series FASTIN-FASTON with a connecting cross-section of 1.0 - 2.5 mm^2 (18 -14 AWG).

BOMAG part-no.: 079 900 35

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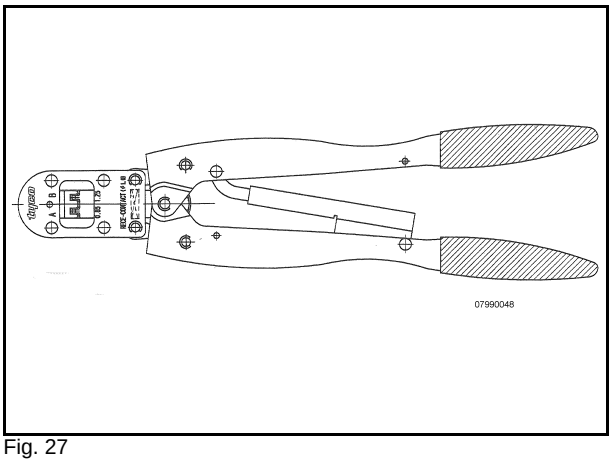


Fig. 27

47. Crimping pliers for AMP-contacts of series SUPER-SEAL with connecting cross-section 0.75 - 1.25 mm^2.

BOMAG part-no.: 079 900 48

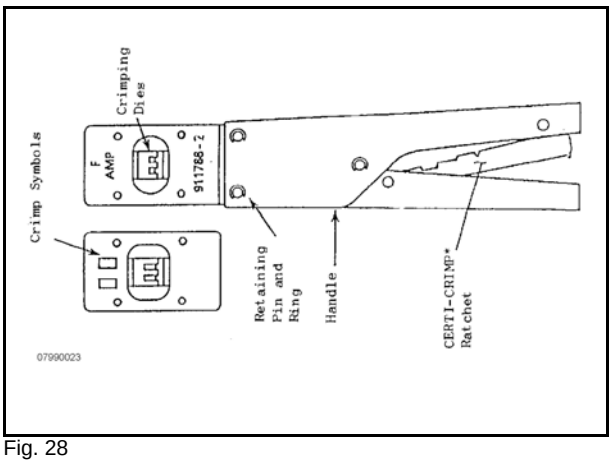


Fig. 28

48. Crimping pliers for AMP-contacts of series .070-SERIES with a connecting cross-section of AWG 20 - 18 (0.5 - 0.9 $mm^{2)}$ and AWG 16 (1.25 - 1.5 mm^2).

BOMAG part-no.: 079 900 23

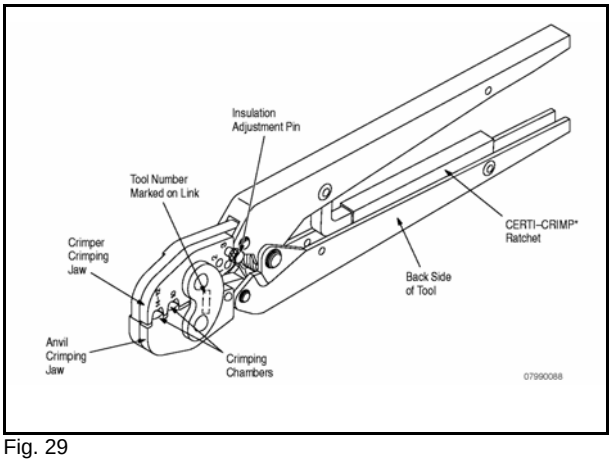


Fig. 29

49. Crimping pliers for AMP-contacts of series FASTON with connecting cross-section AWG 14 - 10.

BOMAG part-no.: 079 900 88

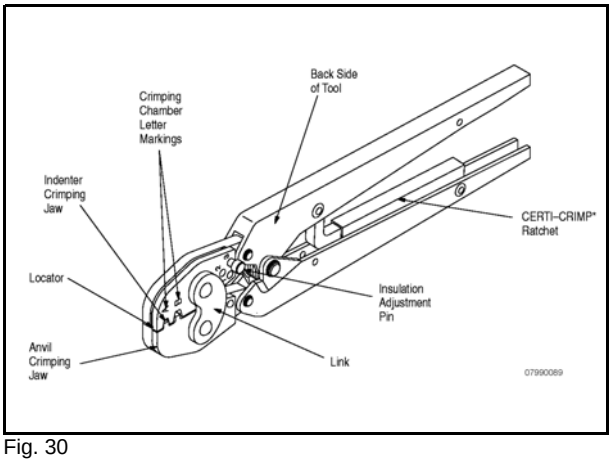


Fig. 30

50. Crimping pliers for AMP-contacts of series FASTON with connecting cross-section AWG 16 - 14 and AWG 18.

BOMAG part-no.: 079 900 89

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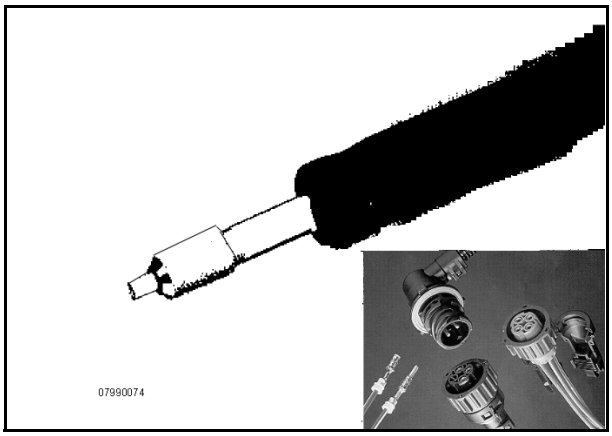


Fig. 31

51. Disassembly tool for AMP-contacts of series CIRCULAR-CONNECTOR.

1.5 mm^2, BOMAG part-no.: 079 900 74

2,5 mm^2, BOMAG part-no.: 079 900 75

Spare sleeve 1.5 mm^2, BOMAG part-no.: 079 900 76

Spare sleeve 2,5 mm^2, BOMAG part-no.: 079 900 77



Fig. 32

Universal tools

52. Universal pressing pliers with toggle lever transmission and adjustable end pressure for Crimping roller connector 0.14 - 1.0 mm^2.

BOMAG part-no.: 972 038 47

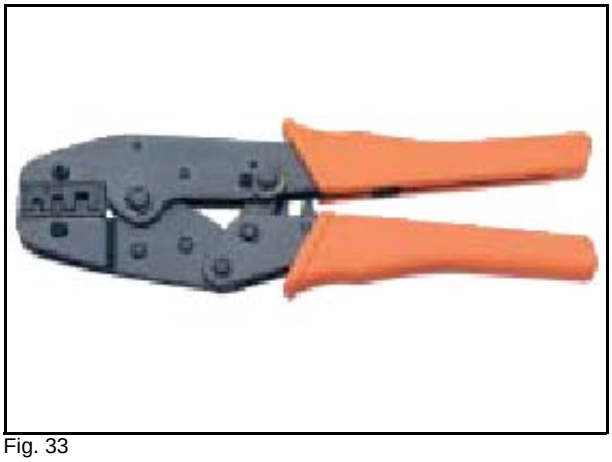


Fig. 33

53. Precision pressing pliers for non-insulated flat male and female connectors0.5 - 6,0 mm^2.

BOMAG part-no.: 079 900 70

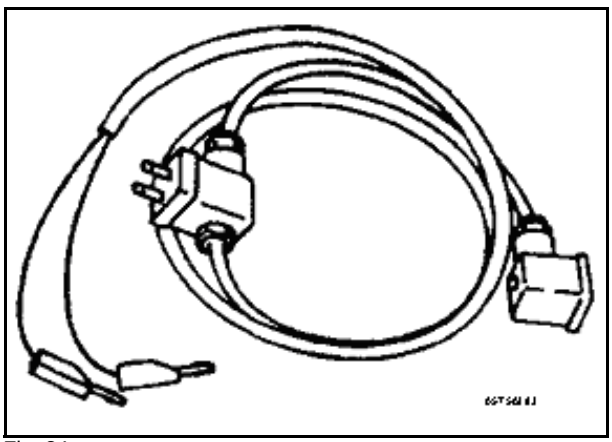


Fig. 34

Measuring adapter

54. Current measurement adapter for Hirschmann plugs.

BOMAG part-no.: 057 503 83

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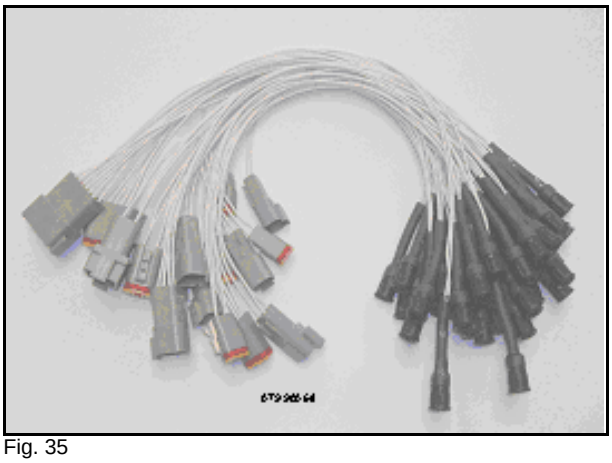


Fig. 35

55. Voltage measurement adapter for Deutsch plugs, 8-piece (2 to 12 pole).

    BOMAG part-no.: 079 900 68

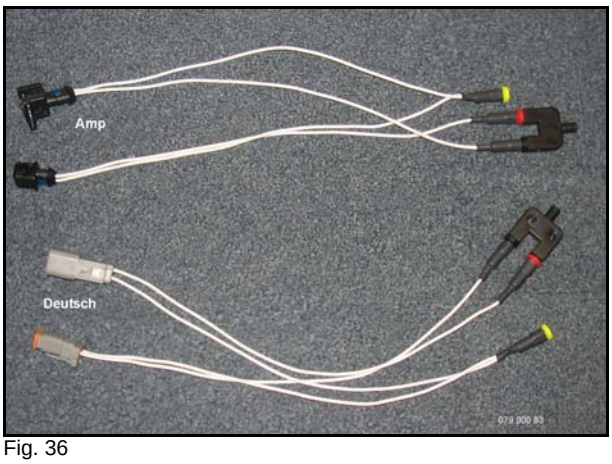


Fig. 36

56. Current measurement adapter for Deutsch and AMP plugs, 2 pole.

    BOMAG part-no.: 079 900 83

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9 Machine related electrics

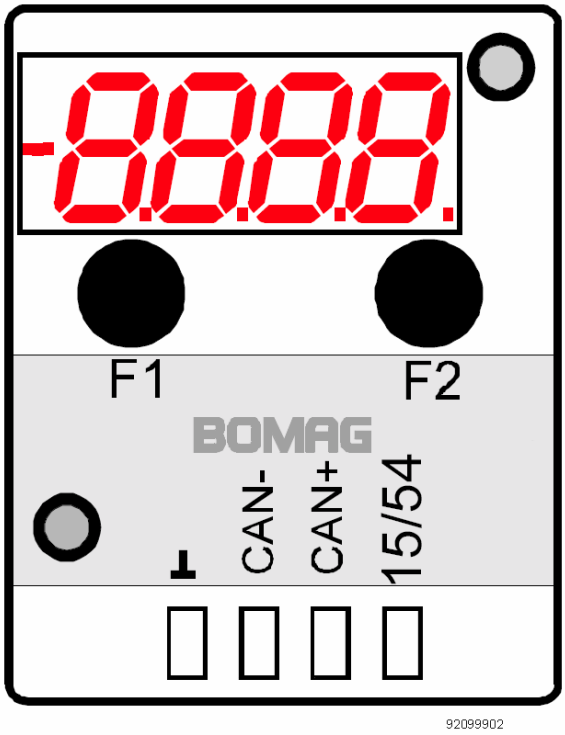
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9.1 Electrics BEM (BOMAG Evib-meter)

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BOMAG Evib-meter (BEM)



i Hinweis

The documentation "Service Training Electrics MESX" contains also the documentation BEM (BOMAG Evib-meter).

The BOP (BOMAG Operation Panel) is only installed in connection with BVC machines, BEM-machines are equipped wit display module. The display module is used for the output of fault codes and display values, as well as for the input of code numbers.

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BOMAG

Service Training
Electrics

MESX

Version 3.01

Status: 01.04.2005
Author: T.Löw / TE
Dateiname: p:\schulung\wz-4\elektrik\bvc\englisch\mesx_v3.01_gb.doc

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1 Document alteration list

Version	Date	Description of changes	resp.
0.00	27.04.2004	Creation of version 1	Löw
1.00	05.05.2004	➔ Block diagrams added ➔ Description of display module extended ➔ "Proof of software change" added	Löw
1.01	23.07.2004	➔ Description of BOP display pages added.	Löw
2.00	31.08.04	➔ Input code 4602 replaced by code 4606 ➔ Machine type BW219D added	Löw
3.00	15.10.2004	➔ Item "How to proceed when replacing components?" added ➔ Description for ESX Pin 0:35 added ➔ Description fault code 4601 and 4606 corrected ➔ Description Software Version 3.00 added	Löw
3.01	16.11.2004	➔ Description Code 7534 from version 3.00 added ➔ Description Software change V3.01 added ➔ Description Code 7573 from version 3.01 added ➔ Description of menus "Amplitude limitation" and "Imperial display" added ➔ Description Software Version up to 3.03 added ➔ Terminal designation MESX canged from X0 to X44 ➔ Description of codes 7502, 7511, 7512, 7532, 7541, 7542, 7550, 7551, 7552, 7562, 7571, 7572, 7576 from version 3.03 added ➔ Proof of "Software change" changed to "Software MESX" ➔ Item "Proof of software change BOP" added ➔ Item "Adjustment possibilities on BCM05mobile" added ➔ Block diagram BTMplus / VARIOCONTROL and BCM05mobile added ➔ Serial numbers added to list of machine types	Löw, Horch

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2 Proof of software change MESX

Version	Date	Description of changes	resp.
1.00	25.03.2004	Creation of version 1.00	Löw
1.01	05.04.2004	➔ Printout modified ➔ Amplitude limitation for Automatic changed to 0.3 mm ➔ Default setting in Automatic changed to "MAX"	Löw
1.02	13.04.2004	➔ BW213 BVC implemented ➔ Printer control modified (Xon, Xoff protocol) ➔ Software version and revision documented in printout ➔ Finished criterion extended (weak spots of 2 m are tested) ➔ Bmfsa code input for DH machines modified	Löw
1.03	05.05.2004	➔ Learning mode for travel distance modified (value range check) ➔ Finished criterion for polygonal drum deactivated ➔ 2-stage jump information implemented ➔ Self-latching of control during shut-down implemented ➔ Saving of current adjustment values during shut-down implemented. ➔ Bmfsa code input for DH machines modified ➔ BW211 D, BW213 D and BW213 DH implemented ➔ Query for software version of BOP implemented	Löw
1.04	16.04.2004	➔ BW226 BVC Polygon implemented ➔ Max. adjustment angle limited to 80° ➔ Max. valve current for BW177 limited to 1000mA	Löw
1.05	26.07.2004	➔ BW219DH and BW213 BVC Polygon implemented ➔ Termination criteria for while loops incorporated into Evib calculation	Löw
2.00	31.08.2004	➔ Number of machine variants extended to 25 (BW219D) ➔ Problem with sporadic SW crash eliminated	Löw
3.00	15.10.2004	➔ Distance pulse changed to 10m for BW226 ➔ Amplitude limitation realized in automatic mode ➔ Simulation mode realized ➔ Changeover metric/imperial realized ➔ minimum required BOP version changed to 3.00 (always the same version as MESX)	Löw
3.01	16.11.2004	➔ The ESC-key does not abort the printout, it only resets the measurement ➔ Machine variant BW226BVC added	Löw
3.02	01.12.2004	➔ Machine type BW216D activated ➔ Completion report for BW226BVC with smooth drum activated	Löw
3.03		➔ Designation on printout modified (RC; DI) ➔ Default setting for amplitude limitation set to "inactive". ➔ Machine types 177PDH, 179DH, 179PDH, 213PDH, 214DH, 214PDH 216D, 216DH,216PDH, 219PDH, 226DH, 226PDH, 226BVC RC" enabled. ➔ Controller settings for BW213BVC and BW226BVC optimized with respect to pressure peaks ➔ Minimum speed for swivelling of of exciter changed to 0.18 km/h => Build-up of the machine with vibration at standstill is thereby avoided	Löw

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3 Proof of software change BOP

Version	Date	Description of changes	resp.
1.00	25.03.2004	first software version for series production	Löw
1.01	13.04.2004	Revision of BVC diagnostics screen	Löw
1.02	23.04.2004	2-stage jump information (yellow and red)	Löw
3.00	15.10.2004	➔ Realization of imperial display ➔ Simulation mode implemented on BOP ➔ New Part-No. 582 701 92	Löw
3.01	24.1.2005	➔ Part-No. changed to 58 701 93 ➔ Designation "ESX" replaced by "MESX" and "BOP" by "BOP"	Löw
3.02		➔ Amplitude bar graph in imperial display mode corrected	Löw

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4 Known faults

Despite the fault monitoring of inputs and outputs on the ESX control, the ESX control is not able to detect all faults. The following list contains a selection of known fault reactions of the control, which mostly have a different cause to the one described in this documentation.

Behaviour of machine	Possible cause
During initial commissioning the display shows the reading "ct0"	Bit rate on bmfsa not set to 125 kBit => see "Setting the bit rate"

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5 How to proceed when replacing components?

Each machine is adjusted individually during initial commissioning. This is mainly accomplished by setting the correct machine type (see "5.4 List of machine types", or "7.1 Adjusting the machine type BOP").

The following chapter describes the necessary adjustments to the control when replacing individual components in the measuring system.

5.1 How to proceed when replacing an ESX control?

Attention:	**A machine must not be operated with a wrong type adjustment, because in such a case the correct function of the control cannot be assured!** **Therefore set the machine type in the first step! see "5.4 List of machine types", or "7.1 Adjusting the machine type"**

After setting the machine type check the following items:

- Check the direction signal, invert the signal if necessary, see 6.4, or 7.2.
- Set the machine serial number (only on machines with BOP), see: 7.5
- Set the printer language (only machines with printer), see: 7.4

5.2 How to proceed when replacing a rear axle sensor?

Check the direction signal, invert the signal if necessary, see 6.4, or 6.4.

5.3 Which components can be replaced without a subsequent adjustment procedure?

- BOP
- Acceleration transducer
- Valve block for exciter adjustment
- Printer
- Bmfsa display module
- All switches in the dashboard

Note:	**A final function test of the complete machine is highly recommended.**

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5.4 List of machine types

Since the same control is used for all single drum rollers with the new measuring technology, it is necessary to adjust the machine type after installing a new control.
This is necessary during first time commissioning as well as in case of a spare parts installation. This type adjustment is necessary, because the machines have e.g. different axle loads or different drum widths, which requires the calculation of measuring values to be adapted. The adjustment procedure is described under items "6.3 Changing the machine type (only via display module" or "7.1 Adjusting the machine type (BOP)".

The following machine types can be adjusted:

Machine type	First serial number	Last serial number	Code	Available from version
177 D	101 582 20 1001	XXX XXX XX XXXX	7500	1.00
177 DH	101 582 21 1001	XXX XXX XX XXXX	7501	1.00
177 PDH	101 582 22 1001	XXX XXX XX XXXX	7502	3.03
177 BVC	101 582 23 1001	XXX XXX XX XXXX	7503	1.00
179 DH	101 582 24 1001	XXX XXX XX XXXX	7511	3.03
179 PDH	101 582 25 1001	XXX XXX XX XXXX	7512	3.03
		XXX XXX XX XXXX		
211 D	101 582 40 1001 101 582 41 1001	XXX XXX XX XXXX	7520	1.03
213 D	101 582 50 1001	XXX XXX XX XXXX	7530	1.03
213 DH	101 582 51 1001	XXX XXX XX XXXX	7531	1.03
213 PDH	101 582 52 1001	XXX XXX XX XXXX	7532	3.03
213 BVC	101 582 53 1001	XXX XXX XX XXXX	7533	1.02
213 BVC Platten	101 582 54 1001	XXX XXX XX XXXX	7534	3.00
213 BVC DI	101 582 53 1001	XXX XXX XX XXXX	7535	1.05
214 DH	101 582 58 1001	XXX XXX XX XXXX	7541	3.03
214 PDH	101 582 59 1001	XXX XXX XX XXXX	7542	3.03
216 D	101 582 62 1001	XXX XXX XX XXXX	7550	3.03
216 DH	101 582 60 1001	XXX XXX XX XXXX	7551	3.03
216 PDH	101 582 61 1001	XXX XXX XX XXXX	7552	3.03
219 D	101 582 72 1001	XXX XXX XX XXXX	7560	2.00
219 DH	101 582 70 1001	XXX XXX XX XXXX	7561	1.05
219 PDH	101 582 71 1001	XXX XXX XX XXXX	7562	3.03
226 DH	101 582 80 1001 101 582 83 1001	XXX XXX XX XXXX	7571	3.03
226 PDH	101 582 81 1001 101 582 84 1001	XXX XXX XX XXXX	7572	3.03
226 BVC	101 582 82 1001 101 582 85 1001	XXX XXX XX XXXX	7573	3.01
226 BVC DI	101 582 82 1001 101 582 85 1001	XXX XXX XX XXXX	7575	1.04
226 BVC RC	101 582 82 1001 101 582 85 1001	XXX XXX XX XXXX	7576	3.03

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6 Possible adjustments on machines without BOP

6.1 Description of the Display Module

Note:	**The display module described next is only used in machines without the Bomag Operation Panel (BOP). On machines with BOP the settings are made via the BOP! (see item 7 "Adjustment/display possibilities on machines with BOP")**

The display module consists of a 4-digit display and two keys, F1 and F2.
It is used for the output of fault codes and display values as well as for the input of code numbers.

Faults and warnings are displayed by flashing. If several faults are detected, the displayed fault codes will change in a 3 second cycle.

Display values are permanently displayed, whereby values from **0 0 0 0** ...**9 9 9 9** are possible. Higher values lead to the display "**– – – –** ", negative values are indicated by the "minus dot" lighting up (see

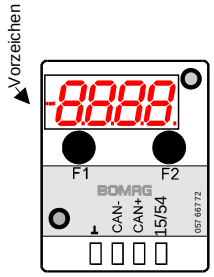


illustration).

The following description describes the input of code numbers.

6.2 Input of code numbers

For the diagnostics of control inputs and outputs various code numbers can be entered via the display module of the control. The input of a code number is performed as follows:

1. Press both keys (F1 and F2) on the instrument cluster for 2 seconds.
   ☞ The value **0 0 0 0** will be displayed, whereby the 1st digit is flashing.
2. The value of the flashing digit can be increased by pressing the left hand key (F1). When the figure **9** is displayed and the left hand key (F1) is pressed again, the display will return to the value **0** .
3. When pressing the right hand key (F2) the flashing digit will move one digit to the right. When the 4th digit is flashing, the right hand key (F2) is pressed once again to confirm the input. The desired function is then executed or the desired value is displayed respectively.

In order to terminate a display function you must either enter code number **0 0 0 0** or switch the ignition off.

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6.3 Changing the machine type (only via display module)

For simple checking the currently adjusted machine type is displayed for approx. 3 seconds on the display module of the central electrics when switching the ignition on. It can also be checked at any time by entering code **7000.**

Adjusting the machine type requires the following sequence:

Note:	**Parameter adjustments can only be performed when the engine is not running.**

- Enter code number **7 0 1 0** . This code number activates the function "Adjusting machine type".

The display module now permanently shows the code **7 0 1 0 .**

- Select and enter the machine from the table above.

The display module now permanently shows the entered code. (e.g. **7 5 3 3**)

- Enter code number **7 0 1 1** . This code number confirms the entered machine type.

After confirming the machine type the control initiates a restart, the display module shows the new machine type for approx. 3 seconds.

- Switch the ignition off and on again.

After this the newly adjusted machine type will be displayed for approx. 3 seconds.

Attention:	**A machine must not be operated with a wrong type adjustment, because in such a case the correct function of the control cannot be assured!** **New controls are delivered with a default machine type setting 7 5 0 0 .**

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6.4 Inverting the direction signal (only via display module)

Depending on the installation position, the axle sensor used delivers a 12V output signal in forward and reverse.

This direction signal may need to be inverted, so that exciter adjustment (only BVC machines) and printout for the travel direction correspond with the actual travel direction.

Note: Parameter adjustments can only be performed when the engine is not running.

- Enter code number **7 6 0 0** . This code number activates the function "Invert direction signal".

The display module now permanently shows the code **7 6 0 0 .**

- Enter code number **7 6 0 1** . This code number inverts the direction signal.

The display module now permanently shows the code **0 0 0 1** (signal inverted), or the code **0 0 0 0** (signal not inverted).

In succession the code number **1 0 0 1** can be used to check whether the direction signal is correctly interpreted (see item 14 "14").

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6.5 Changing the bit rate (only with display module)

The multi-function display can be operated with different CAN transmission speeds. For operation in our machines the bit rate must be set to 125 kBit/s. The bit rate is changed as follows:

- Hold both keys (F1 and F2) of the multi-function display depressed and switch on the ignition. ☞ The currently set bit rate is displayed, e.g. **0 1 0 0 .**
- The bit rate can now be changed in fixed steps by pressing the right hand key (F2). Hold the key depressed until the display reads **0 1 2 5** .
- By pressing the left hand key (F1) the bit rate is accepted and the display changes back to the normal display mode.

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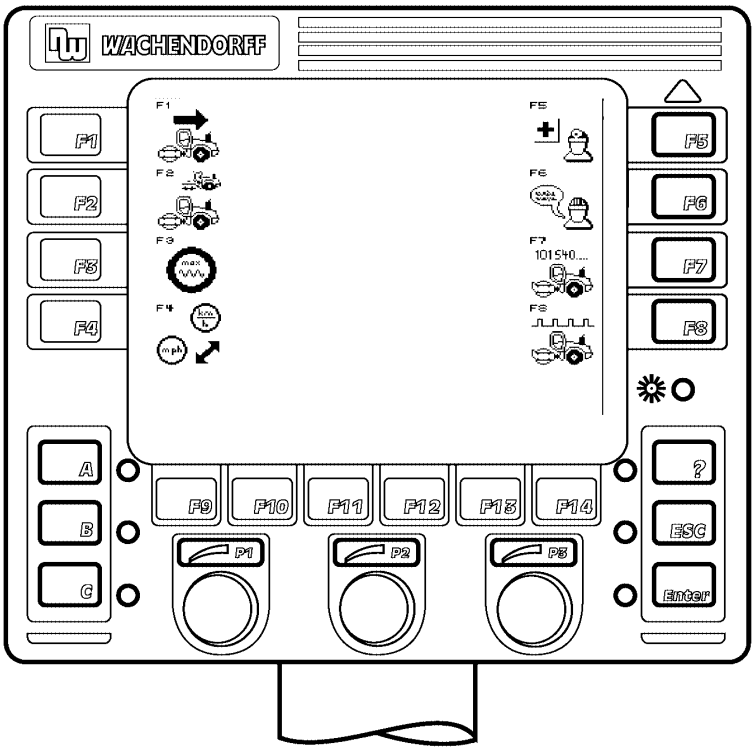
7 Adjustment/display possibilities on machines with BOP

7.1 Adjusting the machine type (BOP)

Adjusting the machine type requires the following sequence:

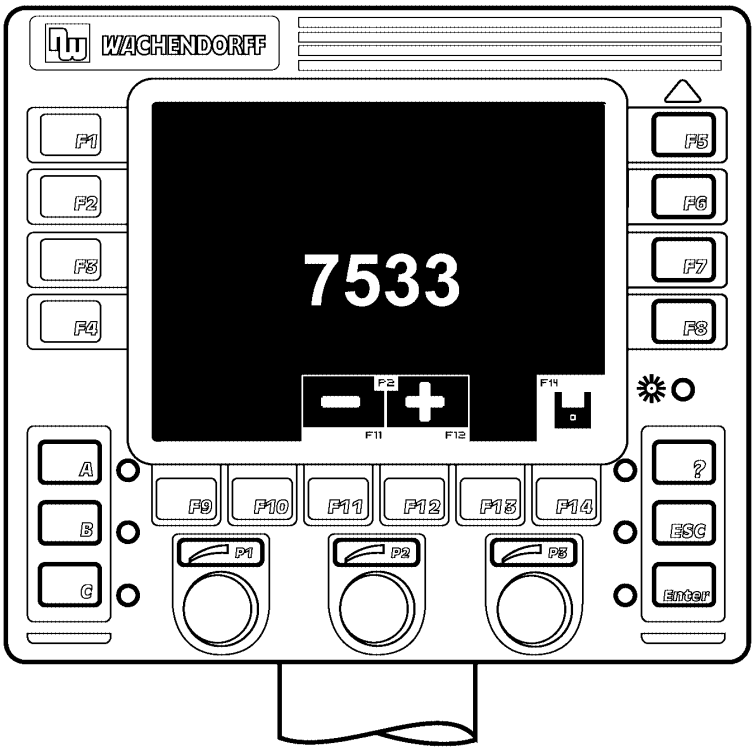
Note:	Parameter adjustments can only be performed when the engine is not running.

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F2" to open the screen page "Adjust machine type". The following screen is displayed:

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- The desired machine type can be selected by pressing the keys "F11" and "F12". (see "List of machine types" under item 5.4 ".
- After selecting the desired machine type press key "F14", until the symbol (F14) lights green for confirmation (approx. 4s).

When releasing the key the start screen will automatically be displayed and the control will initiate a restart.

- Switch the ignition off and on again.

BOP and MESX are now adjusted to the new machine type.

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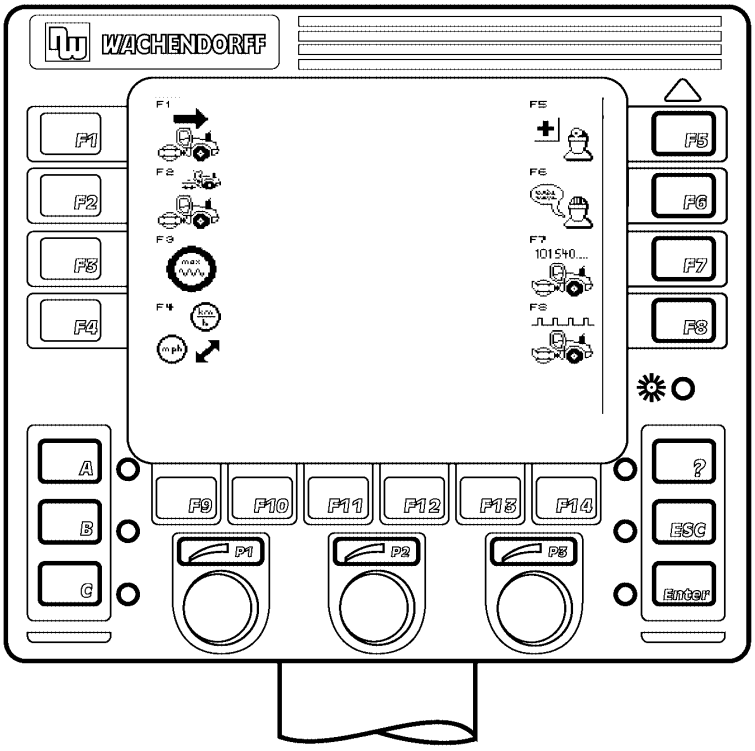
7.2 Inverting the direction signal via the BOP control terminal

Depending on the installation position, the axle sensor used delivers a 12V output signal in forward and reverse.

This direction signal may need to be inverted, so that exciter adjustment (only BVC machines) and printout for the travel direction correspond with the actual travel direction.

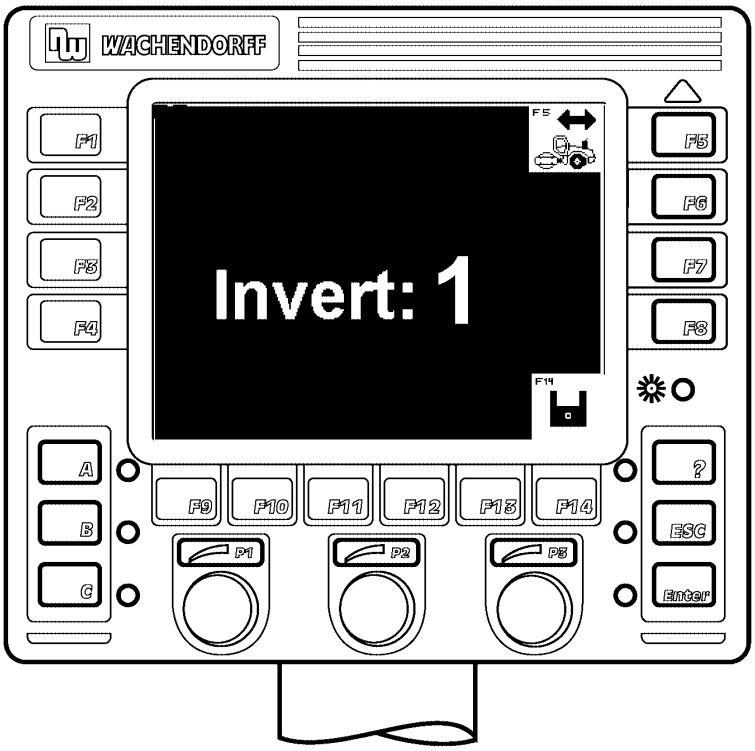
Note: Parameter adjustments can only be performed when the engine is not running.

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F1" to open the screen page "Invert direction signal". The following screen is displayed:

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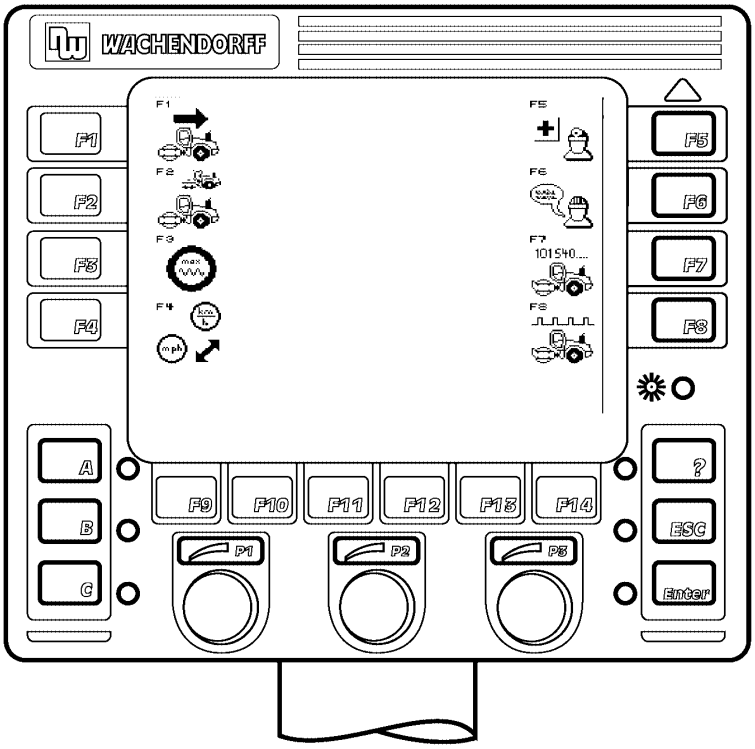
- The direction signal can now be inverted or not inverted by pressing key "F5" ("Invert = 1" or "Invert = 0").
- After the desired change press key "F14" to save the adjustment. The symbol lights green for a moment as a sign of confirmation.
- Press "ESC" to leave the page.

Check on the printout or in the diagnostics menu whether the travel direction has been correctly detected.

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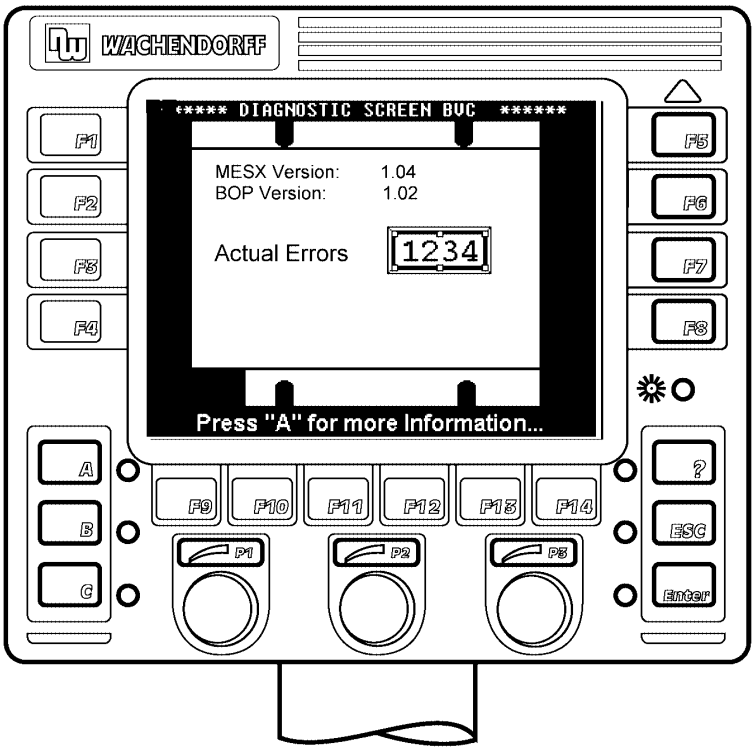
7.3 Accessing the diagnostics menu

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F5" to open the screen page "Diagnose1". The following screen is displayed:

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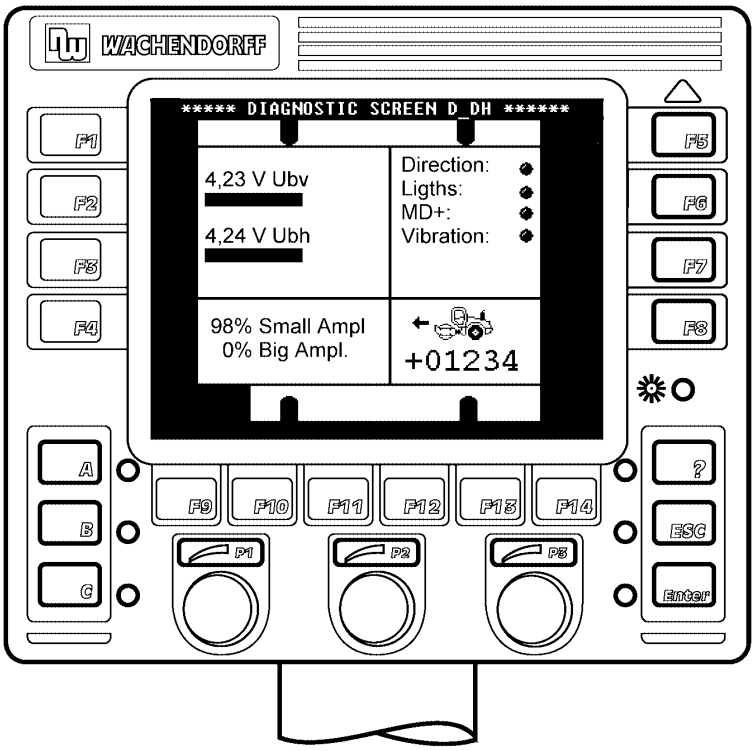


If an actual error is present the corresponding error code will be displayed in the field "Actual Errors".

- Press "ESC" to leave the page.
- By pressing key "A" you can change into a machine specific, more detailed diagnostics menu (see below).

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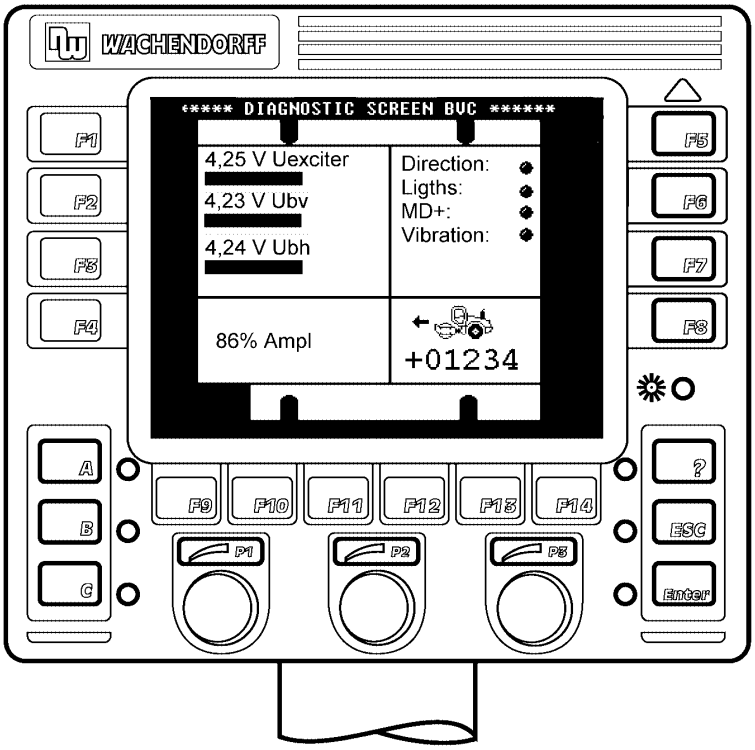
7.3.1 Extended diagnostics on machines with circular exciter (BTMplus, BTMprof)



4.23 V Ubv:	actual voltage front acceleration transducer
4.24 V Ubh:	actual voltage rear acceleration transducer
98% Small Ampl:	Triggering of solenoid valve for low amplitude in percent
0% Big Ampl:	Triggering of solenoid valve for high amplitude in percent
Direction:	Status MESX input travel direction (LED on = 12V)
Ligths:	Status MESX input light detection (LED on = 12V)
MD+	Status MESX input MD+ (detection engine running) (LED on = 12V)
Vibration:	Status of vibration detection in the MESX (LED on = Vibration ON)
+01234	Distance pulses detected by the MESX (10cm steps). The actually detected travel direction can be recognized by the roller symbol above.

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7.3.2 Extended diagnose BVC machines

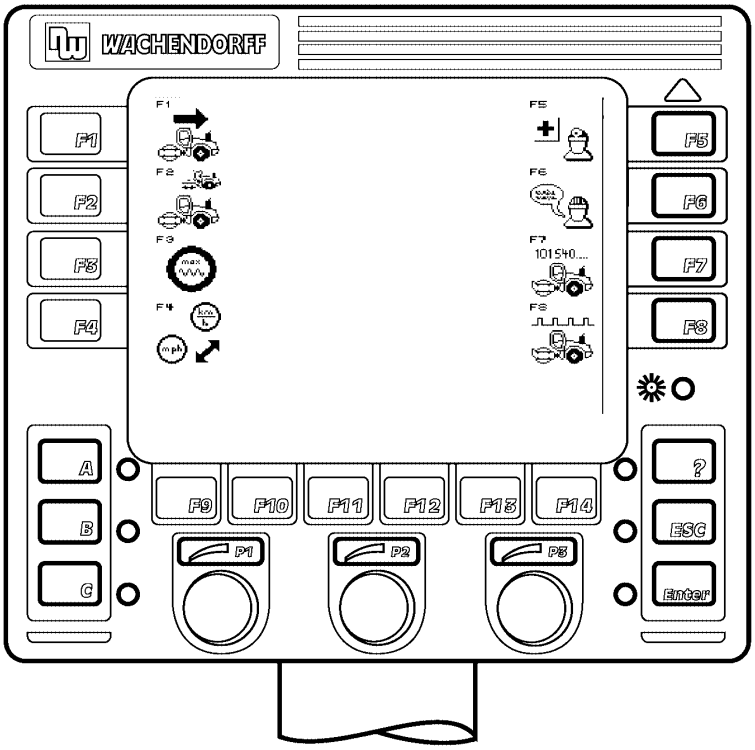


4.25 V Uexciter:	actual voltage of exciter position potentiometer
4.23 V Ubv:	actual voltage front acceleration transducer
4.24 V Ubh:	actual voltage rear acceleration transducer
98% Ampl:	Triggering of solenoid valve for vibration valve in percent
Direction:	Status MESX input travel direction (LED on = 12V)
Ligths:	Status MESX input light detection (LED on = 12V)
MD+	Status MESX input MD+ (detection engine running) (LED on = 12V)
Vibration:	Status of vibration detection in the MESX (LED on = Vibration ON)
+01234	Distance pulses detected by the MESX (10cm steps). The actually detected travel direction can be recognized by the roller symbol above.

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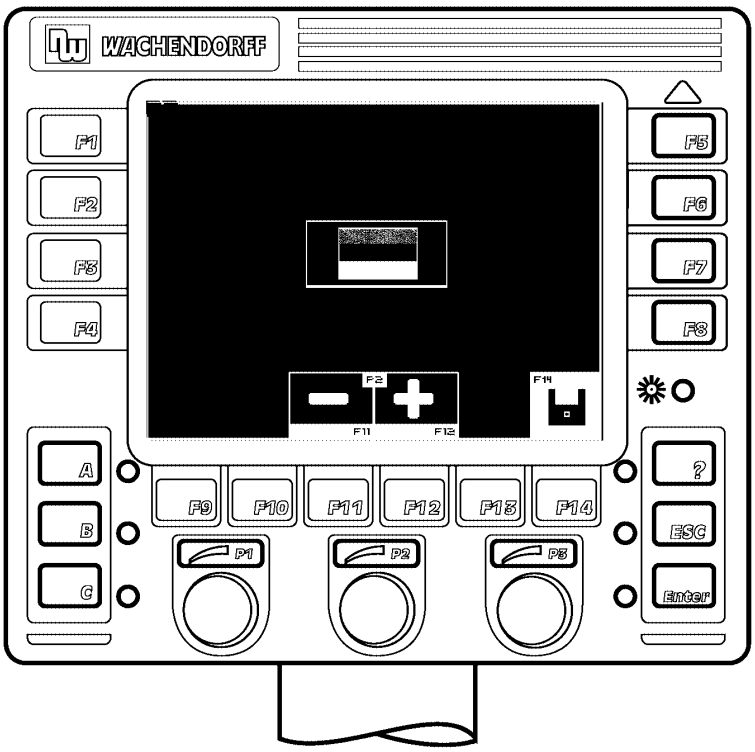
7.4 Changing the printout language

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F6" to open the screen page "Printout language". The following screen is displayed:

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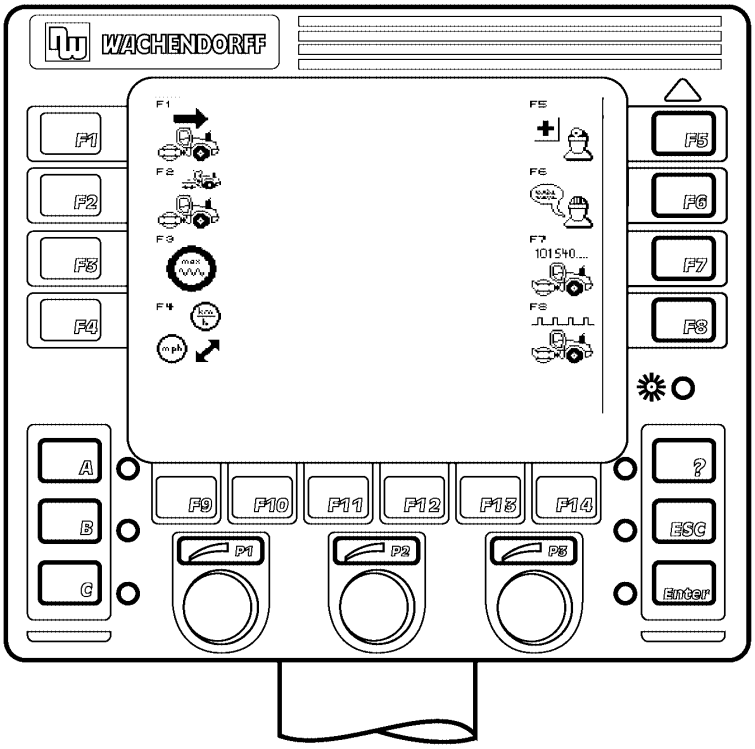


- The desired printout language can be selected by pressing the keys "F11" and "F12".
- After selecting the desired language press key "F14" to save the adjustment. The symbol (F14) lights green for a moment as a sign of confirmation.
- Press "ESC" to leave the page.

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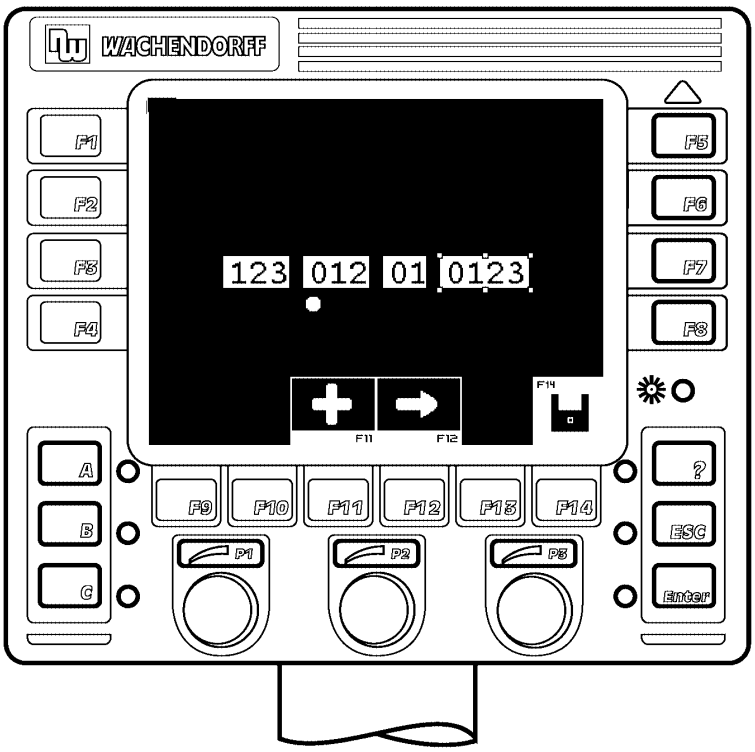
7.5 Setting the machine serial number

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F7" to open the screen page "Serial number". The following screen is displayed:

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- The desired printout language can be selected by pressing the keys "F11" and "F12".
- After the adjustment press key"F14" to save the adjustment. The symbol (F14) lights green for a moment as a sign of confirmation.
- Press "ESC" to leave the page.

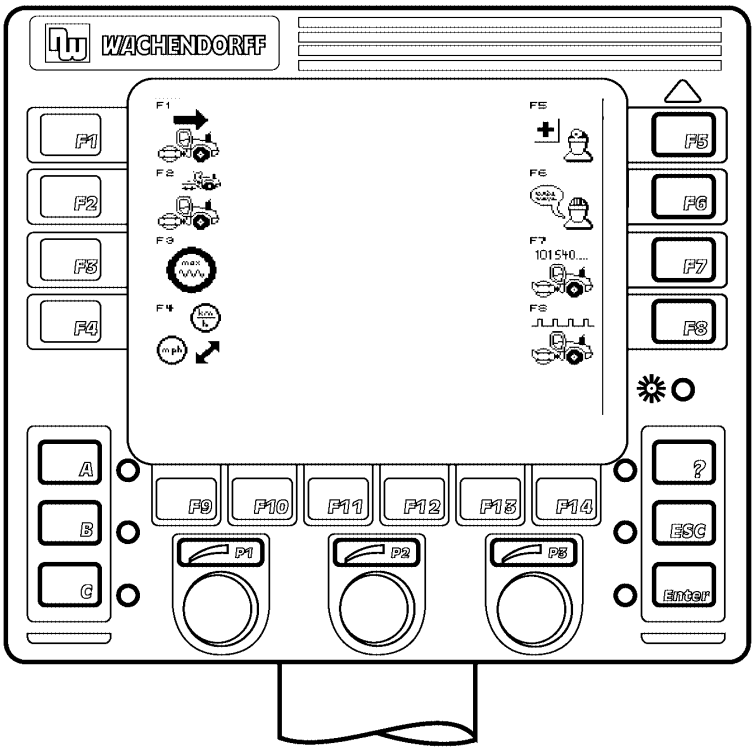
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7.6 Teaching distance pulses

The distance pulses for the different machine types are already set by default after adjusting the correct machine type. However, due to slippage on the rear axle the recorded distance measurement may deviate from the actually travelled distance. In this case the distances pulses can be adjusted accordingly.

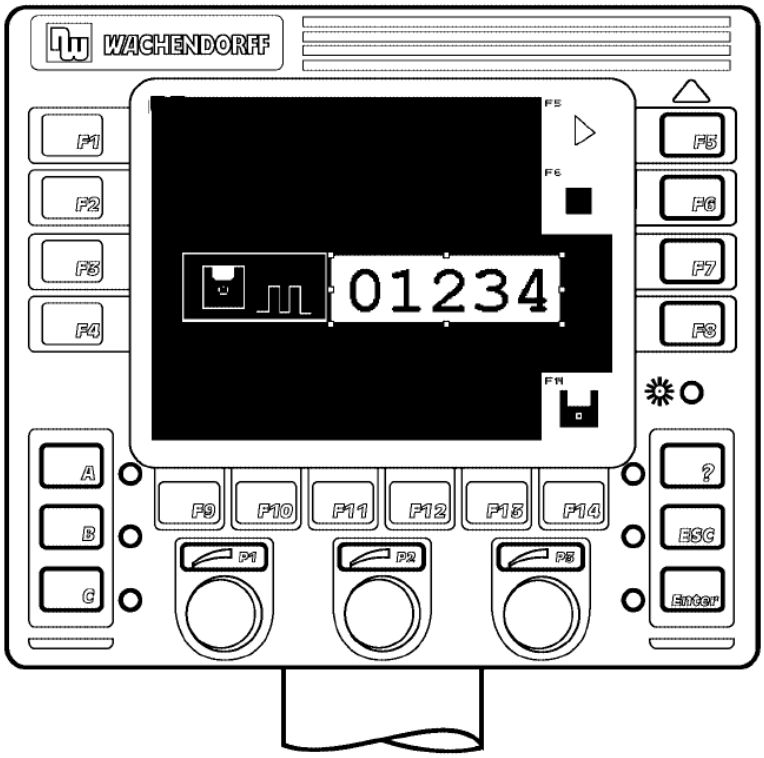
Note: An adaptation of the distance pulses is only possible within a range of +/- 10% of the preset value.

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F8" to open the screen page "Distance pulses". The following screen is displayed:

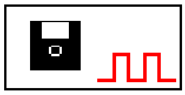
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- Pressing the key "F5" starts the teach mode. The following symbol appears:



- Drive a distance of 10 m length in forward and press the key "F6" at the end. The following symbol appears:

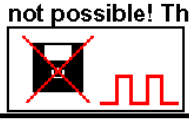


- After the end of the measuring travel press key "F14" to save the adjustment. The following symbol appears:



- Press "ESC" to leave the page.

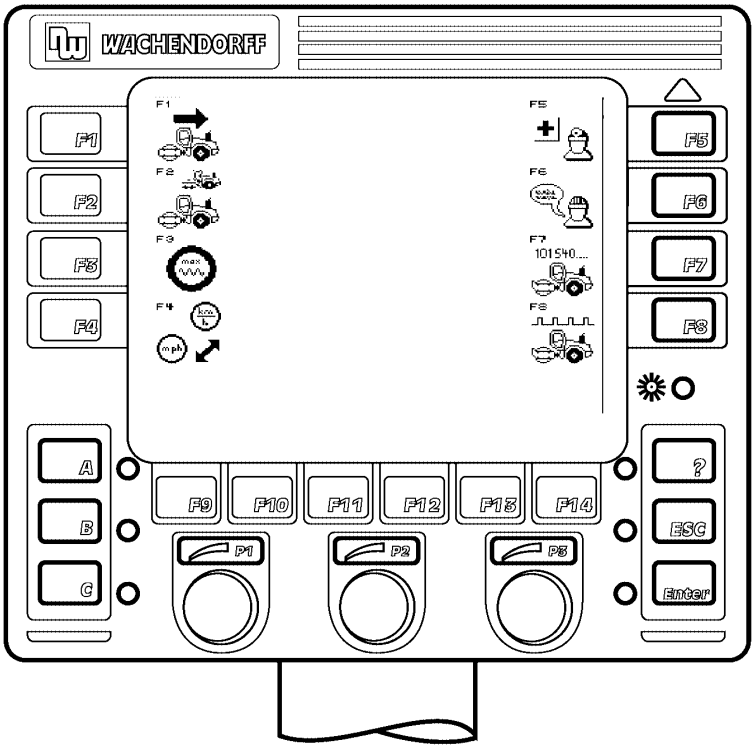
Note: If the following symbol is displayed after the end of the travel distance the measured distance pulses are not in the range of +/- 10% of the preset value. Saving is in this case not possible! The measurement must be repeated!



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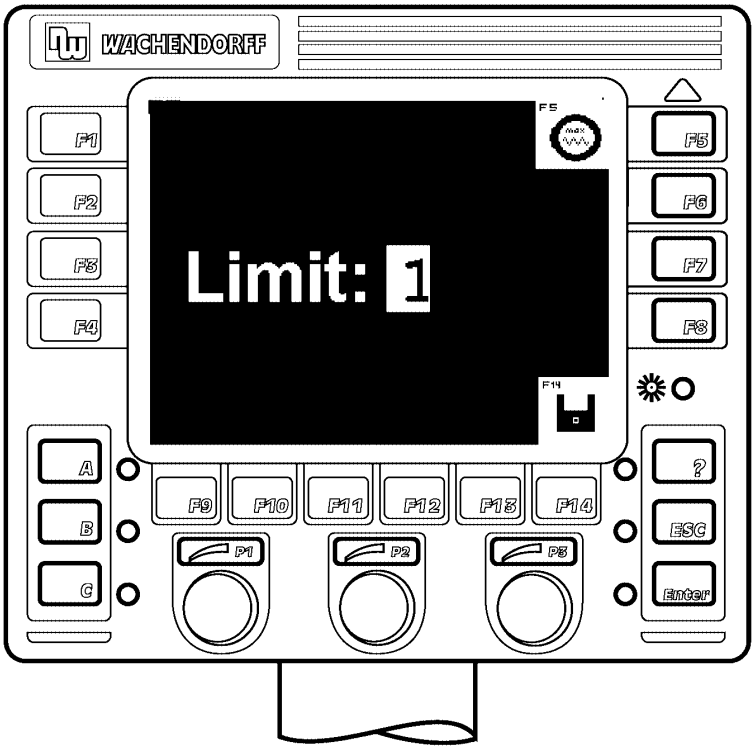
7.7 Activating the amplitude limitation (only BVC machines)

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F3" to open the screen page "Amplitude limitation". The following screen is displayed:

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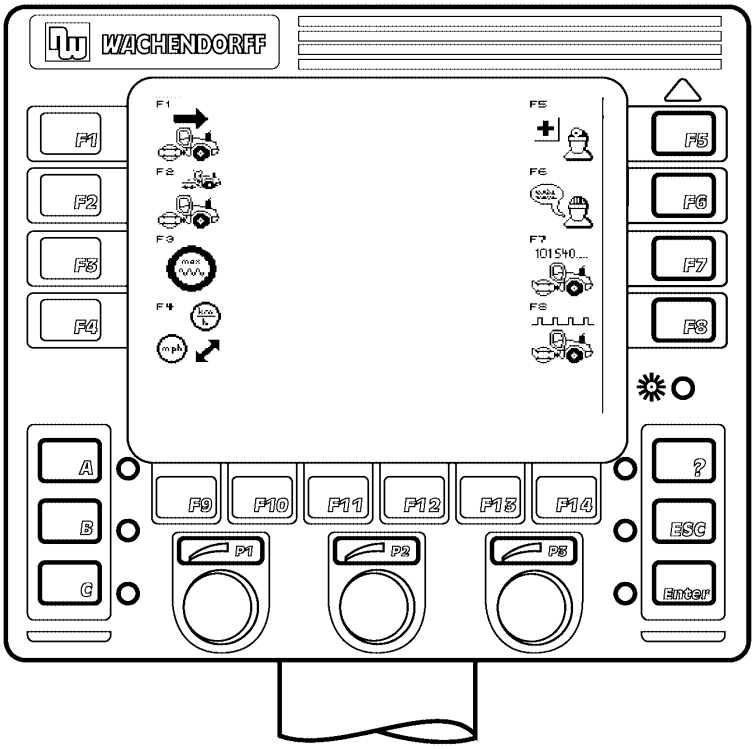


- The limitation can now be activated or deactivated by pressing key "F5" ("Limit = 1" or "Limit = 0").
- After the desired change press key "F14" to save the adjustment. The symbol lights green for a moment as a sign of confirmation.
- Press "ESC" to leave the page.

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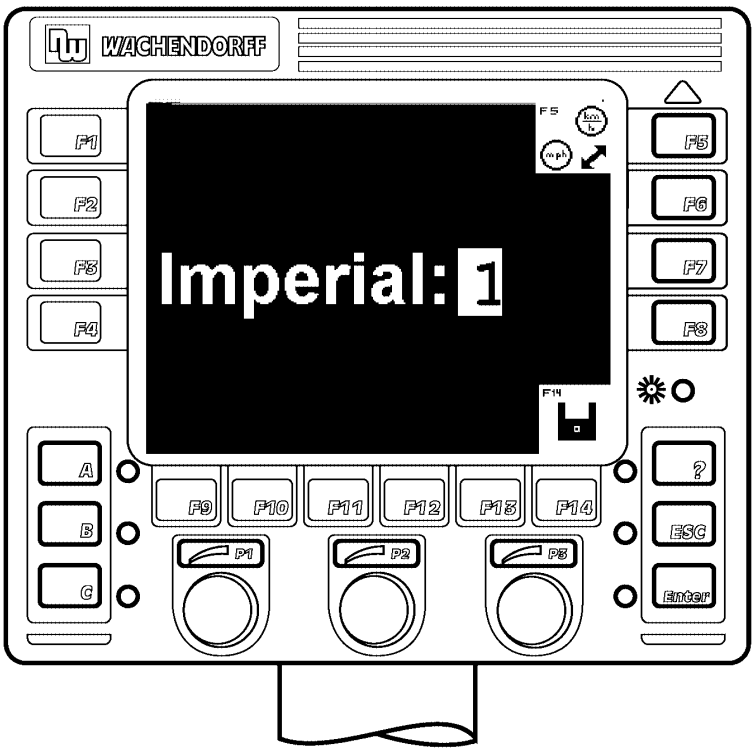
7.8 Changing the display mode (metric/imperial)

- Press key "?" to open the screen page "MENU". The following screen is displayed:



- Press key "F4" to open the screen page "Display mode". The following screen is displayed:

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- The imperial display (mph, °F, etc.) can now be activated or deactivated by pressing key "F5" ("Imperial = 1" or "Imperial = 0").
- After the desired change press key "F14" to save the adjustment. The symbol lights green for a moment as a sign of confirmation.
- Press "ESC" to leave the page.

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8 Possible settings on the BCM05mobile

Insert the BCM05mobile into the holder and close the clamp. Switch on the ignition and subsequently the BCM05mobile by holding the yellow switch on the right depressed for approx. 1-2 seconds; wait and confirm the time dialog.
For functions beyond the following description, please refer to the BCM05 user manual.

8.1 Reading the software version

Select "Configuration" at the right hand edge of the window.
The software currently installed in the BCM05mobile is displayed at the top left unter the name BOMAG.

8.2 Changing the language

Open the service window: press the top switch of the three switches at the right hand edge of the touchscreen "Configuration" for about 5 seconds, until a roller symbol appears under the software version number at the left hand side of the display. Release the "Configuration" switch and press the symbol within 3 seconds. The touchscreen now shows 4 switches near the right hand edge and select the bottom switch "Service".

Note: After this setting the service window must be closed to avoid unauthorized access. Press "Close window" at the bottom right in the service window.

Press the field "Language". A list with the available languages pops up. Choose the desired language and confirm with "Select".

8.3 Changing the unit system (metric/imperial)

Open the service window: press the top switch of the three switches at the right hand edge of the touchscreen "Configuration" for about 5 seconds, until a roller symbol appears under the software version number at the left hand side of the display. Release the "Configuration" switch and press the symbol within 3 seconds. The touchscreen now shows 4 switches near the right hand edge and select the bottom switch "Service".

Note: After this setting the service window must be closed to avoid unauthorized access. Press "Close window" at the bottom right in the service window.

Shift the switch in the "Unit" field to the desired position.

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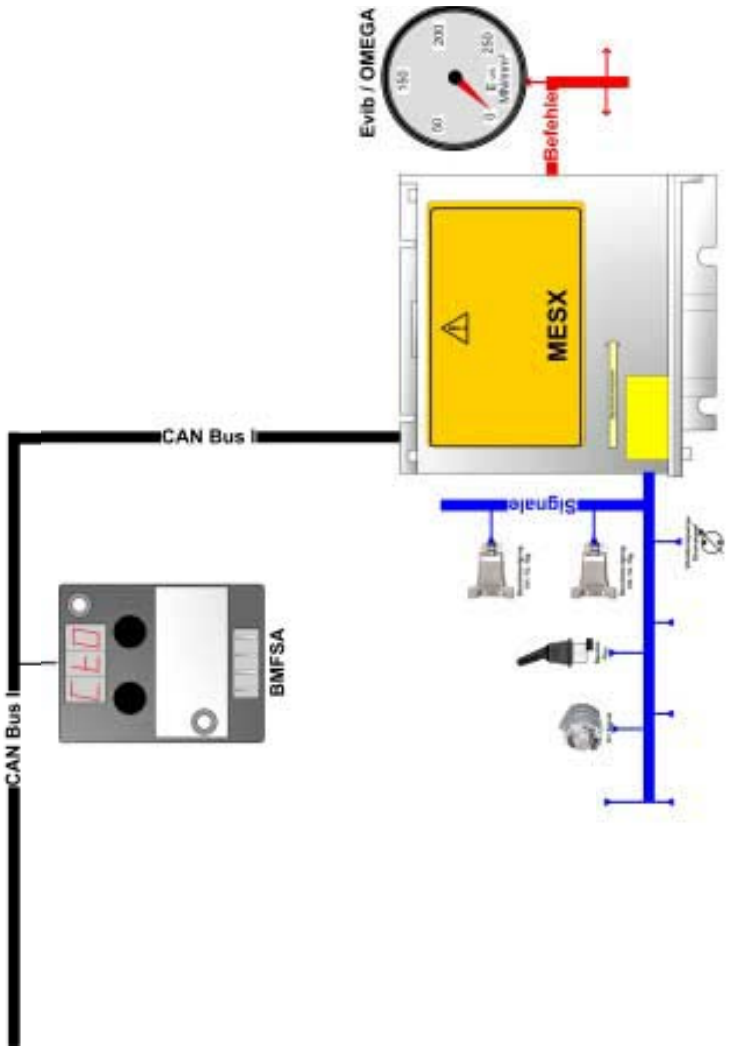
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BOMAG

Service Training MESX

Block diagram

9 Block diagram BEM



Block diagram

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Status: 01.04.2005
Author: T. Löw / TE

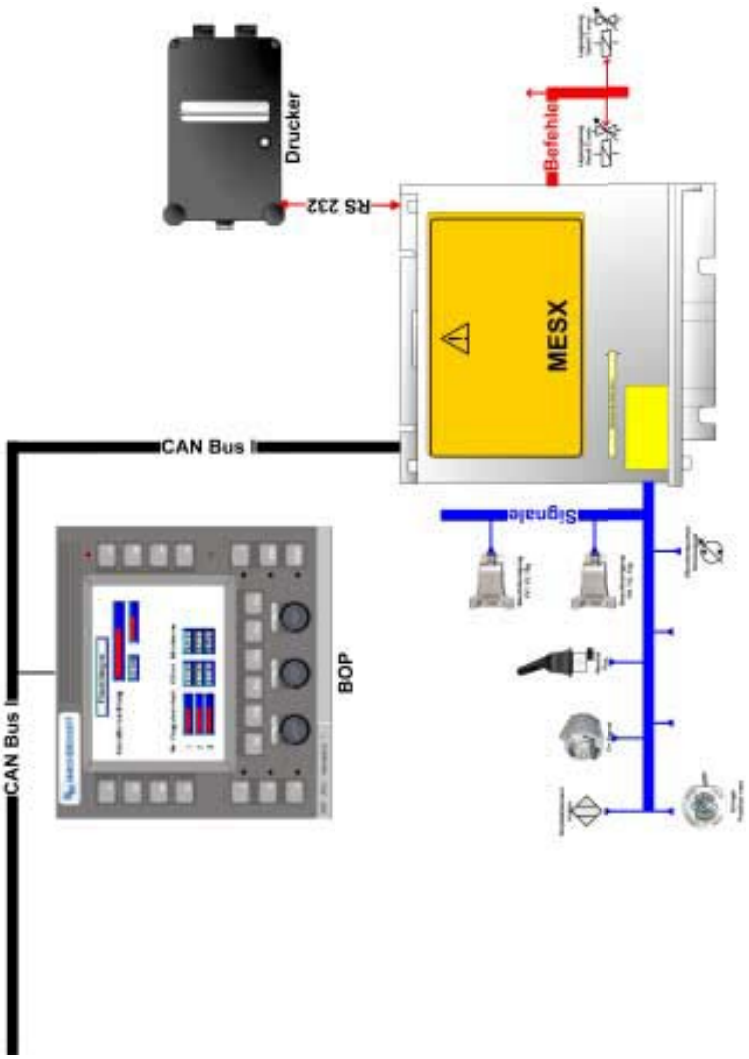
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BOMAG

Service Training MESX

Block diagram

10 Block diagram BTMplus / VARIOCONTROL

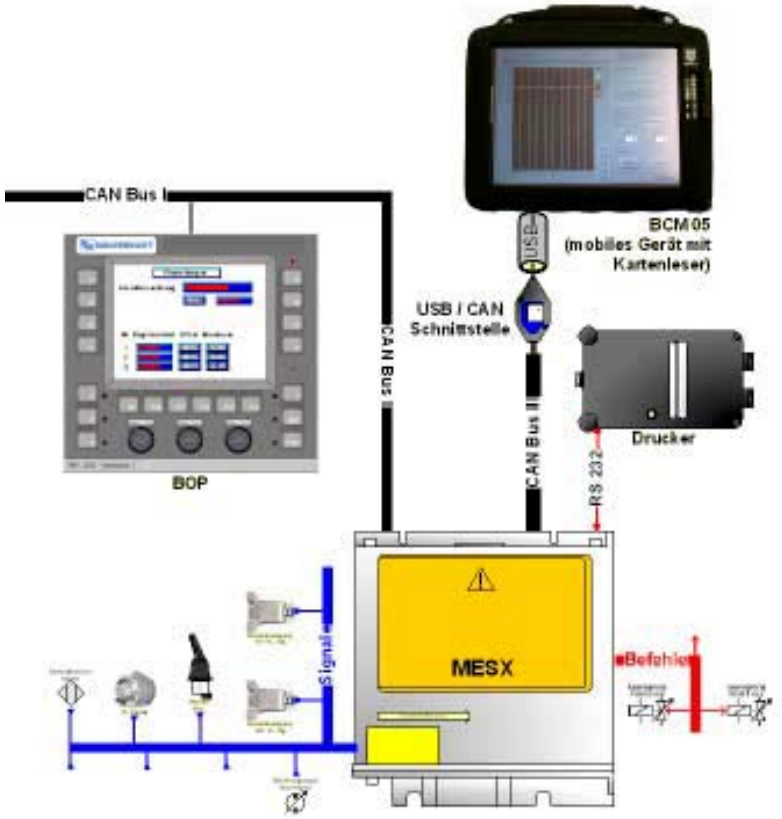


Block diagram

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Author: T. Löw / TE

11 Block diagram BTMplus / VARIOCONTROL and BCM05mobile



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12 Description of the Signals on the ESX-Control

Notes:
1. Wherever the value of 12 V is mentioned in the following text it refers to the current battery voltage under due consideration of voltage drops in the lines.

ESX terminal	Signal description	Nominal values (voltage / current)
X44:1	**AGND** = Analogue ground: Ground potential for sensors (steering joystick, speed range switch etc.)	approx. 0 V measured against ground (terminal 31)
X44:2		
X44:3	Output **Evib Display** PWM (max. 2.5 A)	PWM signal (100Hz): ☞ approx. 0..6 V
X44:4	Interface **RS 232 RxD**, used for printer control.	Measurement not possible!
X44:5	Interface **RS 232 TxD**, used for printer control.	Measurement not possible!
X44:6		
X44:7	Input **acceleration transducer VH20g/HR15g** Analogue input / voltage input 0..8.5 V	Acceleration signal (measured against **AGND**) Open circuit voltage (vibration off): ☞ 4,2..4,3 V
X44:8		
X44:9	Input **exciter position front** Analogue input / voltage input 0..8.5 V	Position of front exciter (measured against **AGND)** Bottom stop ☞ approx. 2.2 V Neutral position ☞ approx. 4.25 V Top stop ☞ approx. 6.6 V

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ESX terminal	Signal description	Nominal values (voltage / current)
X44:10		
X44:11		
X44:12		
X44:13		
X44:14		
X44:15	Input **vibration 1 On** Digital input active high	Vibration on: ☞ > 6 V Vibration off: ☞approx.0 V
X44:16	Input **button "START" (option)** Digital input active high	Push button pressed ☞ 12 V Push button not pressed ☞ 2 V
X44:17	Input **button "STOP" (option)** Digital input active high	Push button pressed ☞ 12 V Push button not pressed ☞ 2 V
X44:18	Input **button "PRINT" (option)** Digital input active high	Push button pressed ☞ 12 V Push button not pressed ☞ 2 V
X44:19	Input **button "CLEAR" (option)** Digital input active high	Push button pressed ☞ 12 V Push button not pressed ☞ 2 V
X44:20		
X44:21		
X44:22		
X44:23	Output **voltage supply for sensors** This output supplies steering joystick, travel speed range switch, etc. Without this voltage the control cannot work correctly and will switch to override condition (emergency operation).	Nominal voltage = 8,5 V Permissible range: approx. 7,65..9,35 V **This voltage must be measured against AGND.**
X44:24		

ESX terminal	Signal description	Nominal values (voltage / current)
X44:25		
X44:26	Interface CAN-Bus Wire -, is used to communicate with the BOP operating unit.	Measurement not possible!
X44:27	Interface CAN-Bus Wire +, is used to communicate with the BOP operating unit.	Measurement not possible!
X44:28	Input **potential terminal 15** Digital input active high This signal **must** be present, so that the control can work.	Control switched on ☞ 12 V Control switched off ☞approx.2 V
X44:29	Input **acceleration transducer VV/VL15g** Analogue input / voltage input 0..8.5 V	Acceleration signal (measured against **AGND**) Open circuit voltage (vibration off): ☞ 4,2..4,3 V
X44:30	Input **acceleration transducer VH/VR15g** Analogue input / voltage input 0..8.5 V	Acceleration signal (measured against **AGND**) Open circuit voltage (vibration off): ☞ 4,2..4,3 V
X44:31	Input **acceleration transducer VV20g/HR15g** Analogue input / voltage input 0..8.5 V	Acceleration signal (measured against **AGND**) Open circuit voltage (vibration off): ☞ 4,2..4,3 V
X44:32		
X44:33	Interface CAN-Bus2 Wire -, is used to communicate with the BCM05.	Measurement not possible!
X44:34		
X44:35	Input **distance transducer** Digital input active high	Transducer delivers square-wave pulses Frequency depends on machine type.

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ESX terminal	Signal description	Nominal values (voltage / current)
X44:36		
X44:37	Input **D+ generator** Digital input active high	Engine running / engine is started ☞ 12 V Engine not running ☞ 0 V
X44:38	Input **vibration 2 On** Digital input active high	Vibration on: ☞ > 6 V Vibration off: ☞approx.0 V
X44:39		
X44:40		
X44:41		
X44:42		
X44:43		
X44:44		
X44:45		
X44:46	Output **valve 1 front** PWM digital output (max. 4 A)	permissible current range: approx. 0..1,5 A
X44:47	Output **valve 2 front** PWM digital output (max. 4 A)	permissible current range: approx. 0..1,5 A
X44:48		
X44:49		
X44:50		
X44:51		
X44:52		

ESX terminal	Signal description	Nominal values (voltage / current)
X44:53	Interface CAN-Bus2 Wire +, is used to communicate with the BCM05.	Measurement not possible!
X44:54	Voltage supply for electronics	Emergency stop not actuated ☞ 12 V Emergency stop actuated ☞ 0 V
X44:55	Ground connection electronics	0 V measured against ground
X44:56	Voltage supply for outputs	approx. 12 V measured against ground
X44:57	Voltage supply for outputs	approx. 12 V measured against ground
X44:58	Voltage supply for outputs	approx. 12 V measured against ground
X44:59	Voltage supply for outputs	approx. 12 V measured against ground
X44:60	Voltage supply for outputs	approx. 12 V measured against ground
X44:61		
X44:62		
X44:63		
X44:64		
X44:65	Mouse port Baby Boards	approx. 0 V
X44:66	Mouse port Baby Boards	approx. 0 V
X44:67	Mouse port Baby Boards	approx. 0 V
X44:68	Mouse port Baby Boards	approx. 0 V

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13 Fault codes of the ESX control

13.1 Overview

Fault code	Fault description
4501 –	Position controller (exciter potentiometer, valves)
4502 –	Acceleration transducer
4600 –	Internal software errors
8250	

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13.2 Description of fault reactions

Fault reaction	Description of fault reaction
1	Warning. Fault code is displayed. Signal light in BOP (option) lights in 5 second intervals.
2	Function affected, the faulty function is replaced by an emergency function. Fault code is displayed. Signal light in BOP (option) lights in 5 second intervals.
3	Partial function faulty, the partial function cannot be overridden by an emergency function. After the occurrence of the fault the machine is stopped, after returning the travel lever to neutral the machine can move again. The machine can still be driven to a limited extent, but must be repaired by the service department as soon as possible. Fault code is displayed. Signal light in BOP (option) lights in 5 second intervals.
4	Partial function faulty, the partial function cannot be overridden by an emergency function. The machine is no longer able to drive, e.g. because parts of the travel system are defective ☞ the diesel engine is shut down. Fault code is displayed. Signal light in BOP (option) lights in 1 second intervals.
5	Fatal fault. The function of the control can no longer be guaranteed. Control is switched off. Error code is displayed. Signal light in BOP (option) lights permanently.

Note: Errors with error reaction 1 are only warning messages and are NOT stored in the error log.

13.3 Detailed description of fault codes and their possible causes

Fault code	Fault description	Possible cause	Terminal on ESX	Input code for diagnose	Fault reaction
4501	Input exciter potentiometer front The voltage applied to the input is below the specified range (see signal description).	-{}-☞ Wire breakage in current path ☞ Current path has short circuit to ground ☞ No voltage supply to potentiometer ☞ Fuse FM ? has tripped or wire breakage in voltage supply current path ☞ Potentiometer defective	X44:09		5
4502	Input exciter potentiometer front The voltage applied to the input is above the specified range (see signal description).	☞ Current path connected to +12 V / +8,5 V ☞ Potentiometer not connected to ground ☞ Potentiometer defective	X44:09		5

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Fault code	Fault description	Possible cause	Terminal on ESX	Input code for diagnose	Fault reaction
4521	Output proportional solenoid front Valve for exciter up Output current too low.	☞ Current path has short circuit to voltage supply ☞ Current path has non-permitted connection to another current path ☞ Current path is interrupted	X44:46		2
4522	Output proportional solenoid front Valve for exciter up Output current too high.	☞ Current path has short circuit to ground ☞ Current path has non-permitted connection to another current path	X44:46		2
4523	Output proportional solenoid front Valve for exciter up Fault when calibrating the valve	☞ Current path is interrupted ☞ Current path has unpermitted connection to another current path / ground	X44:46		2
4526	Output proportional solenoid front Valve for exciter down Output current too low.	☞ Current path has short circuit to voltage supply ☞ Current path has non-permitted connection to another current path ☞ Current path is interrupted	X44:47		2
4527	Output proportional solenoid front Valve for exciter down Output current too high.	☞ Current path has short circuit to ground ☞ Current path has non-permitted connection to another current path	X44:47		2
4528	Output proportional solenoid front Valve for exciter down Fault when calibrating the valve	☞ Current path is interrupted ☞ Current path has unpermitted connection to another current path / ground	X44:47		2

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Fault code	Fault description	Possible cause	Terminal on ESX	Input code for diagnose	Fault reaction
4531	Position controller positive limit reached The exciter does not move to the desired direction or does not move at all.	☞ Supply and ground terminal on exciter potentiometer mixed up ☞ Valves for "Exciter up" and "Exciter down" mixed up ☞ MD+ input has 12 V potential, even though the engine is not running	X44:09 X44:37	5000	2
4532	Position controller negative limit reached The exciter does not move to the desired direction or does not move at all.	☞ Supply and ground terminal on exciter potentiometer mixed up ☞ Valves for "Exciter up" and "Exciter down" mixed up ☞ MD+ input has 12 V potential, even though the engine is not running	X44:09 X44:37	5000	2
4601	Input acceleration transducer 1 The voltage applied to the input is below the specified range (see signal description).	☞ Current path has no connection to +12 V / +8,5 V ☞ Current path connected to ground ☞ Transducer defective	X44:29, or X44:31	4601	2
4602	Input acceleration transducer 1 The voltage applied to the input is above the specified range (see signal description).	☞ Current path connected to +12 V / +8,5 V ☞ Current path not connected to ground ☞ Transducer defective	X44:29, or X44:31	4601	2
4606	Input acceleration transducer 2 The voltage applied to the input is below the specified range (see signal description).	☞ Current path has no connection to +12 V / +8,5 V ☞ Current path connected to ground ☞ Transducer defective	X44:30, or X44:07	4606	2
4607	Input acceleration transducer 2 The voltage applied to the input is above the specified range (see signal description).	☞ Current path connected to +12 V / +8,5 V ☞ Current path not connected to ground ☞ Transducer defective	X44:30, or X44:07	4606	2

Fault code	Fault description	Possible cause	Terminal on ESX	Input code for diagnose	Fault reaction
8000	Error message "Incorrect BOP Software version" The software version of the BOP is too old, i.e. various functions cannot be displayed. This fault cannot be rectified on the machine. The BOP needs to be replaced.		-	-	2
8001 - 8999	Fault message „severe software fault in control“ This fault cannot be rectified on the machine. The control must be immediately replaced.	-	-	-	5
9000 - 9998	Error message "Communication via CAN bus disturbed" The modules controlled via the CAN bus cannot be addressed by the main control (ESX). The respective machine functions are not available	☞ Wire breakage in CAN bus lines ☞ Short circuit between CAN bus lines ☞ One or both CAN bus line(s) has (have) connection to 12V or ground	X44:26 X44:27-	-	2
Ct0	Display module has no connection to ESX-control.	☞ Wire breakage in CAN bus lines ☞ Short circuit between CAN bus lines ☞ One or both CAN bus line(s) has (have) connection to 12V or ground ☞ Incorrect bit rate in display module (nominal value: 125 kBit)	X44:26 X44:27	-	-

14 Input codes for ESX control (only via display module on BEM)

14.1 Travel system

Input code	Description of display function	Display values
1000	**Transducer for travel direction** Show status of transducer.	0000 ☞ 0 V 0001 ☞ 12 V
1001	**Travel direction** Displays the travel direction derived by the control from the "transducer for travel direction".	1000 ☞ Forward travel detected 0000 ☞ Neutral position 000I ☞ Reverse travel detected
1002	**Transducer for distance pulses** The distances pulses summarized since starting the machine are displayed. If the machine has travel a longer distance in reverse than in forward, the value will be negative	Display value = travel distance in 10 cm
1003	**Travel speed** Shows the actual speed.	Display value = max. speed in km/h
1010	**Parameter "Show distance pulses per 10m"** Eeprom Parameter is displayed	Depending on the selected machine type, e.g. 5896 for BW177 BVC
1011	**Parameter "Invert travel direction"** Eeprom Parameter is displayed	0000 ☞ Direction signal is not inverted 000I ☞ Direction signal is inverted

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14.2 Vibration

Input code	Description of display function	Display values
3 0 0 0	**Vibration status general** The status of vibration is displayed.	0 0 0 0 ☞ Vibration OFF 0 0 0 1 ☞ Vibration ON
3 0 0 1	**Vibrations status low amplitude** The vibration status for low amplitude is displayed.	0 0 0 0 ☞ Vibration OFF 0 0 0 1 ☞ Vibration ON
3 0 0 2	**Vibrations status high amplitude** The vibration status for high amplitude is displayed.	0 0 0 0 ☞ Vibration OFF 0 0 0 1 ☞ Vibration ON

14.3 Light

Input code	Description of display function	Display values
3 0 1 0	**Input light switch** The status of the lighting is displayed.	0 0 0 0 ☞ Light OFF 0 0 0 1 ☞ Light ON

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14.4 Acceleration transducer

Input code	Description of display function	Display values
4 6 0 1	**Acceleration transducer 1** Shows the voltage of transducer 1.	Display value = voltage in V
4 6 0 6	**Acceleration transducer 2** Shows the voltage of transducer 2.	Display value = voltage in V

14.5 Diesel engine

Input code	Description of display function	Display values
5 0 0 0	**Input MD+** Show status of diesel engine.	0 0 0 0 ☞ Engine OFF 0 0 0 1 ☞ Engine ON

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14.6 Setting the machine type

Input code	Description of display function	Display values
7000	Shows the adjusted machine type	see adjustment instructions (page **Fehler! Textmarke nicht definiert.**)!
7010	Switches on function „Set machine type“	see adjustment instructions (page **Fehler! Textmarke nicht definiert.**)!
7011	Confirms entered machine type	see adjustment instructions (page **Fehler! Textmarke nicht definiert.**)!
7500..7599	Preselect machine type	see adjustment instructions (page **Fehler! Textmarke nicht definiert.**)!

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14.7 Parameter change

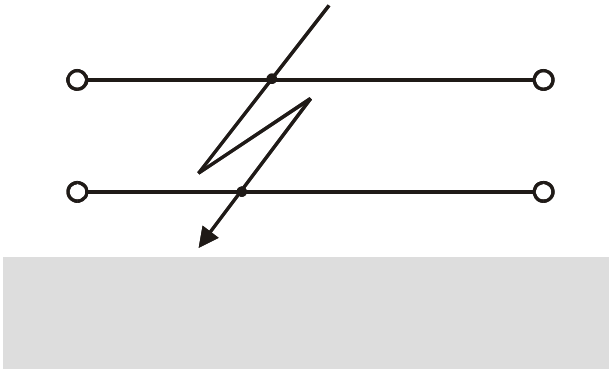
Input code	Description of display function	Display values
7 6 0 0	Switch on function "Invert travel direction"	Display value 7 6 0 0
7 6 0 1	Inverts the actually adjusted travel direction	see adjustment instructions (page **Fehler! Textmarke nicht definiert.**)!

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15 Terminology in connection with ESX

Short circuit
A direct, unwanted connection between two different cables or between machine and cables.
Examples:
Two lines rub against each other until the insulation has worn off.
A conductive line rubs off the insulation at the vehicle ground.



Wire breakage
This generally means that a connection is interrupted. Possible reasons may be:

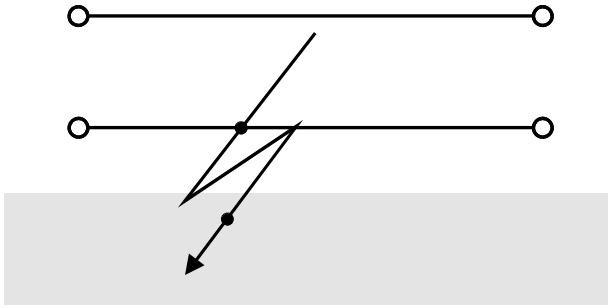
Line:
- torn (not necessarily visible from outside)
- chafed
- chafed mostly in connection with a *short circuit to ground*



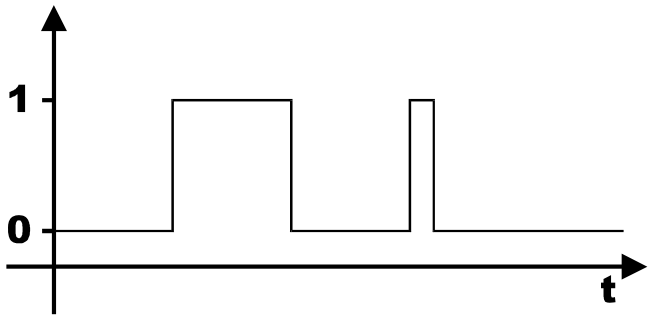
Terminal, cable lug
- loosened, slipped off
- broken off,
- corroded,
- socket / plug faulty

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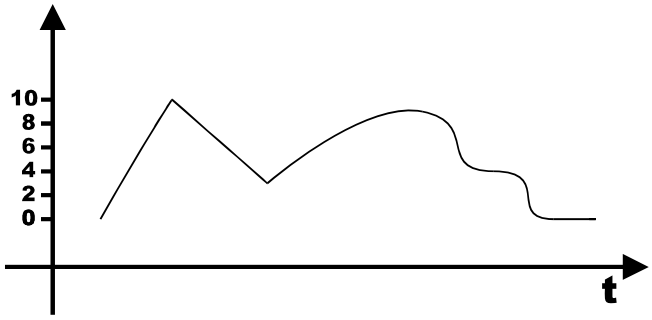
Short circuit to ground
Line, terminal has direct connection to vehicle ground, often in connection with *wire breakage*



Digital
There are only two permissible states, e.g. switched on or off; lamp on / off; current flows / does not flow; valve open / closed (black-white valve)

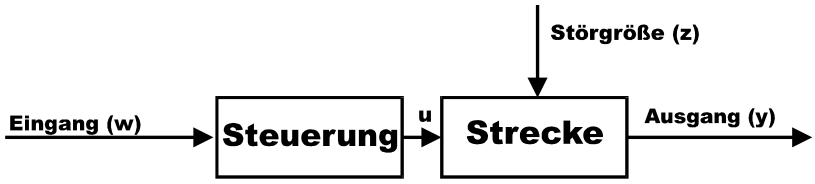


Analogue
In contrast to *Digital* many conditions are permitted within a certain range. For instance room temperature 0° **to** 40°; current 4mA **to** 20mA; voltage 0V **to** 8,5V; resistance 100 Ω **to** 300 Ω; valve 0% **to** 100% opened (proportional valve)

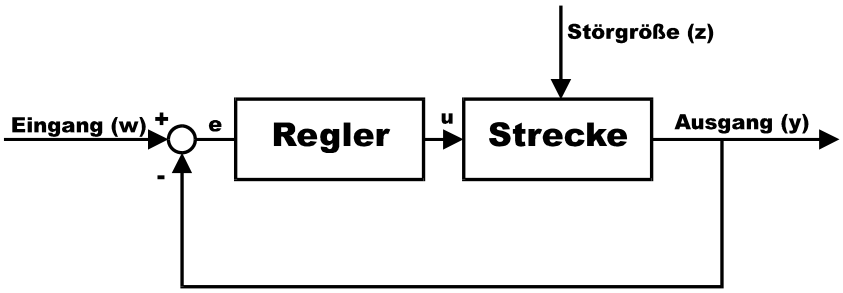


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Control
Controlling describes the process during which an input value influences a distance (the value to be controlled), following a fixed command. For this purpose all possible interfering factors (e.g. temperature, humidity ...) must be known.



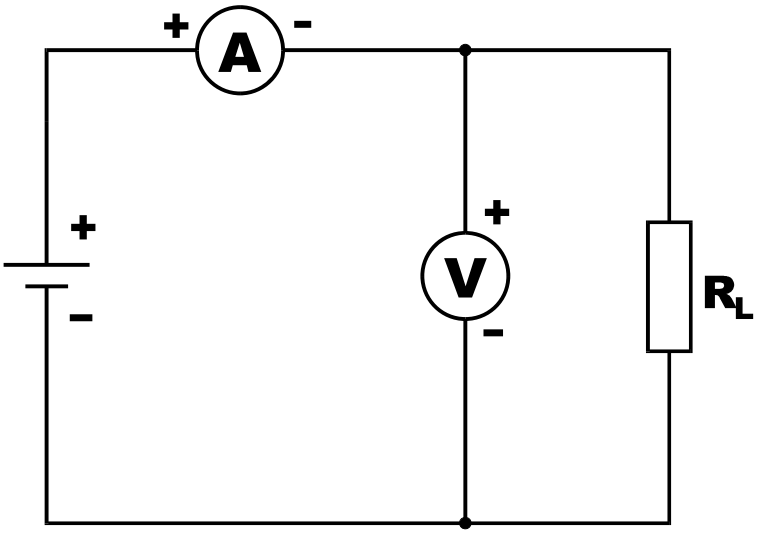
Closed loop control
Closed loop control is a process during which a value, the closed loop control value (e.g. pressure), is continually measured and compared with a nominal value (guide value). The result of this comparison will affect the closed loop control value, thereby adapting the closed loop control value to the guide value.
This sequence occurs in a closed circuit, the co-called closed loop control circuit.



Marking	Closed loop control	Control
Operating path:	closed (closed loop control circuit)	open (control chain)
Measurement and comparison of value to be adjusted:	Value to be adjusted is measured and compared.	Values to be controlled are not measured and compared.
Reaction to faults (generally):	Counteracts to all faults targeting the system to be controlled.	Does not respond to unknown faults
Technical expense:	Low expense: Measurement of the value to be controlled, comparison of nominal and actual value, power amplification	High expense if many faults have to be considered, low expense if not faults occur.
Performance in unstable systems	For unstable systems closed loop controls must be used.	In unstable systems controls cannot be used.

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Current and voltage measurement



Ohm's law:

U = Voltage
R = Resistance
I = Current

$$U = R * I$$

$$I = \frac{U}{R}$$

$$R = \frac{U}{I}$$

Plausibility check
The control (ESX) runs a plausibility check on all inputs. This means the control checks permanently whether certain state combinations are permitted; e.g. travel lever position forward **and** reverse will cause an fault message, because this condition is normally not possible.

Override / emergency operation
In the event of a major fault the control will switch off and the override function will take over. This has the effect that the machine can still be moved and steered with reduced speed. Steering and dozer blade movements are only possible with a constant speed.
(see also: page 34, "")

GND - AGND
Besides the "normal" battery ground (terminal 31) in the vehicle there is an additional analogue ground, which is only to be used for sensors. (see description of the signals on the ESX-control)

PWM – digital output
Certain outputs on the ESX are designed as so-called PWM – digital outputs. This means that these outputs are special current outputs. Here it is possible to measure a current, but **no** voltage. These outputs are used to trigger proportional valves.

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9.2 Seat contact module

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Seat contact switch

Only machines with cabin are equipped with the seat contact circuitry.
This circuit also contains the vibration relay. Machines with ROPS or sun canopy are not equipped with the seat contact circuitry.

The following applies in general:
When the seat is not occupied it can be assumed that in the worst case the machine may perform uncontrolled movements. In such an instance the machine must be shut down at the latest after 4 seconds. During these 4 seconds the driver must be warned about this condition by the warning buzzer in the dashboard and the area around the machine by the backup alarm. To start travel movement of the machine the driver's seat must be occupied, as otherwise the diesel engine will be shut down immediately. This prevents the machine from being started from the outside (e.g. through the open window).

1. Starting of the engine should only be possible with the travel lever in position "Brake".

2. Driver standing (seat contact control light does not light up): While the engine is running shift the travel lever to travel operation --- then engine shut be shut down immediately, the seat contact light lights up, warning buzzer and backup alarm sound. If the travel lever is returned to "Brake" position during the shut-down process, the fuel solenoid is switched on again and the engine will automatically start. Otherwise the engine must be restarted.

3. Driver seated: (seat contact control light does not light up): Normal operation, no warning active. Driver gets up --- control light comes on and both warning buzzers sound. Driver sits down again within 4 seconds --- machine returns to normal operation. Driver **does not** sit down again within 4 s --- engine is shut down. If the driver sits down again while the engine is being shut down, the fuel solenoid is switched on again and the engine will automatically start. Otherwise the engine must be restarted.

In addition to the seat monitoring system all monitoring functions are implemented by the

Module UPM2

.

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The hardware us available under BOMAG part-number 057 664 81.

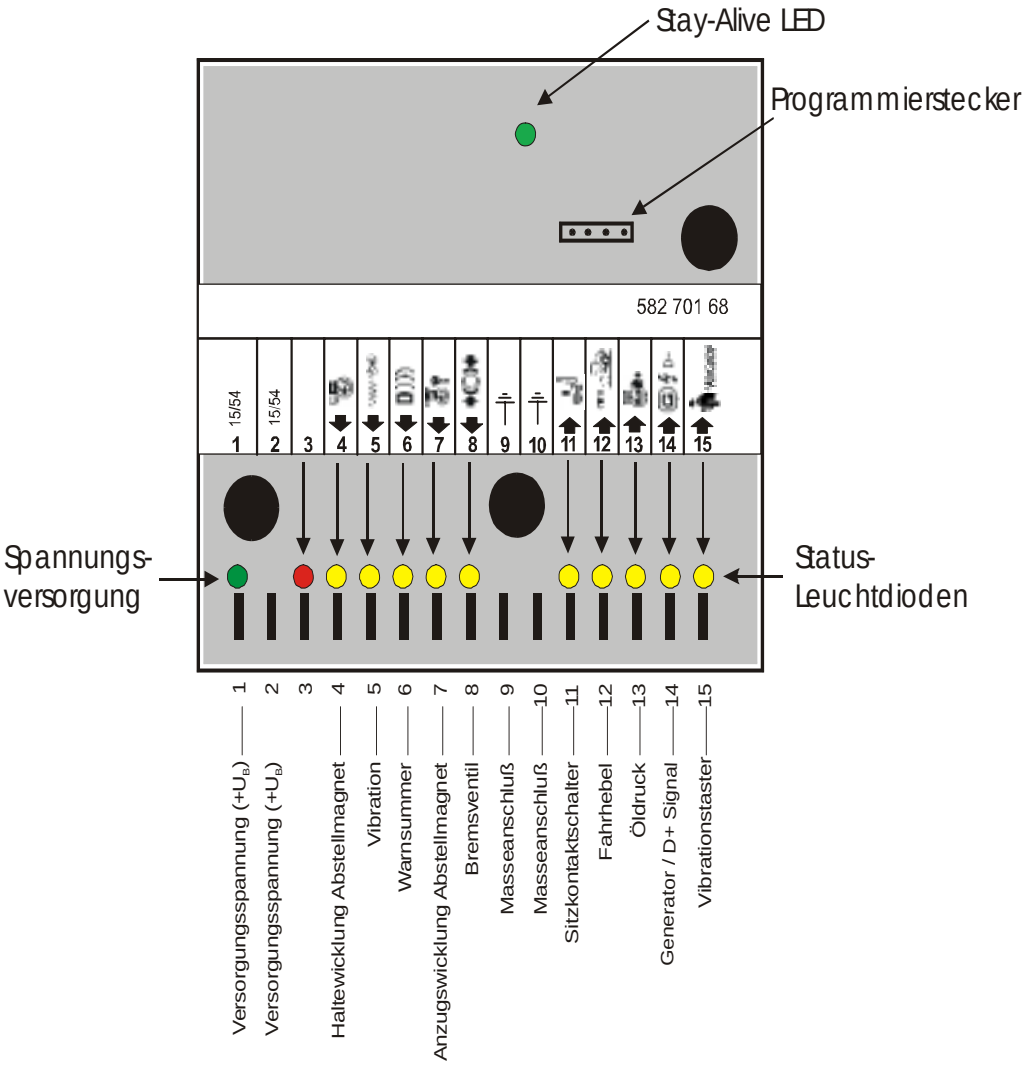


Fig. 1: Module

The complete module (including the specific software) is available under BOMAG part-number 582 701 68.

The following applies when measuring the signal levels:

PIN	Potential with LED on	Potential with LED off
Inputs	Ground 0V	Input open
Output PIN8	Ground 0V	Output open
Outputs general	≈ operating voltage (U_B- 0,7V)	Ground 0V (<< 1V)

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Emergency operation

If a bridge is inserted **between PIN 2 and PIN 3** of the module, the bias coil is permanently supplied with current (as long as the ignition is on) and the vibration is switched on (vibration can be switched on/off with the vibration selector switch).
Inserting a bridge between PIN 10 and the connecting cable to PIN 8 opens the brake (the brake can then be switched on/off e.g. via the parking position of the travel lever). The module is then bridged (only with motors without pickup winding.

Description of function

In addition to monitoring the seat occupation this module can also be used to control the hydraulic brake and the function of the vibration relay.
The following sequences were used in the UPM2 software to realize the seat occupation monitoring system:

Switching on the ignition

- The Stay-Alive-LED on the module shows the software version (currently version 3) once by means of a flashing code (changes to permanent light).
- When the travel lever is in neutral position (PIN12 = Active-LOW) the bias coil of the shut-down solenoid (PIN4 = Active-HIGH) is switched on and the pickup winding (PIN7 = Active-HIGH) is energized for 2 seconds. In this situation the seat contact switch has no effect. There will be no visual or audible warning if the driver's seat is not occupied.
- If the travel lever is returned to neutral position after the ignition has been switched on, the bias coil is automatically switched on and the pickup winding is automatically energized for 2 seconds (starting is now possible).
- As long as no D+ signal is detected (starting has not yet been performed and the engine is therefore not yet running), the vibration can be switched on by the vibration control switch.
- Vibration is switched off.

Starting the engine is only possible with the travel lever in neutral position. Since the starter does still rotate despite this fact, external blockage of the starter is required when the travel lever is operated.

Starting the engine

- If running of the engine is detected through D+, the hydraulic brake is automatically released (if it is no longer activated by the travel lever in parking position).
- If the travel lever is not in neutral position (irrespective of the seat contact), the bias coil of the shut-down solenoid is switched off again.

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Engine running

- Vibration can be switched on with the vibration push button when D+ or oil pressure is applied (OR-linkage).
- The bias coil remains switched on.
- There will be no visual or audible warning when the driver's seat is unoccupied even though the travel lever is out of neutral position.
- If the driver's seat is not occupied and the travel lever is actuated in this condition, the bias coil of the shut-down solenoid is immediately switched off and the engine will stop. The signalling device (horn) is activated.
  When D+ is no longer applied (engine not running) the signalling device is switched off and the hydraulic brake closes after 1.5 seconds.
- When leaving the driver's seat after shifting the travel lever out of neutral, the signalling device will be activated. 4 seconds later the bias coil of the shut-down solenoid will be switched off and the engine will stop.

Engine stops

- If the engine stops, but D+ is still applied, the bias coil is switched on again and the pickup winding is energized for 2 seconds, as soon as the driver takes his seat or the travel lever is returned to neutral position.
- The signalling device is switched off. The module is then in *Engine Running* mode and responds as described above.

Engine has stopped

The following applies in all cases (irrespective of travel lever and seat contact) if the D+ signal is missing:

- If the D+ signal is no longer applied the module will decide that the engine has stopped.
- The bias coil of the shut down solenoid is immediately switched off and the brake closes 1.5 seconds later.
- The machine can be restarted by switching the ignition off and on again (new start).
- However, if the D+ signal (for what ever reason) returns by itself, the bias coil of the shut down solenoid is automatically switched on and the pickup winding is energized for 2 seconds, if the driver has sat down.
- If the driver is not sitting while D+ returns, the reaction will be as described above in *Engine Running* mode, depending on the history (was the driver's seat left or the travel lever actuated first?).
- If, in addition to the missing D+, there is no oil pressure, the vibration will be shut down. The vibration is not automatically switched on if one of the signals returns!

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New start

A new start (after the engine has been shut down) is only possible after switching the ignition on again (see *Switching on ignition*) or after D+ has returned (see *Engine has stopped*).

Miscellaneous

Due to the design of the Perkins engines restarting of a still turning engine by returning the travel lever to neutral or sitting down on the driver's seat is not possible.
On machines with Perkins engine restarting always requires the ignition, if the bias coil of the shut down solenoid hd been switched off (picking up of the winding only possible after the engine has stopped).

The pickup winding must be triggered by an additional relay, because the module is only able to supply a current of 4 ampere.
The module works from a supply voltage of 7 Volt.

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0 Hardware description

The seat occupation monitoring module consists of the modified UPM2 module.
The inputs are configured to match the following table:

Input	*Behaviour*	*Comment*
Input **PIN11**	**LOW**-active	**LED lights when** applying **ground potential (0V)!**
Input **PIN12**	**LOW**- active	**LED lights when** applying **ground potential (0V)!**
Input **PIN13**	**LOW**- active	**LED lights when** applying **ground potential (0V)!**
Input **PIN14**	**LOW**- active	**LED lights when** applying **ground potential (0V)!**
Input **PIN15**	**LOW**- active	**LED lights when** applying **ground potential (0V)!**

0.1 Pin assignment of inputs

Signal name	**Module pin**	**Signal at input**	
Seat contact switch	11	**0V** = driver sits, **+U_B** = driver stands up,	LED **on** LED **off**
Travel lever	12	**0V** = travel lever neutral position **+U_B** = travel lever actuated	LED **on** LED **off**
Oil pressure	13	**0V** = oil pressure fault **+U_B** = no oil pressure fault	LED **on** LED **off**
Generator / D+ signal	14	**0V** = engine stopped **+U_B** = engine running	LED **on** LED **off**
Vibration button	15	**0V** = Vib. on/off **+U_B** = Vib. off/on	LED **on** LED **off**

0.2 Pin assignment of outputs

Signal name	**Module pin**	**Signal at output**	
Bias coil for shut down solenoid	4	**+U_B** = ON **0V** = OFF	LED **on** LED **off**
Vibration	5	**+U_B** = Vibration should be on **0V** = Vibration should be off	LED **on** LED **off**
Warning buzzer/light	6	**+U_B** = Warning buzzer on **0V** = Warning buzzer off	LED **on** LED **off**
Pickup winding shut down solenoid	7	**+U_B** = ON **0V** = OFF	LED **on** LED **off**
Brake valve	8	**+U_B** = Brake applied **0V** = Brake released	LED **off** LED **on**

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10 Speedometer Module

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10.1 Speedometer module



Fig. 1 Speedometer module

Description of function

With the programmable module BM UPM the software realizes a speedometer function. To ensure that the tachometer function is not only realized for one special roller, there is a possibility to adapt the module to any machine with the help of a self-teaching mode.

- Whenever the module is switched on the system runs a self-test by passing through the entire display range in both directions. The display self-test takes approx. 15 seconds.
- After this the module changes to measuring mode. The frequency of the travel pulses of the roller is detected and converted to a proportional output voltage that triggers the display.
- The output signal for the display is a PWM-signal.

Manual testing of the speedometer

When the module is in learning mode a manual display test can be performed via the input "Test". For this purpose the input "IN" must be energized with 12 Volt, whereupon the speedometer is constantly triggered with 3 Volt.

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Pin-no. module	Pin name	Description
Test	E_ANZEIGENTEST	Input HIGH active: Activate manual display test
IN	E_WEGIMPULSE	Input: Path pulses
Learn	E_LERNMODUS	Input: HIGH active: Activate teach mode
OUT -	Display -	Output: Ground connection for speedometer
OUT +	Display +	Output: Output voltage for speedometer
GND (2X)	Ground	Input: Module ground connection
15/45 (2X)	15/54	Input: Module voltage supply

Teaching the module

In self-teach mode the number of arriving path pulses is detected at the input (IN). The number of recorded pulses is referred to as pulse number per 10 or 18 m (machine dependent) travel distance of the roller.

- Connect the ground cable (-).
- Connect the sensor signal (speed sensor) to frequency input (IN).
- Install a cable bridge from terminal "15/54" to the connection "Teach".
- Connect potential "Ignition / 15" to connection "15/54".
- Switch on the ignition, start the engine and travel a distance of exactly 10 m.

⚠ Caution

BW24RH, BW27RH, C550H and C560H = travel 18 meters.

All other machines = travel 15 meters.

i Note

If the module is in teach mode the LED on output "OUT +" will flash with the frequency of the path pulses arriving at input (IN).

- Disconnect the cable bridge from "Teach" to "15/54“.
- Switch the ignition off and on again (Reset).

The module has now learned the pulses of the speed sensor.

- Connect the speedometer (0 to 6 Volt) to "OUT +" and "OUT –“.

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11 Service Training

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11.1 Service Training Machine

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BOMAG

Service Training



Single Drum Roller

BW 211 / 213 D- 4
BW 216 D-4

with Deutz engine 2012 und 1013EC

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BOMAG **Service Training**

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BW 211 / 213 / 216 D-4

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Foreword

Reliable construction equipment is of greatest advantage for all parties involved:

- for the customer/user it is a basis for an exact calculation of utilization periods and the completion of projects as scheduled.
- in the rental business it means that the equipment can be reliably used and planned without having to stock a large number of stand-by machines.
- for the manufacturer it means that customers are satisfied, provides him with a good image and gives him a feeling of confidence.

It is BOMAG's philosophy to design and produce the machines with highest possible reliability. This aspect of simple and easy maintenance was one of the key issues when developing and designing the machine:

- the location of components in the machine eases maintenance work,
- the high quality standard of BOMAG is the basis for the considerable extension of the service and maintenance intervals.
- the After Sales Service of BOMAG, including excellent operating and maintenance instruction manuals, high quality training courses and on-site machine demonstrations helps the customer to maintain their machines in good condition over a long period of time.

Permanent training of BOMAG's own service personnel as well as the service personnel of BOMAG Profit Centres and dealers is therefore a general prerequisite for BOMAG's excellent world-wide service.

This program of permanent training is only possible with appropriate and up-to-date training material for trainers as well as persons attending the training courses.

This training manual has not only been written as a support for the professional work of the trainer, but also for the trainees attending these training courses.

The different levels of product training demand, that the training performed by BOMAG, its Profit Centres or its dealers reflects the high quality of the training conducted at the Training Centre at BOMAG in Boppard. For this reason we invested a lot of time in the preparation of these materials .

The structure of this training manual enables us to change or up-date individual chapters in case of alterations to the machine.

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Documentation

For the BOMAG machines described in this training manual the following documentation is additionally available:

Attention!

The currently valid part numbers for the documents can be taken from the Doclist or the Customer Service page in the BOMAG (BOMAG Secured Area) in accordance with the serial number of the machine.

1. **Operating and maintenance instructions**
2. **Spare parts catalogue**
3. **Wiring diagram ***
4. **Hydraulic diagram ***
5. **Repair instructions**
6. **Service Information**

* The document versions valid at the date of printing are part of this training manual.

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BOMAG Service Training

General

The new BOMAG single drum rollers D-4 are mainly further developments of their predecessors of series 3.

These machines have been successfully and reliably used for years on construction sites all over the world, especially in earth construction and on sanitary landfill sites.

High compaction power and excellent traction are characteristics, which are of utmost importance for this type of machine.

All components installed in these machines are manufactured in series production and are subjected to stringent quality tests. This guarantees a high level of reliability and safety.

As with many other BOMAG products, and here especially with the large single drum rollers of the new generation, we have decided to use the same successful drive concept with diesel engine (water cooled) and hydrostatic drives also for these machines. The hydrostatic drives transfer the output power of the engine directly to drum, drive wheels and steering.

The drive wheels are driven by fast rotating hydraulic motors and axle, whereas the drum is driven by slow running radial piston motors.

On construction machines the work place of the operator is of utmost importance. Under such working conditions the health and safety of the operator must be the greatest concern.

The cabin is very spacious and clearly arranged. The driver’s seat is very comfortable and can be individually adjusted for every operator, even for his weight.

All control elements and gauges are within the reach and in the sight of the operator.

A monitoring display with light emitting diodes and clear pictograms informs the operator about any operating faults. The operator is therefore always informed about the present condition of the machine.

The generously glazed cabin with windscreen wiper and washer systems for front and rear windscreens, as well as a heated rear windscreen, offers clear vision to all sides.

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Important characteristics of the new generation of single drum rollers are

- strong ROPS/FOPS according to SAE-standard
- wear free service brake by closed hydrostatic travel circuits
- disc brakes in axle and drum drive motor serve as parking and emergency brakes
- high stability due to low centre of gravity and the use of an articulated joint
- operating safety due to the use of monitoring boards for all important system data
- automatic engine shut down under a too high engine temperature and too low engine oil pressure.

The machines of series D-4 are well designed down to the smallest detail, so that they can meet the toughest demands on large scale construction sites all over the world.

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Novelties

The new instrument cluster shows important warnings and control data of the machine.



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Deutz diesel engine

Single drum rollers of series BW 211 / 213 D-4 are powered by a Deutz diesel engine of product range BF4M 2012 C.

Roller of series BW 216 AD-4 are powered by Deutz diesel engines of series BF4M 1013 EC.

These engines are characterized by the following positive features:

- short and compact design,
- low noise level,
- almost vibration-free running,
- low fuel consumption,
- low exhaust emissions (EPA II),
- high power reserves and
- good access to all service points.

Crankcase and cylinders of this engine are made of alloyed cast iron. This provides strength and ensures high wear resistance.

The forged steel conrods are fitted with compensation weights near the conrod bearing seats. These weights compensate manufacturing tolerances with respect to weight and centre of gravity.

The pistons are made of an aluminium alloy. The combustion chamber recess is slightly offset from the middle at its side walls are inclined for 10° towards the inside. All pistons are fitted with three piston rings and a cast iron ring carrier for the first ring. The pistons are lubricated by an oil mist.

The forged crankshaft is equipped with integrated counterweights.

The block-type cylinder head is made of cast steel. Each cylinder is fitted with one intake and one exhaust valve. The valve guides are shrunk into the cylinder head. The valve seat rings are made of high-grade steel and are also shrink fitted.

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Service side

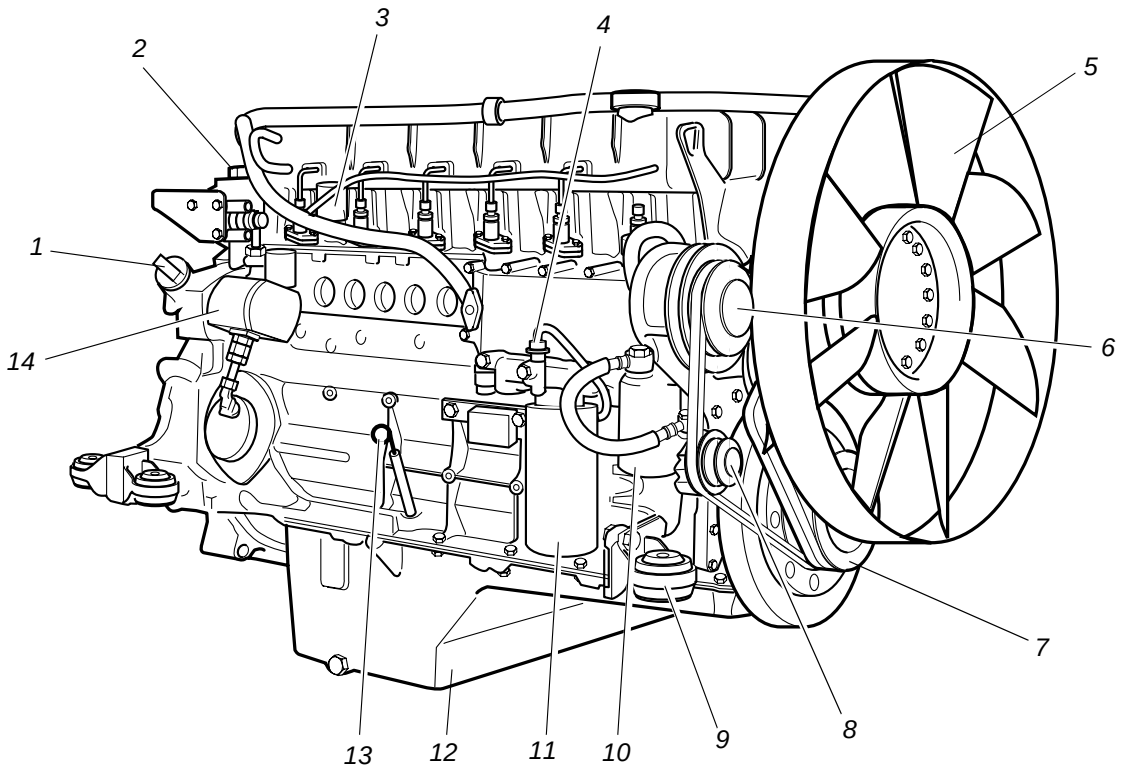


Fig. 1: Service side BFM 1013/2012

1	*Oil filler neck*	*8*	*Fuel pump*
2	*Valve, boost fuel supply*	*9*	*Engine mounting*
3	*Engine solenoid*	*10*	*Fuel filter*
4	*Oil pressure switch*	*11*	*Lubrication oil filter*
5	*Cooling air blower*	*12*	*Oil sump*
6	*Coolant pump*	*13*	*Dipstick*
7	*V-belt pulley*	*14*	*Steering/charge pump*

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Starter side

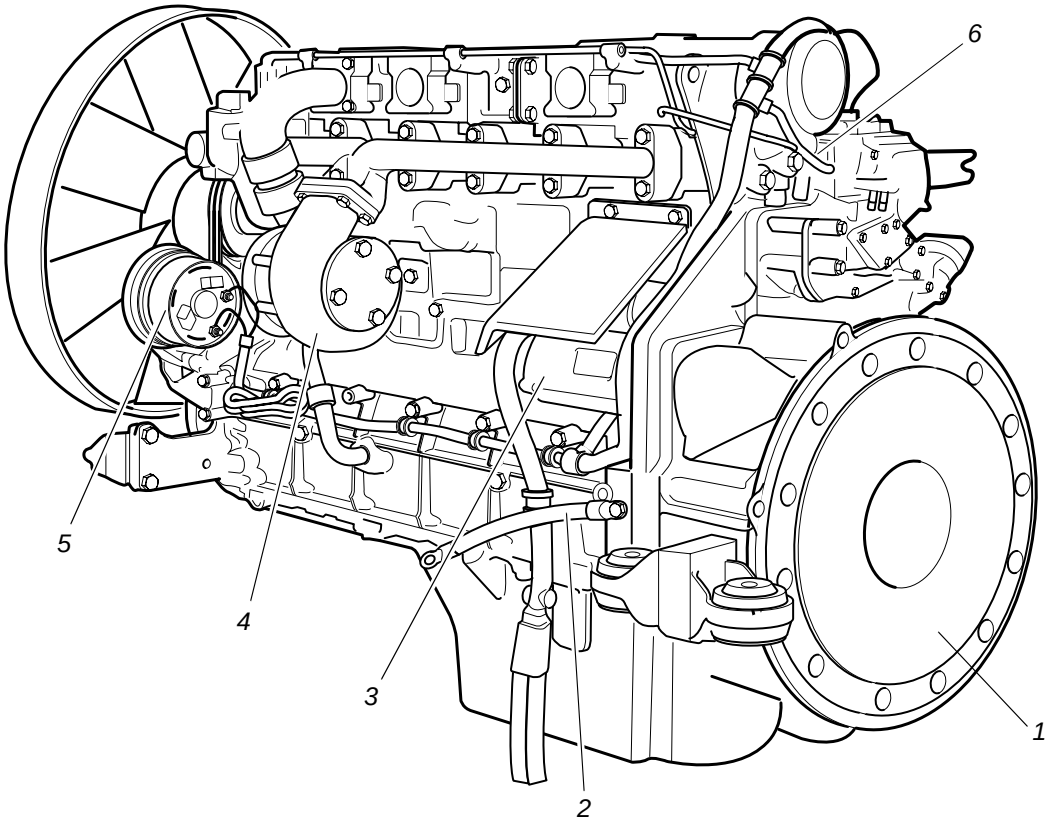


Fig. 2: Starter side

1 Flywheel
2 Ground cable
3 Starter
4 Turbo charger
5 Generator
6 Coolant temperature switch

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BOMAG Service Training

Lubrication oil circuit

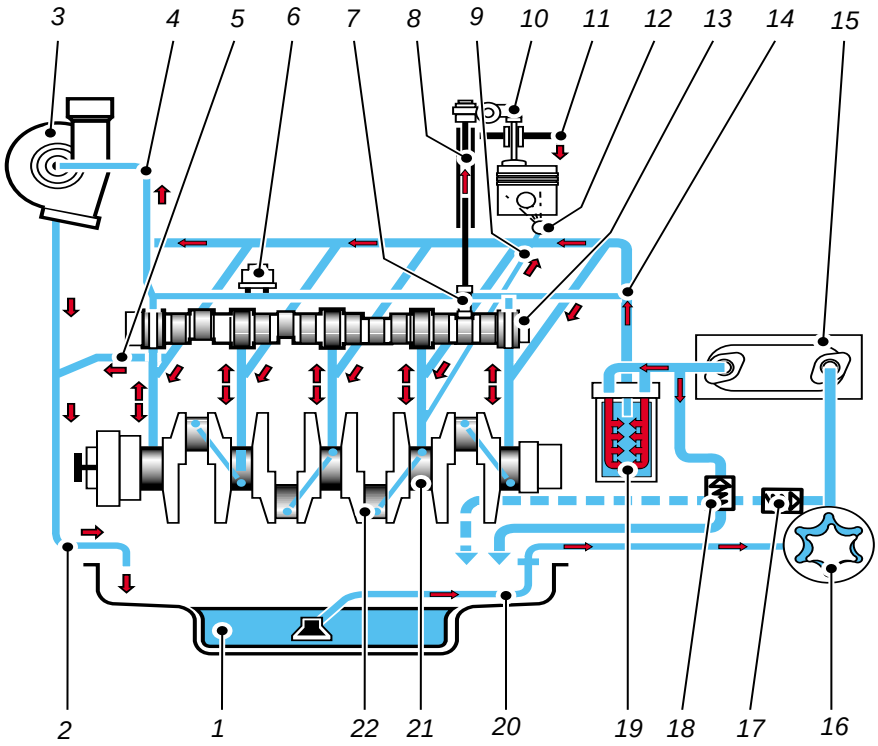


Fig. 3: Lubrication oil circuit

1	*Oil sump*	12	*Piston cooling nozzle*
2	*Return flow turbo charger to crankcase*	13	*Camshaft bearing*
3	*Turbo charger*	14	*Main oil channel*
4	*Oil line to turbo charger*	15	*Lubrication oil cooler*
5	*Line to mass balance wheel (2 x)*	16	*Lubrication oil pump*
6	*Oil pressure sensor*	17	*Pressure relief valve*
7	*Valve with pulse lubrication*	18	*Leak oil return line*
8	*Push rod, oil supply to rocker arms*	19	*Lubrication oil filter*
9	*Line to spray nozzles*	20	*Suction line*
10	*Rocker arm*	21	*Crankshaft bearing*
11	*Return flow to oil sump*	22	*Conrod bearing*

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Lubrication oil circuit

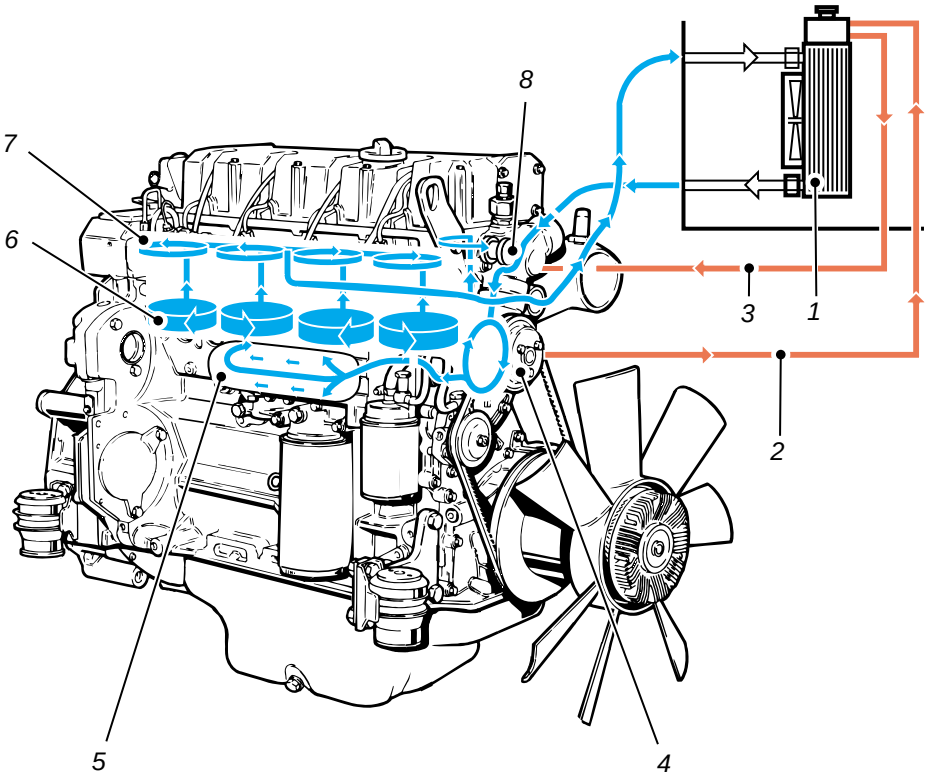


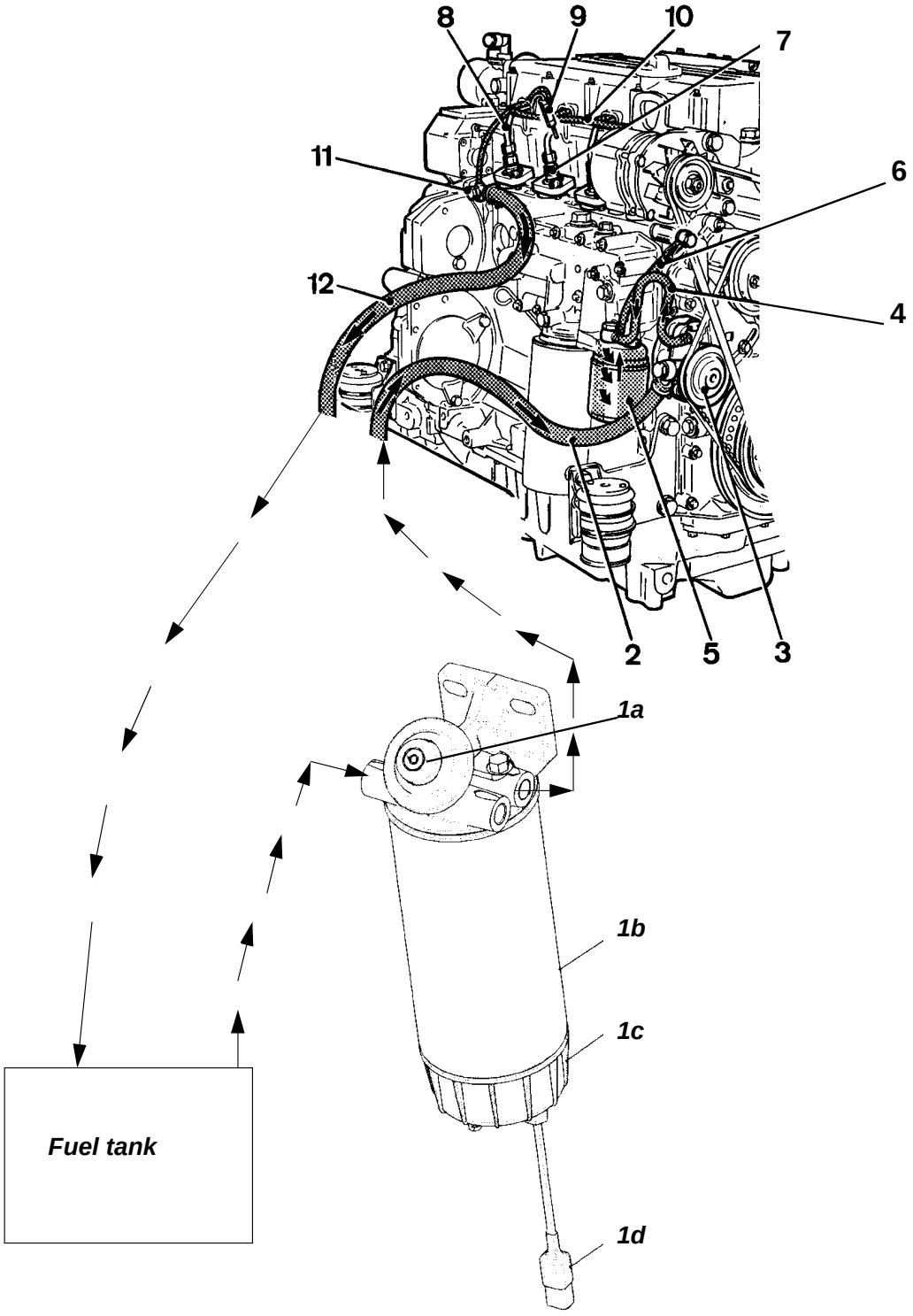
Fig. 4: Lubrication oil circuit

1 Cooler
2 To cooler
3 From cooler
4 Coolant pump
5 Lubrication oil cooler
6 Cylinder cooling
7 Cylinder head cooling
8 Ventilation connection between cylinder head and heat exchanger

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FuelFuel system



Fuel system

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Legend:

1a Fuel lift pump
1b Fuel pre-filter
1c Water separator
1d) Water proportion sensor
2 Feed to fuel lift pump
3 Fuel lift pump
*4 Connecting line lift pump – main filter (**fuel pre-pressure up to 10 bar**)*
*5 Main fuel filter (**pressure resistant**)*
6 Connecting line main filter – supply for injection pump
7 Single injection pump
8 High pressure line
9 Injection nozzle
10 Leakage line
11 Pressure retaining valve - 5 bar
12 Return flow to tank

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Fuel pre-filter with water separator

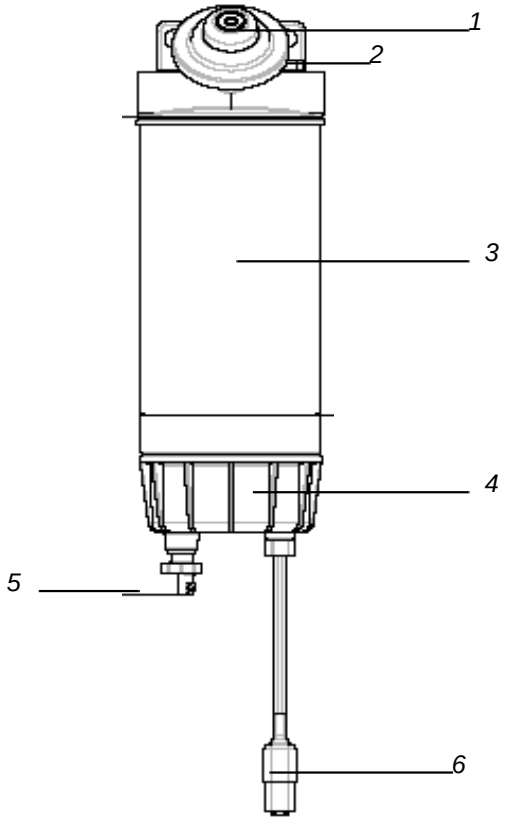


Fig. 5: Fuel pre-filter with water separator

1) Lift pump
2) Vent valve
3 Filter element
4) Water and dirt collecting bowl
5 Drain valve
6 Electric connection for water level sensor

The fuel pre-filter / water separator consists mainly of:

- the dirt / water sediment bowl with water level warning sensor
- and the filter element

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Function:

The fuel lift pump draws the fuel through both filters.

The water resistant filter element retains remaining smaller dirt and water particles.

Once the water level reaches the height of the warning connections, the warning light in the dashboard lights up.

Draining off water or fuel :

If the filter element is clogged before a service is due (indicated by e.g. a power drop), the filter may be regenerated as follows to keep up operation of the engine:

- Open the bleeding screw (this applies atmospheric pressure to the filter element and releases bigger dirt particles from the bottom side of the filter, which will then sink down.
- Open the drain valve and let approx. 0.5 l of fuel run out. The fuel above the filter element presses through the filter element and cleans the underside of the filter element from dirt.
- Close the drain valve.

Draining off larger dirt particles or sludge:

- Unscrew the water separator housing

Bleed the system by operating the fuel lift pump and then tighten the bleeding screw.

Main fuel filter

Attention!

The main fuel filter is subjected to approx. 10 bar fuel pre-pressure from the fuel lift pump. This pressure is considerably higher than on other engines. For this reason only original filter elements must be used. Filter elements of similar design or with adequate dimensions are not necessarily pressure resistant!

A filter element of insufficient pressure resistance will be damaged by the high pressure and will disintegrate. This causes severe damage to the injection system!

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BOMAG Service Training

Checking and adjusting the valve clearance

Excessive or insufficient valve clearance can cause failure of the engine as a result of mechanical and thermal overloads. The valve clearance must therefore be checked and, if necessary, adjusted at the intervals specified in the operating and maintenance instructions.

Note: The valve clearance must be checked and adjusted when the engine is cold.

Intake valve = 0.3 mm **Exhaust valve= 0.5 mm**

- Turn the crankshaft until both valves on cylinder 1 are overlapping (the exhaust valve is not yet closed, the intake valve starts to open).

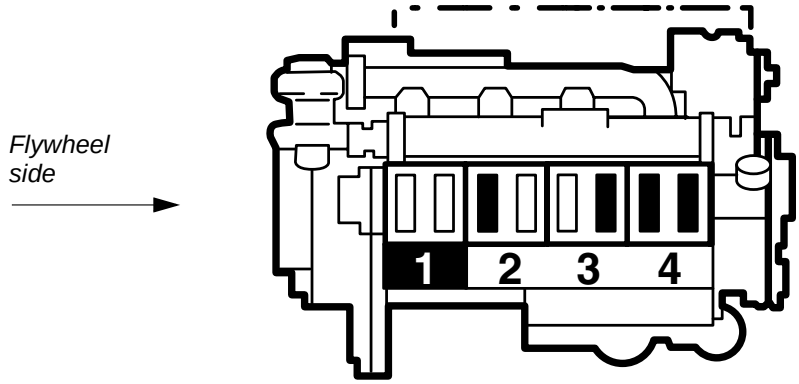


Fig. 6: Crankshaft position 1

- Check and adjust the valve clearance by following the black marking in the adjustment schematics. For control purposes mark the respective rocker arm with chalk.

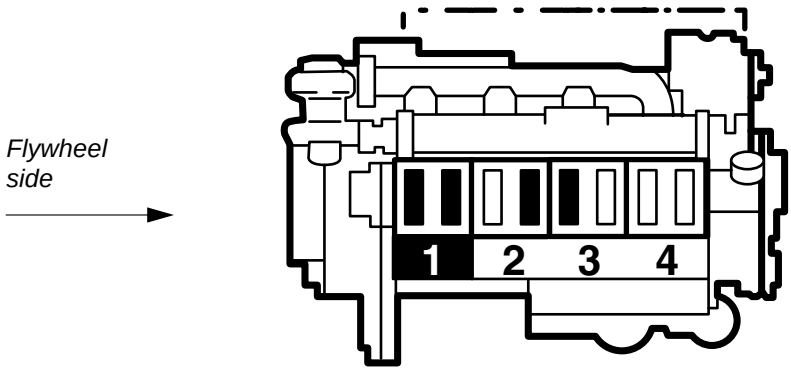


Fig. 7: Crankshaft position 2

Turn the crankshaft one full turn (360°) further.

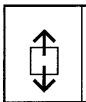
Check and adjust the valve clearance by following the black marking in the adjustment schematics.

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BOMAG Service Training

Explanation of pictograms

During the following work the following pictograms are used for the reason of simplicity:

	Zerlegen von Baugruppen		Personenschäden verhüten Hinweis auf Gefahrenstelle
	Zusammenbauen zu einer Baugruppe		Materialschaden verhüten Teilbeschädigung
	Abbauen - Ausbauen behindernder Teile		Unterbauen - Abstützen - Abfangen
	Einbauen - Anbauen Teile, die beim Ab-/ Ausbau hinderten		Einölen
	Achtung, wichtiger Hinweis		Einfetten
	Prüfen - Einstellen z. B. Drehmomente, Maße, Drücke usw.		Markieren vor dem Zerlegen, beachten beim Zusammenbau
	Spezialwerkzeug		Wuchten Ausgleichen von Unwuchten
	Einbaurichtung beachten		Einfüllen - Auffüllen - Nachfüllen z. B. Öl, Kühlwasser usw.
	Kontrollieren - Prüfen Sichtprüfung		Ablassen z. B. Öl, Kühlwasser usw.
	Bedingt wiederverwendbar Bei Bedarf auswechseln		Lösen z. B. Lockern einer Spanneinrichtung
	Beim Zusammenbau immer erneuern		Spannen z. B. Anziehen einer Spanneinrichtung
	Entsichern - Sichern z. B. Splint, Sicherungsblech usw.		Entlüften
	Sichern - Kleben z. B. Dichtmittel flüssig		Spanabhebende Bearbeitung

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plug-in injection pump

Deutz diesel engines of product range 2012/1013 are equipped with plug-in injection pumps of series PF 33 from Bosch.

The concept of the plug-in fuel injection pumps enables the realization of high injection pressures in connection with extremely short injection lines, which contributes to a high hydraulic stiffness of the injection system. This in turn provides the prerequisite for low exhaust emission values (soot) in combination with a low fuel consumption.

Plug-in fuel injection pumps have the following plunger dimensions:

- Stroke 12 mm
- Diameter 9 mm

Cavitation in the injection lines and injection overrun, which is normally associated with high pressures, is prevented by a return flow nozzle arranged after the pressure valve
The constant volume relief is 50 mm^3.

Assembling the plug-type injection pumps

The adjustment of the injection pump timing (FB) affects:

- the fuel consumption,
- the power
- the exhaust emission

of the engine.

On engines of series 2012/1013 the start of delivery is adjusted without tolerance. The start of delivery is entered in degree of crank angle measured from the top dead centre of the piston and depends on application, power and speed setting of the engine.

The plug-in injection pump is in position of start of delivery when the plunger just closes the fuel supply bore in the plunger sleeve.

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On engines with inline injection pumps the engine drive is turned to start of delivery position and closing of the fuel supply bore is determined by means of a high pressure pump. Occurring tolerances are compensated in the coupling of the injection pump drive, whereby the injection pump camshaft is turned to start of delivery position against the fixed engine drive.

The injection pump cams on engines of series 2012/1013 are arranged on the camshaft of the engine. For this reason the conventional adjustment method for the start of delivery cannot be used.

The start of delivery of the injection pump must be adjusted using the new method.

For this the conventional adjustment method is subdivided into length measurements of individual engine parts and calculations.

The permissible manufacturing tolerances for the components

- cylinder crankcase,
- camshaft,
- plunger
- plug-in injection pump

are measured and eliminated by the adjustment of the start of delivery.

However, in cases of interest for BOMAG engineers the engine will not be overhauled completely, but individual injection pumps will be replaced.

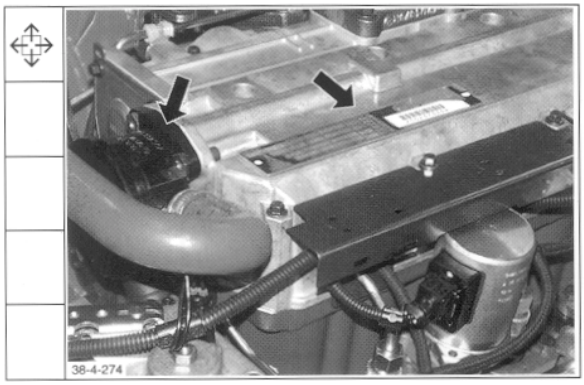
Crankcase, camshaft and plunger remain unchanged.

This results in a certain installation measurement for the engine drive, which is stamped on the engine type plate.

In column „EP“ it is stamped as „CODE“ for each cylinder.

Note:
If an injection pump and/or nozzle is replaced, the respective high pressure line between pump and nozzle must also be replaced..

1. Remove crankcase ventilation and cylinder head cover.



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Fig. 8:

2. Remove the engine solenoid

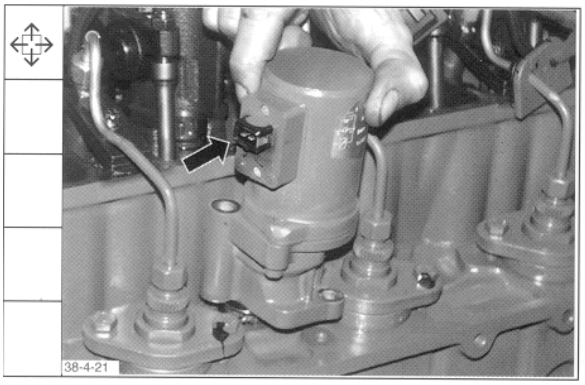


Fig. 9:

3. Insert the pressing device, WILBÄR No. 100 830 carefully into the groove in the governor rod and tighten.

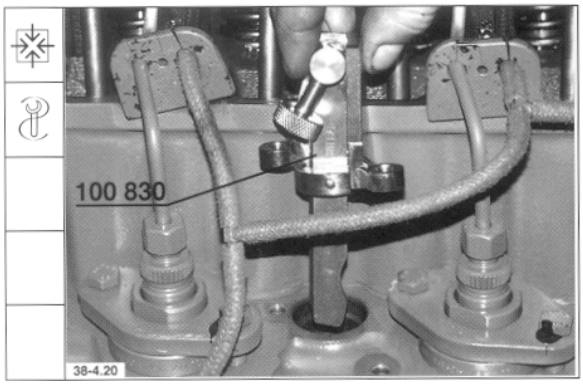


Fig. 10:

4. Turn the knurled fastening screw to press the governor rod to stop position.

Note:

Tighten the knurled fastening screw by hand.

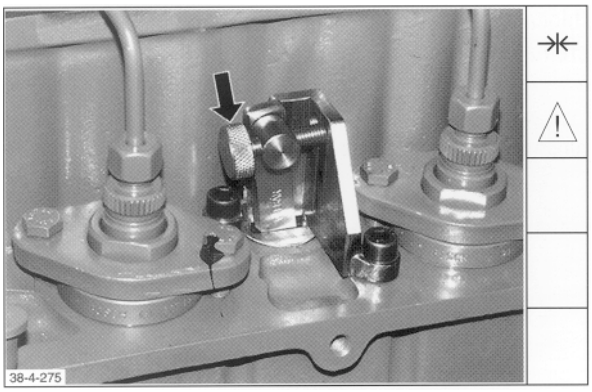


Fig. 11:

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5. Set the cylinder of the injection pump to be replaced to ignition top dead centre (valves overlapping). Then turn the crankshaft approx. 120° against the sense of rotation.

Note:

View on flywheel

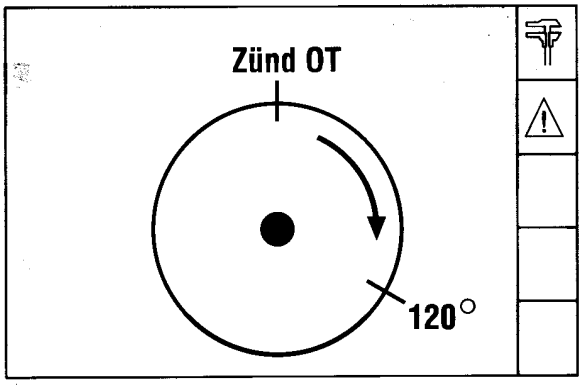


Fig. 12:

6. Remove injection line and injection pump.

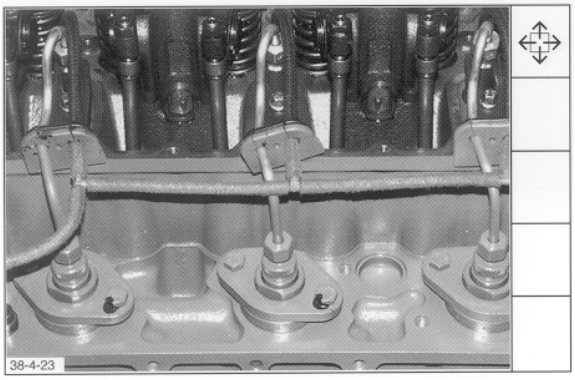


Fig. 13:

7. Take the compensation shim carefully out with the rod magnet.

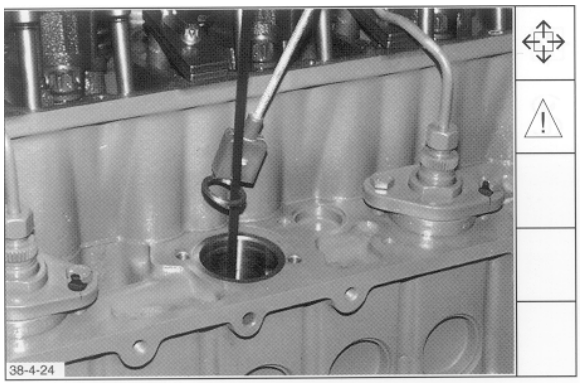


Fig. 14:

Determine the thickness of the new compensation shim:

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Determination of the compensation shim thickness when replacing plug-in fuel injection pumps

On the engine type plate column - EP – contains a code for the plug-in fuel injection pump for each cylinder.

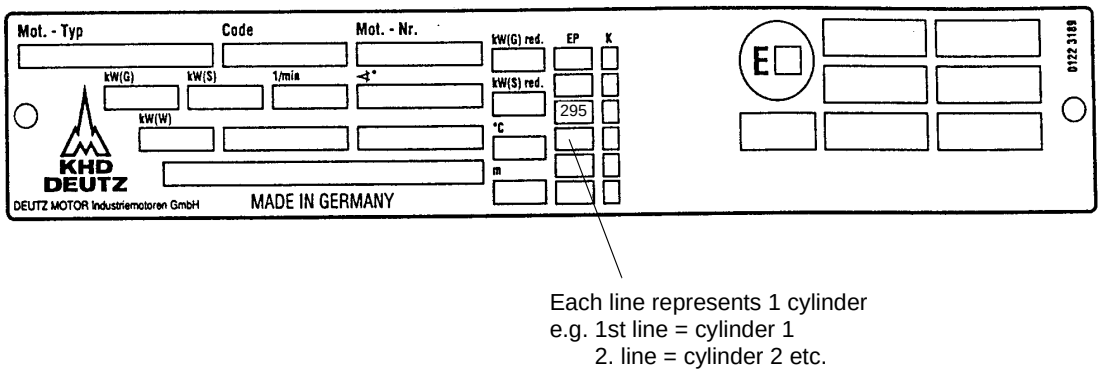


Fig. 15: Injection pump code BFM 2012/1013

The EP-code is used to determine the installation measurement to be corrected „E_k“ from table 1.

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E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code
119,250	230	119,850	254	120,450	278	121,050	302
119,275	231	119,875	255	120,475	279	121,075	303
119,300	232	119,900	256	120,500	280	121,100	304
119,325	233	119,925	257	120,525	281	121,125	305
119,350	234	119,950	258	120,550	282	121,150	306
119,375	235	119,975	259	120,575	283	121,175	307
119,400	236	120,000	260	120,600	284	121,200	308
119,425	237	120,025	261	120,625	285	121,225	309
119,450	238	120,050	262	120,650	286	121,250	310
119,475	239	121,075	263	120,675	287	121,275	311
119,500	240	120,100	264	120,700	288	121,300	312
119,525	241	120,125	265	120,725	289	121,325	313
119,550	242	120,150	266	120,750	290	121,350	314
119,575	243	120,175	267	120,775	291	121,375	315
119,600	244	120,200	268	120,800	292		
119,625	245	120,225	269	120,825	293		
119,650	246	120,250	270	120,850	294		
119,675	247	120,275	271	120,875	295		
119,700	248	120,300	272	120,900	296		
119,725	249	120,325	273	120,925	297		
119,750	250	120,350	274	120,950	298		
119,775	251	120,375	275	120,975	299		
119,800	252	120,400	276	121,000	300		
119,825	253	120,425	277	121,025	301		

*Fig. 16: Injection pump code table **BFM 2012***

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E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code	E_K (mm)	EP code
		145.7	349	146.3	373	146.9	397
		145.725	350	146.325	374	146.925	398
		145.75	351	146.35	375	146.95	399
		145.775	352	146.375	376	146.975	400
		145.8	353	146.4	377	147.0	401
		145.825	354	146.425	378	147.025	402
		145.85	355	146.45	379	147.05	403
		145.875	356	146.475	380	147.075	404
		145.9	357	146.5	381	147.1	405
		145.925	358	146.525	382	147.125	406
145.35	335	145.95	359	146.55	383	147.15	407
145.375	336	145.975	360	146.575	384	147.175	408
145.4	337	146.0	361	146.6	385	147.2	409
145.425	338	146.025	362	146.625	386	147.225	410
145.45	339	146.05	363	146.65	387	147.25	411
145.475	340	146.075	364	146.675	388	147.275	412
145.5	341	146.1	365	146.7	389	147.3	413
145.525	342	146.125	366	146.725	390	147.325	414
145.55	343	146.15	367	146.75	391	147.35	415
145.575	344	146.175	368	146.775	392	147.375	416
145.6	345	146.2	369	146.8	393	147.4	417
145.625	346	146.225	370	146.825	394	147.425	418
145.65	347	146.25	371	146.85	395	147.45	419
145.675	348	146.275	372	146.875	396		

*Fig. 17: Injection pump code table **BFM 1013***

E_k (mm) = corrected injection pump measurement, determined by EP-code on type plate and from table 1.

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During the manufacture of the plug-in fuel injection pump the high pressure method is used to determine the wear in the fuel supply bore. In this position – injection pump plunger in start of fuel delivery position - the distance between pump contact face and plunger foot contact face is measured.

Measurement "A" in 1/100 mm has been written on the pump with an electric marker.

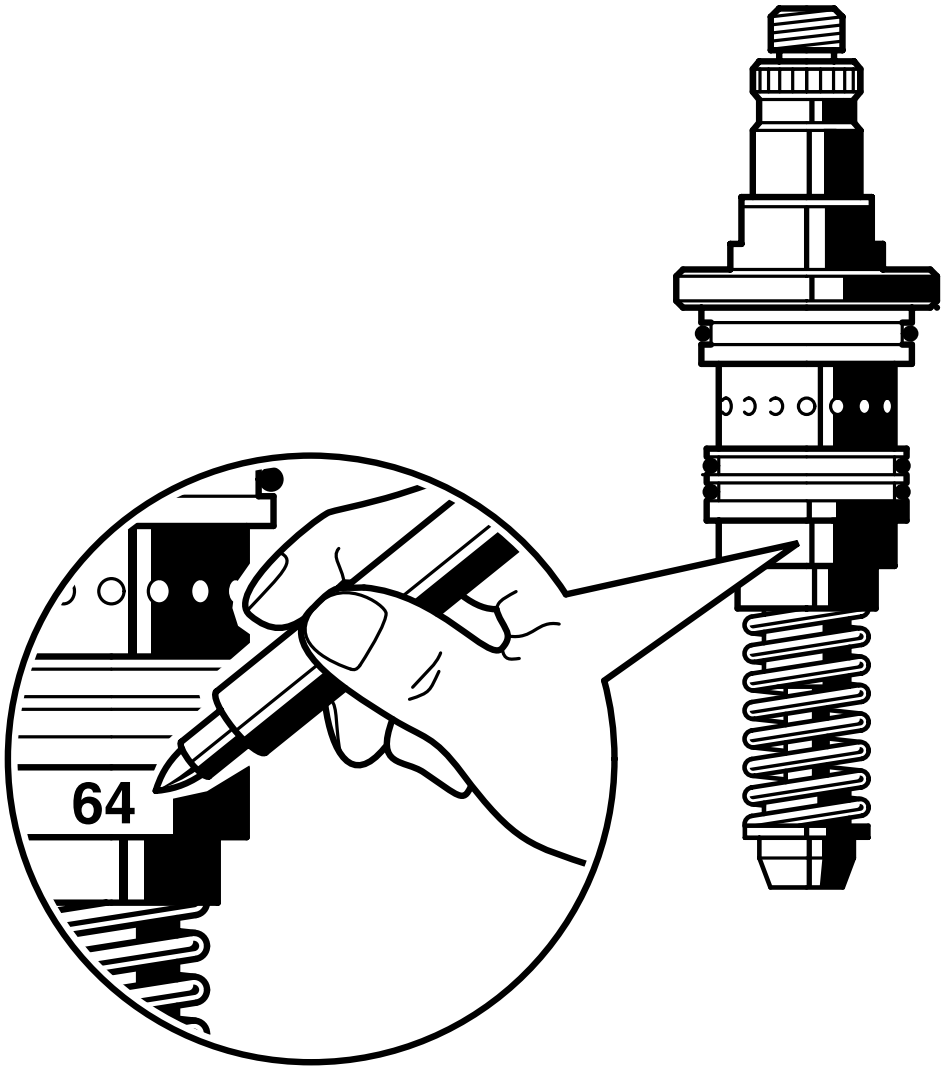


Fig. 18: Plunger code inscription

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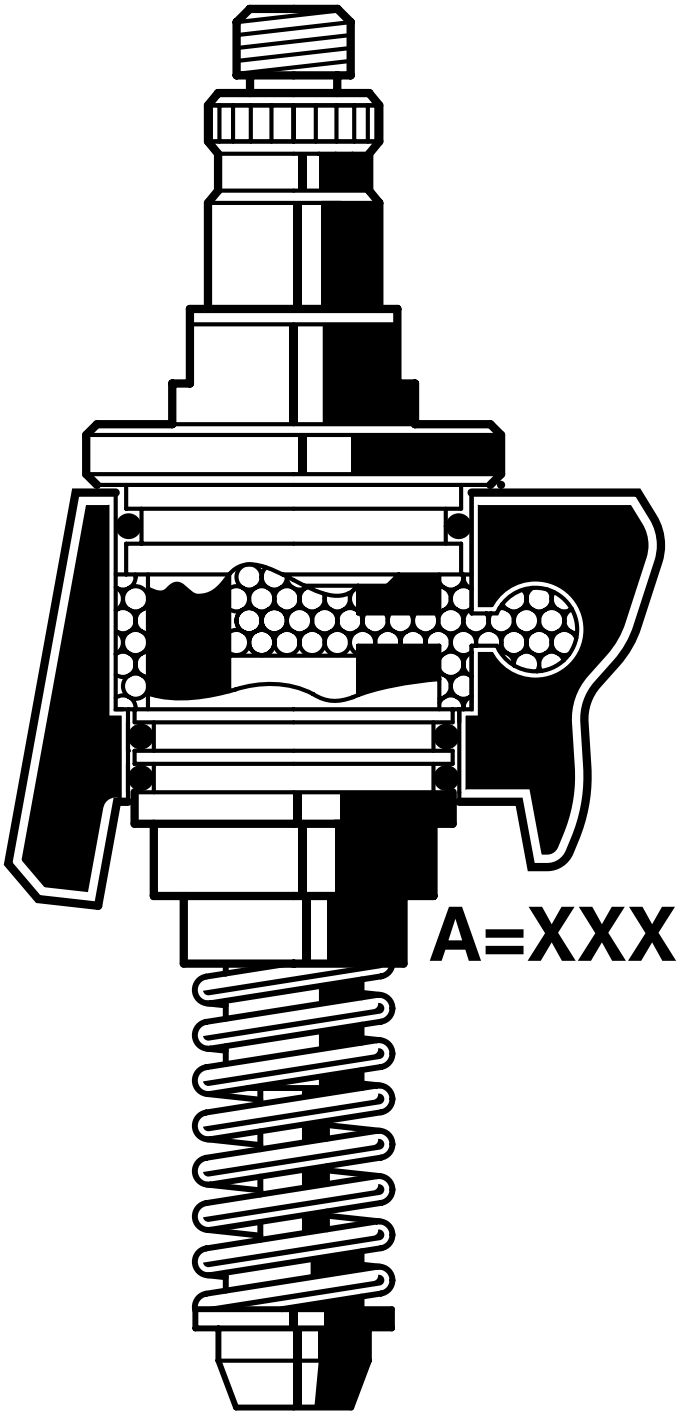


Fig. 19: Individual injection pump

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Measurement "A" specifies by how many 1/100 mm the gap between contact area on cylinder crankcase and plunger foot is longer than the hydraulic base measurement L_o.

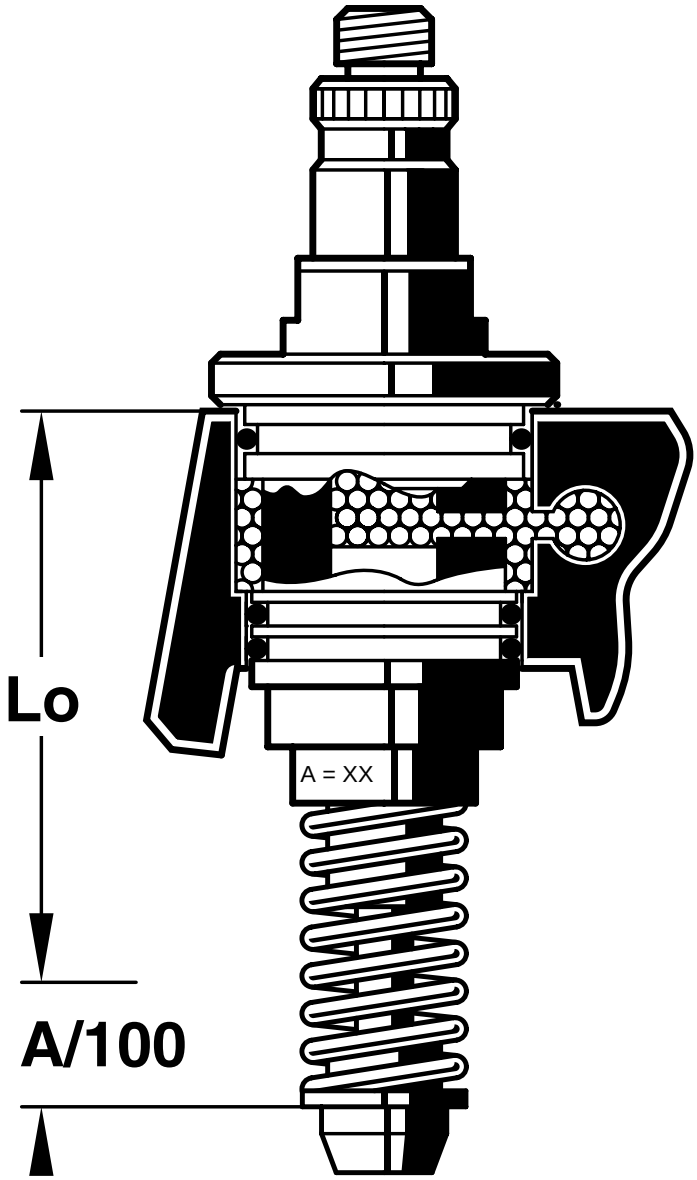


Fig. 20: Presentation of measurement „A“

- L_o = 117.5 mm - BFM 2012
- L_o = 143 mm - BFM 1013

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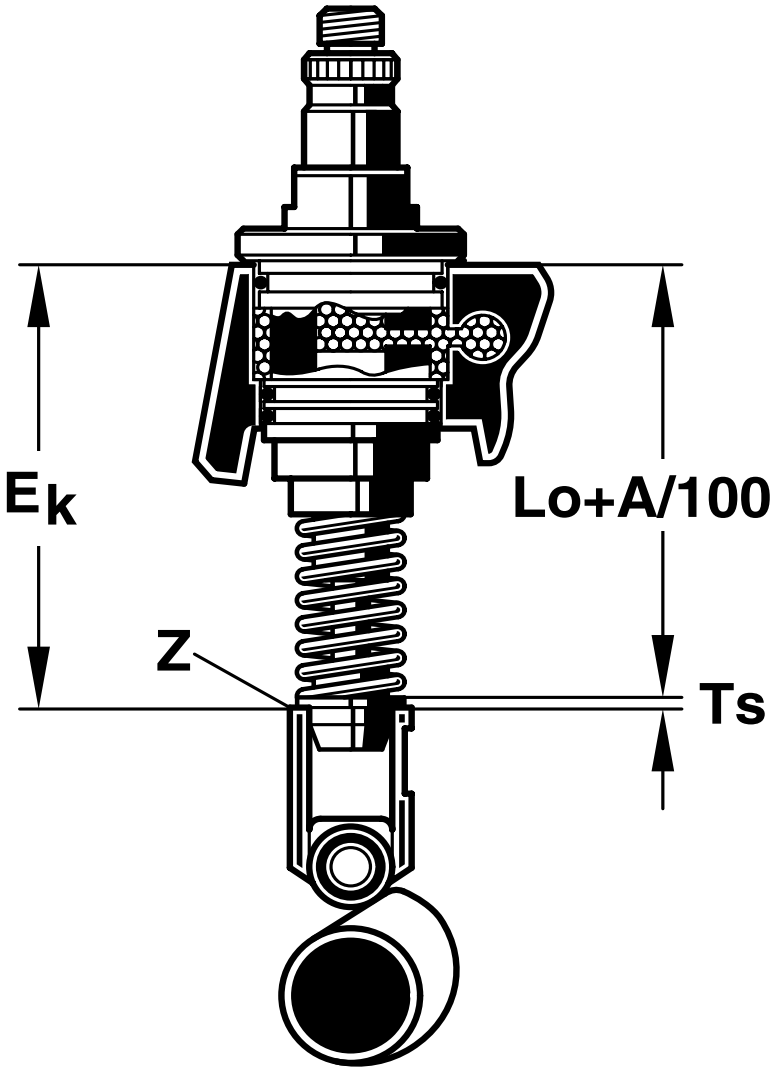


Fig. 21: Drive in start of delivery position after determination of „T_S“

The plug-in fuel injection pump is now positively connected with the drive, which has been set to start of delivery by inserting a compensation shim "Z" of calibrated thickness..

The illustration explains that according to calculation:

$(E_k) - (L_o + A/100)$

there is a gap „Ts“ between injection pump plunger foot and roller plunger. This gap has to be compensated with a compensation shim "Z" of appropriate (calculated) thickness.

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Theoretical thickness „T_S“ (mm)	Compensation shim thickness „S_S“ (mm)	Theoretical thickness „T_S“ (mm)	Compensation shim thickness „S_S“ (mm)
0.95 - 1.049	1.0	2.45 - 2.549	2.5
1.05 - 1.149	1.1	2.55 - 2.649	2.6
1.15 - 1.249	1.2	2.65 - 2.749	2.7
1.25 - 1.349	1.3	2.75 - 2.849	2.8
1.35 - 1.449	1.4	2.85 - 2.949	2.9
1.45 - 1.549	1.5	2.95 - 3.049	3.0
1.55 - 1.649	1.6	3.05 - 3.149	3.1
1.65 - 1.749	1.7	3.15 - 3.249	3.2
1.75 - 1.849	1.8	3.25 - 3.349	3.3
1.85 - 1.949	1.9	3.35 - 3.449	3.4
1.95 - 2.049	2.0	3.45 - 3.549	3.5
2.05 - 2.149	2.1	3.55 - 3.649	3.6
2.15 - 2.249	2.2	3.65 - 3.749	3.7
2.25 - 2.349	2.3	3.75 - 3.850	3.8
2.35 - 2.449	2.4		

Tabelle 1: Compensation shims 2012/1013

For the determination of the theoretical shim thickness „T_S“ it is also necessary to determine measurement L_O + A/100 of the new fuel injection pump, which must then be subtracted from the corrected injection pump measurement E_K.

$T_S = E_K - (L_O + A/100)$ [mm]

The real compensation shim thickness „S_S“ is determined with the help of table 2.

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Exemplary calculation for BFM 2012

EP-code read off engine type plate: 295

- see table 1

corrected injection pump measurement „E_k“: 120,875 mm

L_o = 117.5 mm (fixed measurement)

Value for A/100 read off new injection pump A/100 = 42

- $T_s = E_k - (L_o + A/100)$
  T_s = 120,875 mm - (117.5 +42/100 mm)
  T_s = 2.955 mm

see also table 1

T_s = 3.0 mm

Exemplary calculation for BFM 1013

EP-code read off engine type plate: 397

- see table 1

corrected injection pump measurement „E_k“: 146.9 mm

L_o = 143 mm (fixed measurement)

Value for A/100 read off new injection pump A/100 = 133

- $T_s = E_k - (L_o + A/100)$
  T_s = 146,9 mm - (143 + 133/100 mm)
  T_s = 2.57 mm

- see also table 1

  T_s = 2,6 mm

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8. P?lace the new calculated compensation shim on the roller plunger.

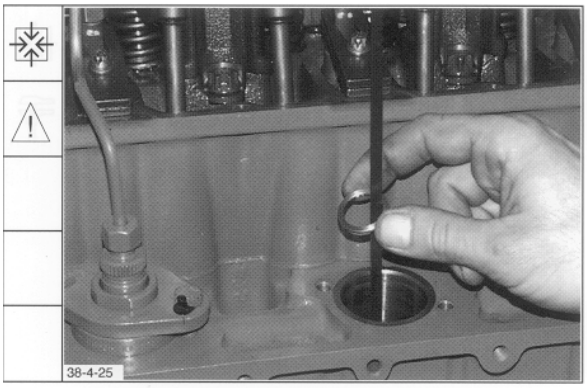


Fig. 22:

9. Turn the injection pump control lever to approx. middle position.

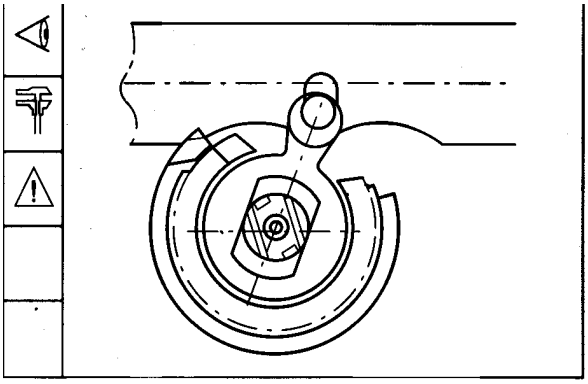


Fig. 23:

10. Apply some oil to the locating bore in the crankcase and the O-rings on the injection pump. Carefully insert the injection pump control lever into the governor rod.

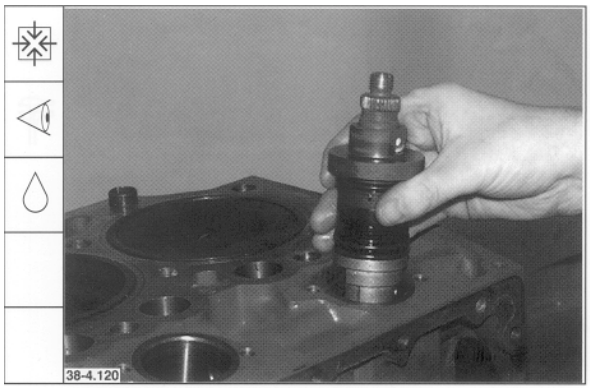


Fig. 24:

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11. Attach the flange.

Note:

The chamfer must face towards the injection pump body



Fig. 25:

12. Slightly oil the screws and tighten them evenly with 5Nm.



Fig. 26:

13. Loosen the screws again for 60°.

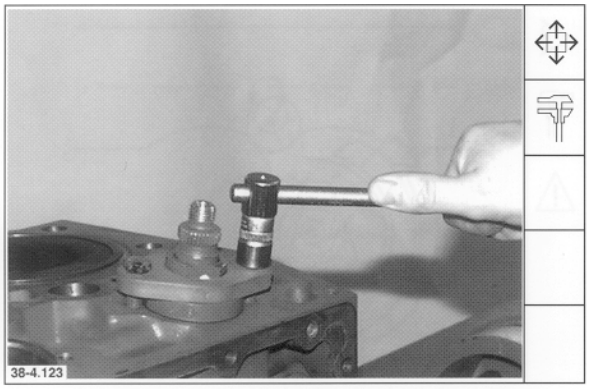


Fig. 27:

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14. ***Carefully*** turn the injection pump with and open end spanner in anti-clockwise direction against the noticeable stop

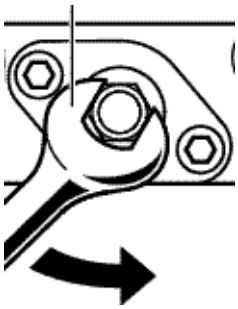


Fig. 28:

15. Tighten the screws again for 60° and continue in stages with tightening torques of **7 Nm**, **10 Nm** and **30 Nm**.

Note:

Start with the outer screw, viewed from the flywheel. (see arrow).



Fig. 29:

16. Back out the knurled screw of the pressing device, remove the pressing device.

17. Reinstall the engine solenoid with a new O-ring.

18. Reinstall the cylinder head cover. Tightening torque: **9 +/-1 Nm.**

Note:

If necessary replace the gasket.

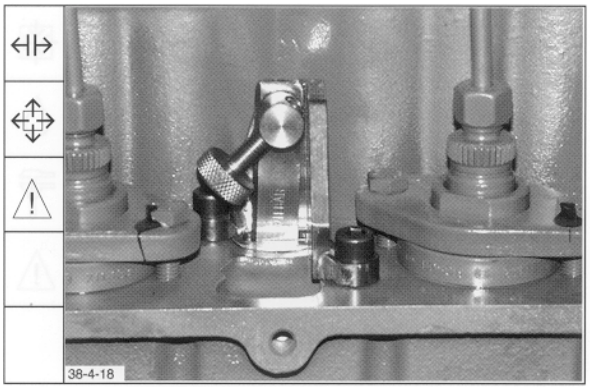


Fig. 30:

19. Slightly oil the O-ring of the crankcase ventilation. Reassemble the crankcase ventilation. Tightening torque **9 +/- 1Nm**

Note: If necessary replace the gasket.

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Tools

The following tools can be ordered from the respective supplier (in brackets) under the stated part-number.

For tools from Hazet and Bosch you should consult your nearest representative, orders to Wilbär should be addressed to:

Co. Wilbär
P.O. box 140580
D - 42826 Remscheid

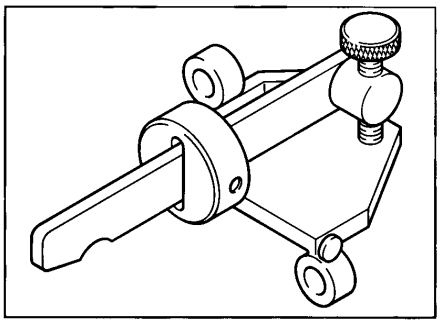


Fig. 31

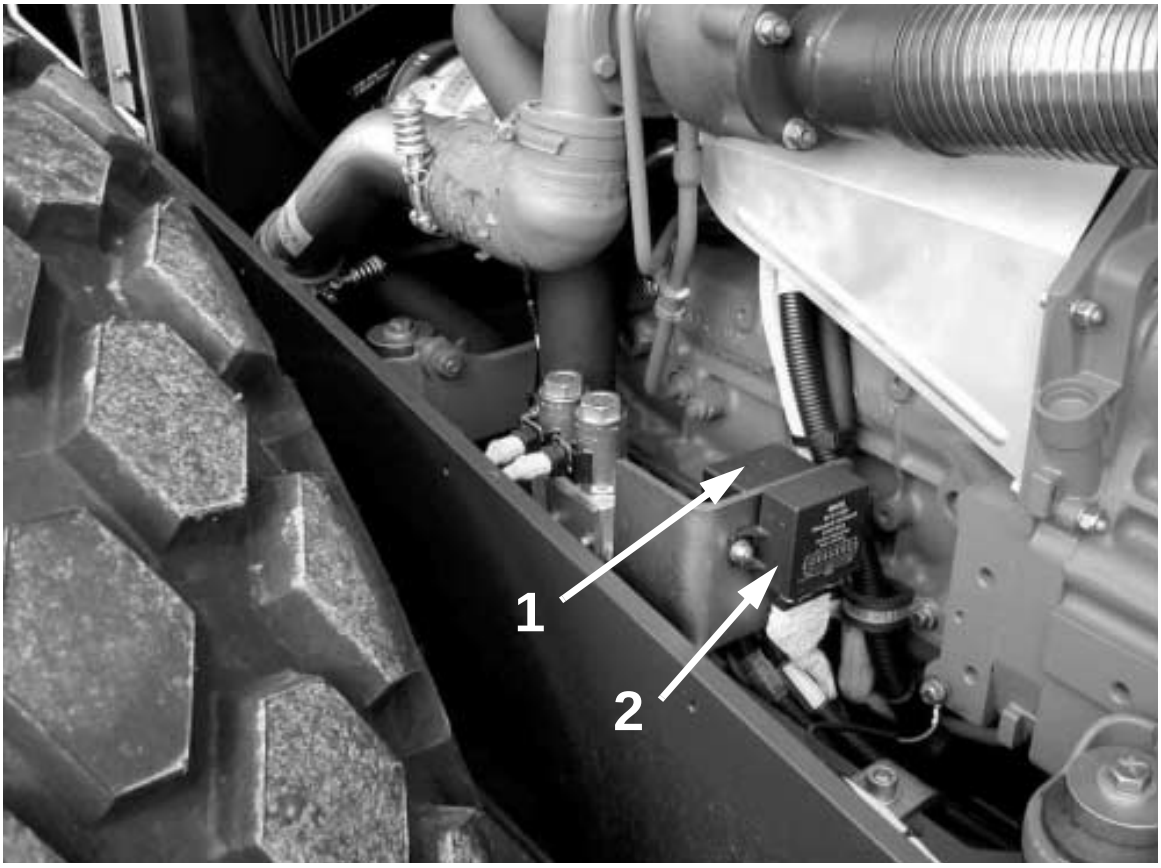
- Pressing device for governor rod 100 830 (Wilbär)

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Diesel engine, components and test points

Starter side

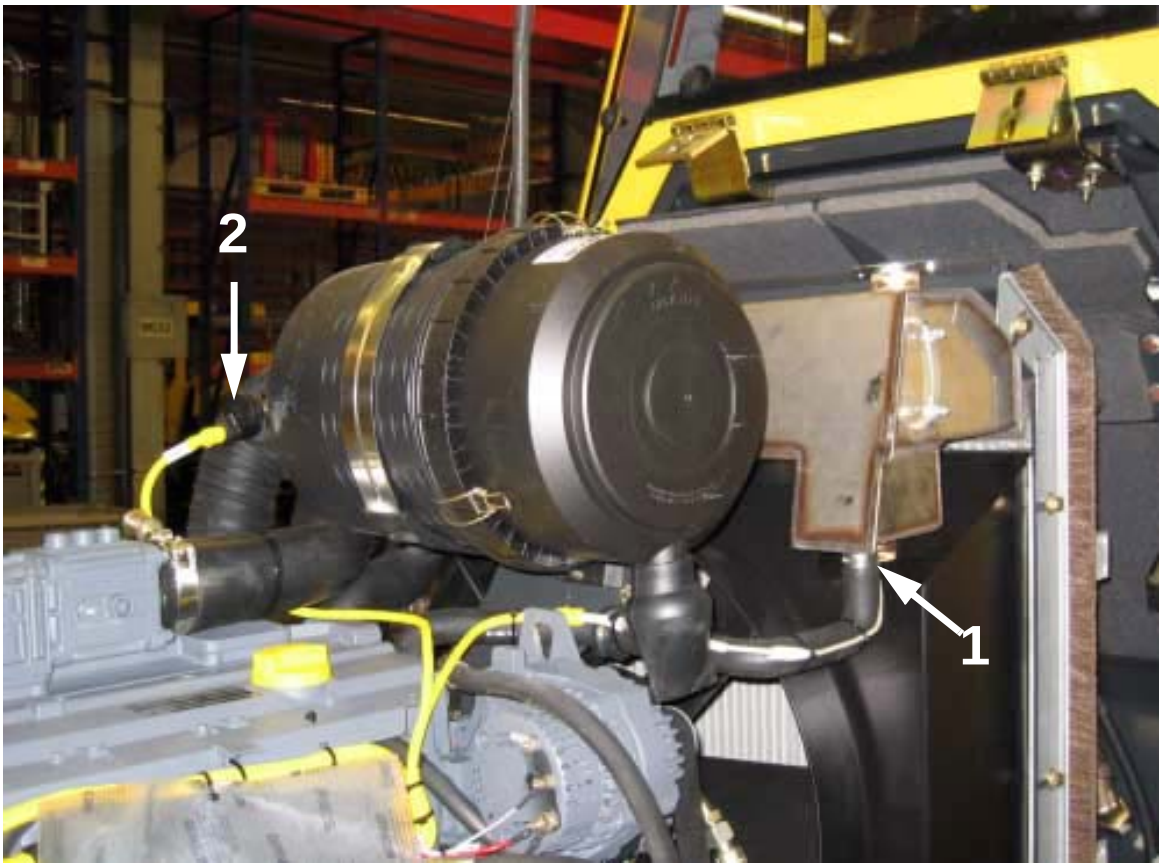


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Heating flange module	A 13		
2	High current relay for heating flange	K 14		0/12 V

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Air intake - blower side

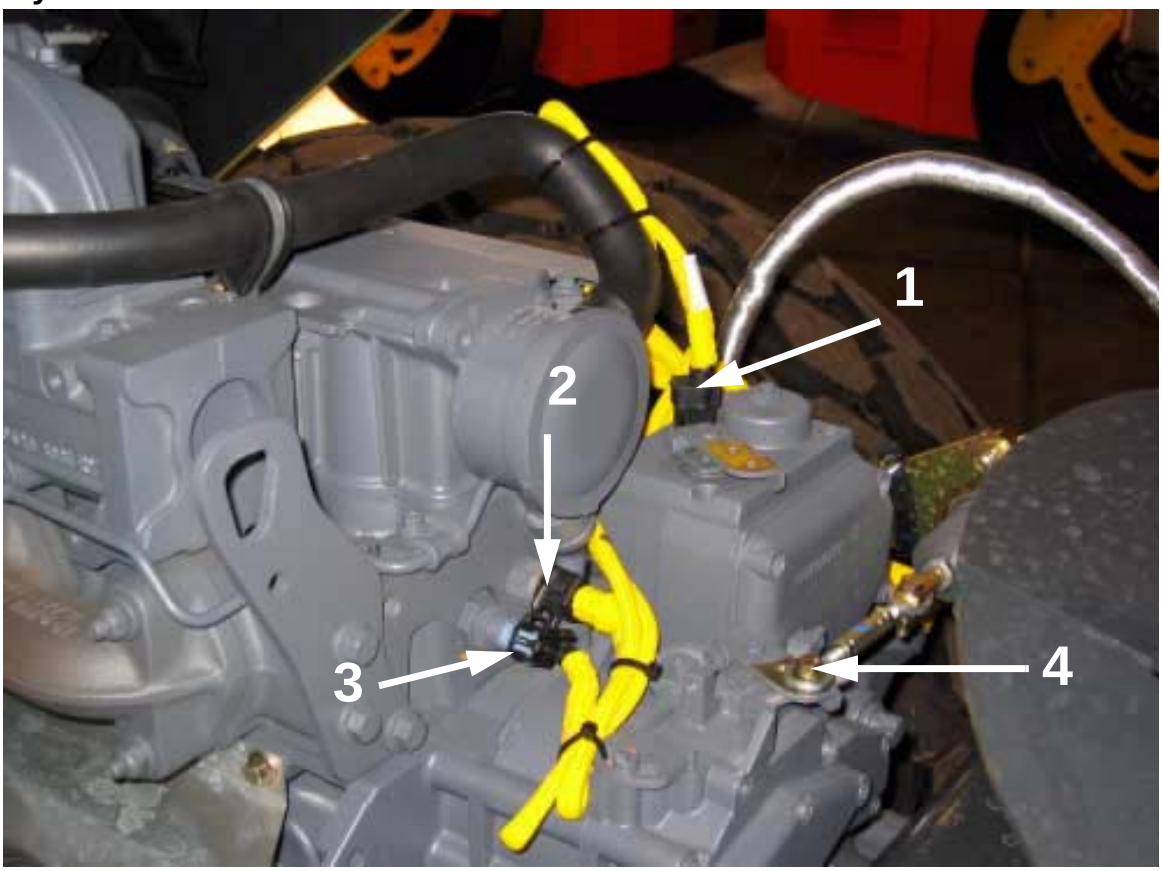


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Coolant level sensor	B 55		
2	Pressure differential switch for air filter	B 03		pressureless open, 50 mbar

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Flywheel end

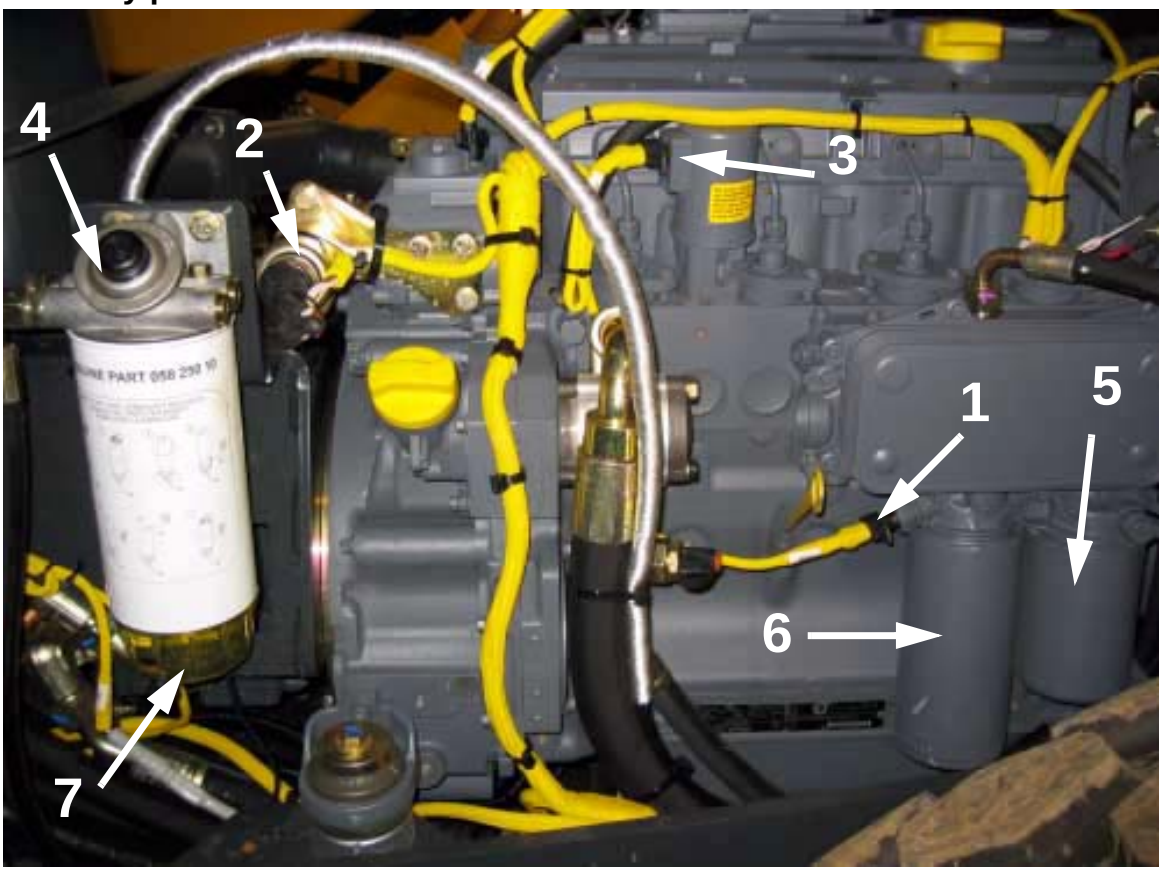


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Boost fuel valve	Y 01		0/12 V
2	Coolant temperature switch with warning light	B 30		cold open,
3	Coolant temperature flange for heating flange	B 113		approx. 2 Ω at 20°C
4	Throttle lever			

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Auxiliary power take-off side

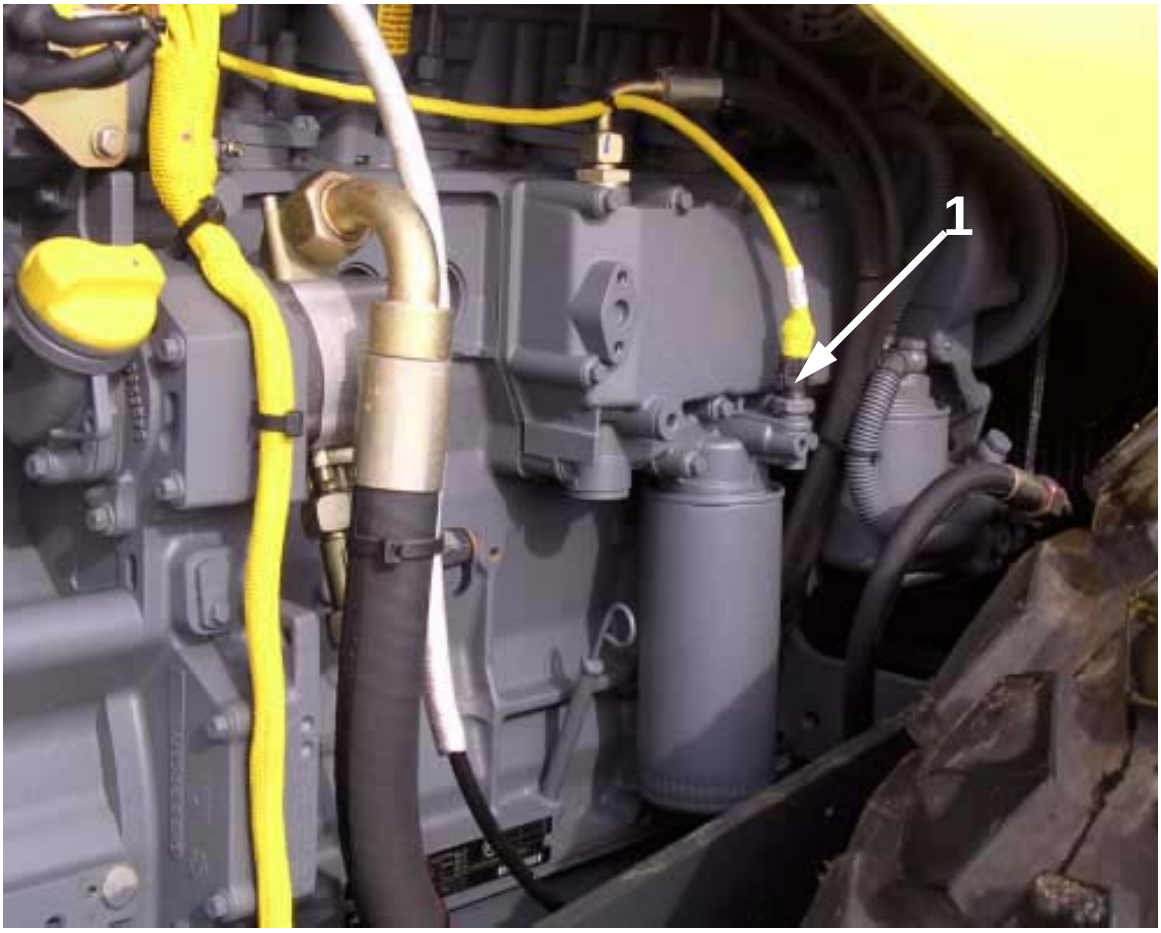


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Engine oil pressure switch	B 06		pressureless closed,
2	Engine solenoid, speed control	Y 120		
3	Engine shut-down solenoid	Y 58		
4	Fuel pre-filter with hand pump			
5	Fuel filter			
6	Engine oil filter			
	Water separator sensor, fuel	B 124		

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Auxiliary power take-off side (1013EC): BW 216 D-4

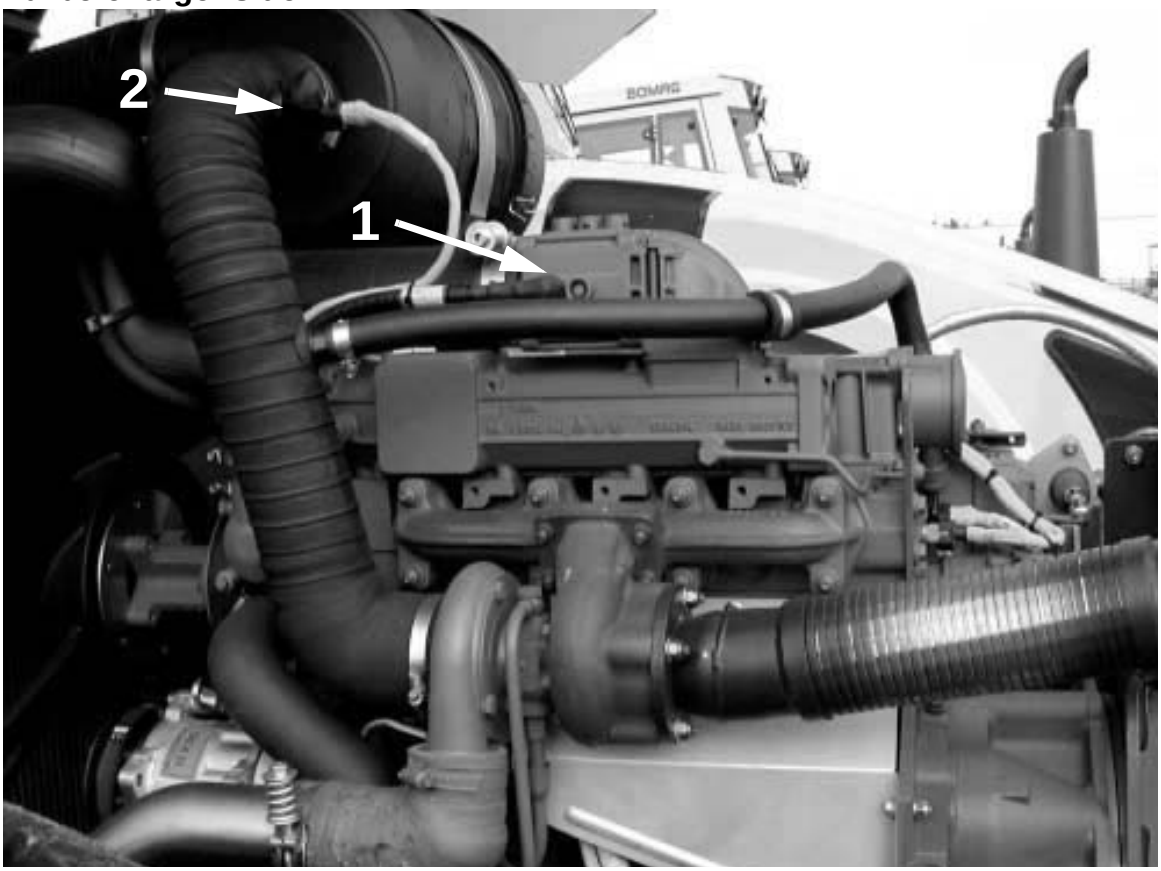


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Engine oil pressure switch	B 06		pressureless closed,

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Turbo charger side



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Heating flange	R 19		0/12 V, 167 A, approx. 0,07 Ω
2	Pressure differential switch for air filter	B 03		pressureless open, 50 mbar

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Diesel engine monitoring:

Warning and control lights are integrated in the instrument cluster



Display and shut-down functions

	Control light	Warning buzzer	Shut down time 10 s	Shut down time 2min
Air filter service switch	X			
Water separator Fuel filter	X	X		X
Engine oil pressure	X	X	X	
Coolant temperature	X	X		X

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	Control light	Warning buzzer	Shut down time 10 s	Shut down time 2min
Minimum coolant filling level	X	X	X	

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Travel circuit

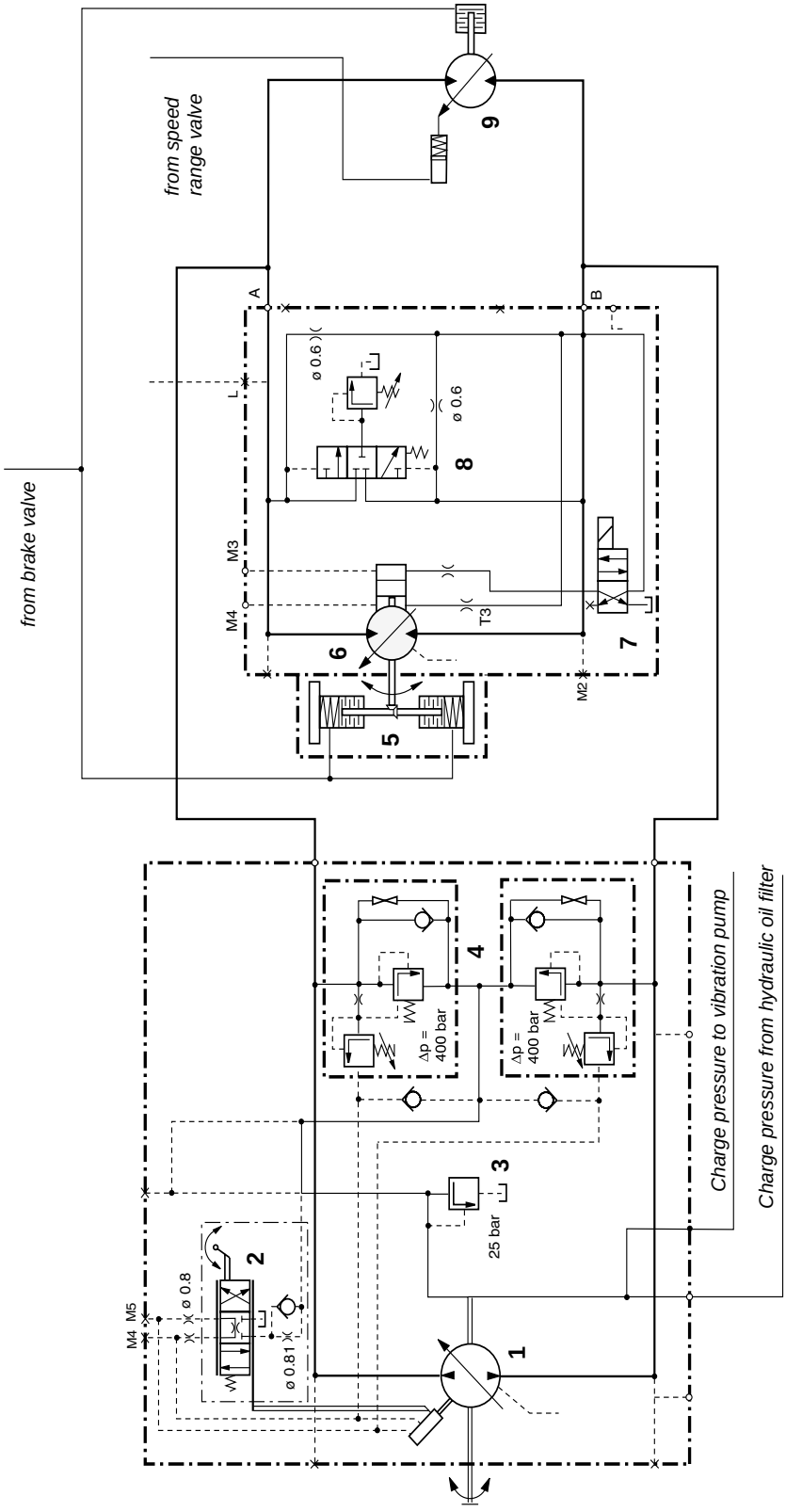


Fig. 1: Hydraulic diagram travel system BW 211 / 213 D-4

1 *Travel pump Sauer 90 R 075*
2 *Servo control*
3 *Charge pressure relief valve*
4 *Multi function valve*
5 *Rear axle*
6 *Axle drive motor Sauer 51 D 110*
7 *Speed range valve*
8 *Flushing valve*
9 *Drum drive motor Poclain MSE 18 2CX*

BW 211 / 213 D-4 / Deutz 2012C
BW 216 D-4 / Deutz 1013 EC

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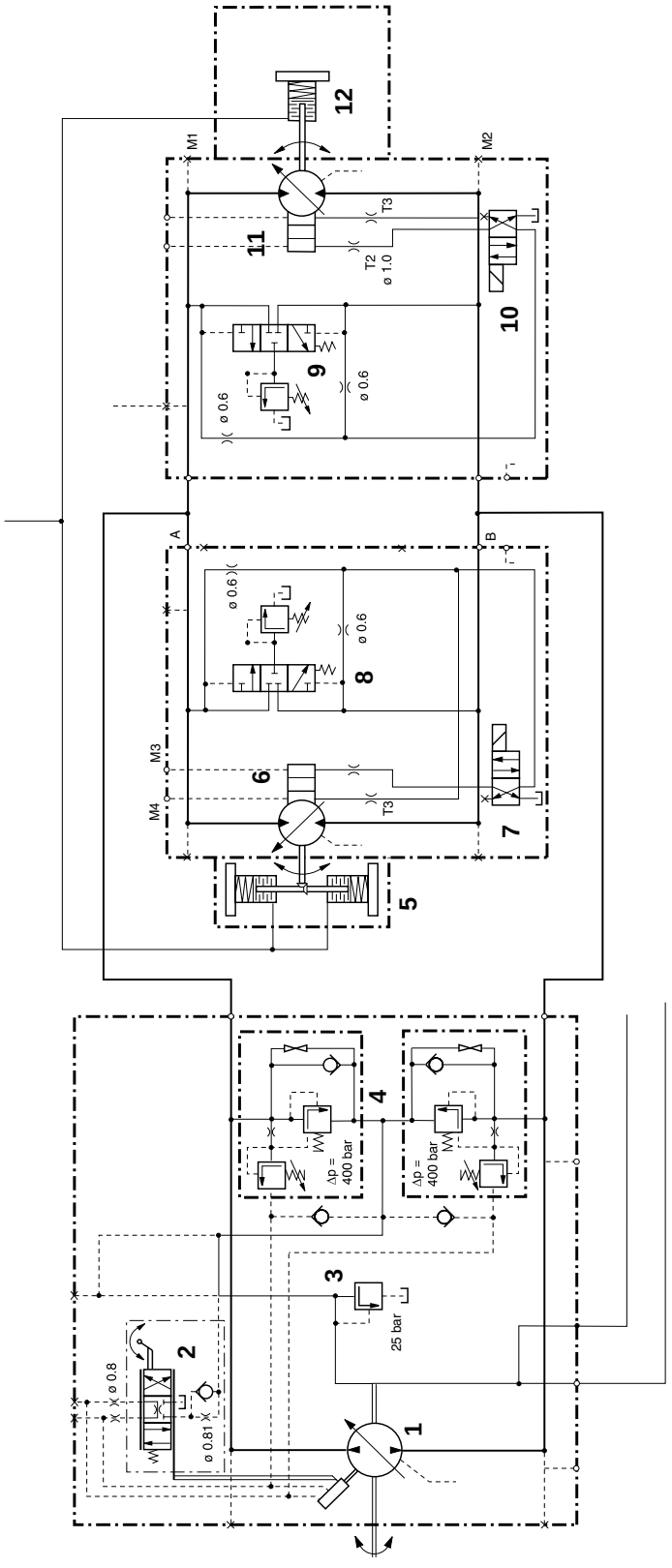


Fig. 2: Hydraulic diagram travel system BW 216 D-4

1	*Travel pump Sauer 90 R 075*	*5*	*Rear axle*	*9*	*Flushing valve (drum drive motor)*
2	*Servo control*	*6*	*Axle drive motor Sauer 51 D 110*	*10*	*Speed range valve (drum drive motor)*
3	*Charge pressure relief valve*	*7*	*Speed range valve*	*11*	*Drum drive motor (Sauer 51 C 110)*
4	*Multi function valve*	*8*	*Flushing valve*	*12*	*Reduction gear Sauer CR 31*

BW 211 / 213 D-4 / Deutz 2012C
BW 216 D-4 / Deutz 1013 EC

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The travel system of the single drum rollers is a closed hydraulic circuit and consists mainly of:

- travel pump with control and safety elements,
- drum drive motor with integrated multi-disc brake (BW 211 and 213 D-4),
- drum drive motor with reduction gear (BW 216 D-4),
- axle drive motor,
- charge pump (also for vibration circuit),
- hydraulic oil filter (in charge circuit),
- hydraulic oil cooler with thermostat
- hydraulic lines.

Travel pump and vibration pump are connected to a tandem pump unit. The charge pump is an integral part of the vibration pump.

The travel pump is the first pump section, flanged directly to the flywheel side of the diesel engine.

The pump delivers the hydraulic oil to the travel motors for drum and axle drives. The multi-function valves in the pump limit the pressure in the closed circuit to (Δp = 400 bar between low and high pressure sides).

A flushing valve in the axle drive motor (and in the Sauer drum drive motor 51 C 110) flushes a certain oil quantity out of the closed circuit when the machine is driving (Δp between the two sides of the closed circuit).

Leakage in the individual components of the circuit are replaced by the charge circuit through the boost check valves in the travel pump.

The charge pumps draw hydraulic oil out of the tank and deliver it through the hydraulic oil filter and the charge pressure relief valve to the boost check valves in travel and vibration pumps. The machine is fitted with two charge pumps. One pump is integrated in the vibration pump and the other pump is driven by the auxiliary output of the engine and serves primarily as steering pump.

The charge circuit provides the oil for the charge system and the control functions in the closed circuits for travel and vibration drive, as well as to release the parking brakes and to change the travel speed ranges.

Both travel motors are designed with variable displacement. The operator can choose from four different travel speed ranges.

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Travel pump

The travel pump is a swash plate operated axial piston pump with variable displacement, most suitable for applications in hydrostatic drives with closed circuit.

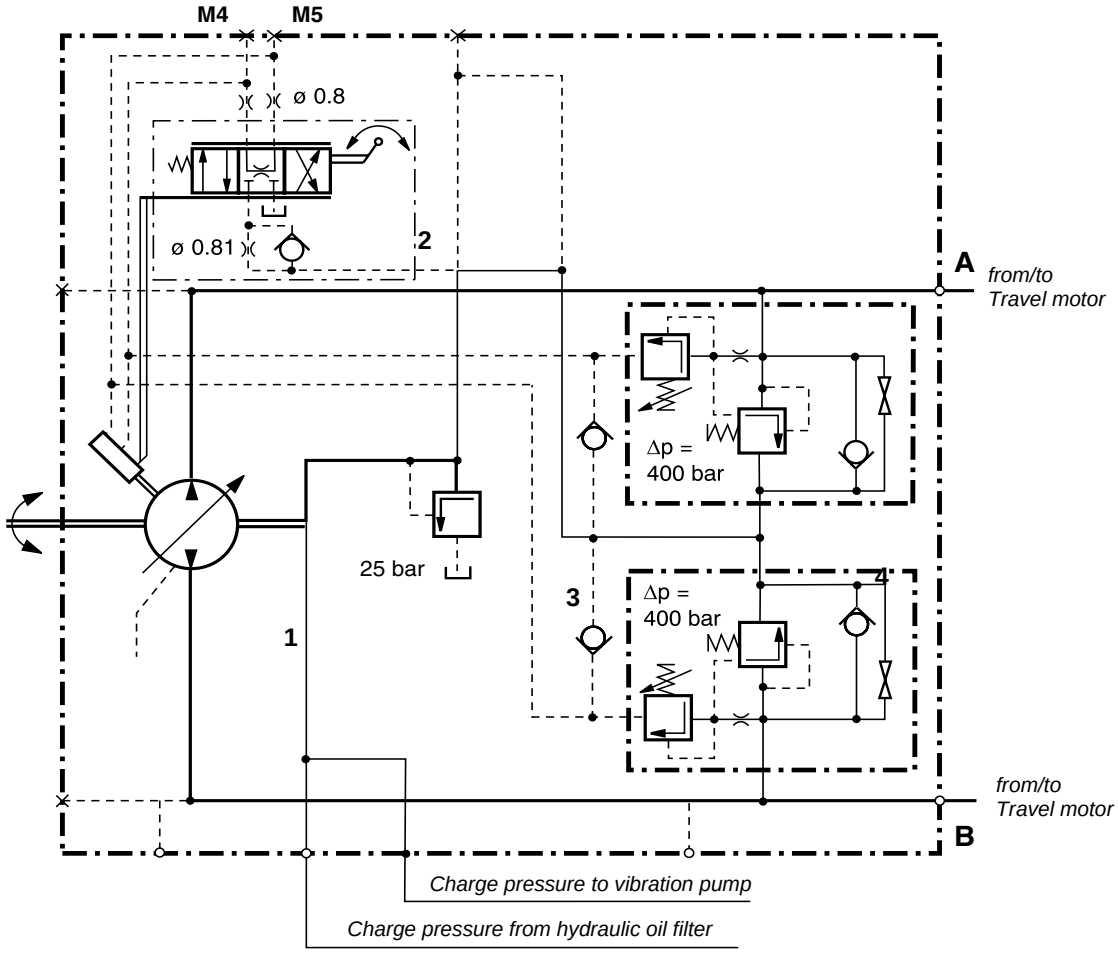


Fig. 3: Hydraulic diagram of travel pump

1	*Pump drive*	*3*	*Charge pressure relief valve*
2	*Servo control*	*4*	*Multi-function valves*

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The travel pump delivers the hydraulic oil to the motors on rear axle and drum. The pump flow is proportional to the pump speed (output speed of diesel engine) and the actual displacement (swashing angle of swash plate) of the pump.

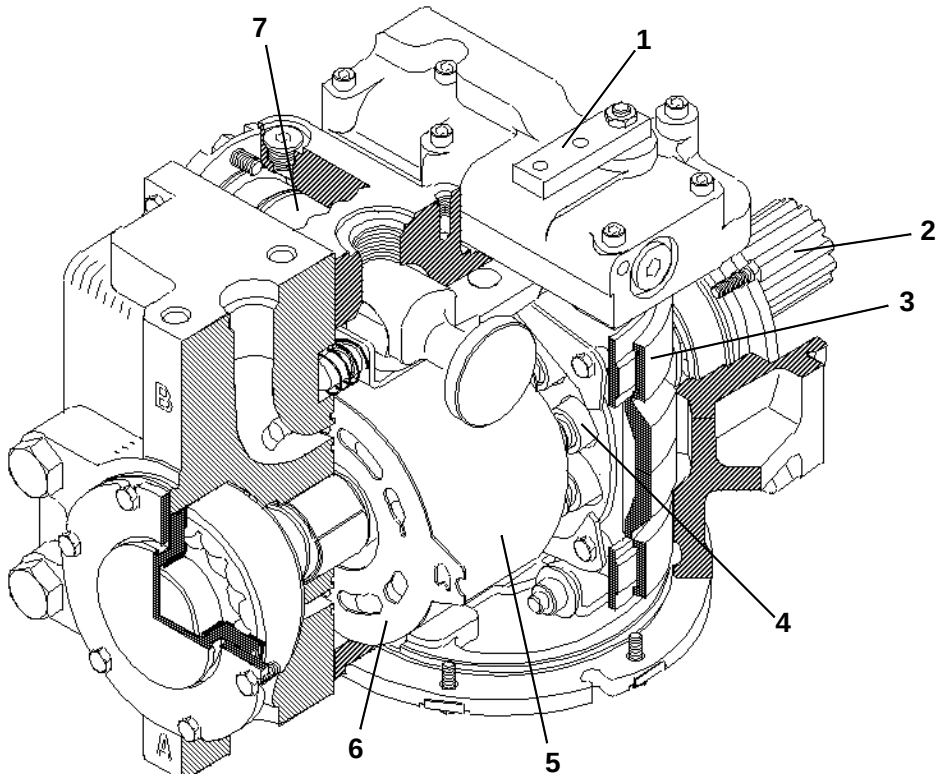


Fig. 4: Travel pump

1	*Control lever*	*5*	*Cylinder block*
2	*Drive shaft*	*6*	*Valve plate*
3	*Swash plate bearing*	*7*	*Control piston*
4	*Pistons with slipper pads*		

With the servo control the swashing angle can be infinitely adjusted from neutral position (0) to both maximum displacement positions.

When altering the swash plate position through the neutral position, the oil flow will be reversed and the machine will drive to the opposite direction.

All valves as well as the safety and control elements needed for operation in a closed circuit, are integrated in the pump.

Note:
These machines are equipped with two charge pumps.

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Cross-sectional view of travel pump

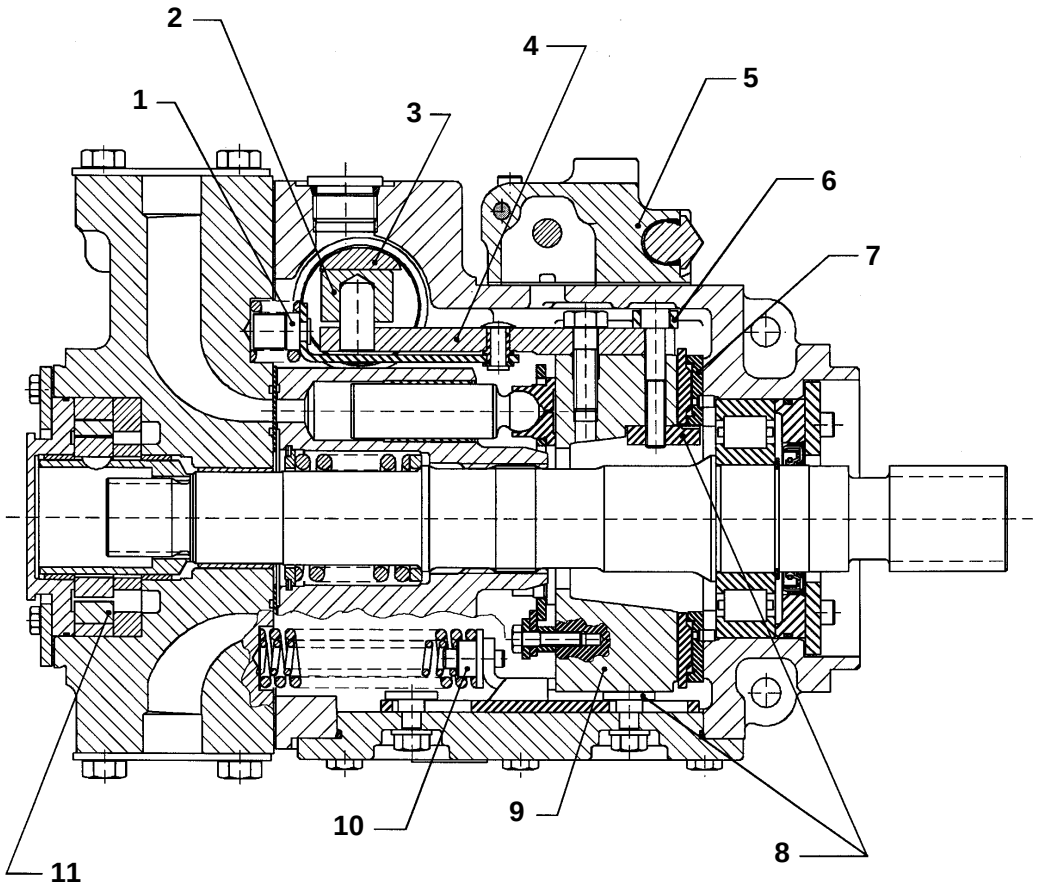


Fig. 5: Cross-sectional view of travel pump

1	*Retainer for swash plate*	*7*	*Swash plate bearing*
2	*Sliding block*	*8*	*Swash plate guide*
3	*Control piston*	*9*	*Swash plate*
4	*Servo arm*	*10*	*Swashing lever*
5	*Servo valve*	*11*	*Charge pump (only in vibration pump)*
6	*Feedback device*		

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View of the rotating group

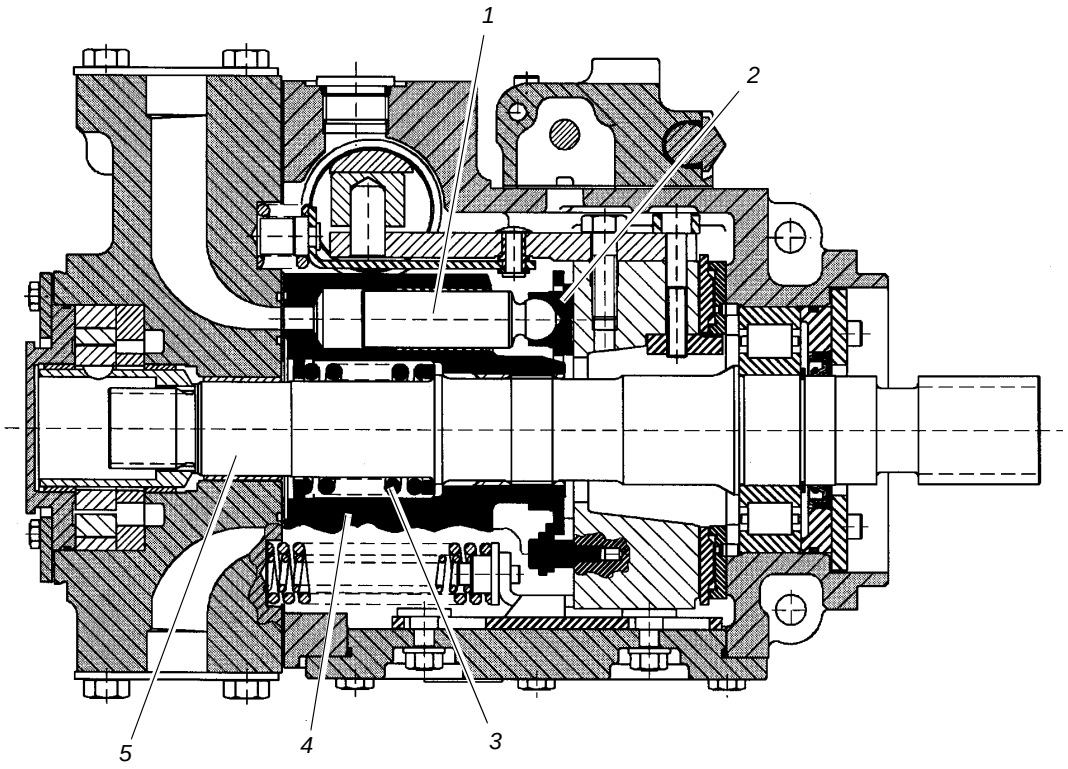


Fig. 6: Travel pump, view of the rotating group

1 Working pistons
2 Slipper pad
3 Pre-tensioning spring
4 Cylinder block
5 Drive shaft

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Description of function

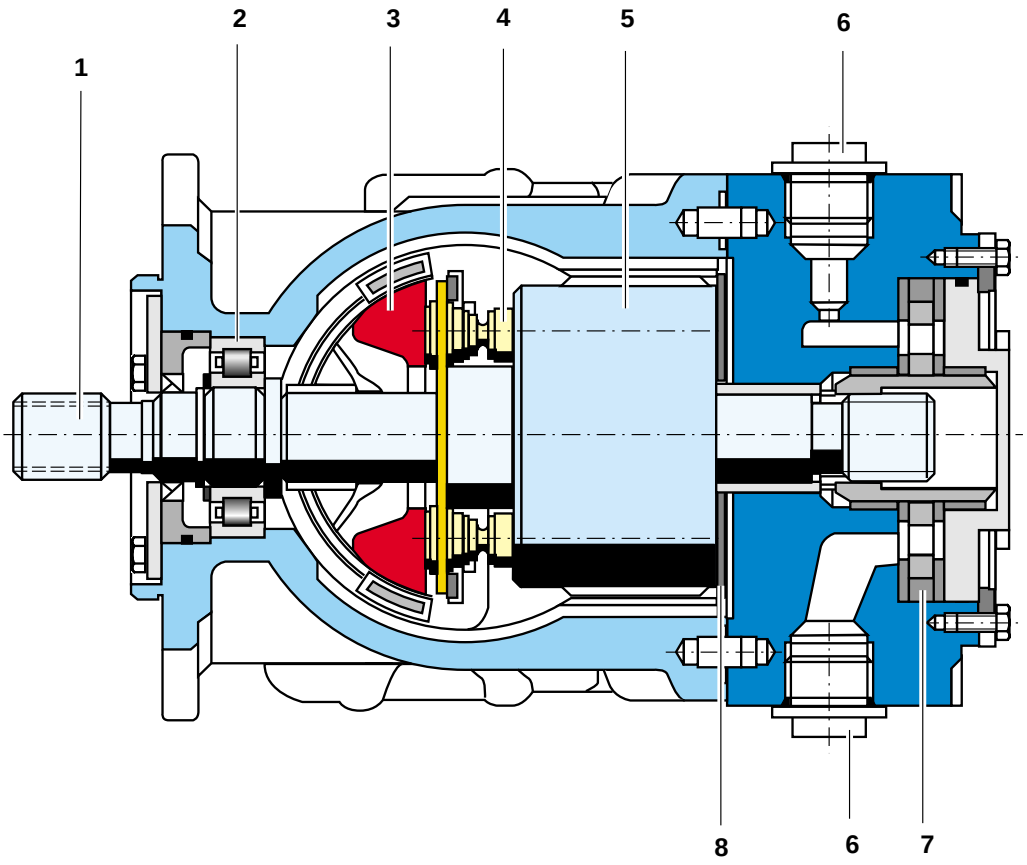


Fig. 7: Function of travel pump

1	*Drive shaft*	*5*	*Cylinder block*
2	*Drive shaft bearing*	*6*	*Multi-function valves*
3	*Swash plate*	*7*	*Charge pump (only in vibration pump)*
4	*Pistons with slipper pads*	*8*	*Valve plate*

The drive shaft (1) is directly driven by the diesel engine via an elastic coupling. the shaft turns the tightly connected cylinder block (5).

With the rotation of the drive shaft (1) the cylinder block (5) moves the working pistons (4). The slipper pads of the working pistons abut against the swash plate (3).

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When moving the swash plate out of neutral position, the working pistons will perform a stroke movement with every rotation of the cylinder block.

The slipper pads are hydrostatically balanced and are retained on the sliding face of the swashing cradle by a retaining device.

During a full rotation of the cylinder block each working piston will move through the bottom and top dead centre back to the initial position. During this movement each piston performs a complete stroke.

During the piston stroke each piston draws in a certain quantity of oil from the low pressure side of the hydraulic circuit and presses it out into the high pressure side.

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Tandem pump, connections and adjustment points

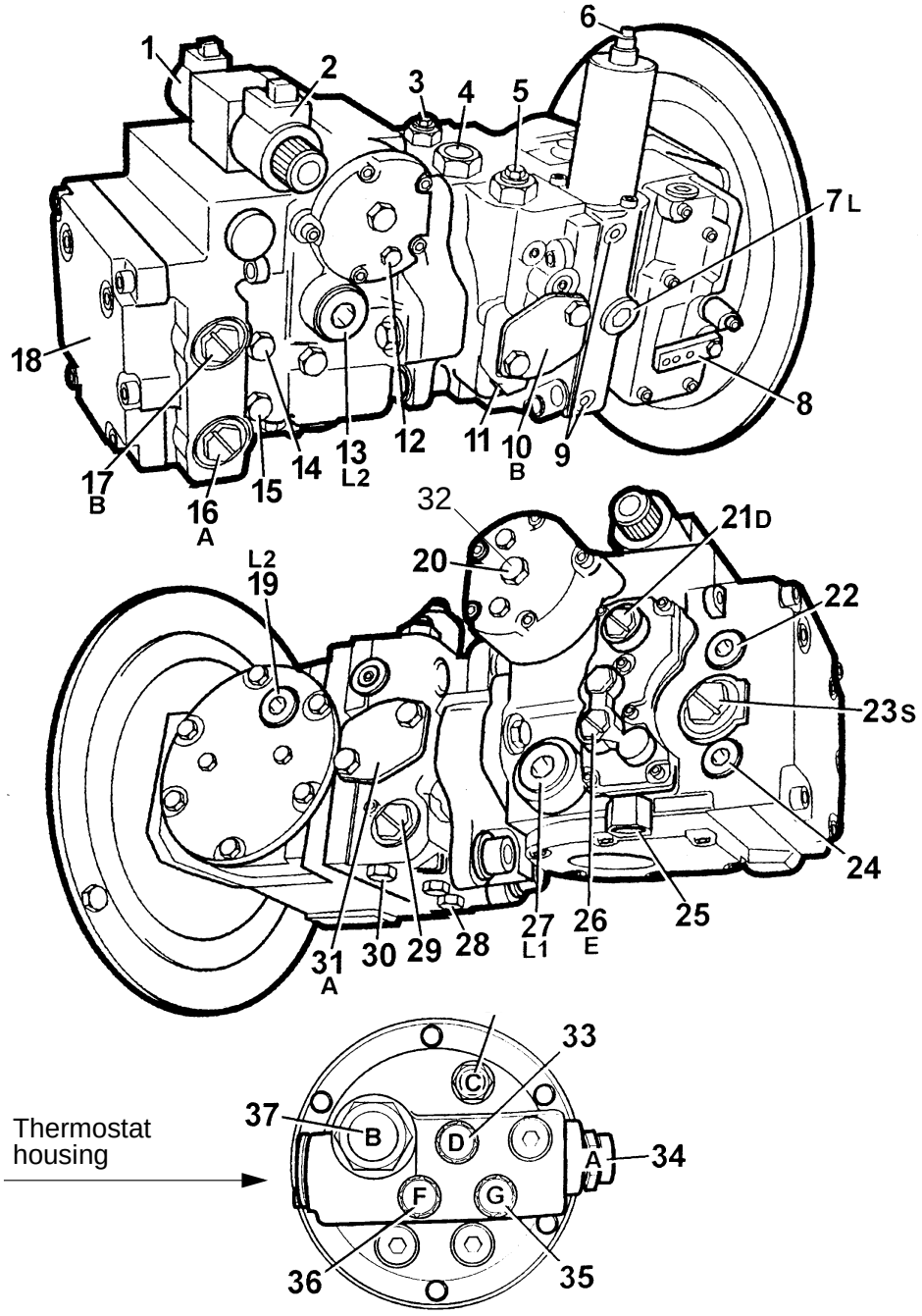


Fig. 8: Connections and adjustment points

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1 *Control solenoid, high frequency (vibration pump)*
2 *Control solenoid, low frequency (vibration pump)*
3 *Multi-function valve 400 bar (charging and pressure limitation), travel system*
4 *Charge pressure to solenoid valve for brakes and speed range selector, charging vibration*
5 *Multi-function valve 400 bar (charging and pressure limitation), travel system*
6 *Adjustment screw, mechanical neutral position*
7 *Port L, leak oil to vibration pump*
8 *Travel lever*
9 *Pressure test port, pilot pressure*
10 *High pressure port B, high pressure reverse*
11 *Charge pressure relief valve, 26 bar*
12 *Adjustment screw, low frequency*
13 *Port L2, leak oil to tank*
14 *Pressure test port MB, high frequency*
15 *Pressure test port MA, low frequency*
16 *High pressure port A, low frequency*
17 *High pressure port B, high frequency*
18 *End plate with integrated charge pump (only in vibration pump)*

19 *Port L2*
20 *Adjustment screw, high frequency*
21 *Port D, charge pressure to filter*
22 *Multi-function valve 345 bar (charging and pressure limitation), vibration high frequency*
23 *Port S, suction line between hydraulic oil tank and charge pump*
24 *Multi-function valve 345 bar (charging and pressure limitation), vibration low frequency*
25 *Charge pressure relief valve, vibration pump (blocked)*
26 *Port E, charge oil from travel pump*
27 *Port L1, leak oil port to travel pump*
28 *Pressure test port MB, high pressure reverse*
29 *Charge oil from filter*
30 *Pressure test port MA, high pressure forward*
31 *High pressure port A, high pressure forward*
32 *Adjustment screw for mechanical neutral position, vibration*

Thermostat housing: 33, 34, 35, 36 Leak oil port
37 *cooler inlet*

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servo control

The servo control (mechanical – hydraulic displacement control) converts the mechanical input signal of the pump control lever into a position controlling output signal. This position controlling signal determines the swashing angle of the swash plate (the displacement of the pump), as well as the swashing direction (flow direction of the pressure fluid).

The flow quantity delivered by the variable displacement pump is proportional to the value of the mechanical input signal. A mechanical feedback device ensures the fixed correlation between the mechanical input signal and the swashing angle of the swash plate (displacement of pump).

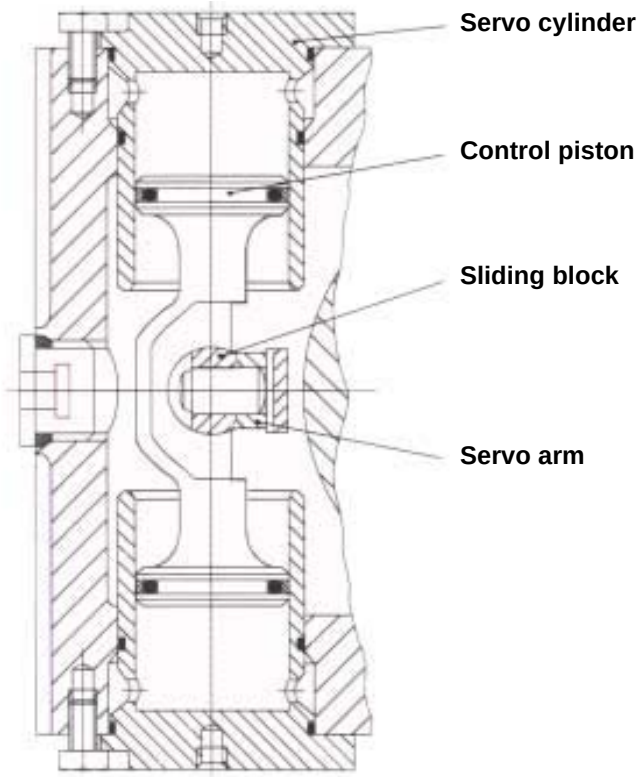


Fig. 9: Control piston

A mechanical safety device (spring) makes sure that a too fast lever movement will not cause any damage to the servo control.

The pump displacement can be adjusted by actuating the pump control lever via travel lever and travel control cable. This requires only very little manual forces and only a slight movement of the lever.

Since the control is spring centred, the swash plate will automatically return to neutral position under the following conditions, thereby interrupting the oil flow and braking the machine:

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- when shutting the engine down,
- if the external control cable comes loose,
- if the pressure in the charge circuit drops below a certain value.

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Multi-function valves

High pressure limitation

Pumps of series 90 are equipped with so-called multi-function valves, which activate a pressure override and a pressure relief valve, one after the other.

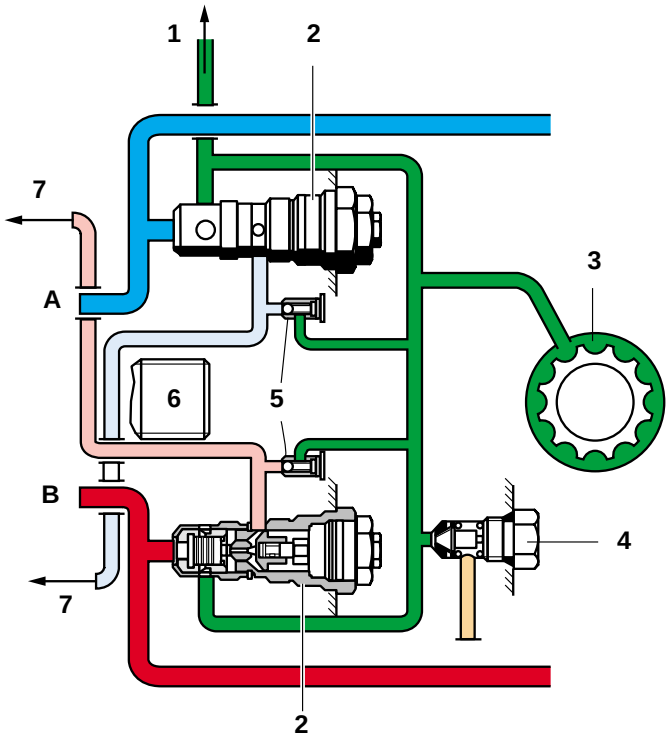


Fig. 10: Multi-function valves

1	*to the control*	*6*	*Drive shaft*
2	*Multi-function valve*	*7*	*to the control piston*
3	*Charge pump*	*8*	*to the control piston*
4	*Charge pressure relief valve*	*A*	*Port A*
5	*Pilot pressure relief valve*	*B*	*Port B*

If the adjusted pressure is reached, the pressure override will move the swash plate quickly back towards neutral position, thereby limiting the system pressure. The average response time is less than 90 ms.

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In case of a very quick increase in pressure (pressure peaks) the system utilizes the function of the pressure relief valves as a protection for the hydraulic systems. In such a case the pressure override works as a pre-control unit for the control piston of the pressure relief valve. The pressure level of the high pressure relief valve is higher than the pressure level of the pressure override. The high pressure relief valves will only respond if the pressure override is not able to swash the pump back quick enough in case of sudden pressure peaks.

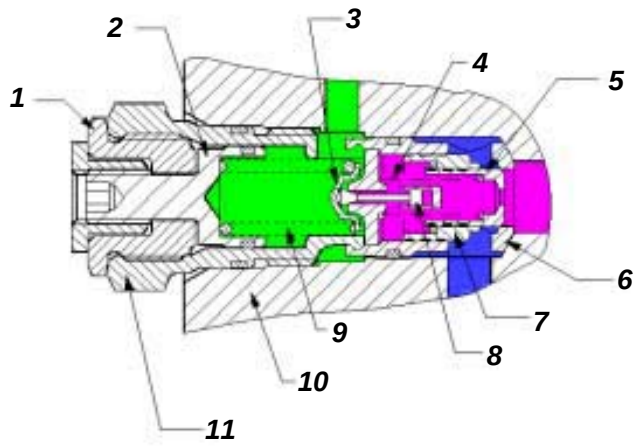


Fig. 11: Multi-function valve, details

1	*Reducing fitting*	*7*	*Check valve*
2	*Hydraulic by-pass piston*	*8*	*Pressure limitation*
3	*Spring plate*	*9*	*Spring*
4	*Spring*	*10*	*By-pass housing*
5	*High pressure relief valve*	*10*	*By-pass sleeve*
6	*Valve seat*		

Pressure override and high pressure relief valve are both parts of the multi-function valve, which is screwed into the pump.

With its possibility to swash the swash plate inside the pump back within a period of 90 ms, the pressure override makes sure that the high pressure relief valves will only respond in exceptional cases. This protects the hydraulic circuit against overheating and reduces the load on the diesel engine.

Note:
The multi function valves must be tightened with a torque of 89 Nm!

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Charge pressure relief valve

The machines are equipped with two charge pumps, one driven by the auxiliary output of the engine (steering and charge pump) and the other pump is integrated in the vibration pump.

The pressures of both pumps are limited by a charge pressure relief valve.

The charge pressure relief valve is a direct acting valve with fixed adjustment and is part of the safety elements in a closed hydraulic circuit. This valve limits the pressure in the charge circuit to the adjusted value (26 bar).

The charge circuit compensates leaks and flushing quantities in the closed travel and vibration circuits and provides the necessary pressure to control the travel and vibration pumps and to operate the multi-disc brakes in the travel drives.

Since feeding of cool and filtered oil is only possible in the low pressure side of the closed circuit, the pressure in the low pressure side is almost identical with the pressure in the charge circuit.

When parking the machine on level ground with the engine running, the pressures in both sides of the closed circuit are identical (charge pressure).

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Flushing valve

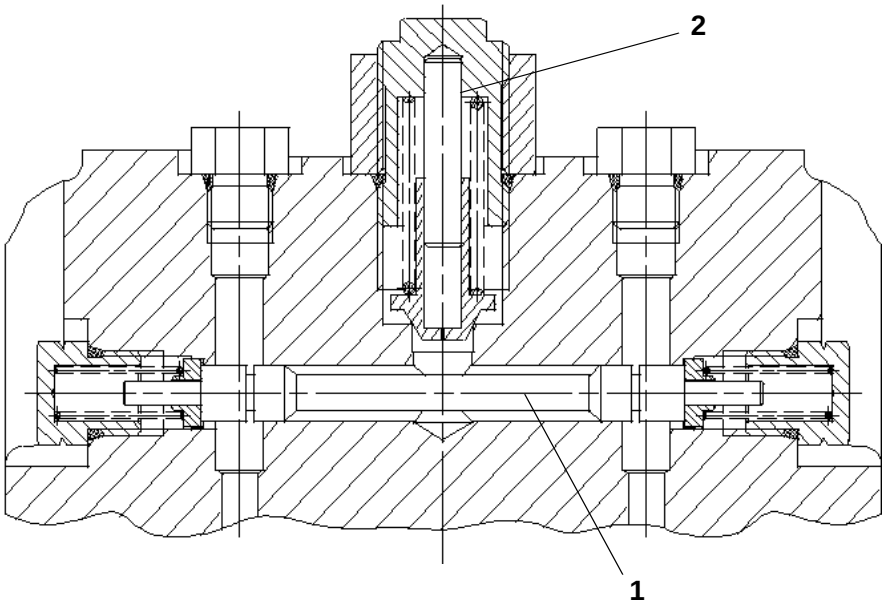


Fig. 12 Cross-section of flushing valve

1 Flushing spool

2 Flushing pressure relief valve

The flushing valves are integrated in the axle drive motor, or on the BW 216 D-4, also in the drum drive motor. In case of a pressure increase in one of the two sides of the closed circuit the flushing valves have the function to flush a certain quantity of oil out of the low pressure side.

The valve is operated by the pressure difference between the two sides of the closed circuit (A and B). If the pressure in one side is higher than in the other, this pressure will move the valve out of neutral position against the neutral setting spring. Oil can now flow out of the low pressure side. This oil flows through a thermostat valve back to the tank. The oil quantity flushed out of the closed circuit is immediately replaced by oil entering from the charge circuit through the corresponding boost check valve (part of the multi-function valve).

In this way the closed travel circuit is permanently supplied with cool and filtered oil and the temperature household of the hydraulic system is maintained at a permissible level.

Axle drive motor,

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The axle drive motor is a swash plate controlled axial piston motor of series 51 D 110 with variable displacement.

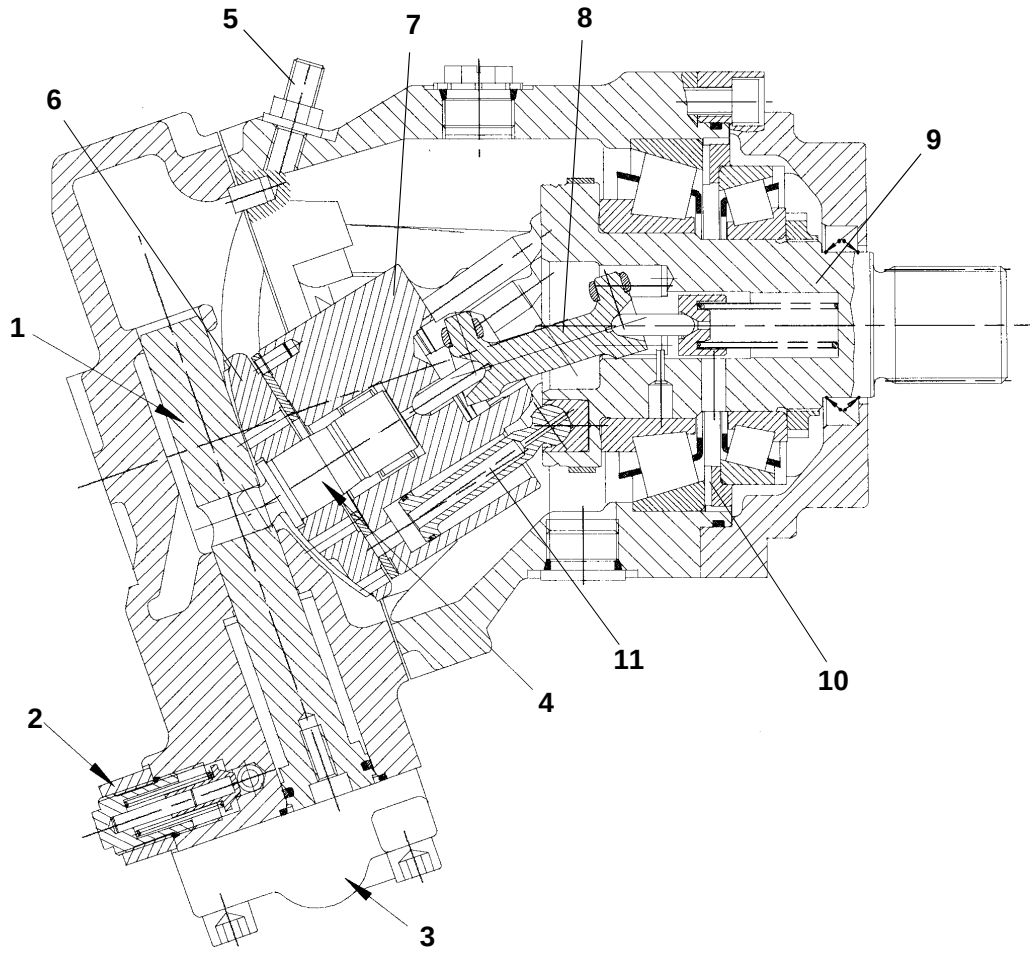


Fig. 13: Axle drive motor,

1	*Control piston*	*7*	*Cylinder block*
2	*Flushing valve*	*8*	*Universal joint*
3	*Control*	*9*	*Output shaft*
4	*Spindle with ball*	*10*	*Output shaft bearing*
5	*Q_{min}-screw*	*11*	*Working piston*
6	*Valve plate*		

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The motor can be adjusted to two fixed displacements. This is accomplished by changing the angle between cylinder block and output shaft.

With a large angle position the motor works with maximum displacement, slow speed and high torque.

When changing the swash plate position to minimal angle the motor works with minimum displacement, high speed and low torque.

The displacement is changed by a control piston, which is tightly connected with the valve segment. Changing of the displacement is accomplished by pressurizing the corresponding control piston side with pressure oil from the charge circuit via a 4/2-way solenoid valve.

Function

The motor is connected with the travel pump via the high pressure ports A and B. The hydraulic oil flows under high pressure through the corresponding port to the back of the working pistons. Since the working pistons are arranged under an angle to the output shaft, the pressurized pistons will perform a stroke movement, thereby causing a rotation of the output shaft.

Once the respective piston has passed its dead centre (max. extended position), it will change to the low pressure side. As the rotation progresses, the piston will move back into the cylinder bore. Oil is thereby displaced out of the cylinder chamber through the low pressure side back to the pump.

The synchronizing shaft with roller surfaces ensures uniform rotation of output shaft and cylinder block. The ball joints of the pistons run in journal bearings, which are pressed into the outer shaft. For the connection between output shaft and pistons no other parts are required. The output shaft runs in two tapered roller bearings.

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Rear axle

Releasing the axle drive brake manually (on both axle drive designs)

For manual releasing of the brakes on the rear axle you should proceed as follows:

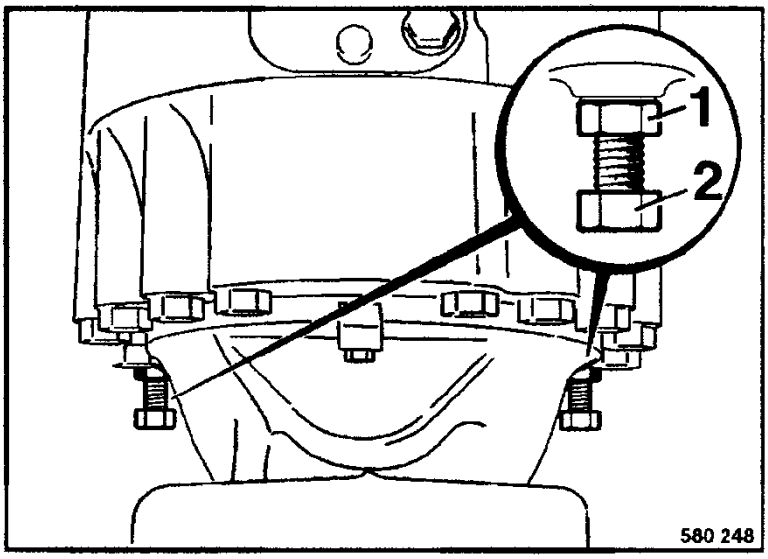


Fig. 14: Manual releasing of rear axle brakes

- Slacken the counter nut (Fig. 14, Pos. 1) and back it off by approx. 8 mm.
- Turn the brake releasing screw (2) in against the stop.
- To release the brake tighten the screw for max. 1 complete turn.

Attention!

Turn the screws on both sides in uniformly (alternately by 1/4 of a turn)

- Repeat this procedure on the opposite side of the axle.

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BW 211 / 213 D-4 Front drum drive motor: Radial piston motor MSE 18 2 CX

On single drum rollers of series BW 211 and 213 D-4 the drum is driven by a hydraulic radial piston motor.

These drum drive motors consist of three housing parts, the flat distributor, the cylinder block with the working pistons and the output shaft.

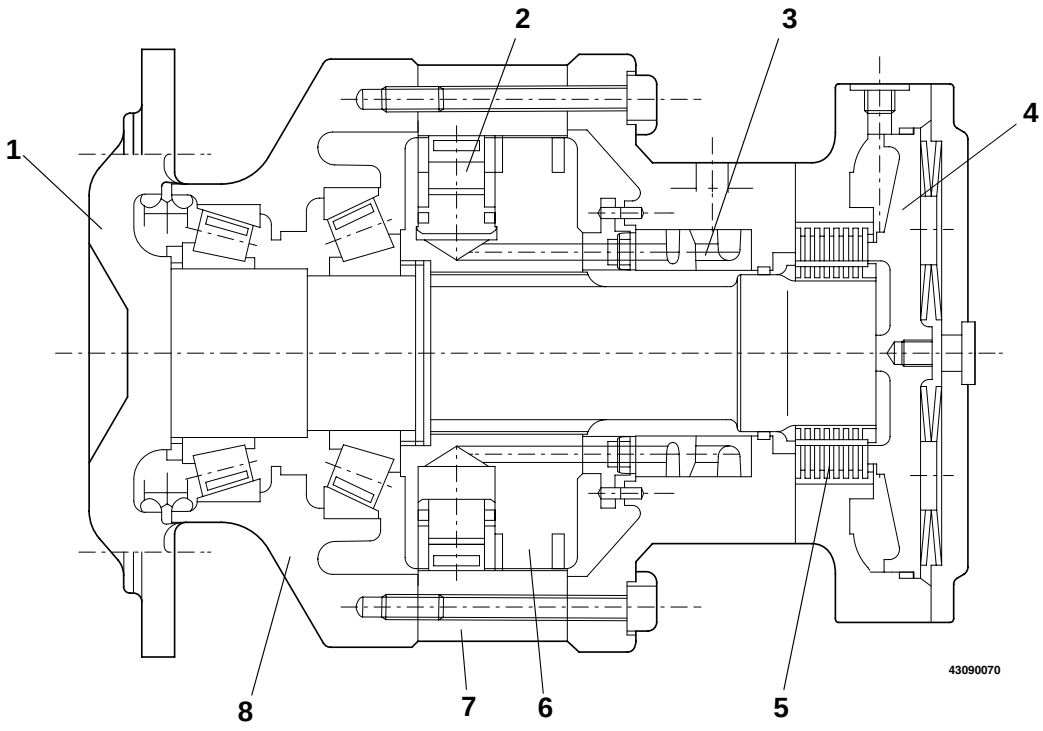


Fig. 15: Drum drive motor

1 Drive shaft with output flange
2 Piston with roller
3 Oil distributor
4 Brake piston
5 Multi-disc brake
6 Cylinder block
7 Cam ring
8 Bearing plate

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The housing consists of:

- bearing section (drive shaft bearings),
- torque section (cam race) and
- oil distributor.

Pressure oil flows through the flat distributor to the working pistons in the cylinder block. This pressure oil presses the working pistons with the rollers against the cam race of the torque section and forces the rollers to roll along the cam race.

This transforms the axial movement of the pistons to a radial movement of the cylinder block. The cylinder block transfers this rotation via a splined connection to the output shaft.

The output shaft runs in two tapered roller bearings. It transfers the rotary movement via the drive disc and the rubber elements to the drum.

The function of the radial piston motor is described hereunder. The piston positions described in this explanation can be seen in the related illustration.

The movement of a piston along the cam race must be examined in several phases during a full rotation:

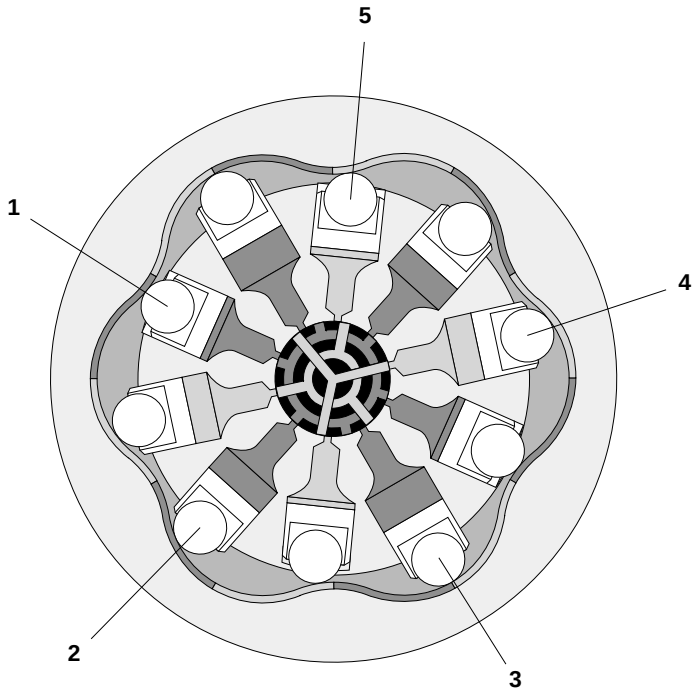


Fig. 16: Function of the radial piston motor

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Piston position 1:

The oil enters into the oil distributor under pressure, flows through the distributor and presses against the piston. The rotation starts at this point. The pressure applied to the back of the piston moves the roller along the cam and causes a rotation of the cylinder block.

Piston position 2:

At this point the opening cross-section for the oil flow to the piston has reached its maximum size. The piston continues his travel along the cam race towards the valley between two cams. As the movement continues the opening cross-section for the oil supply decreases.

Piston position 3:

Once the piston has reached the bottom of the valley, the oil flow to the piston is interrupted. The piston is no longer driven. It has reached its dead centre. Now another piston must be driven to move the first piston out of the dead centre.

Piston position 4:

Other driven pistons now move the first piston out of the dead centre. The oil behind the piston is now connected with the low pressure side and the reverse movement of the piston presses the oil back to the pump.

Piston position 5:

The pumping movement of the motor back to the pump comes to an end, the connecting bore between cylinder chamber and low pressure side closes again. The piston will now reach its second dead centre position. This point is the start of a new working cycle.

Reversing the oil flow reverses also the rotation of the motor.

The output shaft runs in two tapered roller bearings. It transmits the rotary movement via the drive disc and the rubber elements to the drum.

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Releasing the brake in the radial piston motor manually

For manual releasing of the brake in the Poclain motor (drum drive) you should proceed as follows:

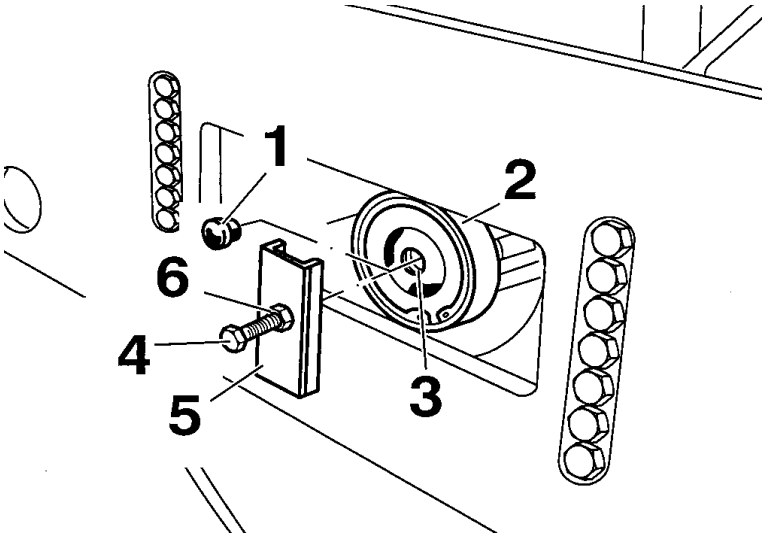


Fig. 17: Manual releasing of the brake in the Poclain motor

- Remove the plug 1 (Fig. 17).
- Lay the U-bar (5) across the brake housing (2) and turn the screw (4) into the tapped bore (3) until it bottoms.
- Turn the nut (6) down and tighten it for approx. one turn. The drum must turn freely.

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BW 216 D-4 Front drum drive motor: Bent axle motor 51 C 110 with reduction gear CR 31

The drums on the DH216 D-4 versions are driven by a swash plate operated Sauer bent axle motor 51 C 110. This motor is almost identical with the rear axle motor. Another detailed description at this point is therefore not necessary.

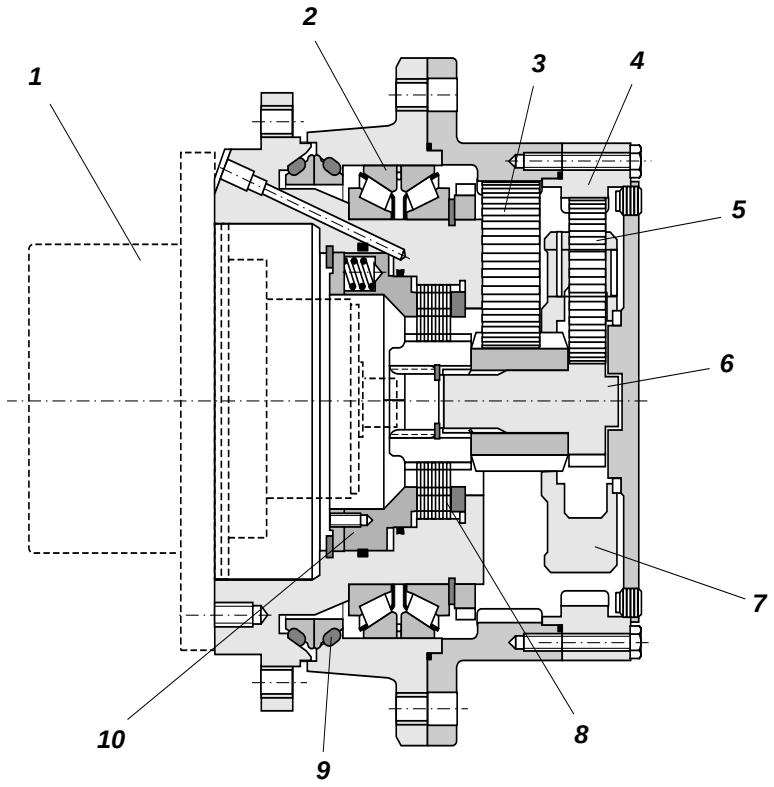


Fig. 18: Reduction gear CR 31

1	*Travel motor*	*6*	*Sun gear*
2	*Tapered roller bearing*	*7*	*Planet carrier*
3	*Spur wheel*	*8*	*Brake discs*
4	*Hollow wheel*	*9*	*Mechanical seal*
5	*Planet wheel*	*10*	*Brake piston*

This motor is a fast rotating hydraulic motor. Since the output speed of this motor is much too high to drive the drum, a reduction gear reduces the output speed to the actually required drum drive speed.

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Brake control

During operation the closed hydrostatic travel circuit has the function of a service brake. When moving the travel lever from full forward or reverse position towards neutral, the travel pump will follow towards zero position relative to the movement of the travel lever. The oil flow is thereby reduced and the machine is hydraulically braked. When moving the travel lever to neutral position, the pump will also return to neutral, the supply of oil is interrupted and the hydraulic circuit brakes the machine to standstill.

However, since minor leaks cannot be avoided in any hydraulic circuit and such minor leaks will cause creeping of the machine when it is parked on a slope with the engine running, the machine is additionally equipped with multi-disc brakes in drum drive and both wheel drives. When engaging the travel lever in neutral position the multi-disc brakes will close and the machine can be parked on slopes with the engine running and without the risk of creeping.

However, these parking brakes can also be operated via a 3/2-way solenoid valve. In de-energized condition the multi-disc brakes in the travel drives are unloaded. The charge pressure to the brakes is interrupted and the oil from the brake housings flows as leak oil back into the tank.

If the brake solenoid valve is supplied with current while the engine is running and the brake is open, the connection of the brake line to the tank is interrupted and oil from the charge circuit is guided to the brake pistons. The oil pressure works against the spring force of the brake spring and relieves the brake discs.

Manual releasing of the brake in the drum drive reduction gear

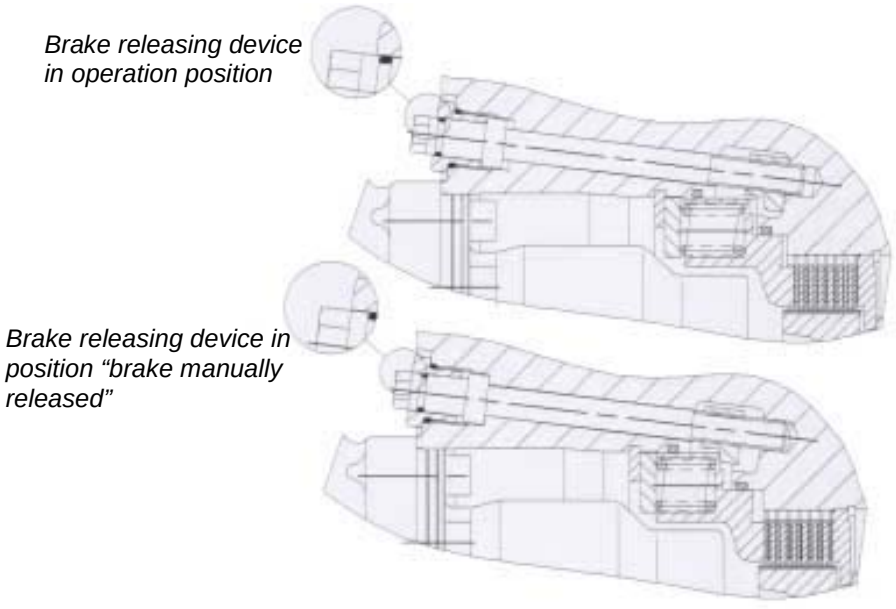


Fig. 19 Manual brake releasing device

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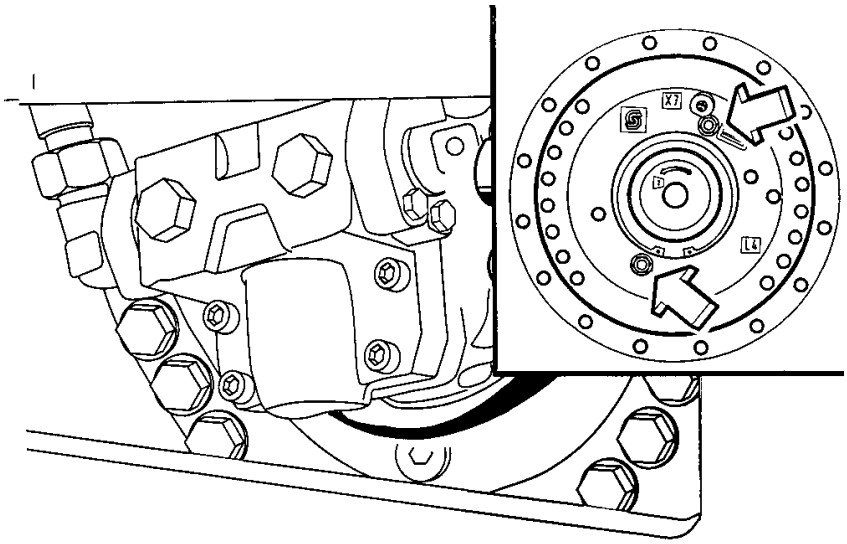


Fig. 20: Manual releasing of the brake in the drum drive CR31

- Turn both screws (Fig. 20) for releasing the brake in the drum drive reduction gear evenly in clockwise direction, until the drum can be turned freely.

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Travel circuit: BW 211 / 213 D-4 Drum drive with radial piston motor

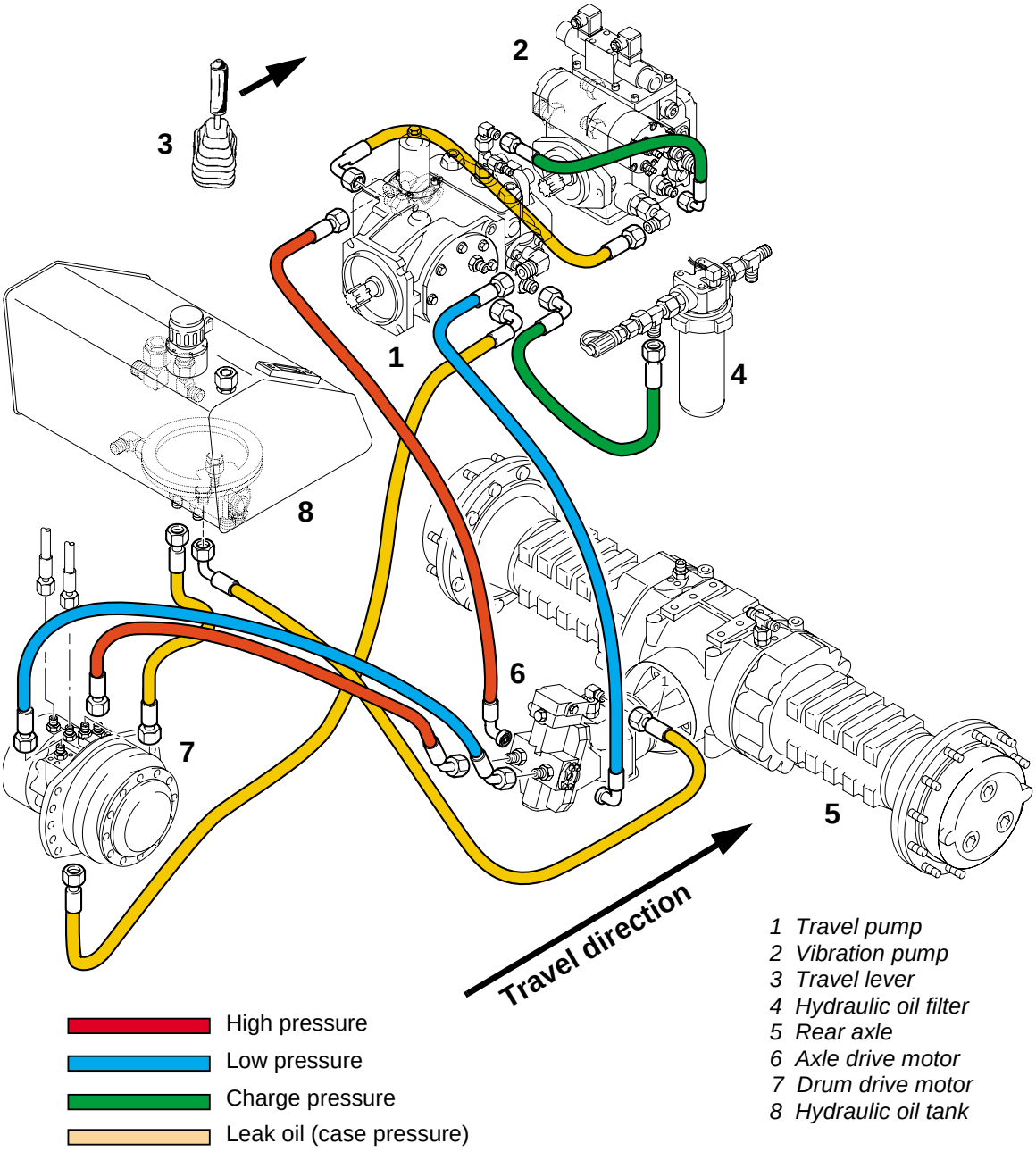


Fig. 21: BW 211 / 213 D-4, travel circuit, routing of hoses

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Travel circuit: BW 216 D-4 Drum drive with travel motor with reduction gear

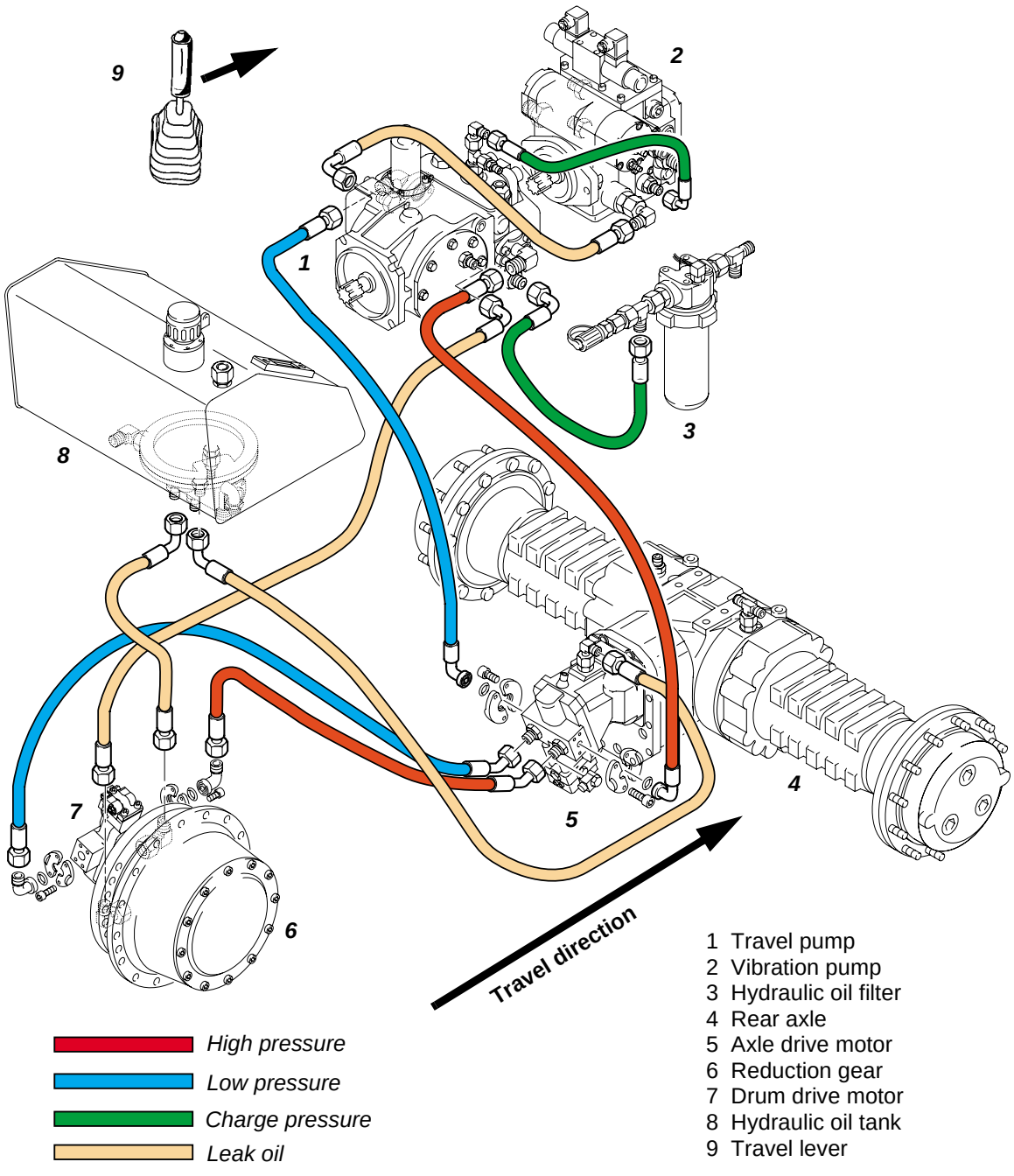
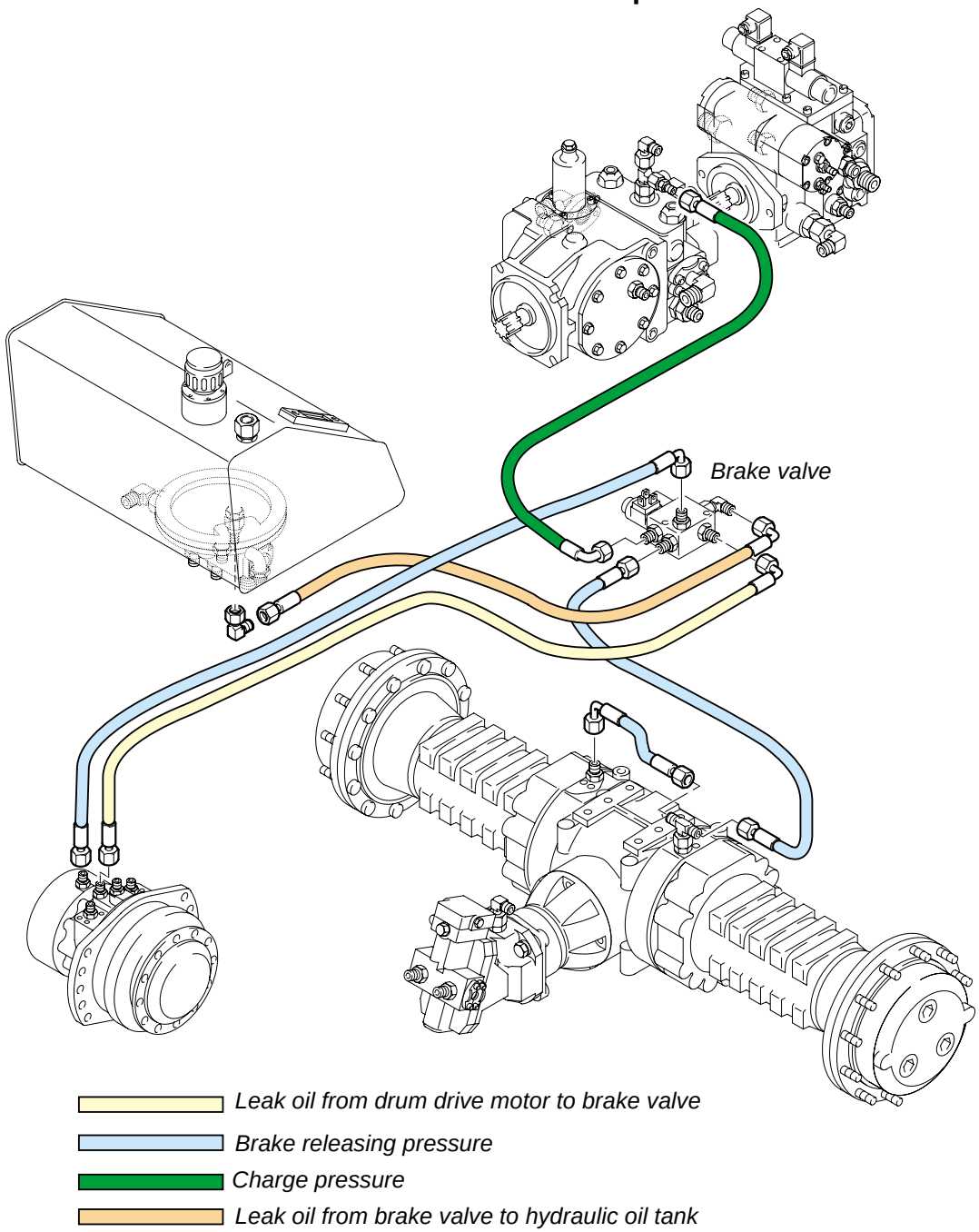


Fig. 22: Travel circuit with 51 C 110 and CR 31

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Brake control: BW 211 / 213 D-4 with radial piston motor



BW 211 / 213 D-4 / Deutz 2012C
BW 216 D-4 / Deutz 1013 EC

- E 30 -

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Brake circuit Brake control: BW 216 D-4 Travel motor with reduction gear

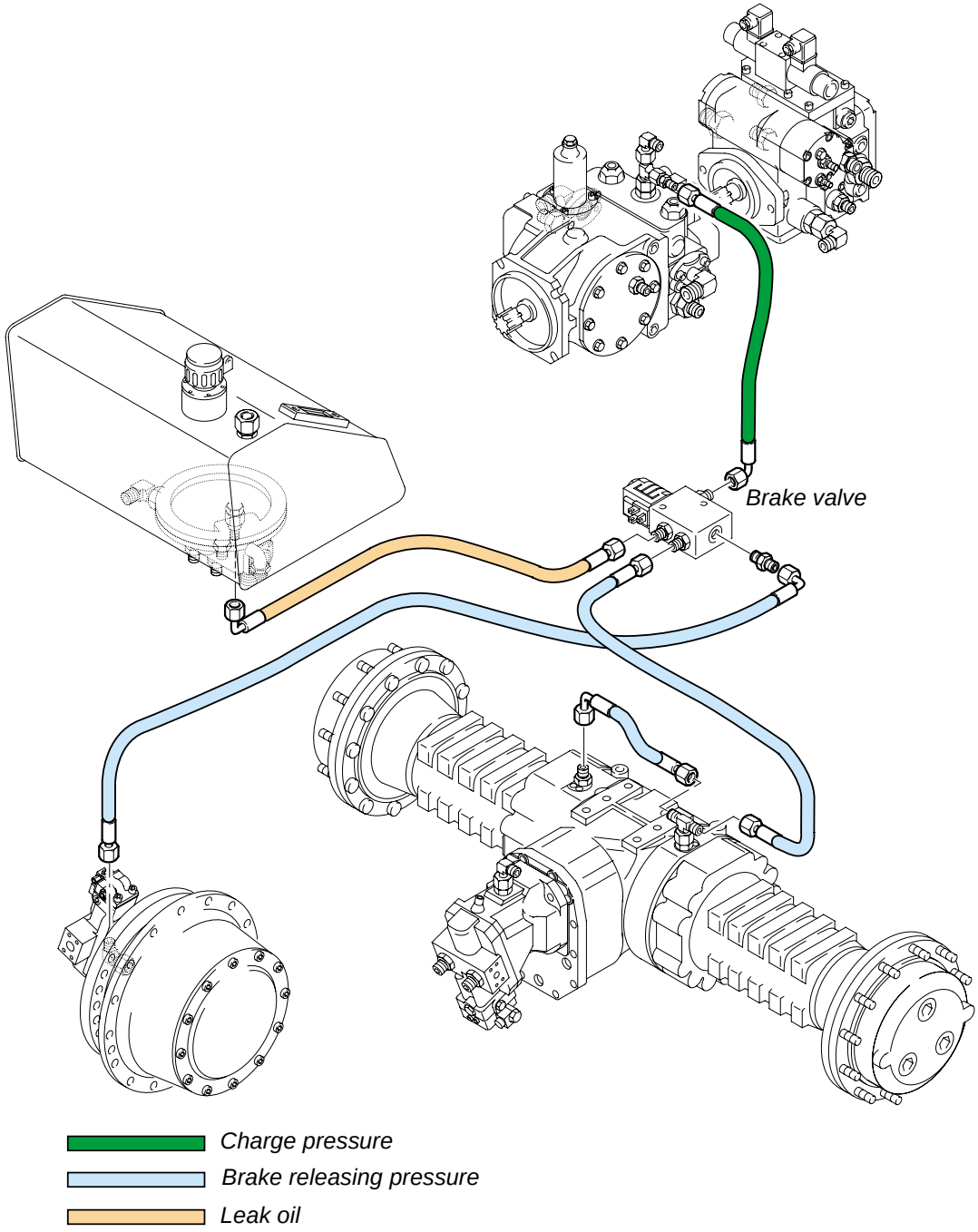


Fig. 23: Brake circuit

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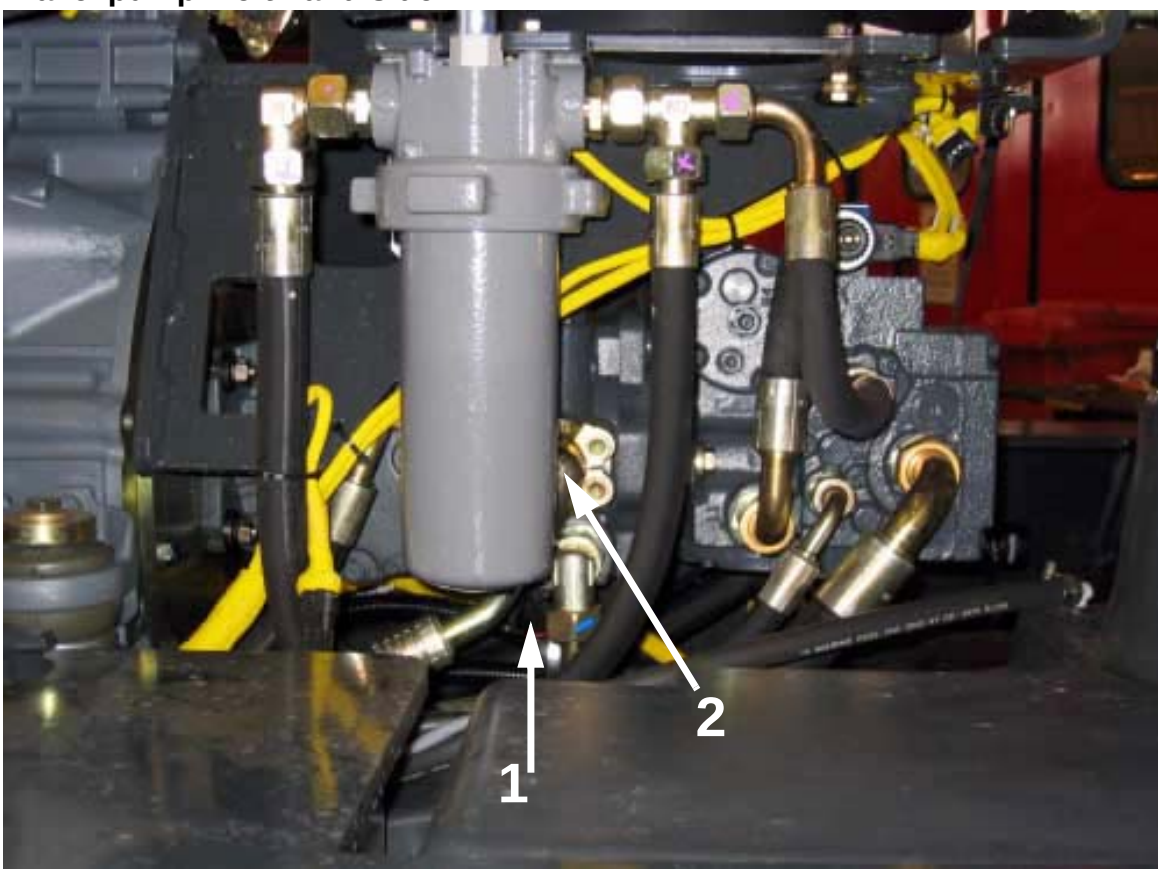
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Travel drive, components and test points

Travel pump: left hand side

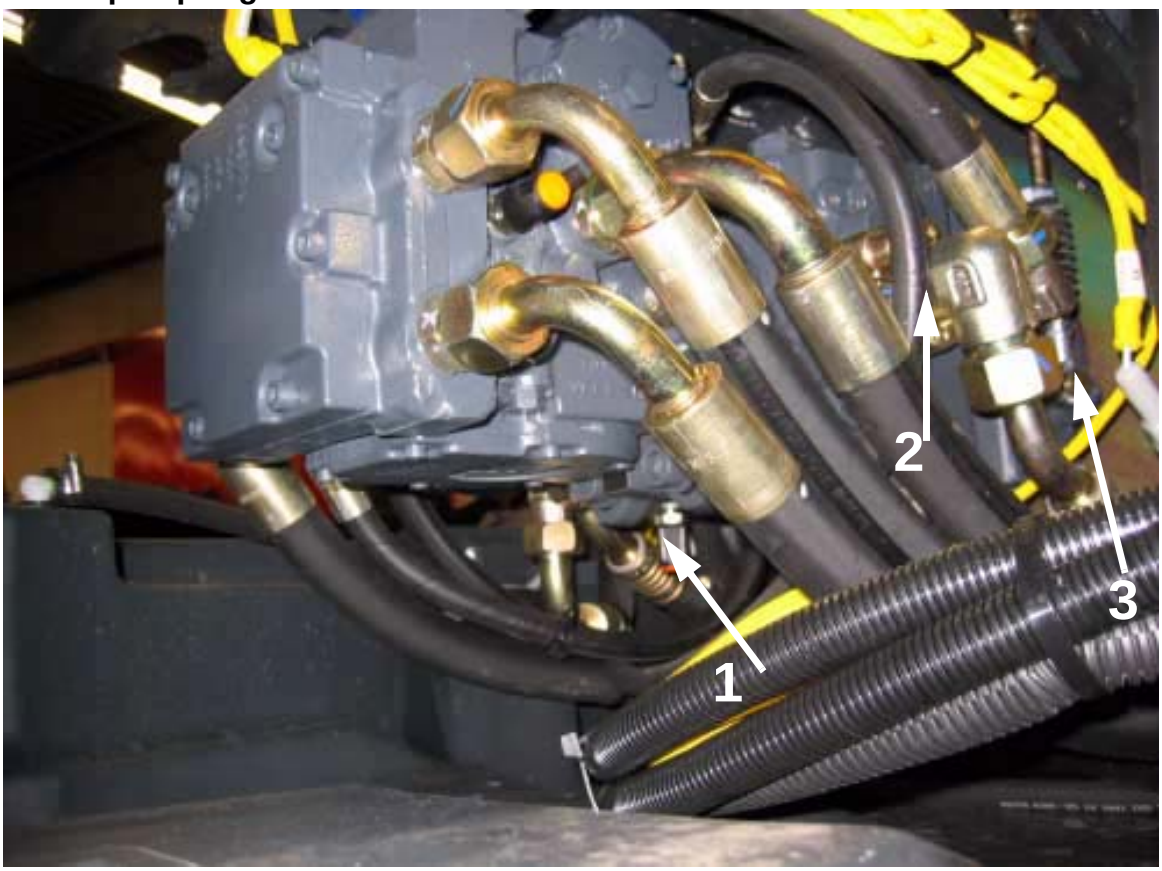


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Test port, forward		10, MD	max. 426 bar
2	High pressure port, forward		10, A	

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Travel pump: right hand side



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Test port, reverse		10, MC	max. 426 bar
2	High pressure port, reverse		10, B	
3	Travel control (travel control cable)			

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Front travel motor with radial piston motor for BW 211 / 213 D-4

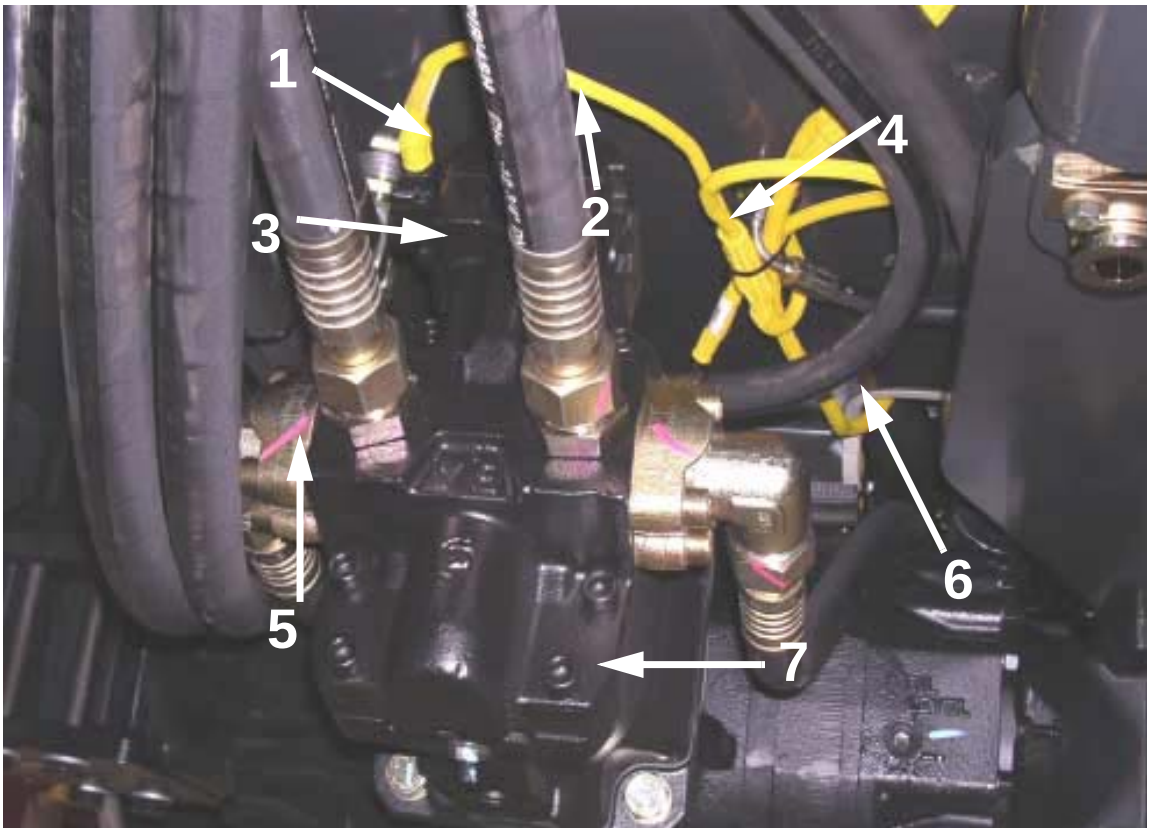


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	High pressure port, forward		12, L	
2	High pressure port, reverse		12, R	
3	Brake		12	open, 26 bar pressureless closed
4	Cross-flushing of travel pump T1		12	
5	Cross-flushing outlet to tank		12, 1	
6	Travel speed range selector		12, Y	Motor Qmax, depressurized Motor Qmin, 26 bar

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Rear travel motor: Axle motor

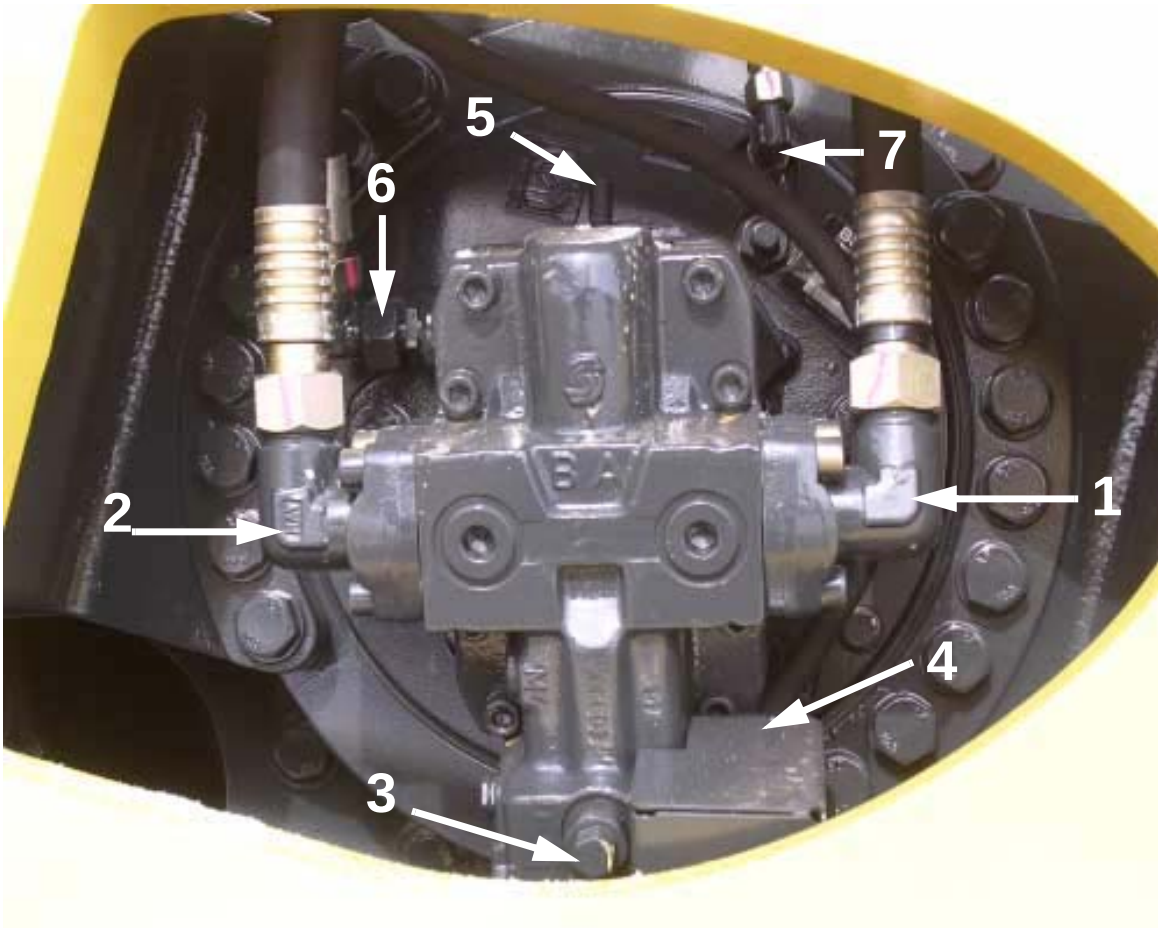


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Solenoid for speed range selector valve	Y31	14	Motor Qmax--- depressurized, Motor Qmin--- 26 bar
2	Flushing valve		14	
3	High pressure port, drum drive motor forward		14, A	
4	High pressure port, drum drive motor reverse		14, B	
5	High pressure from travel pump forward		14, A	
6	High pressure from travel pump reverse		14, B	
7	Qmin- setscrew		14	

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BW 216 D-4 Travel motor with reduction gear (drum drive motor)



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Pressure travel forward		16 - A	
2	Pressure travel reverse		16 - B	
3	Flushing valve		16	
4	Solenoid for speed range selector valve	Y 30	16	Motor Qmax, depressurized Motor Qmin, 26 bar
5	Qmin- setscrew		16	
6	Leak oil port		16	
7	Brake port on gearbox		16	

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BW 211 / 213 D-4 Brake and travel speed range selection



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Speed range selector valve for front travel motor (Poclain)	Y 31	08, a2	Motor Qmax, depressurized Motor Qmin, 26 bar
2	Brake valve	Y 04	08, a1	open, 12V closed, de-energized

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BW 216 D-4 Brake valve



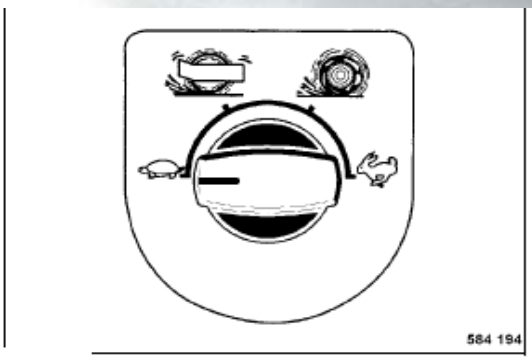
Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Brake valve	Y 04	08,	open, 12V closed, de-energized

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Travel lever console with rotary switch for speed range selection





Drehschalter Fahrstufen ohne ASC

Stellung "Schild-kröte"	=	Arbeitsfahrbereich in der Ebene
Stellung "Banda-ge"	=	wenn die Bandage durchdreht
Stellung "Rä-der"	=	wenn die Räder durchdrehen
Stellung "Hase"	=	Transportfahrbereich, z.B. bei Fahrten zur Arbeitsstelle

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Travel lever



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Initiator for backup alarm	B14		0 / 12V, normally closed
2	Initiator for brake	B13		Normally closed, opened in braking position 0/12V

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Trouble shooting

The following trouble shooting chart contains a small selection of possible faults, which may occur during operation of the machine. The fault list is by no means complete, however, the fault table is based on the experience of the central service department, i.e. the list covers almost all faults that have occurred in the past.

Procedure:

The following trouble shooting table contains both electrical as well as mechanical and hydraulic faults.

The numerical values specified in the table indicate the probability of the fault cause and thereby the recommended trouble shooting sequence, based on our latest field experience.

TROUBLE SHOOTING TRAVEL SYSTEM BW 211 / 213 / 216 D-4	**SYMPTOMS**	**Machine does not drive (forw. and reverse)**	**Machine drives to one direction only**	**Machine travels with travel lever in 'Neutral'**	**Max. travel speed not reached**	**Hydraulic oil overheating**				
POSSIBLE CAUSES										
Brake valve (electric/mechanical/hydraulic)		1								
Brake in axle/drum drive motor (mechanical/hydraulic)		2			2	3				
Travel speed range switch position /defective/wiring					1					
Charge pump / charge pressure relief valve(s) dirty/defective		2			3					
Pump control (servo control)		2	1	2	3					
Pressure override/ travel pump high pressure limitation dirty/out of adjustment/defective		3	2		3	3				
Adjustment of travel cable				1	2					
Travel pump mechanical neutral				3	3					
Travel pump(s) defective		3		3	2					
Axle drive motor control valve (electric / mechanical / hydraulic)					1	2				
Flushing valve axle drive motor seized			3							
Travel motor(s) defective		3			3					
Hydraulic oil cooler soiled (internally/externally)						1				
Thermostat (hydraulics) soiled/jammed/defective						2				
Kupplung Dieselmotor-Pumpe		2								
Dieselmotor					1					

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Vibration system

The vibration system of the single drum rollers of generation D-4 works with two frequencies and two amplitudes. This enables perfect adaptation of the machine to various types of soil and different applications.

The vibration drive is a closed hydraulic circuit. The circuit consists of:

- the vibration pump,
- the vibration motor and
- the pressure resistant connecting hoses

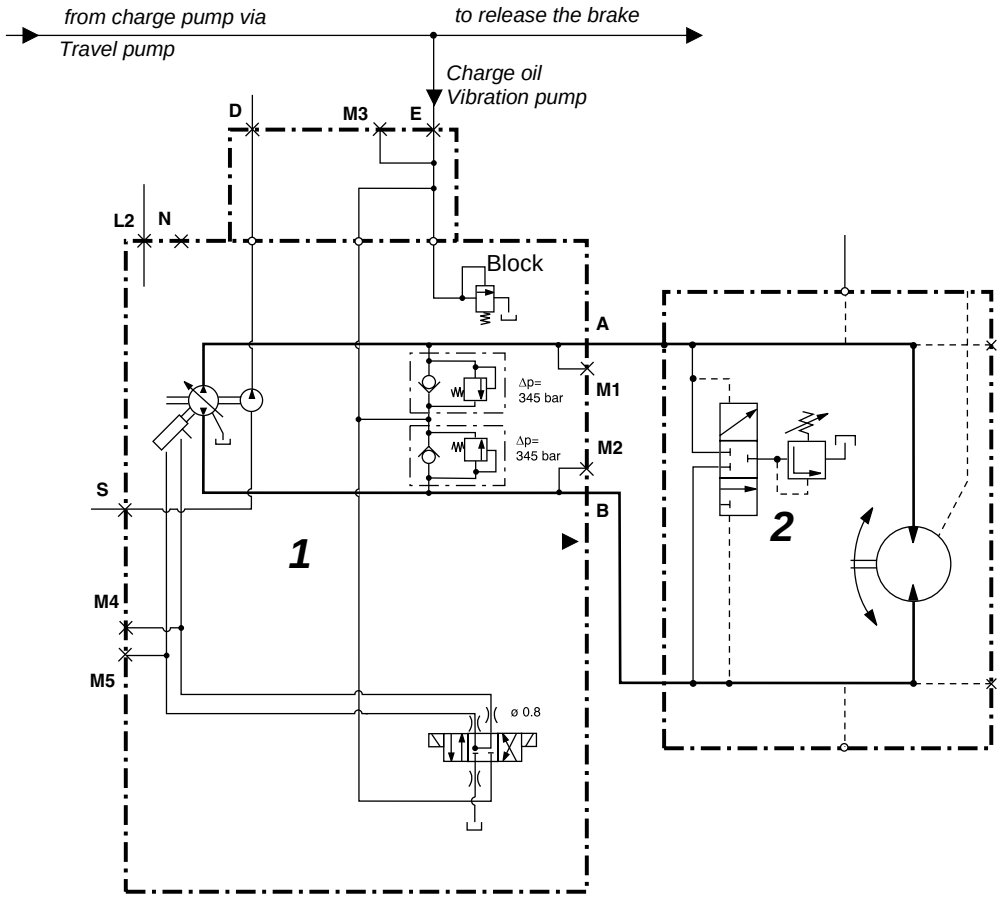


Fig. 1: Vibration circuit

1 Vibration pump

2 Vibration motor

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Vibration pump and travel pump are joined together to a tandem pump unit. This tandem unit is directly driven by the diesel engine.

When operating a 4/3-way solenoid valve on the pump control the pump is actuated out of neutral position to one of the two possible displacement positions, pilot oil from the charge circuit is guided to one of the two control piston sides. The swash plate inside the pump will swash to the corresponding side and the pump will deliver oil to the vibration motor. The vibration motor starts and rotates the vibrator shaft inside the drum.

When altering the position of the swash plate through the neutral position to the opposite side, the oil flow will change its direction and the vibration motor will change its sense of rotation.

Since the end stops for the swash plate are set to different swashing angles to both directions, the angle for the piston stroke is also different to both sides. This angle influences the length of the piston stroke and thereby the actual displacement of the pump.

- Large angle = high displacement = high vibrator shaft speed (frequency)
- Small angle = low displacement = slow vibrator shaft speed (frequency)

The eccentric weights on the vibrator shaft are fitted with additional change-over weights. Depending on the sense of rotation of the vibrator shaft these change-over weights add to or subtract from the basic weights.

This results in the following constellations:

- Basic weight + change-over weight = high amplitude
- Basic weight - change-over weight = low amplitude

In order to achieve effective compaction results the vibration system is designed in such a way, that high amplitude is coupled with low frequency and low amplitude with high frequency.

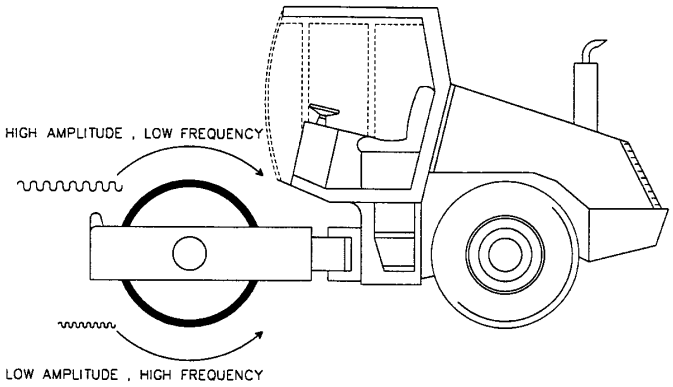


Fig. 2:

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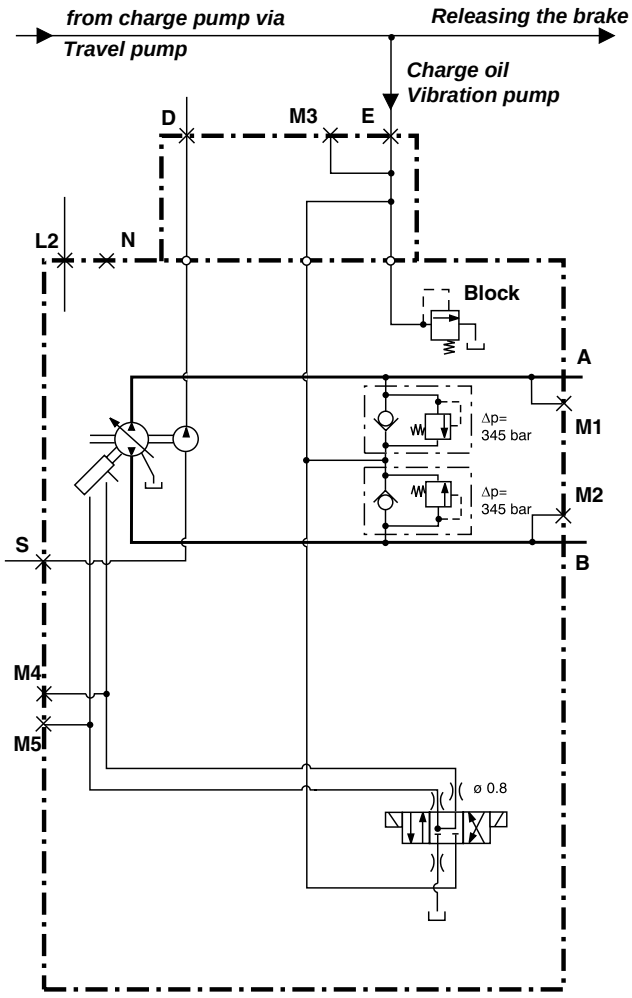
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Vibration pump

Similar to the travel pump the vibration pump is also a swash plate operated axial piston pump with variable displacement for operation in a closed circuit.

The displacement of the pump is proportional to the engine speed and the chosen displacement.

When actuating the swash plate out of neutral position the flow quantity to the chosen direction will increase from ”0” to the maximum value. When altering the position of the swash plate through the neutral position to the opposite side, the oil flow will change its direction and the vibration motor will change its sense of rotation. All valves and safety elements for operation in a closed circuit are integrated in the pump.



1 Vibration pump
2 Charge pump
3 High pressure limitation
4 4/3-way solenoid valve

Fig. 3: Hydraulic diagram vibration pump

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Function

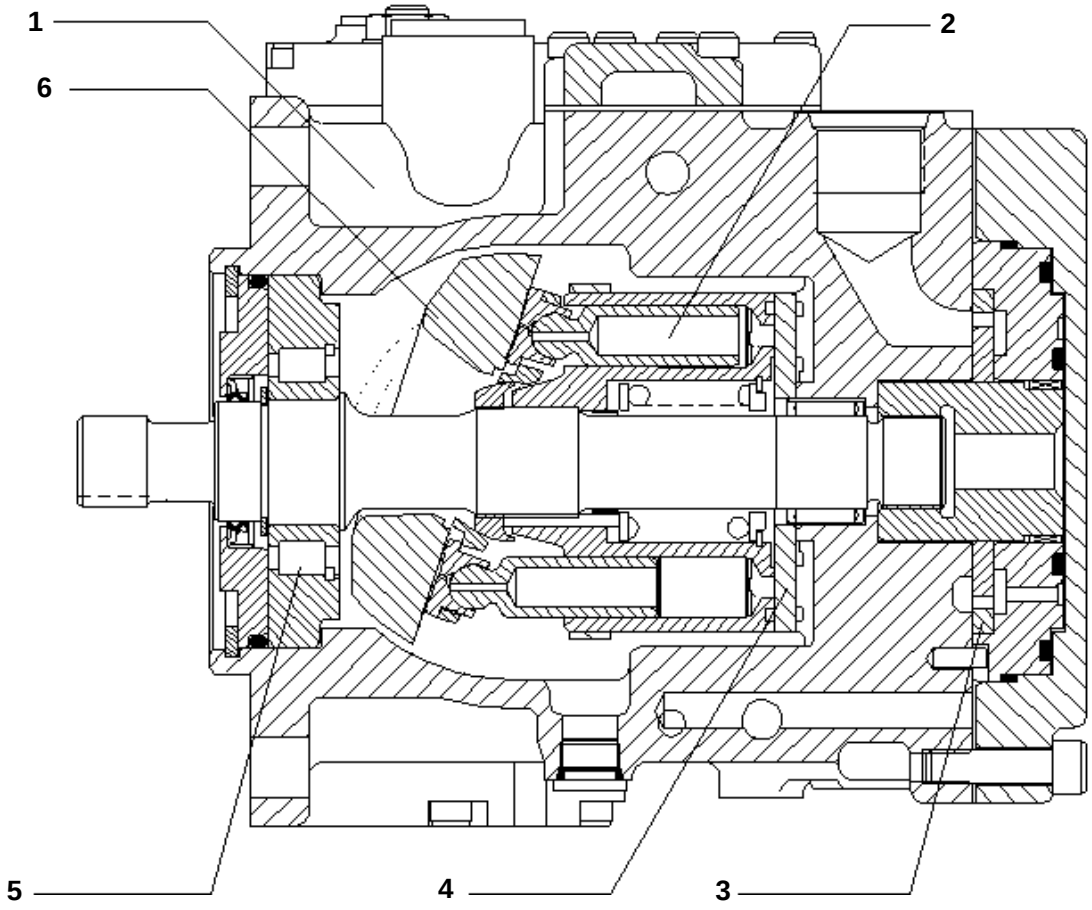


Fig. 4 Cross-section of vibration pump

1 Servo piston
2 Working pistons
3 Charge pump
4 Valve plate
5 Roller bearing
6 Swash plate

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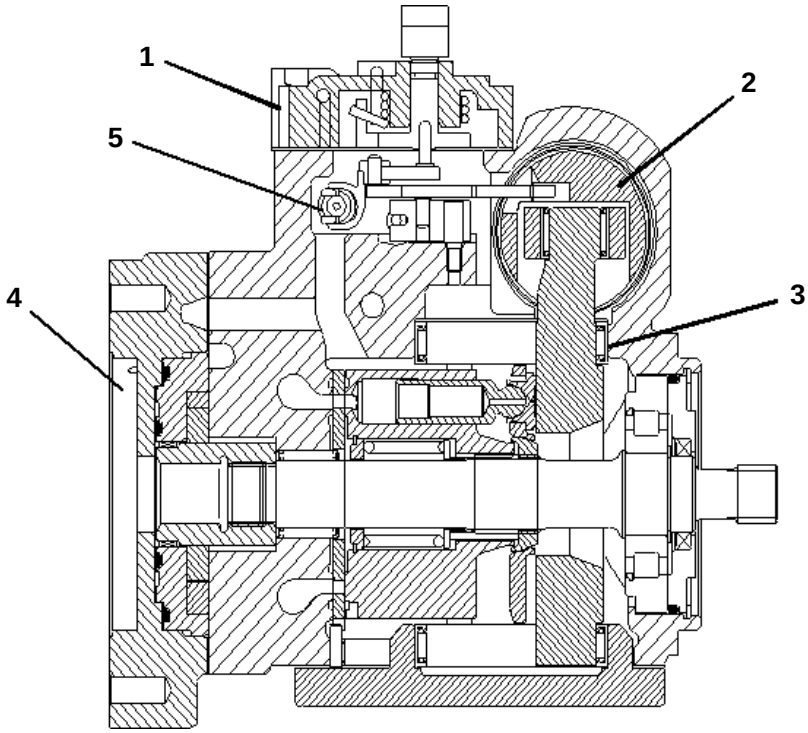


Fig. 5 Cross-section of vibration pump

1 Control
2 Servo piston
3 Friction free swash plate bearing
4 Attachment plate
5 Spool valve

The engine drives the drive shaft with the cylinder block. The cylinder block carries the working pistons.

The slipper pads rest against the sliding surface of the swash plate and are at the same time held on the sliding surface by a retaining device.

During each rotation the piston pass through their upper and lower dead centre back to their initial position. Between both dead centres each piston performs a full working stroke. During this stroke movement oil is drawn in from the low pressure side of the closed circuit and pressed out through the slots in the valve plate into the high pressure side. The oil quantity depends on the piston area and the length of the working stroke.

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During the suction stroke the oil is drawn into the piston chamber, i.e. the charge pressure forces it into the piston chamber. On the opposite side the piston presses the oil out into the high pressure side of he closed circuit.

Control

The electro-hydraulic displacement control (remote control) converts the electric input signal to a load controlling output signal. Since the pump is not equipped with a proportional control, but a 12 Volt solenoid valve, the pump is always actuated to one of the two end stop positions.

Charge pumps

These machines are equipped with two charge pumps.

One of the pumps is an external gear pump, which is directly driven by the auxiliary output of the engine and serves also as steering pump.

The second pump is an internal gear pump and is located in the end cover of the vibration pump.

The oil flow generated by the charge pumps is joined together with the return flow from the steering valve before the hydraulic oil filter and flows through the filter to the charge ports on travel pump and vibration pump.

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High pressure relief valves

As a measure to protect the closed vibration circuit against to high pressures the vibration pump is fitted with pressure relief valves.

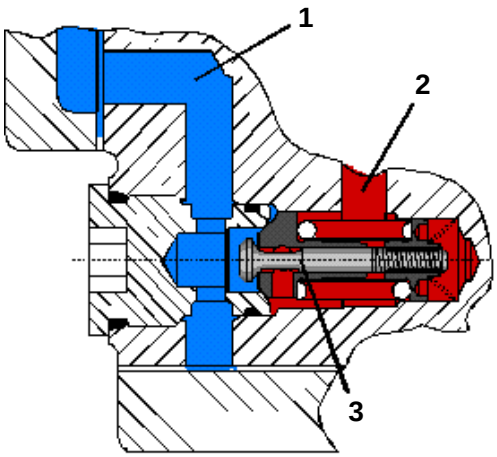


Fig. 6 Pressure relief valve

1 From the charge pump

2 Closed circuit

3 High pressure relief valve with integrated boost check valve

Since the heavy mass of the vibrator shaft must be set into motion during the acceleration of the vibration, very high pressure peaks will occur in the high pressure side of the closed circuit during this phase. The high pressure relief valve reduces these pressure peaks to a value of max. 371 bar (pressure difference between high and low pressure side = 345 bar + charge pressure = 26 bar).

The screw-type cartridges of the high pressure relief valves contain also the boost check valves for the closed vibration circuit. The function of these valves has already been described in the chapter "travel system".

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Vibration motor

The vibration motor is a Bosch-Rexroth (Hydromatik) axial piston motor of series A10FM 45 with fixed displacement in bent axle design. Since the motor can be subjected to pressure from both sides, it is most suitable for the use in closed hydraulic circuits.

The output speed of the motor depends on the oil quantity supplied by the vibration pump.

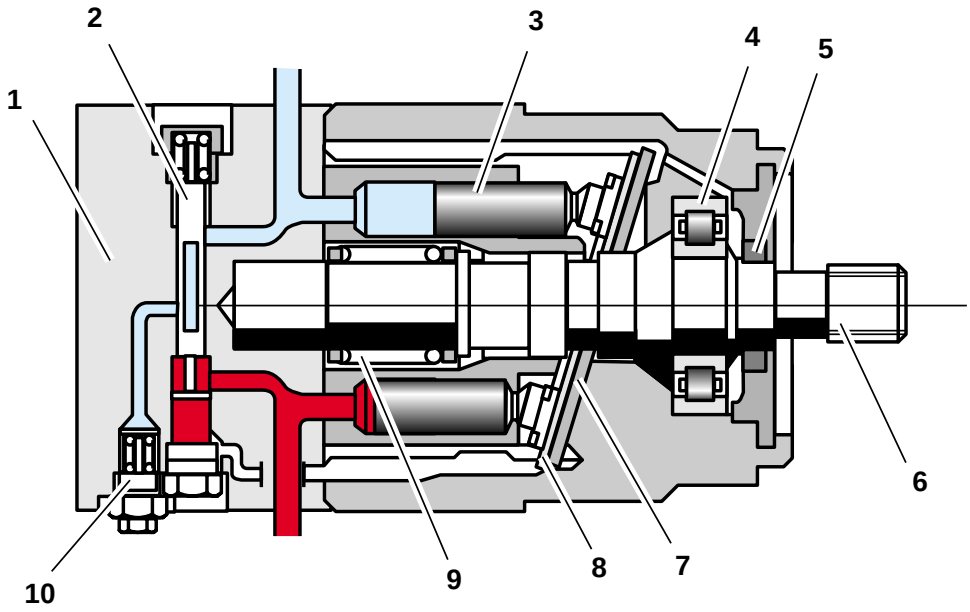


Fig. 7 Cross-section of vibration motor

1 Flushing valve block
2 Flushing valve
3 Working pistons with slipper pads
4 Roller bearing for output shaft
5 Radial seal
6 Output shaft
7 swash plate
8 Retaining plate
9 Pre-tensioning spring
10 Flushing pressure relief valve

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The output torque raises with increasing pressure difference between low and high pressure side in the closed circuit.

Changing the flow direction of the oil will also change the sense of rotation of the vibration motor.

When switching the vibration on the motor must first start to move the resting vibration shaft. This resistance causes a hydraulic starting pressure, which is limited to 345 bar by the corresponding high pressure relief valve. Once the vibrator shaft has reached its final speed, the pressure will drop to a value between 100 and 150 bar (operating pressure). The value of the operating pressure mainly depends on the condition of the ground (degree of compaction, material etc.).

- Hard ground = High operating pressure
- Loose ground = Low operating pressure

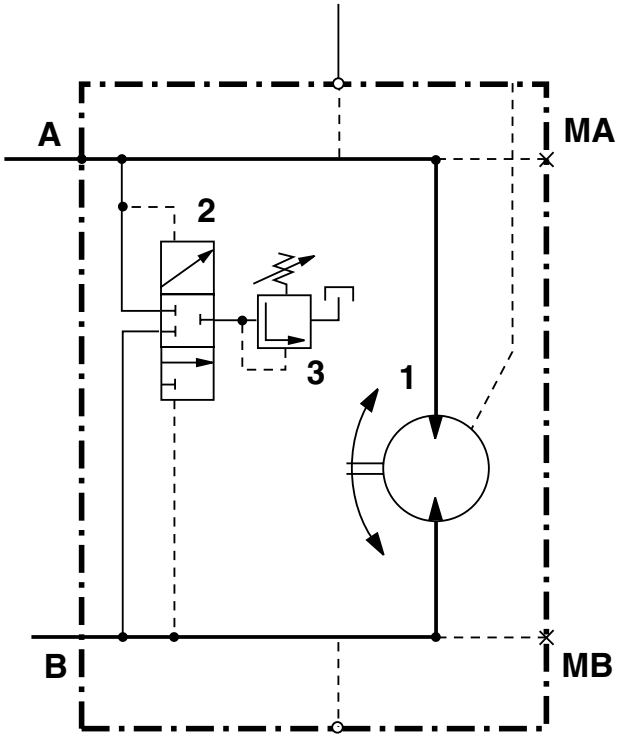


Fig. 8 Circuit diagram of vibration motor

1 Vibration motor

2 Flushing valve

3 Flushing pressure relief valve

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The vibration motor is equipped with an integrated flushing valve. When switching the vibration on a pressure difference will appear between the two sides of the closed circuit. The higher pressure moves the valve spool of the flushing valve against the neutral setting spring, so that oil can flow out of the low pressure side.

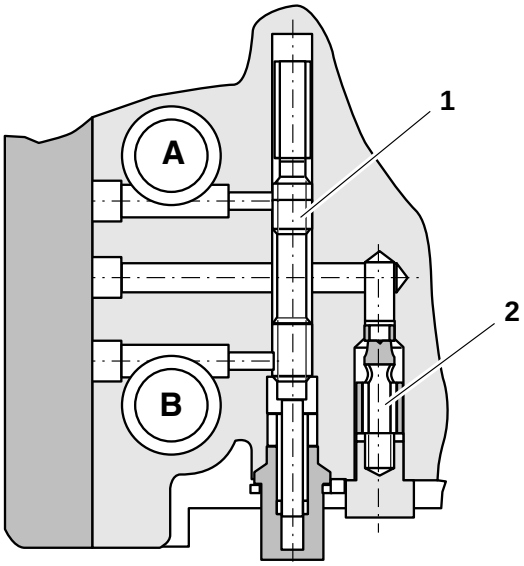


Fig. 9 Flushing valve

1 Flushing spool

2 Flushing pressure relief valve

The flushing valve is fitted with a downstream 13 bar pressure relief valve. This valve ensures that only a certain quantity of hydraulic oil is flushed out of the low pressure side.

This oil flows via a thermostat valve back to the hydraulic tank. The flushed out oil is immediately replaced with fresh and filtered oil through the corresponding boost check valve.

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Drum

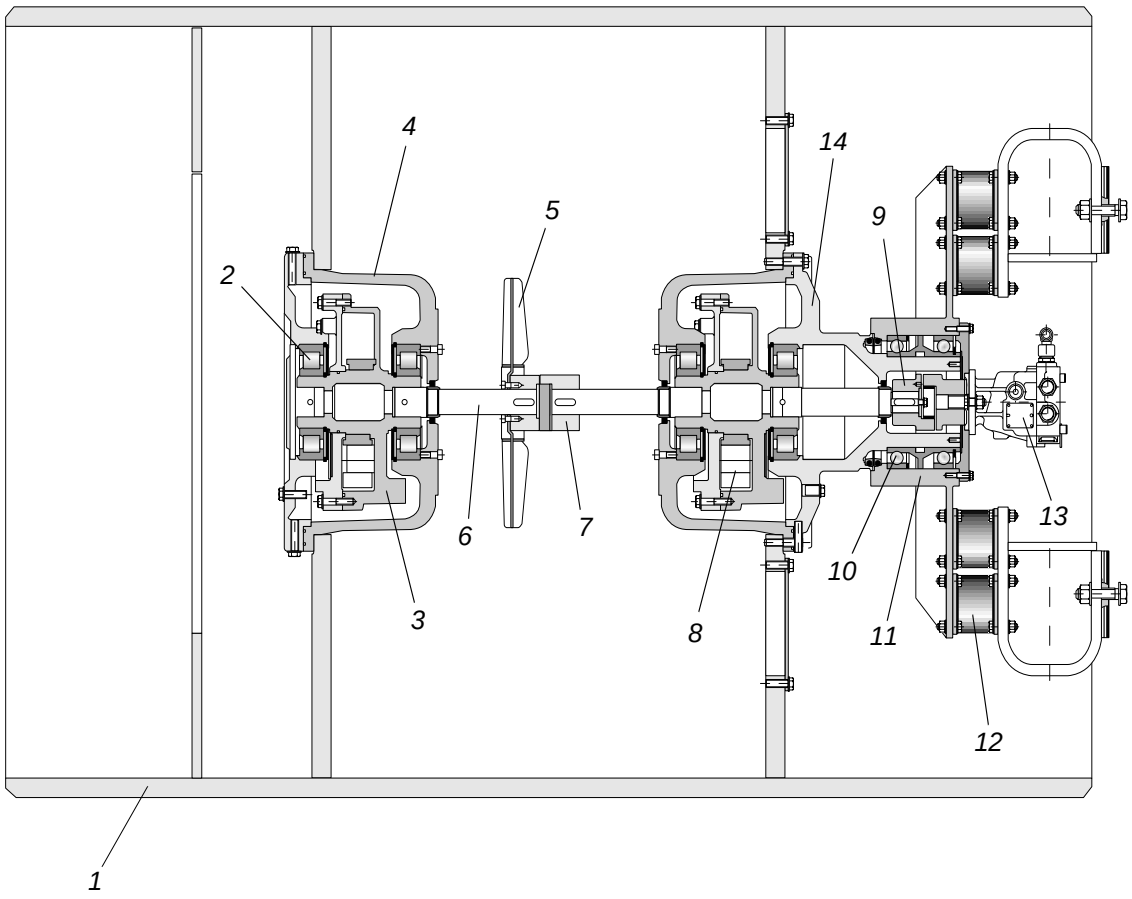


Fig. 10 Cross-section of drum

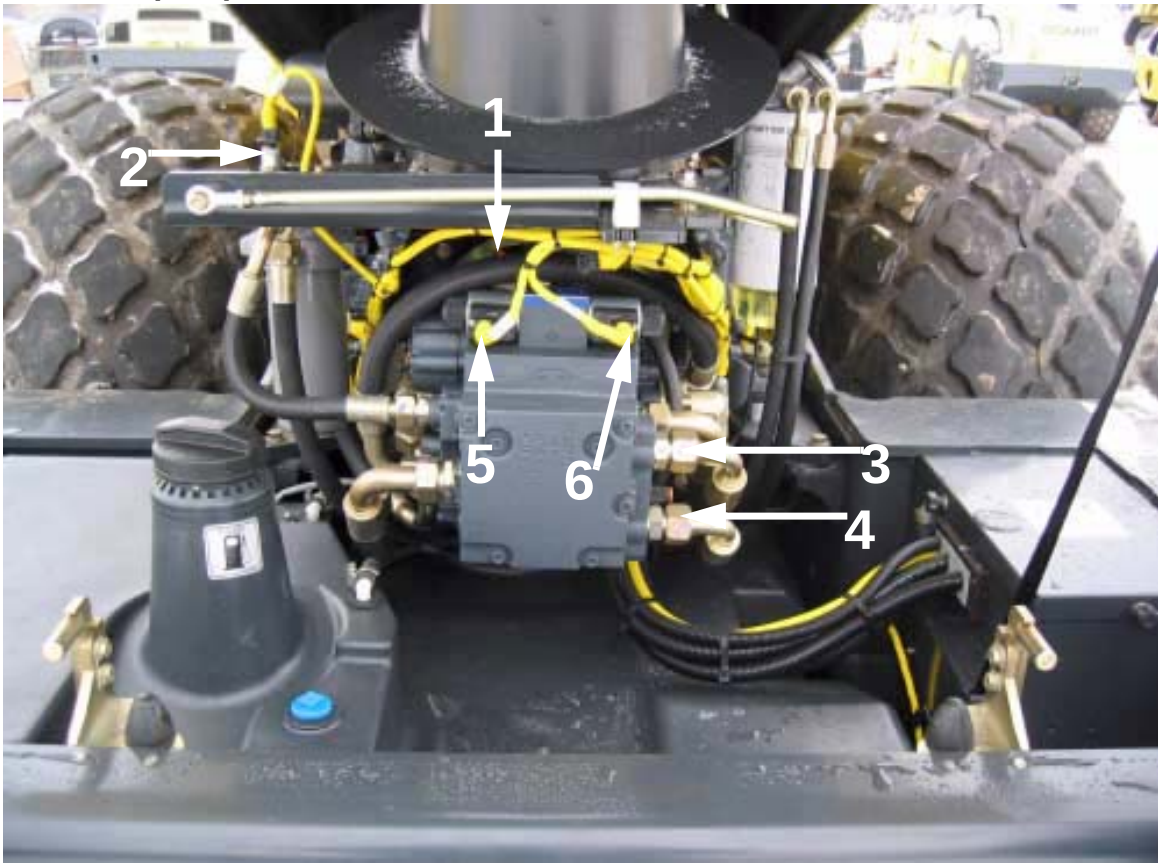
1	*Drum shell*	*8*	*Change-over weight*
2	*Vibration bearing*	*9*	*Coupling vibr.-motor – vibrator shaft*
3	*Basic weight*	*10*	*Travel bearing*
4	*Vibrator housing*	*11*	*Travel bearing housing*
5	*Cooling fan*	*12*	*Rubber buffer*
6	*Vibrator shaft*	*13*	*Vibration motor*
7	*Elastic coupling between shafts*	*14*	*Flanged bearing housing*

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Vibration system: Components and test ports

Vibration pump



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Pressure test port, charge pressure		MA	26 bar
2	Differential pressure switch, charge pressure		07	^p 3.5 bar
3	High pressure port, low amplitude		MF	
4	High pressure port, high amplitude		ME	
5	Solenoid valve, low amplitude	Y08		12V / 3.33A
6	Solenoid valve, high amplitude	Y07		12V / 3.33A

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Vibration pump

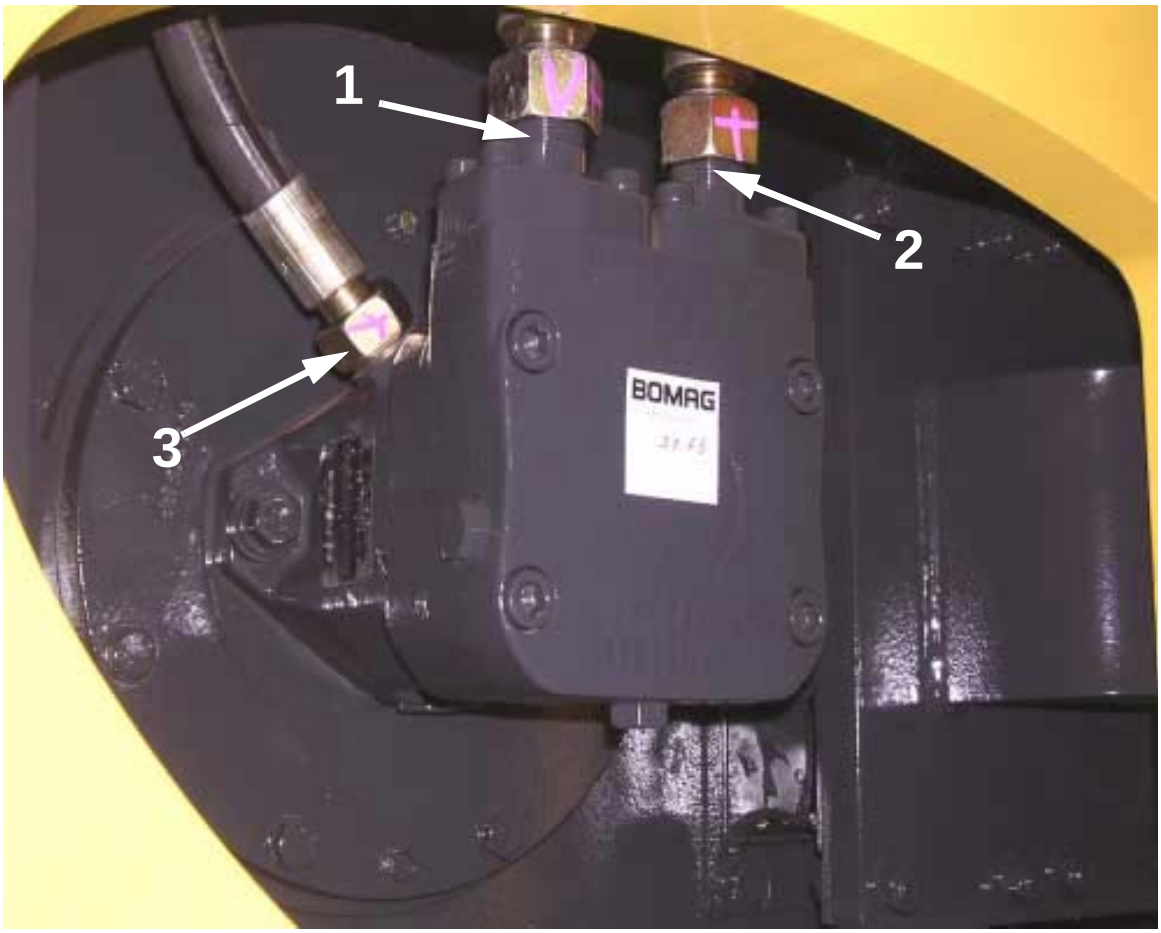


Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	Pressure test port, vibration pressure low amplitude		MF	max. 371 bar
2	Pressure test port, vibration pressure high amplitude		ME	max. 371 bar

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Vibration motor



Pos.	Designation	Pos. in wiring diagram	Pos. in hydraulic diagram	Measuring values
1	High pressure port, low amplitude		16	
2	High pressure port, low amplitude		16	
3	Leak oil and flushing oil port		16	approx. 10 l/min, incl. flushing quantity

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Trouble shooting

The following trouble shooting chart contains a small selection of possible faults, which may occur during operation of the machine. The fault list is by no means complete, however, the fault table is based on the experience of the central service department, i.e. the list covers almost all faults that have occurred in the past.

Procedure:

The following trouble shooting table contains both electrical as well as mechanical and hydraulic faults.

The numerical values specified in the table indicate the probability of the fault cause and thereby the recommended trouble shooting sequence, based on our latest field experience.

TROUBLE SHOOTING VIBRATION BW 211 / 213 / 216 D-4	**SYMPTOMS**	**No vibration (charge pressure OK)**	**Vibration only with one amplitude**	**Exciter shaft speed too low**										
POSSIBLE CAUSES														
Vibration switch (amplitude pre-selection)		1	1											
Vibration push button (on/off)		1												
Electrics defective / wiring		2	2											
Pump control (electrical / hydraulic)		1	1											
Pressure override / high pressure relief valves in vibration pump soiled/out of adjustment/ defective				2										
Charge pump / charge pressure relief valve soiled/ defective		2												
Vibration pump frequency adjustment				2										
Vibration pump defective		2		2										
Coupling between diesel engine and travel pump defective														
Exciter shaft bearings defective				3										
Vibration motor coupling defective		2												
Vibration motor defective		2		1										
Diesel engine				1										

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Electrics: Single drum rollers of series D-4

This chapter describes the peculiarities in the electric system and the necessary adjustments. These instructions solely describe the electrical test for the
D- machines of the single drum rollers of generation 4.

For machines of type DH separate Testing and adjustment instructions are available.

Function test:

Turn the ignition key to "Ignition ON".
The round gauge runs a 3 second self test.
All control lights are active during this time.
The fuel level gauge shows the actual fuel level.
Brake control light (travel lever in braking position), charge control light (engine stopped) and oil pressure warning light (engine off) are active.

Warning and control lights are integrated in the instrument cluster!

Tabelle 1: Inspection of display and shut-down functions

	Control light	Warning buzzer	Shut down time 10 s	Shut down time 2min
Air filter service switch	X			
Water separator Fuel filter	X	X		X
Hydraulic oil filter	X	X		X
Engine oil pressure	X	X	X	
Coolant temperature	X	X		X
Minimum coolant filling level	X	X	X	

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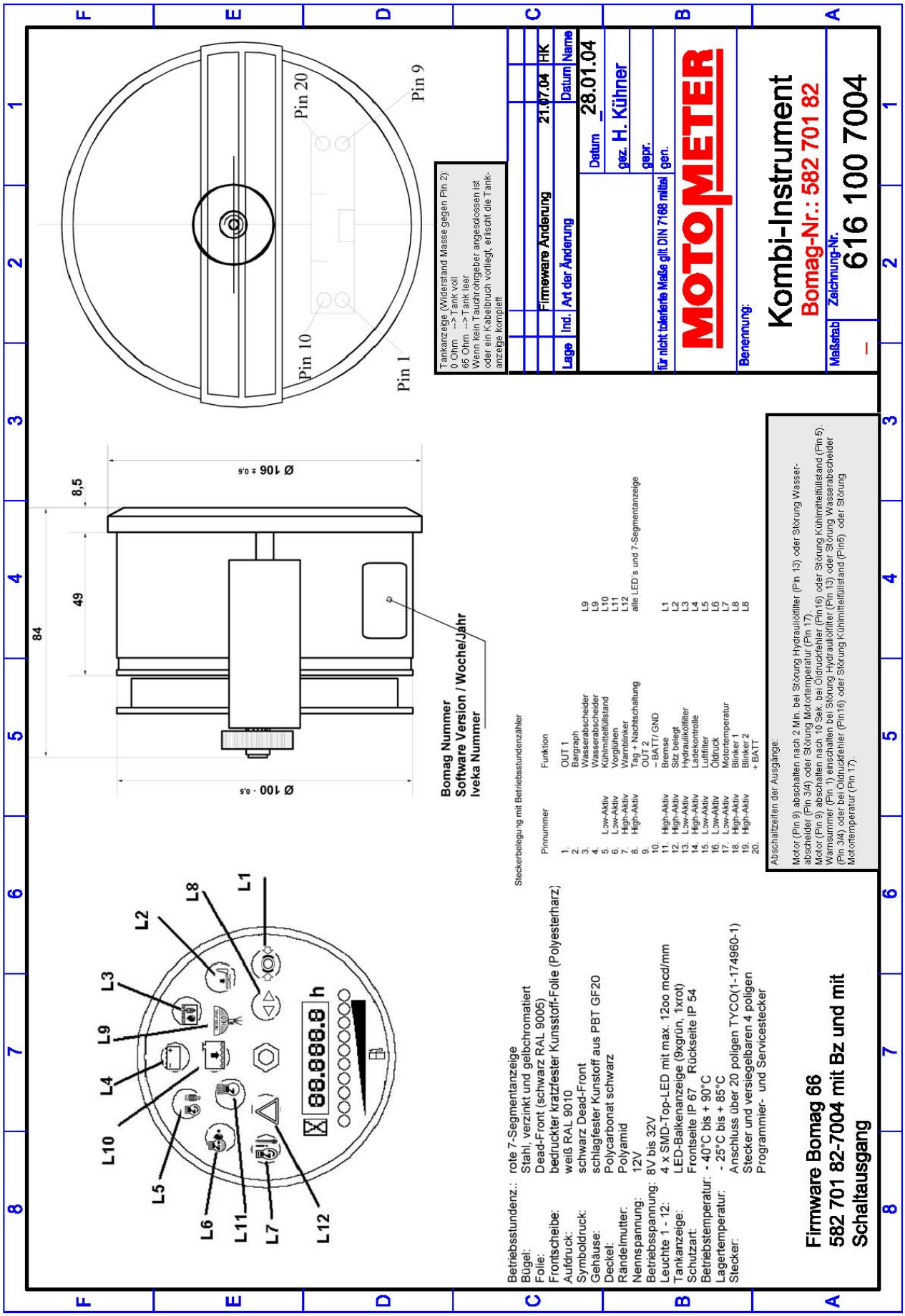
Instrument cluster



Electric junction box with module



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12 Air conditioning system

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12.1 Physical basics

In order to understand the working principle of an air conditioning system one must first become familiar with the physical basics of such a system.

The four well known physical conditions of water apply also for the refrigerant in the air conditioning system.

1. gaseous (invisible)

2. vaporous

3. liquid

4. solid

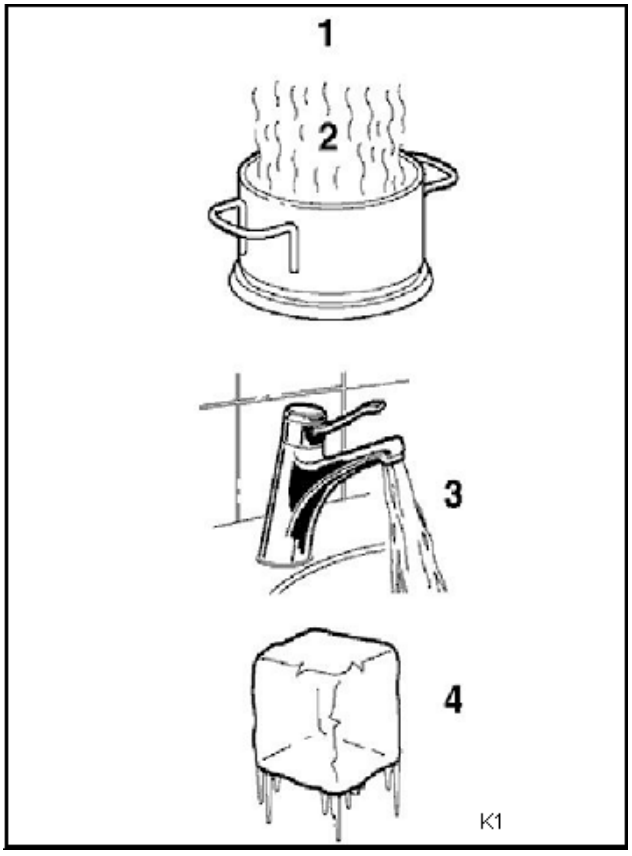


Fig. 1

If the water in a container is heated up (absorption of heat), the rising steam is visible. If the steam is heated up further, due to the absorption of heat, the visible steam will turn into invisible gas. This process is reversible. When withdrawing the heat contained in gaseous water, the gas will turn into steam, then into water and finally into ice.

A - heat absorption

B- Heat dissipation

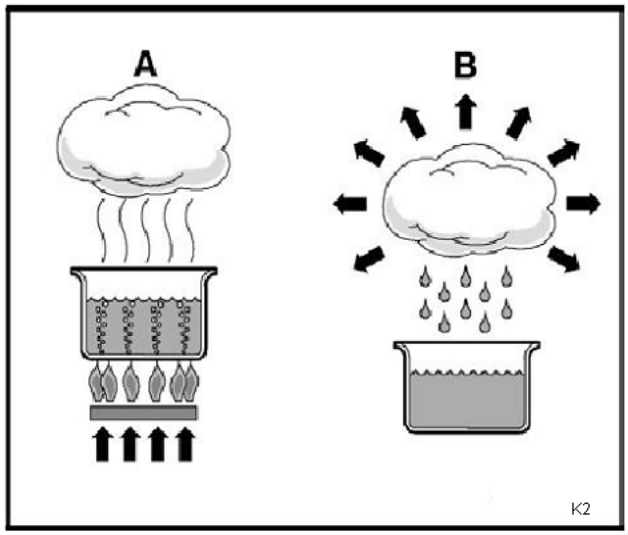


Fig. 2

Heat always flows from the warmer to the colder matter. Any matter consists of a mass of moving molecules. The rapidly moving molecules or a warmer matter dissipate part of their energy to the slower moving molecules with less heat. The movement of the molecules in the warmer matter becomes slower and the molecules in the cooler matter are accelerated. This process continued, until all molecules in the two matters move with identical speed. The matters have then reached an identical temperature and the transfer of heat stops.

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Pressure and boiling point

The boiling point is the temperature at which fluid changes to gaseous state.

Changing the pressure above a fluid also changes the boiling point. It is a well known fact, that e.g. the lower the pressure applied to water, the lower the boiling point.

When looking at water, the following values do apply:

- Atmospheric pressure, boiling point 100°C
- Overpressure 0.4 bar, boiling point 126°C
- Vacuum -0.6 bar, boiling point 71°C

For an optimal exchange of heat, liquid refrigerants must have a low boiling point, so that they can absorb and dissipate heat quickly.

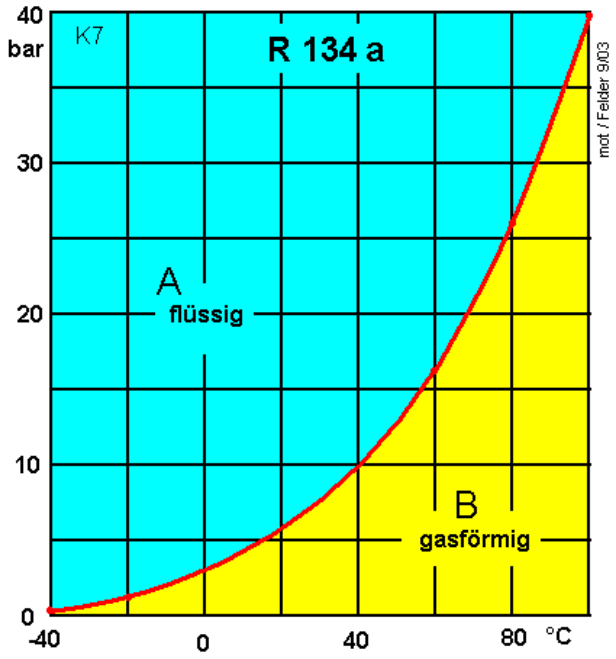


Fig. 3 Steam pressure curve

Steam pressure curve for refrigerant R134a

The steam pressure curve is a means for explaining the operation principle of an air conditioning system.

A- liquid

B- gaseous

The diagram shows the evaporation curve of R134a. The diagram for example shows, that R134a is liquid at 0°C and a pressure of 5 bar, but becomes gaseous at 40°C and 5 bar.

For better understanding one must also be aware of the following:

1. A gas heats up when being compressed (e.g. air pump, turbo charger, ...).

2. When relieving gas it will cool down (e.g. white frost forms on the valve when relieving air pressure from a car tire).

3. Condensing gas dissipates a lot of heat energy.

4. If a fluid evaporates it requires a lot of heat, i.e. the fluid thereby cools down the surrounding environment (e.g. alcohol on skin)

i Note

At absolute pressure 0 bar correspond with an absolute vacuum. The normal ambient pressure (overpressure) corresponds with 1 bar absolute pressure. On the scales of most pressure gauges 0 bar corresponds with an absolute pressure of 1 bar (indicated by the statement -1 bar below the 0).

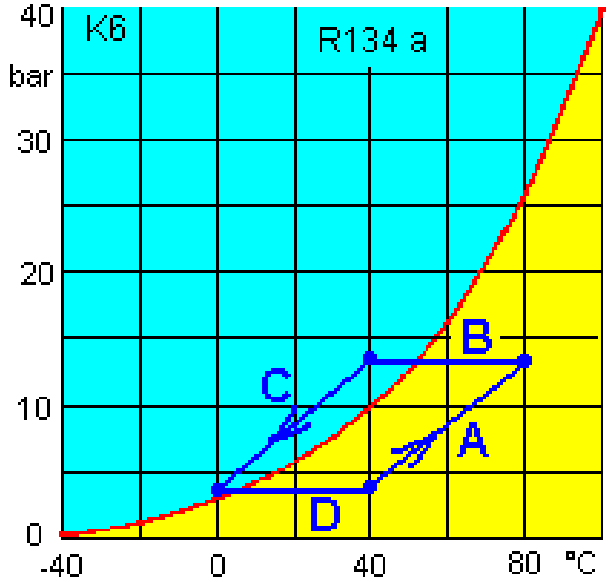


Fig. 4 Pressure - Temperature Diagram

In the pressure - temperature diagram for the refrigerant the drawn in closed curve shows the cycle of the refrigerant. This cycle permanently continues in direction of the arrow.

The characters A, B, C, D stand for:

A - compression

B- condensation

C- relaxation

D- evaporation.

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Excerpt from the wet steam table [1] R134a

1 This table is used for the determination of evaporation and condensation temperature.

Saturation temperature	Overpressure (pressure gauge reading Pe in bar)	Absolute pressure (pamb = 1 bar P in bar)
-20	0,33	1,33
-10	1,01	2,01
0	1,93	2,93
10	3,15	4,15
20	4,72	5,72

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12.2 Refrigerant R134a

General

The evaporation and condensation process is the method commonly used in mobile air conditioning systems. The system in this case works with a substance that boils at low temperature, a substance referred to a refrigerant. The refrigerant used is tetrafluoroethane R134a, which boils at a temperature of -26.5°C and under a steam pressure of 1 bar.

Although the refrigerant circuit is a hermetically closed loop, the system loses approx. 100g of refrigerant over the course of 1 year by diffusion through hoses, pipes and seals, even though the system is free of leaks. If too much refrigerant is lost the cooling power of the system will drop.

Physical data of the refrigerant R134a

Chemical formula:

CH2F-CF3 or CF3-CH2F

Chemical designation:

Tetrafluoroethane

Boiling point at 1 bar:

- 26.5 °C

Solidification point:

-101.6 °C

Critical temperature:

100,6 °C

Critical pressure:

40.56 bar (absolute)

Critical point:

Critical point (critical temperature and critical pressure) means that above this point there is no separating interface between liquid and gas. Above its critical point any substance is gaseous. At temperatures below the critical point all refrigerant types in pressure containers have a liquid and a gaseous phase, i.e. a gas cushion is above the liquid. As long as gas is in the container, besides the liquid, the pressure depends on the ambient temperature.

Characteristics of the refrigerant R134a:

Refrigerant R134a is currently available under the following trade marks.
H-FKW 134a
SUVA 134a
KLEA 134a

Colour:

Refrigerant in form of vapour or liquid is colourless as water. The gas is invisible. Only the bordering layer between gas and liquid is visible. (Fluid level in rising pipe of filling cylinder or bubbles in inspection glass). In the inspection glass the liquid refrigerant R134a may appear coloured (milky). This turbidity results from partially dissolved refrigeration oil and is no indicator for a fault.

Steam pressure:

In an incompletely filled, closed container, vaporous refrigerant will volatilize from the surface in the same quantity that will turn liquid in combination with steam particles. This state of equilibrium occurs under pressure and is frequently referred to as steam pressure. The steam pressure is independent from the temperature.

Physical properties of R134a:

The steam pressure curves of R134a and other refrigerants are partly very similar, making a clear differentiation solely by pressure impossible. With R 134a the compressor is lubricated by special synthetic refrigeration oils, e.g. PAG-oils (polyalkylene glycol oils).

Behaviour with metals:

In pure condition refrigerant R134a is chemically stable and does not attack iron and aluminium. However, contamination of the refrigerant, e.g. with chlorine compounds, leads to aggressiveness against certain metals and plastics. This can cause clogging, leaks or deposits on the pistons of the compressor.

Critical temperature / critical pressure:

Up to a gas pressure of 39.5 bar overpressure (this corresponds with a temperature of 101 °C) the refrigerant R134a remains chemically stable, above this temperature the refrigerant decomposes (see combustibility).

Water content:

In liquid refrigerant water can only be dissolved in very low quantities. In contrast to this refrigerant steam mixes with water steam at any ratio. If the dryer in the

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liquid container has absorbed approx. 8 gr. of water, the refrigerant circuit transports possibly existing water in form of droplets. This water flows to the nozzle of the expansion valve and turns to ice. The air conditioning system stops cooling. Water destroys the air conditioning system, because under high pressures and temperatures and in connection with other contaminants it forms acids.

Inflammability:

Refrigerant is not inflammable. On the contrary, it has fire inhibiting or fire extinguishing properties. Refrigerant is decomposed by flames or glowing surfaces. Ultraviolet light also cracks refrigerant (caused by electric welding). This results in toxic fission products, these must not be inhaled. However, irritation of the mucous membranes is an early and in-time warning.

Filling factor:

In a container there must be a steam space above the liquid space. The liquid expands with increasing temperature. The steam filled space becomes smaller. From a certain time on the container will be filled with just liquid. After this only a minor temperature increase is enough to generate very high pressures in the container, because the liquid would like to expand, but there is no more room. The related forces are high enough to cause the container to burst. In order to avoid overfilling of a container the pressure gas directive clearly specifies how many kilograms of refrigerant may be filled into the container per litre volume. Multiplied with the internal volume this "filling factor" determines the permissible filling capacity For refrigerants used in motor vehicles it is 1.15 kg/l.

Environmental aspects

The contribution of R134a to the greenhouse effect is by factor 10 smaller than the contribution of R12.

Since approx. 1992 the air conditioning systems for newly produced construction equipment were successively converted to refrigerant R134a. This refrigerant does not contain any chlorine and is thus harmless for the ozone layer. Until approx. 1992 air conditioning systems were filled with refrigerant R12. Due to its chlorine atoms this CFC has a high ozone decomposition potential and also a potential to amplify the greenhouse effect. Conversion programs for existing old systems with the ozone damaging R12 are in effect. For reasons of protecting the environment refrigerant must not be discharged into the atmosphere.

12.3 Compressor oil / refrigeration oil

The compressor oil lubricates the movable parts in the compressor, seals e.g. the gap between piston and cylinder inside the compressor to prevent refrigerant loss and prevents other seals in the system from drying up.

Part of the compressor oil dissolves in the refrigerant until saturation is reached, so that a gas mixture of refrigerant, water steam, compressor oil and contrast agent circulates through the system.

Compressor oil (the oil quantity should be 10 % of the refrigerant weight) mixes with the refrigerant and circulates permanently through the system.

In connection with R134a- air conditioning systems special synthetic compressor oils, e.g. polyalkylene glycol (PAG) oils, are used. This is necessary, because e.g. mineral oil does not mix with R134a. Apart from this, the materials in the R134a air conditioning system may be attacked when the mixture is flowing through the refrigerant circuit under high pressure and at high temperatures or if the lubrication film in the compressor tears off. The use of non-permitted oils can cause damage to the air conditioning system, you should therefore only used the approved oils.

Properties of compressor oil / refrigeration oil:

The most important properties are high solvency in connection with refrigerants, good lubrication characteristics, that they are free of acids and their low water content. For this purpose only certain oils can be used. PAG-oils suitable for use with refrigerant R134a are highly hygroscopic and will not mix with other oil. As a protection against the invasion of moisture drums must immediately be closed again after they had been opened. Compressor oil ages under the effect of moisture and acids, becomes dark, viscous and aggressive against metals.

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12.4 Working principle of the air conditioning system

All air conditioning systems are based on the same principle. They extract heat from the surrounding environment. Everybody knows the effect: if a sweating body is exposed to wind it will cool down, because heat is extracted. For this purpose a refrigerant circulates in a closed circuit inside the vehicle. This refrigerant thereby continuously changes its physical state between liquid and gaseous.

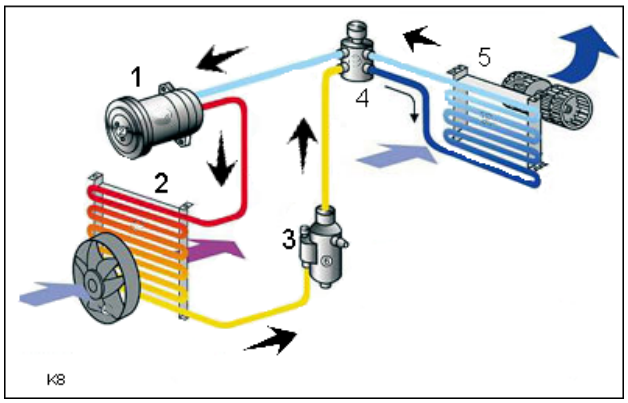


Fig. 1 Principle sketch of an air conditioning system

An engine driven compressor (1) draws in gaseous refrigerant from the evaporator (5) and compresses it. During this process the temperature of the refrigerant increases tremendously.

The refrigerant vapour is then pumped to the condenser (2). This condenser is arranged directly in front of the vehicle radiator, so that a sufficient air flow is assured. In the condenser (2) the gas is cooled down and consequently liquefied.

In the dryer / liquid container (3) the refrigerant is then collected and freed of moisture and contaminants.

The expansion valve (4) regulates the flow rate from the dryer / liquid container (3) back to the evaporator (5) and the circuit starts again.

12.5 Monitoring devices

Pressure switch

The pressure switch (8) is used as monitoring feature for too high and too low pressures. The switching contacts (4 and 5) effect the magnetic clutch of the compressor via a relay (6).

If the system pressure increases excessively, e.g. because of a excessively soiled condenser, a failed fan or a defective expansion valve, the high pressure contact (5) will cut off the electric power supply to the magnetic clutch when the set pressure is reached. When the system pressure drops below the cut-off pressure by the set differential pressure, the magnetic clutch of the compressor is switched on again.

The low pressure contact (4) interrupts the electric power supply to the magnetic clutch when the set pressure is fallen short of (possible causes: lack of refrigerant, defective expansion valve, too low heat load, defective evaporator fan, ...). Since the refrigerant R134a has an evaporation temperature of 0 °C at an overpressure of 2 bar, the low pressure contact (4) is set to approx. 1.5 bar to avoid icing. The switch on pressure is 0.5 to 2 bar higher than the shut-off pressure (depending on system, see description of components.)

Thermostat

A frost protection thermostat (3) protects the evaporator against icing. Similar to the pressure switch, the thermostat activates or deactivates the magnetic clutch for the compressor. Depending on the design, the feeler of the temperature control is mounted between the fins of the evaporator or attached to the evaporator outlet (suction side). With fixed temperature controls the control switches the compressor off at about 1 °C and back on again at about 2.5°C to 5.5 °C (depending on system, see description of components.)

With adjustable temperature regulators the switching point can be changed so that the compressor is already shut down at higher temperatures. This enables regulation of the air temperature.

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Monitoring chain

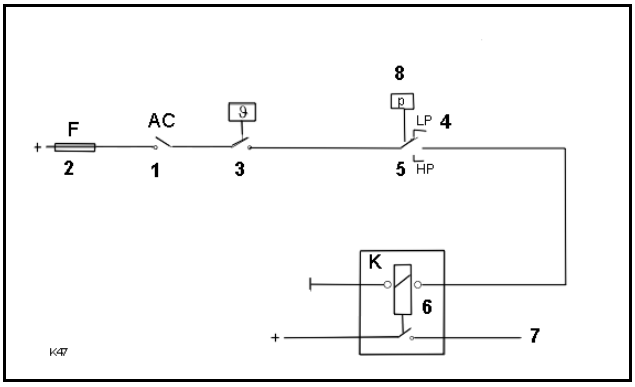


Fig. 2 Monitoring chain consisting of:

- 1 Switch
- 2 Fuse
- 3 Thermostat
- 4 Low pressure switch contact
- 5 High pressure switch contact
- 6 Relay
- 7 Connection for magnetic clutch
- 8 Pressure switch

12.6 Description of components

Compressor

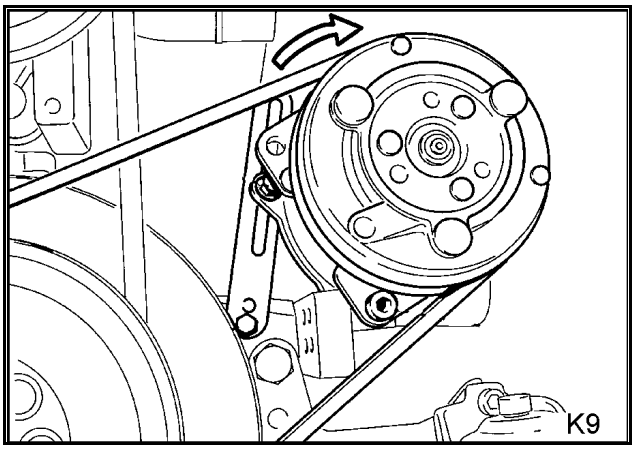


Fig. 1

The compressor is mounted to the engine and has the duty to build up the refrigerant pressure required for the function of the system. Coupling and decoupling is accomplished by an electromagnetically controlled mechanical clutch, which is integrated in the V-belt pulley of the compressor.

Compressor data

Displacement: 155 cm²

Weight: 6,9 kg

max. rpm: 6000

Sense of rotation: cw

Refrigerant: R134a

Oil quantity (scope of delivery): 207 gr

Oil: PAG SP-20 (H14-003-404)

⚠ Caution

The compressor oil level must be checked after replacing a system component or if a leak in the system is suspected. Use only refrigeration oil PAG SP-20 (H14-003-404).

When replacing a heat exchanger, e.g. evaporator or condenser, any compressor oil / refrigeration oil lost by exchanging the components, must be replaced with fresh oil.

The actual quantity depends on the amount of oil that may have been lost in connection with the possible replacement of other components.

Environment

Used compressor oil / refrigeration oil must be disposed of as hazardous waste.

The following table shows how much compressor oil / refrigeration oil will be lost in connection with various types of work on the air conditioning system.

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Reason of oil loss	Amount of oil lost
Loss when emptying	approx. 15 gr
Defective A/C hose	approx. 30 gr
Hose change	approx. 15 gr
Replacement of condenser	approx. 30 gr
Replacement of evaporator	approx. 30 gr
Replacement of liquid container	approx. 30 gr
Replacement of expansion valve	approx. 15 gr

⚠ Caution

Please bear in mind, that the new compressor is delivered with a filling of 207 gr. compressor oil. To avoid excessive oil in the A/C-system and thus a poor cooling effect, the oil level in the A/C-system must be adjusted accordingly.

The quantity depends on the amount of oil that may have been lost in connection with the possible replacement of other components.

The compressor oil quantity must be 10% of the refrigerant quantity in the complete system.

With a refrigerant filling of 1100 gr. the system requires a compressor oil / refrigerant oil filling of 100 gr.

Procedure:

Drain and measure the compressor oil from the old compressor.

Drain the compressor oil from the new compressor and only fill in the exact quantity that had been drained out of the old compressor. The compressor oil from the new compressor can be used for this purpose.

i Note

Topping up compressor oil / refrigeration oil is possible on a pressureless compressor directly into the oil pan, in a pressureless refrigeration system directly into the pressure side, but it is also possible to draw it into the pressure side of the refrigeration system during the evacuation process.

Condenser

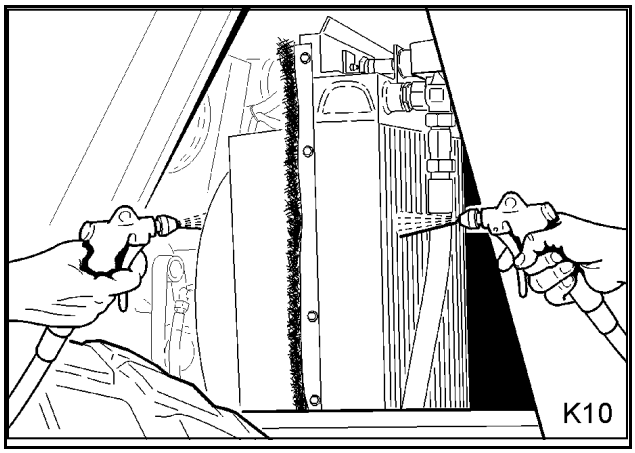


Fig. 1

The condenser is located in front of the the radiator for the machine. It emits heat energy from the system into the surrounding air and liquefies the gaseous refrigerant.

i Note

The fins must be free of dirt and damage.

⚠ Caution

When replacing a heat exchanger, e.g. evaporator or condenser, any compressor oil lost by exchanging the components, must be replaced with fresh oil.

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Dryer / filter / fluid container / inspection glass

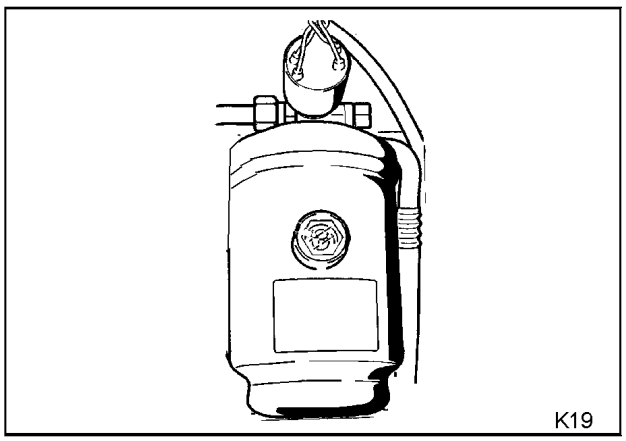


Fig. 1

Dryer / filter

The fluid container collects the fluid drops and passes these then as a constant flow to the expansion valve. Moisture that has entered during assembly of the refrigerant circuit is absorbed by a dryer in the fluid container.

At evaporation temperatures below zero the refrigerant will deposit previously absorbed moisture on the expansion valve, where this water turns into ice and thus adversely affects the controllability of the expansion valve. Moreover, moisture in the refrigerant circuit causes corrosion, forms acids and enters into chemical compositions.

Inside the refrigerant container the heavy liquid refrigerant collects in the lower part of the container, flows through a rising pipe to the outlet marked "A" and thus ensures bubble free operation of the expansion valve.

i Note

Since the absorbing capacity of this filter/dryer is limited, it must be changed within certain service intervals. We recommend to replace it 1 x per years, before the start of the season.

⚠ Caution

The filter/dryer must generally be replaced whenever opening the refrigerant circuit, because moisture will enter in such a case.

This requires emptying the air conditioning system!

Installation position:

The arrow marks on the filter/dryer must point in flow direction, i.e. towards the expansion valve.

Filter/dryer cannot be treated for further use!

Safety valve

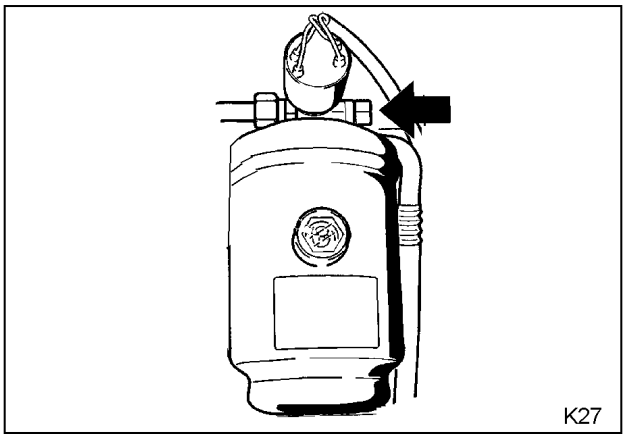


Fig. 2

The fluid container is equipped with a safety valve.

Response pressure 32 +/- 4 bar

Tightening torque 10 - 15 Nm

Inspection glass

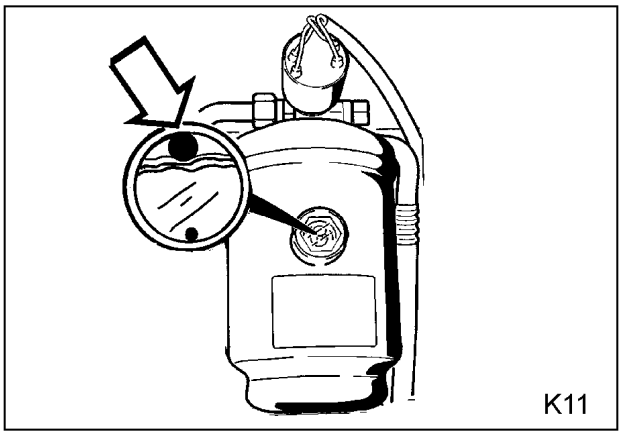


Fig. 3

During operation the refrigerant must flow through the inspection glass without air bubbles. In most cases the presence of air bubbles is a sign for a too low refrigerant level in the system. Apart from this, the refrigerant may not sufficiently condense as a result of a soiled evaporator or a defective condenser fan and the fluid level in the refrigerant container may drop down to a level, at which gaseous refrigerant could flow through the rising tube to the inspection glass. This results in abnormally high temperatures in and on the fluid lines (between refrigerant container and expansion valve), as well as very high pressures in the pressure side.

However, incorrect evacuation or filling may also be the reason for air entering into the system and since air cannot be condensed, one will not be able to get rid of these bubbles by topping up refrigerant. In this case the air conditioning system needs to be evacuated and refilled.

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i Note

Air in the system is characterized by high pressures and temperatures.

On R134a refrigeration systems from KONVEKTA the inspection glasses are equipped with moisture indicators. In addition to the float, the dryer/collector/inspection glass combination has an indicator pearl integrated in the inspection glass, which changes its colour when absorbing moisture.

The refrigerant level should be inside the inspection glass and should only be checked after approx. 5 minutes continuous operation, because the refrigerant must first evenly distribute all over the system.

⚠ Danger

In case of mechanical damage or corrosion on this pressure container this collector unit must be replaced, to avoid bursting and further damage.

Expansion valve

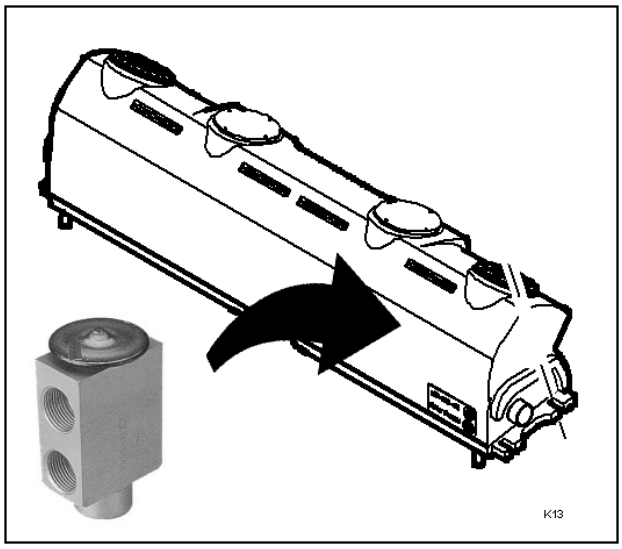


Fig. 1

The expansion valve is mounted inside the HKL-module in the cabin. The expansion valve always allows a small amount of the high pressure liquefied refrigerant to flow into the evaporator, which has a much lower pressure. This lower pressure causes these liquid refrigerant to expand and to evaporate to gaseous state. The heat required for this evaporation process is taken from the ambient air through the lamellas and supplied to the refrigerant. This is the so-called cooling effect.

The thermostatic expansion valve operates with an external pressure compensation. This type of expansion valve works with high accuracy, because it uses pressure and temperature at the evaporator outlet and adjusts and overheating of approx. 7 K. The already installed expansion valves and the ones delivered as spare parts have this overheating value pre-set. In order to prevent a loss in performance or compressor damage you should only use original expansion valves, because adjusting expansion valves takes a lot of time and care.

i Note

In case of dirt in the refrigerant system you should also check or clean the screen at the expansion valve inlet.+

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Evaporator

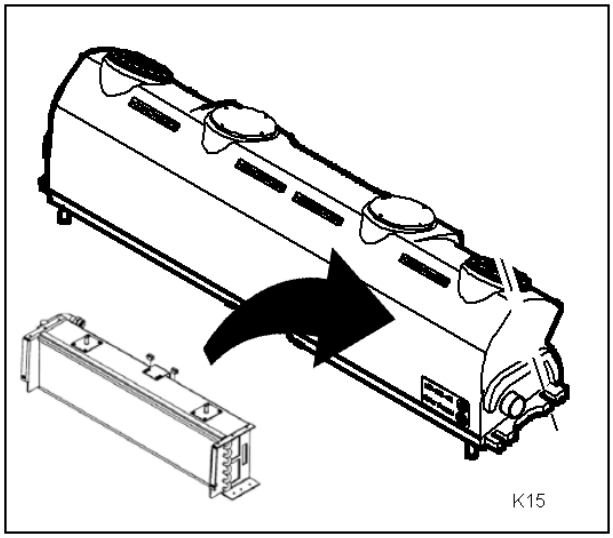


Fig. 1

The evaporator is mounted inside the HKL-module in the cabin. It consists of a heat exchanger (inside air - refrigerant), with refrigerant flowing to a pipe system with cooling flanges.

As with the condenser, correct operation of all fans and cleanliness of the fins must be assured.

Air conditioning systems have a circulation air filter mounted in the air flow in front of the evaporator, which should be cleaned or changed by the operator after each third trip, depending on the amount of dirt.

A condensation water filter is mounted in the air flow after the evaporator. This filter has the function to collect the water that has condensed from the air in the evaporator block and to discharge this water into the water pan With a defective condensation water filter condensation water may flow into the inside of the vehicle.

⚠ Caution

When replacing a heat exchanger, e.g. evaporator or condenser, any compressor oil lost by exchanging the components, must be replaced with fresh oil.

Defroster thermostat

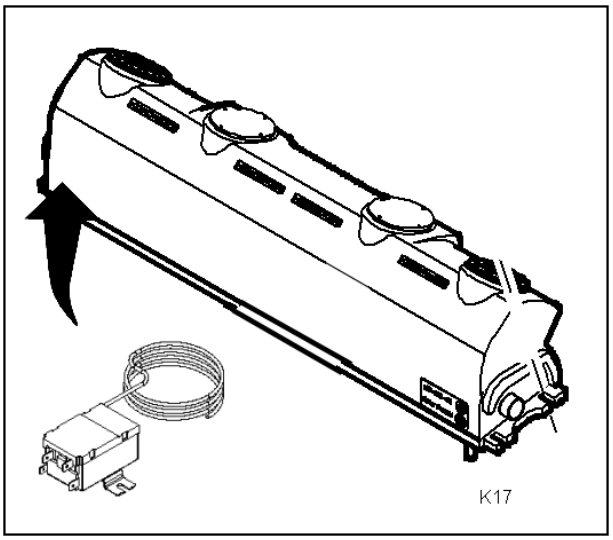


Fig. 1

The feeler of a defroster thermostat to switch off the magnetic clutch in case of icing up or to switch the clutch back on after defrosting, is mounted on the evaporator. The correct adjustment of the defroster thermostat as well as the correct feeler assembly should be checked during maintenance.

Switching point on: + 1°C (± 1°C)

Switching point off: + 5,5°C (± 1°C)

i Note

It is very important that the feeler is mounted downstream of the evaporator, but before the pressure sensor, in countercurrent direction, with full length and insulated against the outside temperature.

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Pressure switch

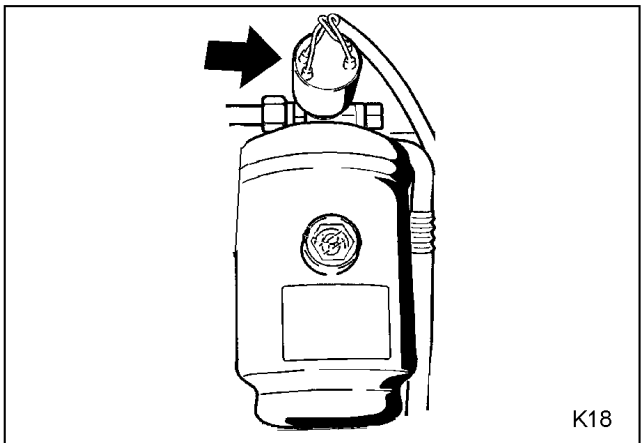


Fig. 1

After a minimum pressure is reached in the low pressure side or a maximum pressure in the high pressure side, the pressure switch will switch of the magnetic clutch of the compressor, thus to avoid destruction of system components by excessive pressure or drawing in external gases and foreign matter as a result of too low pressure.

Working pressure:

Low pressure off: 1,5 ±0,5 bar

Low pressure on: 3.5 bar

Overpressure off: 25,0 ±1,5 bar

Overpressure on: 18,0 ±1,5 bar

Pipes and hoses

Pipes and hoses in air conditioning systems must meet very high requirements with respect to resistance against heat and pressure. The requirements concerning leak tightness and, in case of hoses, against diffusion, i.e. seepage of refrigerant through the hose material, are very high. Pipes and hoses to be used must therefore be specially made for air conditioning purposes. For this reason the hoses have an inside lining of butyl rubber and an outside coating of EDPM rubber. Hose sections exposed to heat are provided with a special heat insulation.

O-rings are made of a special type of chloroprene rubber (neoprene). Before assembly of the air conditioning system these O-rings must be lubricated with compressor oil / refrigeration oil. The O-rings must always be replaced when assembling A/C-components.

Recommended tightening torques for O-ring sealed fittings

Thread	Spanner width	Torque
5/8“	17 or 19	13,6 - 20,3 Nm
3/4“		32,5 - 39,3 Nm
7/8“	27	35,3 - 42,0 Nm
1 1/16“	32	40,7 - 47,5 Nm
M30X2	36	105,0 - 115,0 Nm
M36X2	41	165,0 - 175,0 Nm

Bending radii for air conditioning hoses

Hose type	Nominal width	Bending radius
GH 134	NW8	min. 50 mm
GH 134	NW10	min. 65 mm
GH 134	NW12	min. 75 mm
GH 134	NW16	min. 100 mm
GH 494	NW20	min. 160 mm
GH 494	NW25	min. 194 mm
GH 494	NW32	min. 225 mm

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12.7 Checking the compressor oil level

Checking the compressor oil level / refrigeration oil level

⚠ Caution

The compressor oil level must be checked after replacing a system component or if a leak in the system is suspected. Use only compressor oil / refrigeration oil PAG SP-20 (H14-003-404).

- Run the compressor for 10 minutes at engine idle speed.
- In order to avoid any compressor oil losses you should slowly drain all refrigerant from the air conditioning system.

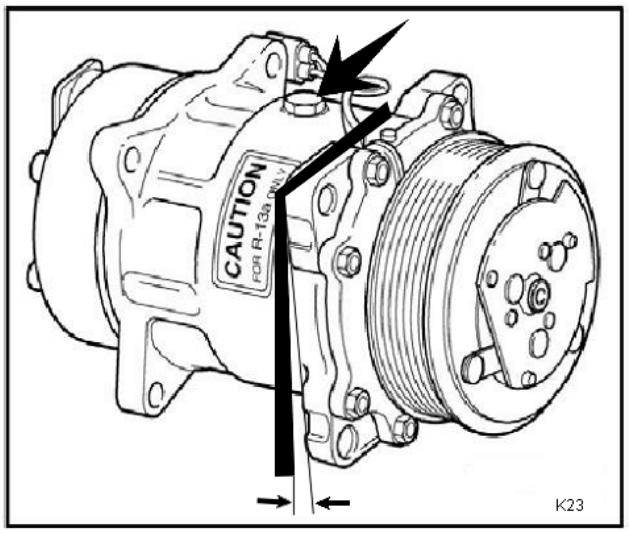


Fig. 1

- Measure the fastening angle (Fig. 1) of the compressor (oil plug at top)
- Remove the oil filler plug.

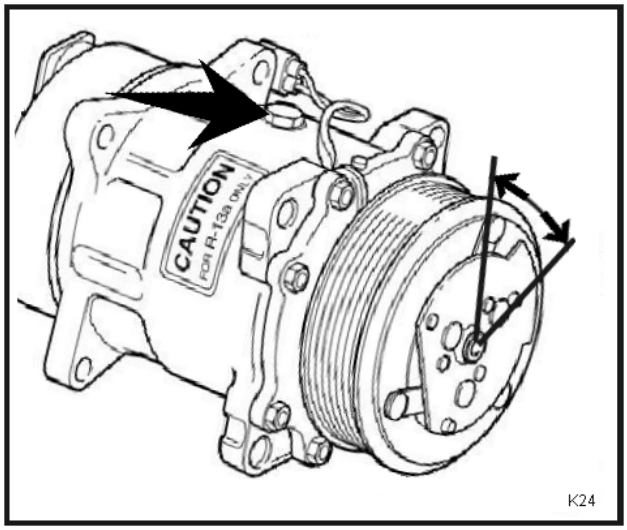


Fig. 2

- Turn the nut that hold the armature clockwise with a socket wrench, until the counterweight is correctly positioned.

i Note

2 o'clock position with inclination to the right (Fig. 2).
10 o'clock position with inclination to the left

- Insert the oil dipstick.
- Pull out the dipstick and count the notches covered by oil.
- Drain off oil or fill up as specified in the table.

Environment

Used compressor oil / refrigeration oil must be disposed of as hazardous waste.

Fastening angle (degree)	Oil dipstick in increments
0	5-7
10	6-8
20	7-9
30	8-10
40	9-11
50	10-12
60	11-13
90	16-18

- Screw the oil filler plug back in.

⚠ Caution

The contact area must be clean and should be free of damage.

Use a new O-ring.

Tightening torque 15 to 25 Nm

- Refill the air conditioning system.

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12.8 Checking the magnetic clutch

- Measure the voltage.

i Note

Nominal value = vehicle voltage

- Check the magnetic coil locking ring for secure fit.
- Check the current consumption.

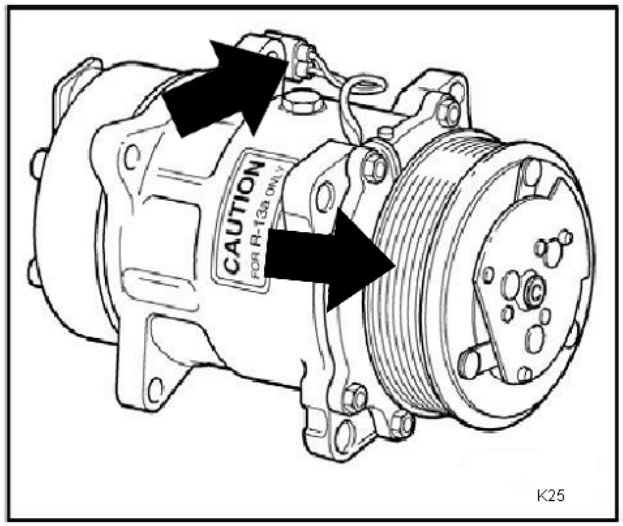


Fig. 1

i Note

Nominal value approx. 3.5 Amp.

Overcurrent indicates a short circuit inside the magnetic coil.

No current indicates an interrupted electric circuit.

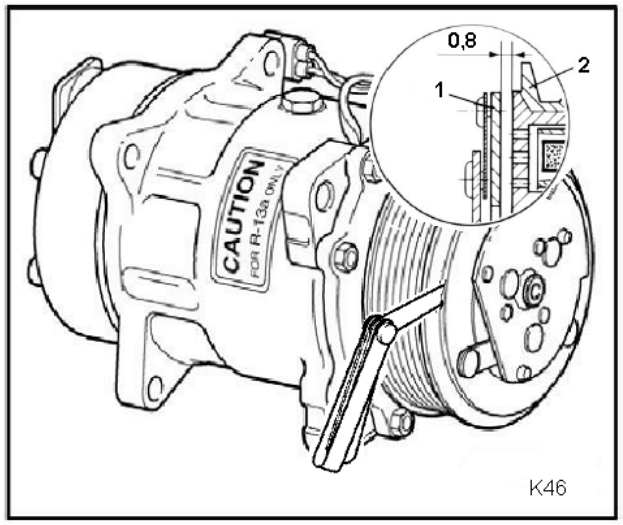


Fig. 2 Measuring the air gap

- Measure the air gap on the magnetic clutch between V-belt pulley (2) and thrust plate (1).

i Note

The gap should be 0.4 to 0.8 mm.

- Take off the drive V-belt and rotate the V-belt pulley by hand while the magnetic clutch is disengaged.

i Note

In case of excessive flatness faults or deviations the magnetic clutch needs to be replaced.

Cross-section of magnetic clutch

Fig. 3 shows a cross-section of the magnetic clutch. If the coil (7) is not supplied with operating voltage, there is no contact between the front plate of the clutch (1) and the V-belt pulley (2). A spring presses the front plate away from the belt pulley. The V-belt pulley rotates with the bearing (3) in idle speed, the compressor does not work. When the coil is supplied with operating voltage (12 or 24 V), a magnetic field is generated and pulls the front plate of the clutch. Both front plate and compressor shaft (8) are then driven by the V-belt pulley, the compressor works.

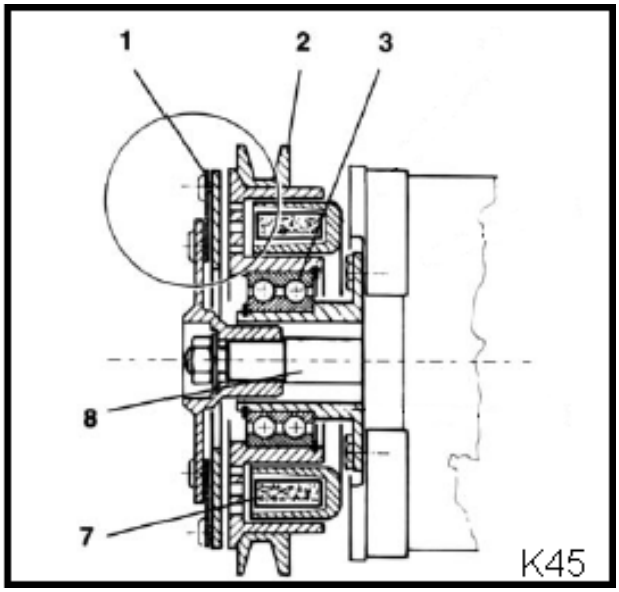


Fig. 3 Cross-section of magnetic clutch

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12.9 Inspection and maintenance work

- Visual inspection of the complete system for damage.
- Check the compressor mounting bracket on the vehicle engine for tight fit and damage.
- Check the condition, alignment and tightness of the V-belt.
- Check the routing of refrigerant hoses and cables in the area of the vehicle engine and transmission, as well as on the chassis for chafing and rectify any detected faults. Ensure sufficient clearance to hot parts, such as the exhaust; install a protective shield, if necessary.
- Check the routing of hoses and hoses on the attachment box or in the cabin.
- Check all hose and screw fittings for leaks.
- Check the fastening of the condenser unit.
- Clean the condenser fins, replace the condenser block if damaged fins are found.
- Check the fastening of the evaporator unit.
- Check the function of evaporator and condenser fans.
- Check the electric control panel. If discolorations on conductors are found, these should be replaced and possibly also the corresponding relays.
- Switch on the cooling system and check the refrigerant level.
- Filter/dryer and filter/dryer/fluid container combinations must always be replaced after opening the refrigerant circuit. If these are in service for more than 1 year, there is a risk that they may be clogged by excessive absorption of moisture! The filter/dryer should be replaced in regular intervals.
- Measure the temperature on the evaporator: Measure the intake air temperature - Measure the blow out air temperature - The temperature difference should be at least 8-10 K.
- Measuring the pressure in the refrigerant circuit

12.10 Checking, replacing the refrigerant compressor V-belt[1]

⚠ Danger

Danger of injury!

Work on the V-belt must only be performed with the engine shut down.

Wear safety goggles.

Check the V-belt

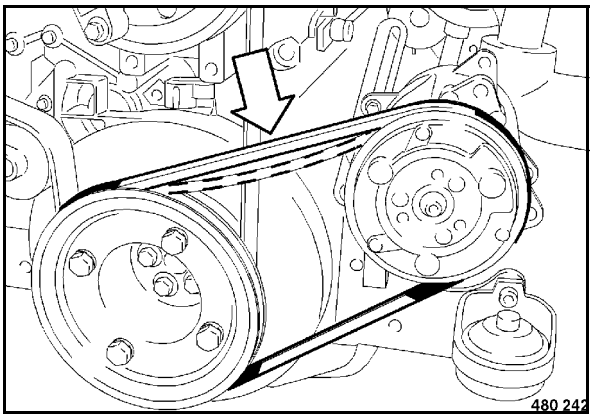


Fig. 4

- Inspect the entire circumference of the V-belt (Fig. 4) visually for damage and cracks. Replace damaged or cracked V-belts.
- Check with thumb pressure whether the V-belt can be depressed more than 10 to 15 mm (0.4 – 0.6 inches) between the V-belt pulleys, retighten if necessary.

Tighten the V-belt.

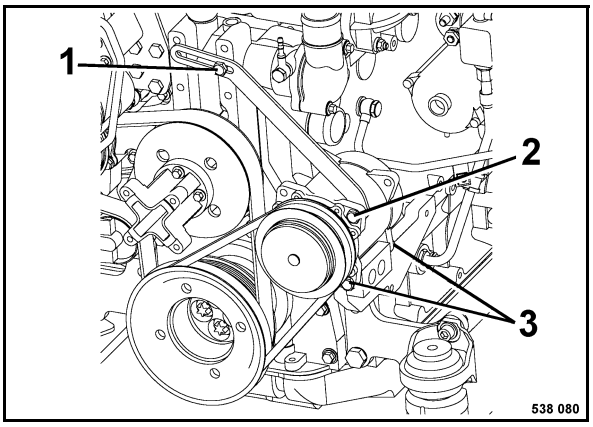


Fig. 5

- Slightly slacken fastening screws 1, 2 and 3 (Fig. 5).

1 Optional equipment

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- Press the compressor in direction of arrow, until the correct V-belt tension is reached.
- Retighten all fastening screws.

Changing the V-belt

- Slightly slacken the fastening screws 1, 2 and 3.
- Press the compressor against the direction of arrow completely against the engine.
- Take the old V-belt off.
- Fit the new V-belt to the V-belt pulleys.
- Tension the V-belt as previously described.

⚠ Caution

Check the V-belt tension after a running time of 30 minutes.

12.11Service the air conditioning[1]

Cleaning the condenser

⚠ Caution

A soiled condenser results in a considerable reduction of air conditioning power.

Under extremely dusty conditions it may be necessary to clean the condenser several times per day.

If, during operation of the air conditioning system, the warning buzzer sounds switch the air conditioning off and clean the condenser.

In case of formation of foam have the air conditioning system inspected by the service department.

⚠ Danger

Danger of accident!

Do not clean with a hot water jet. Heat will cause extreme overpressure, which could cause damage or explosion of the system.

Use access steps and grips to mount and dismount the machine.

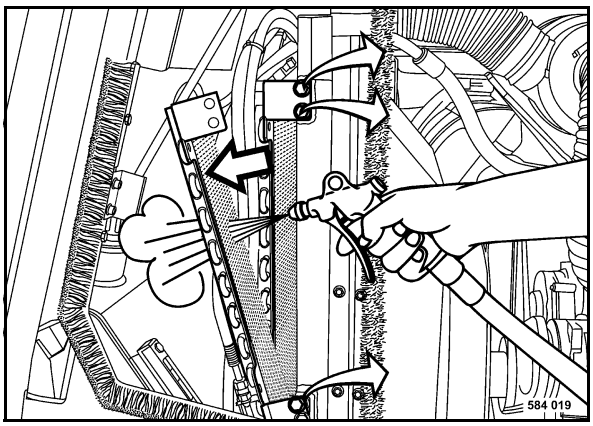


Fig. 6

- Unscrew the condenser fastening screws (Fig. 6) and fold the condenser forward.
- Clean the condenser fins on front and back with compressed air or cold water .

Checking the refrigerant level

- Start the engine.

1 Optional equipment

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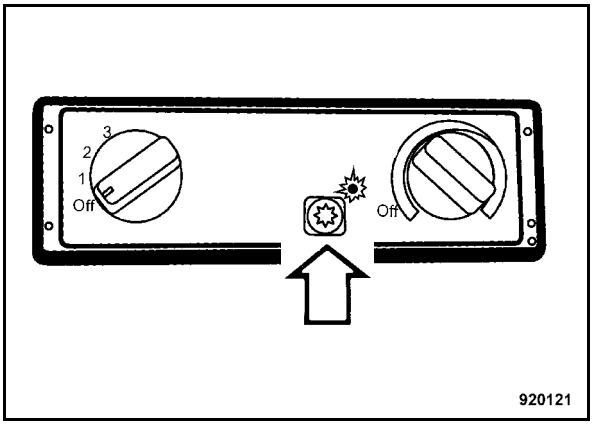


Fig. 7

- Switch the air conditioning (Fig. 7) on.

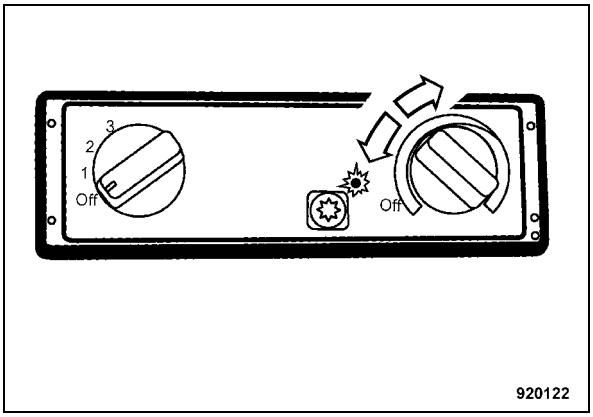


Fig. 8

- Choose a cooling temperature with the rotary switch for cabin heater (Fig. 8) in the blue section.
- Open the air outlet nozzles.
- Check, whether the outflowing air is noticeably cooler.

i Note

The adjusted temperature must be below the actual temperature inside the cabin, so that the compressor will be switched on.

- Open the hood.

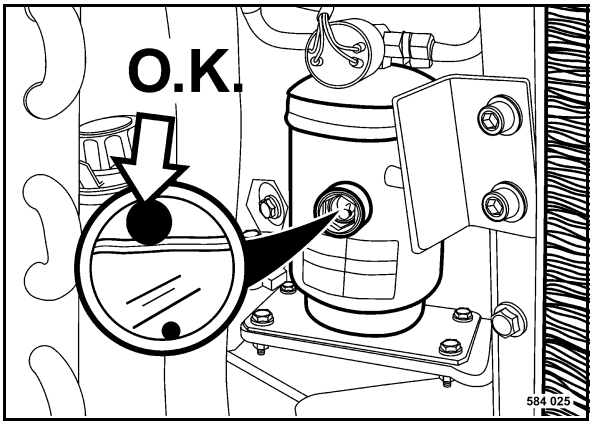


Fig. 9

- Check whether the white float (Fig. 9) inside the inspection glass of the drier/collector unit floats right at the top.

i Note

The refrigerant level is correct.

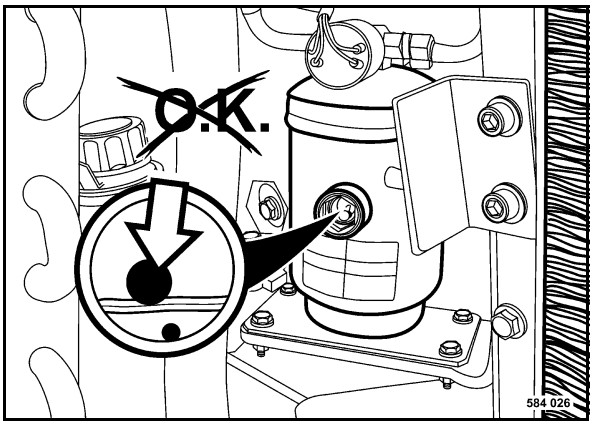


Fig. 10

- If the white float (Fig. 10) inside the inspection glass of the drier/collector unit floats at the bottom, inform the service department.

i Note

The refrigerant level is not correct.

- Refrigerant must be filled up, if necessary check the air conditioning system for leaks.

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Checking the moisture level of the drying agent

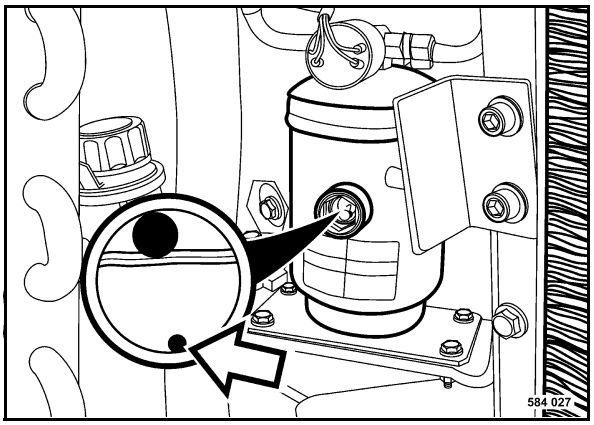


Fig. 11

- Check the moisture indication pearl (Fig. 11) inside the inspection glass of the drier/collector unit.

orange = drying agent o.k.

colorless = moisture level of drying agent too high.

- Inform the service department. Replace drier/collector unit, check air conditioning system.

⚠ Caution

Have the drier/collector unit replaced by the service department every year before the operating season.

Checking the condition of the drier/collector unit

⚠ Caution

According to the regulation for pressure reservoirs all pressure reservoirs must be repeatedly inspected by a specialist. In this sense repeated inspections are external examinations, normally on pressure reservoirs in operation. In connection with this inspection the drier/collector unit must be visually examined twice every year. During these inspections special attention must be paid to corrosion and mechanical damage. If the reservoir is not in proper condition it must be replaced for safety reasons, as a precaution to protect operators and third parties against any danger arising from the handling and operation of pressure reservoirs.

⚠ Danger

Danger of injury!

In case of mechanical damage or corrosion on this drier/collector unit this unit must be replaced, to avoid bursting and further damage.

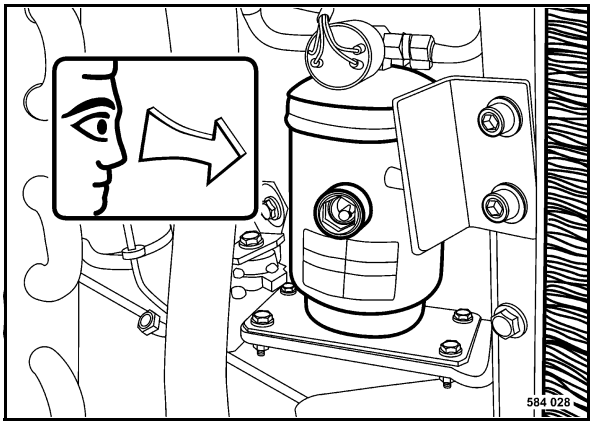


Fig. 12

- Check the drier/collector unit (Fig. 12) for mechanical damage or rust.

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12.12Drying and evacuation

Evacuation of air conditioning systems using R-type refrigerants not only has the purpose of emptying the system of all air before filling in refrigerant, but also to verify the leak tightness over a longer lifetime in the achieved vacuum. However, the most important factor in this work step is the drying of the system.

Any water residues in the refrigerant circuit will combine with the refrigerant, which will lead to the previously described consequential damage.

Vacuum pumps with a capacity of more than 100 l/min and a final pressure of less than 30 micron, i.e. 0.039 mbar should be used to evacuate the refrigeration system.

The refrigerant compressor is not suitable for the purpose of evacuation, because it is not able to achieve a sufficient final vacuum and, apart from this, may be mechanically damaged because of a lack of lubrication when running empty during evacuation.

It is common practice to evacuate the refrigeration system to a final vacuum of 1 Torr, i.e. 1.33 mbar.

An exact time for evacuation and drying cannot be predicted. It can only be determined by means of a vacuum meter. However, if there is no vacuum meter at hand it is generally better to evacuate 1 hour longer than 1 hour too less.

Function drying:

Under normal ambient pressure (1.013 mbar) evaporates absolute at 100° C. If the pressure is reduced, water will already evaporate, e.g. under a pressure of 10 mbar, at an ambient temperature of almost 7°C, but the water will not evaporate all at once. Since it is very difficult to separate the steam from the vacuum in the system, the evacuation process is supported by the co-called vacuum breaking (filling the circuit with dried nitrogen). With vacuum breaking the filled in dried nitrogen absorbs the moisture in the refrigerant circuit, which can then be easily discharged together with the nitrogen.

12.13Emptying in case of repair

For repair work the air conditioning systems must very often be emptied of all refrigerant.

Especially with expensive refrigerants and larger amounts of oil it may be necessary to keep the refrigerant for later use.

For later use these refrigerants must be drawn out with suitable equipment and intermediately stored in collecting containers.

Environment

Contaminated refrigerant must be disposed of environmentally

Releasing refrigerant into the atmosphere is prohibited (see restrictive injunction concerning CFC, day of enforcement 01. 08. 1991, § 8)

Danger

For draining refrigeration systems you should not simply use any delivery containers, but only appropriate pressure bottles, which must be specially marked and should comply with the pressure gas directive.

When transferring refrigerant you must make sure that the bottle does not contain more than the permitted amount of refrigerant in litres and has sufficient gas space for expansion (filling factor: 0,7).

In order to reduce the evacuation period in case of short repairs, you may fill the refrigerant circuit with approx. 0.5 bar nitrogen when opening. This ensures that nitrogen will flow out of the refrigerant circuit while it is open and no air or moisture can enter. However, the necessity for vacuum generation and a dryer change remains.

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12.14Leak test

⚠ Caution

The use of leak detection colouring matter is not permitted, because its chemical composition is unknown and its effect on compressor oil and rubber elements is not predictable. The use of leak detection colouring matter makes any warranty claims null and void.

Before starting the evacuation process, the refrigerant circuit is filled with nitrogen through a pressure reducer valve (approx. 22 bar). After this all connections in the air conditioning system are checked with the help of a suitable leak detection spray. A leak is thereby indicated by means of foam bubbles.

A leak test is required if a pressure drop is noticed.

The leak test must be repeated after filling the air conditioning system with refrigerant.

Leak test with electronic leak tester



Fig. 1 Electronic leak tester

Small leaks with only very low amounts of refrigerant escaping can be detected, e.g. with an electronic leak tester. Such equipment is able to detect leaks of less than 5 gr. per year.

The leak tester used must be specially designed for the refrigerant composition in the air conditioning system. For example, leak detectors for refrigerant R12 are not suitable for R134a, because the refrigerant R134a is free of chlorine atoms, meaning that this leak detector will not respond.

Leak test with soap bubbles

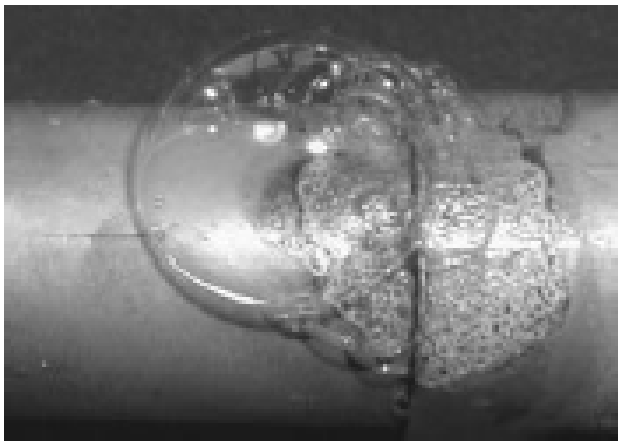


Fig. 2 Soap bubble test

Points susceptible for leakage are sprayed with a soapy solution. Bubbles indicate the leak. The detection limit for R 134a is 250 g/year.

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12.15Filling instructions

Filling of refrigerant into the dried, vented and oil filed machines takes place under various conditions.

In most large series production facilities highly complicated equipment is available for this purpose, whereas individual machines at the place of installation must be filled directly from the refrigerant container.

Liquid refrigerant is only used to pre-fill the pressure side of the evacuated refrigeration system (protective filling).

After switching the refrigeration system on and watching the inspection glass, gaseous refrigerant can be filled into the system while the engine is running, if the refrigerant level is found to be too low (gas bubbles in the inspection glass).

⚠ Caution

Liquid refrigerant in the suction side of the compressor should generally be avoided during filling and operation of the refrigeration system, since this could damage the compressor..

When filling the air conditioning system directly from the refrigerant bottle care must be taken not to overfill the system. As an additional control and for statistical purposes, e.g. for refilling, it is important to write down the weight of the filled in refrigerant.

With correct operation of the air conditioning the refrigerant container should be about 1/3 filled with liquid refrigerant, the evaporator should be maximally filled at the calculated evaporation temperature, i.e. the suction line should only be a few degrees warmer than the evaporation temperature indicated by the pressure gauge.

i Note

White frost on the suction line is no measure for assessing the filling.

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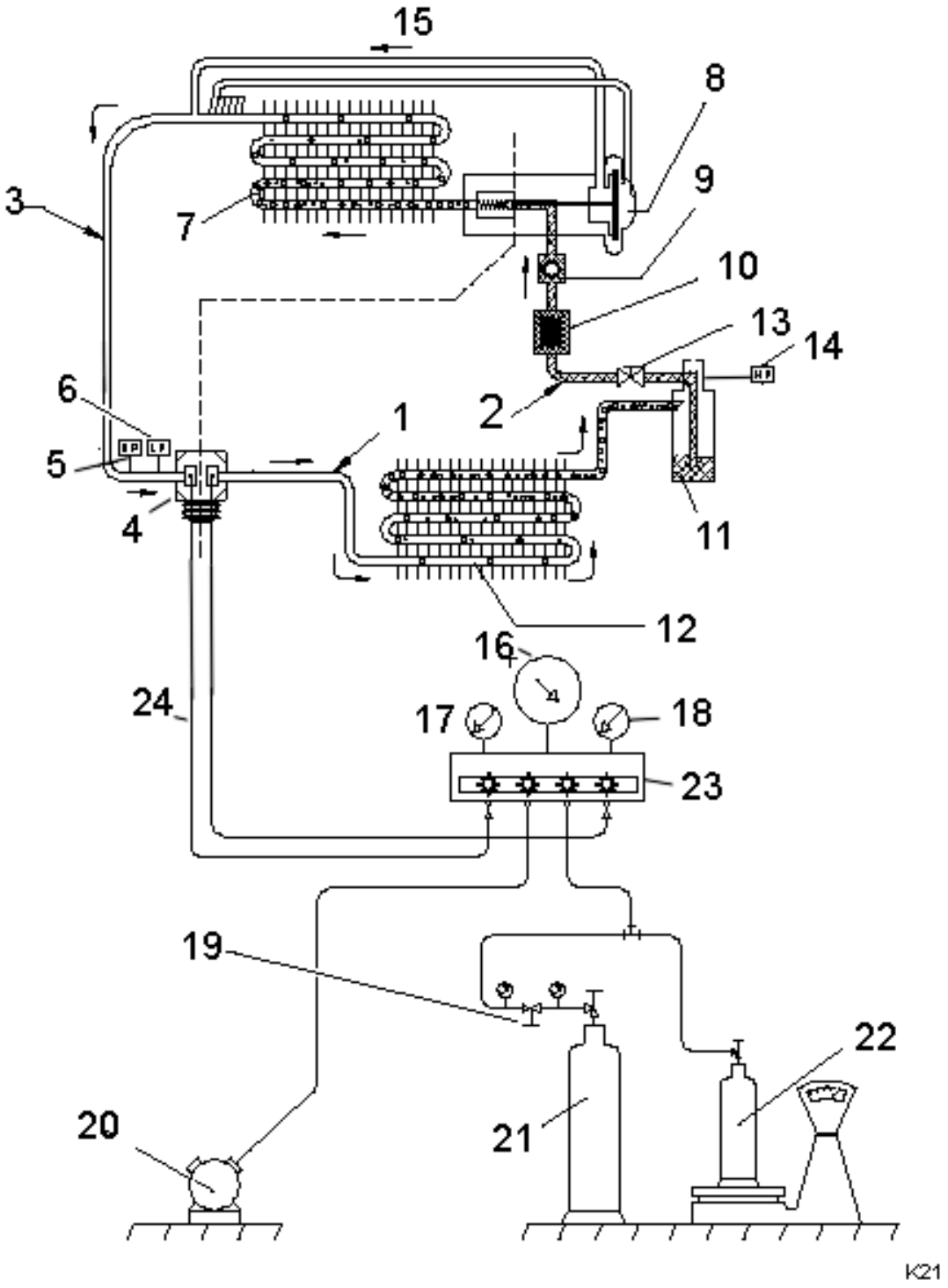


Fig. 1

1 High pressure - gaseous
2 High pressure - liquid
3 Low pressure - gaseous
4 Compressor
5 Compressor pressure switch (not used)
6 not used
7 Evaporator
8 Expansion valve
9 Inspection glass
10 Filter dryer
11 Fluid container
12 Condenser
13 Manual shut-off valve (not used)
14 Pressure switch with high and low pressure contacts
15 Defroster thermostat
16 Vacuum meter
17 Low pressure gauge
18 High pressure gauge

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19 Pressure reducing valve
20 Vacuum pump
21 Nitrogen bottle
22 Refrigerant bottle
23 Pressure gauge bar

Filling instructions

1 Connect the service adapter with the blue hand wheel in the suction side.
2 Connect the service adapter with the red hand wheel in the pressure side (the hand wheels on the service adapters must be fully backed out - left hand stop)
3 Connect the blue suction hose below the blue hand wheel on the pressure gauge bar to the blue service adapter.
4 Connect the red pressure hose below the red hand wheel on the pressure gauge bar to the red service adapter.
5 Connect the yellow hose below the yellow hand wheel on the manometer bar to the 2-stage vacuum pump.
6 Connect the last hose below the black hand wheel on the nitrogen bottle via the pressure reducing valve.
7 Check on the pressure gauge bar that all hand wheels are closed.
8 Turn the hand wheels on both service adapter clockwise. This opens the valves (right hand stop).
9 Open the valve on the nitrogen bottle (only via pressure reducer); pressure approx. 20 bar.
10 Open the black and red hand wheels on the pressure gauge bar and fill nitrogen into the system, until a pressure of approx. 3.5 to 5.0 bar is indicated on the suction side.
11 Then open the blue hand wheel and raise the pressure in the suction side (max. 10 bar). Check for leaks with a leak detection fluid or soapsuds.
12 If the system is leak tight, release the nitrogen from the system. For this purpose disconnect the hose from the nitrogen bottle and open the red, blue and black hand wheels on the pressure gauge bar.
13 Then connect the hose to the refrigerant bottle.
14 Switch on the vacuum pump and open all hand wheels on the pressure gauge bar. In case of a leak no or only an insufficient vacuum will be reached. In this case proceed as described under point 9-12. Once the leak is sealed continue with point 14.
15 Once a sufficient vacuum is reached, both pressure gauges show -1, close all hand wheels on the pressure gauge bar.
16 Switch off the vacuum pump, watch the pressure gauges to see whether the vacuum is maintained.
17 Open the valve on the refrigerant bottle and open the black and red hand wheels on the pressure gauge bar. Fill refrigerant into the system, until a pressure equilibrium between suction and pressure side is reached (reading of pressure gauges).
18 Close the red hand wheel.
19 Perform a leak test with the electronic leak detector.
20 Start the engine and switch on the system.
21 Open the blue hand wheel and continue filling in refrigerant until the inspection glass is free or air bubbles (in fluid container/dryer combinations the white pearl should float in the upper third of the inspection glass). Then close the refrigerant bottle.
22 Close the blue hand wheel on the pressure gauge bar.
23 Preparing the test run: -Close windows and doors -Fan on full speed stage -Mount measuring feelers to air discharge and air intake.
24 Run the system for approx. 20 minutes with medium engine speed.
25 The temperature difference between air discharge and air intake should be (depending on type of air condition) 8-10°C. The ambient temperature thereby is approx. 20°C. (These data are only reference values, which may be influenced by possible insolation)
26 Switch off system and engine and check for leaks again.
27 Turn out (left hand stop) and remove the hand wheels on both service adapters.
28 Fit all valves with dust caps.
29 Perform a leak test.
30 Mark the system with the corresponding type plates and information decals, such as type of oil and refrigerant.

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12.16Trouble shooting in refrigerant circuit, basic principles

Basic principles

Requirements

For trouble shooting two requirements must be fulfilled:

- Expert knowledge
- technical equipment

Technical equipment

The most important aids for trouble shooting are pressure gauges and thermometer. The refrigerant conditions, like overheating and excessive cooling provide important Information when searching for faults. Even your own senses are important aids for trouble shooting. Bubbles in the sight glass, dirt and white frost can be visibly perceived. If the compressor draws in wet steam, this can be noticed by the suction line and it may also be audibly detectable. An overloaded compressor can even be smelled.

The following tools and auxiliary materials should be available for trouble shooting:

- Service station
- Pressure gauge
- Thermometer
- dry nitrogen
- Refrigerant bottle for new refrigerant
- Container for old oil
- Vacuum pump
- Hoses
- Scales
- Suction station
- Leak detector

The measuring equipment must be checked at regular intervals. Calibration can only be made by an approved testing authority.

Pressure gauge

Most pressure gauges used in practice are (for cost reasons) excess pressure gauges. These pressure gauges measure the excess pressure in relation to the ambient pressure (air pressure). In order to achieve the absolute (actual) pressure the ambient pressure must be added to the pressure gauge reading. The absolute pressure is needed for the calculation and determination of material data.

$P_{abs} = P_{amb} + P_e$

P_{abs} = absolute pressure

P_{amb} = atmospheric air pressure (ambient pressure)

P_e = excess pressure (pressure gauge reading)

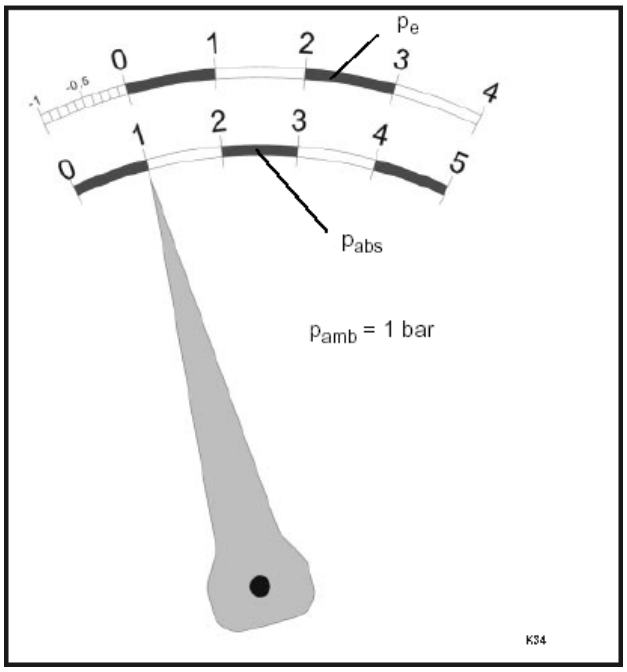


Fig. 2 Pressure gauge

Example:

A totally empty air conditioning system holds an atmospheric pressure of approx. P_{amp} = 1 bar.

Filling the system with refrigerant causes an excess pressure of P_e = 3 bar.

$P_{abs} = P_{amb} + P_e$ = 1 bar + 3 bar = 4 bar

Evacuating the system down to P_e = -0.6 bar, creates a "vacuum" (negative excess pressure).

$P_{abs} = P_{amb} + P_e$ = 1 bar +(- 0,6) bar = 0,4 bar

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Pressure gauge with saturation temperature scale

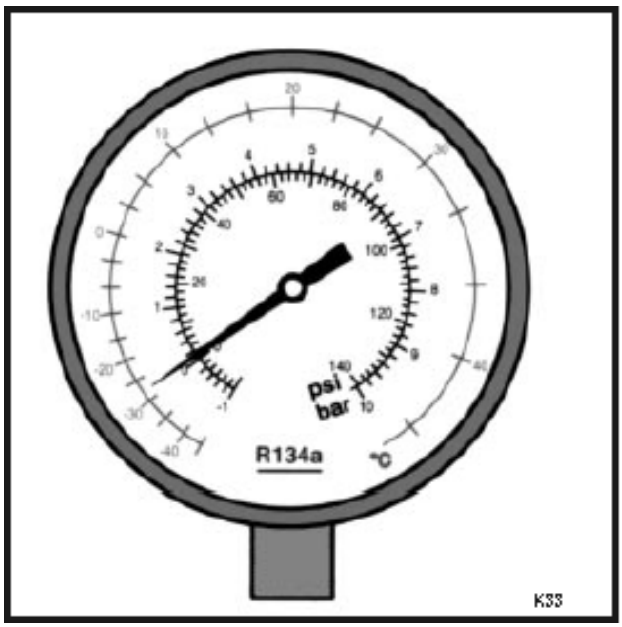


Fig. 3 Absolute pressure gauge

Temperature scales on the pressure gauges always refer to the absolute pressures Pabs. Please note that it is not possible to measure a temperature directly with a pressure gauge. The indicated temperatures are just reference values. Only the saturation temperature is assigned to the measured pressure.

If the refrigerant is fluid, the temperature is below the saturation temperature.

If the refrigerant is gaseous, the temperature is above the saturation temperature.

Pressure gauges must indicate 0 bar when not connected to the system.

Low pressure gauges have a blue, high pressure gauges a red border.

Thermometer

Normally digital thermometers with surface or contact feelers are used. Especially for high temperature differences excellent heat insulation of the measuring location is of utmost importance. The sparing use of a heat conducting paste is highly recommended. If the measuring location is soiled, it needs to be cleaned and probably treated with a fine emery cloth. Only the temperature of the feeler is measured. Due to missing heat insulation and insulating oxide layers on the line, temperature differences of a few degrees Kelvin between the measured and the actual values may arise.

Overheating

Due to its design a refrigerant compressor can only deliver gaseous or vaporous substances. Fluids are not compressible and must therefore not enter into the compression chamber of the compressor.

If the suction condition of the compressor is directly on the dew line, an e.g. incorrect evaporator load can cause "wet suction". This can lead to two processes, which are destructive for the compressor. The liquid refrigerant washes off the lubricating film between piston and cylinder wall, and insufficient lubrication will cause extreme wear. Liquid refrigerant remaining in the cylinder causes a direct energy transfer from piston to cylinder cover during compression. The valve plate may then be damaged by so-called fluid strokes.

Apart from protecting the compressor against fluid, overheating has further advantages. Since the fluid proportions in the drawn in steam reduces the flow rate of the compressor, it may be increased by a overheating. Overheating also improves the oil recirculation.

Common overheating values

The optimal overheating value is approx. 5 - 8 Kelvin. With this overheating the maximum system power is reached. However, the thermostatic expansion valve is unable to regulate this value exactly. Depending on design and operating conditions overheating fluctuates within a range between 4 and 12 Kelvin. The influence of the ambient air on the suction line causes an additional overheating effect.

Overheating is calculated as follows:

$\Delta\, t_{o2h} = t_{o2h} - t_o$

$\Delta\, t_{o2h}$, overheating at evaporator outlet in K

t_{o2h}, temperature at evaporator outlet in °C

t_o, evaporation temperature in °C

„$_h$“ represents "overheated"

Supercooling

It is the function of the expansion valve to reduce the refrigerant to a lower pressure level (evaporation pressure) after it has been liquefied. For an optimal function of the valve pure fluid must be applied to its inlet port.

The refrigerant must "squeeze" (literally speaking) through a throttle gap inside the expansion valve. When comparing a certain mass of refrigerant in fluid and in vaporous state (with constant pressure), the vaporous refrigerant requires a much higher volume. That's why the vaporous refrigerant needs a much longer time to "squeeze" through the throttle gap.

Vaporous refrigerant in front of the expansion valve reduces the flow rate and results in an undersupply of the evaporator with refrigerant. Evaporation pressure and evaporator power will drop.

If the refrigeration system is operated with the "expansion valve inlet" condition directly on the boiling curve, slightest fluctuations in operating condition may cause

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a formation of bubbles in front of the expansion element.

For this reason one shifts the condition "Expansion Valve Inlet" away from the boiling curve into the fluid area and refers to this condition as Supercooling. This supercooling ensures a fluid supply in front of the expansion valve.

Common supercooling values

In systems with fluid container the supercooling at the fluid container outlet is approx. Zero "0" Kelvin (assumed that the system is filled with the correct refrigerant quantity). In this case the fluid container provides the required fluid supply.

Supercooling is calculated as follows:

$\Delta\ \mathbf{t_{c2u} = t_c - t_{c2u}}$

$\Delta\ t_{c2u}$, supercooling at evaporator outlet in K

t_{c2u}, temperature at evaporator outlet in °C

t_c, evaporation temperature in °C

„$_u$“ represents "supercooled"

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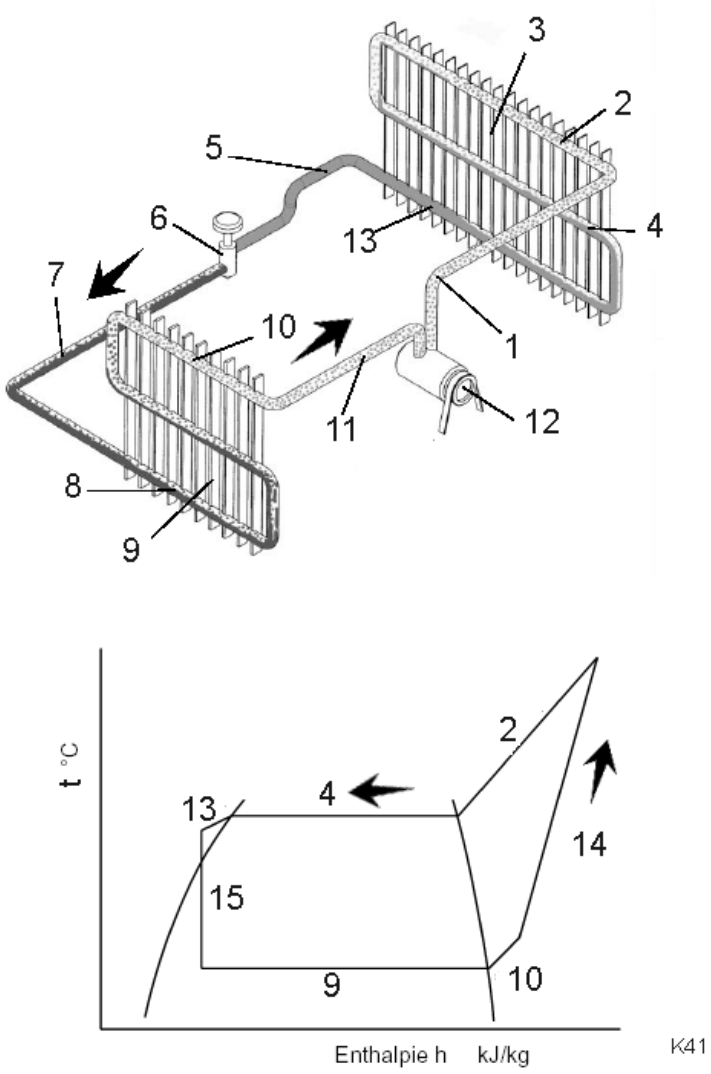


Fig. 1 Refrigerant circuit with t, h- diagram

1 Hot gas line (overheated steam)
2 Deheating (overheated steam)
3 Condenser / liquefier
4 Condensation (wet steam)
5 Fluid line (supercooled fluid)
6 Expansion valve
7 Injection line (wet steam)
8 Evaporation (wet steam)
9 Evaporator
10 Overheating (overheated steam)
11 Suction steam line (overheated steam)
12 Compressor
13 Supercooling (fluid)
14 Compression
15 Expansion

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12.17Trouble shooting, refrigerant circuit diagram

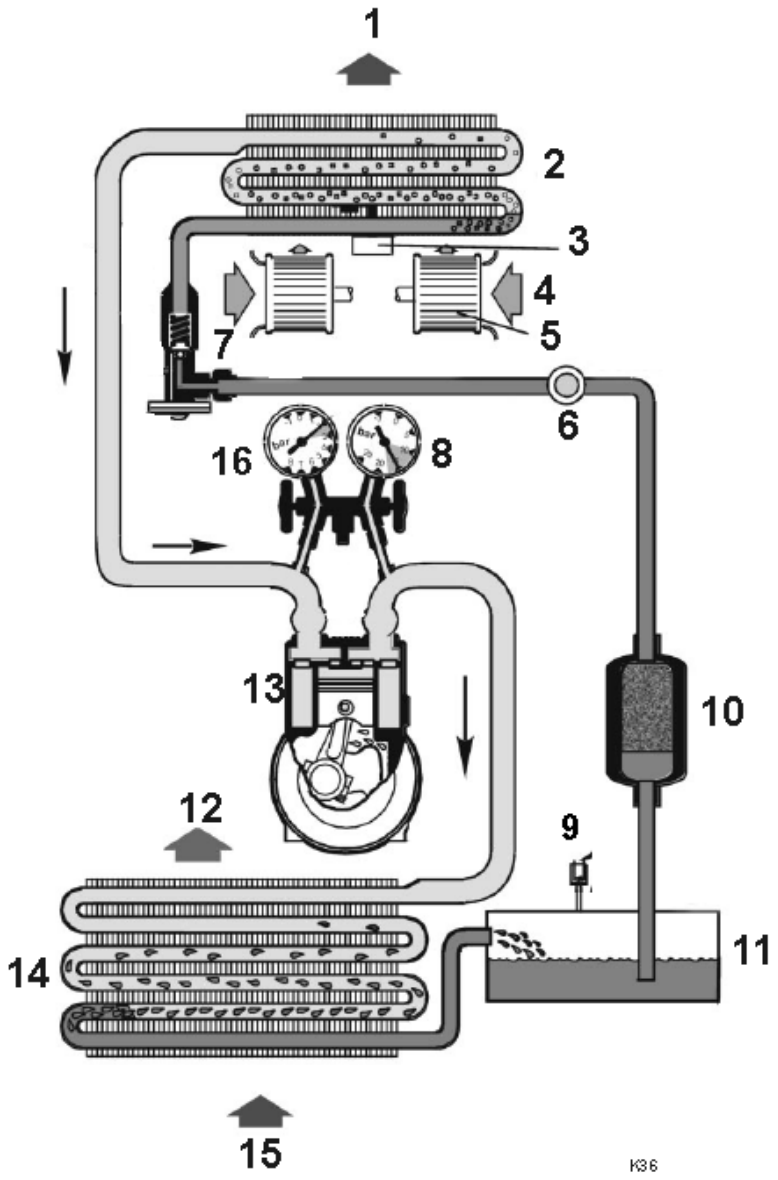


Fig. 1 Refrigerant circuit diagram

1 Cold air
2 Evaporator
3 Thermostat
4 Warm air
5 Fan
6 Inspection glass
7 Expansion valve
8 Pressure gauge, high pressure
9 Pressure switch with high and low pressure contacts
10 Dryer
11 Fluid container
12 Hot air
13 Compressor
14 Condenser
15 Cooling air
16 Pressure gauge, low pressure

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12.18Trouble shooting procedure

Procedure

Knowledge

Trouble shooting is not possible with exact knowledge about the system design, the installed components and their function in the system trouble shooting is not possible:

Visual inspection

With the appropriate experience some faults can be visually detected or felt. Frequently occurring condenser soiling or formation of steam bubbles in the inspection glass can be quickly detected.

In case of unusual formation of hoarfrost on the evaporator the hoarfrost pattern provides useful information. Hoarfrost only occurring at the inlet side is a clear indication of insufficient refrigerant feed, which in turn indicates an incorrectly working expansion valve or a lack of refrigerant.. Complete hoarfrost covering indicates load problems, i.e. no or insufficient air flow.

Even overheating can sometimes be detected with the naked eye. At the end of the evaporator there should be an area which is dry or at least drier at evaporator temperatures above -2 °C.

The fluid line in the refrigeration system is warm. If a local cooling can be felt or if condensation develops, this is a clear indicator for an extreme pressure drop in the line. Similar phenomena can be noticed in case of blocked filters.

Unusually cold pressure lines indicate "wet" intake of the compressor.

The oil level in the compressor sight glass provides information about the oil quantity and the oil recirculation in the system. However, the oil level may also be considerably influenced by condensing refrigerant. Discoloration informs about the state of the oil.

Water in the system can simply be detected through the inspection glass with moisture indicator.

i Note

The dangerous part of common rules is that they apply in most, but not in all cases. The refrigerant states in the individual piping sections or components must therefore be exactly determined by means of pressure and temperature measurements.

Test prerequisites

- Cooler and condenser are clean, clean if necessary.
- The ribbed belt for compressor and generator is correctly tightened.
- All air ducts, covers and seals are OK and correctly fitted. Flaps reach their end positions.
- The engine has operating temperature.
- Evaporator and heating (with highest fresh air fan speed) do not draw leak air.
- The fresh air fan runs when the engine is running and the air conditioning system is set to max. cooling power.
- Ambient temperature above 15 °C.
- The thermostat is correctly installed and the switching temperatures are correct.

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Measuring points and measurements

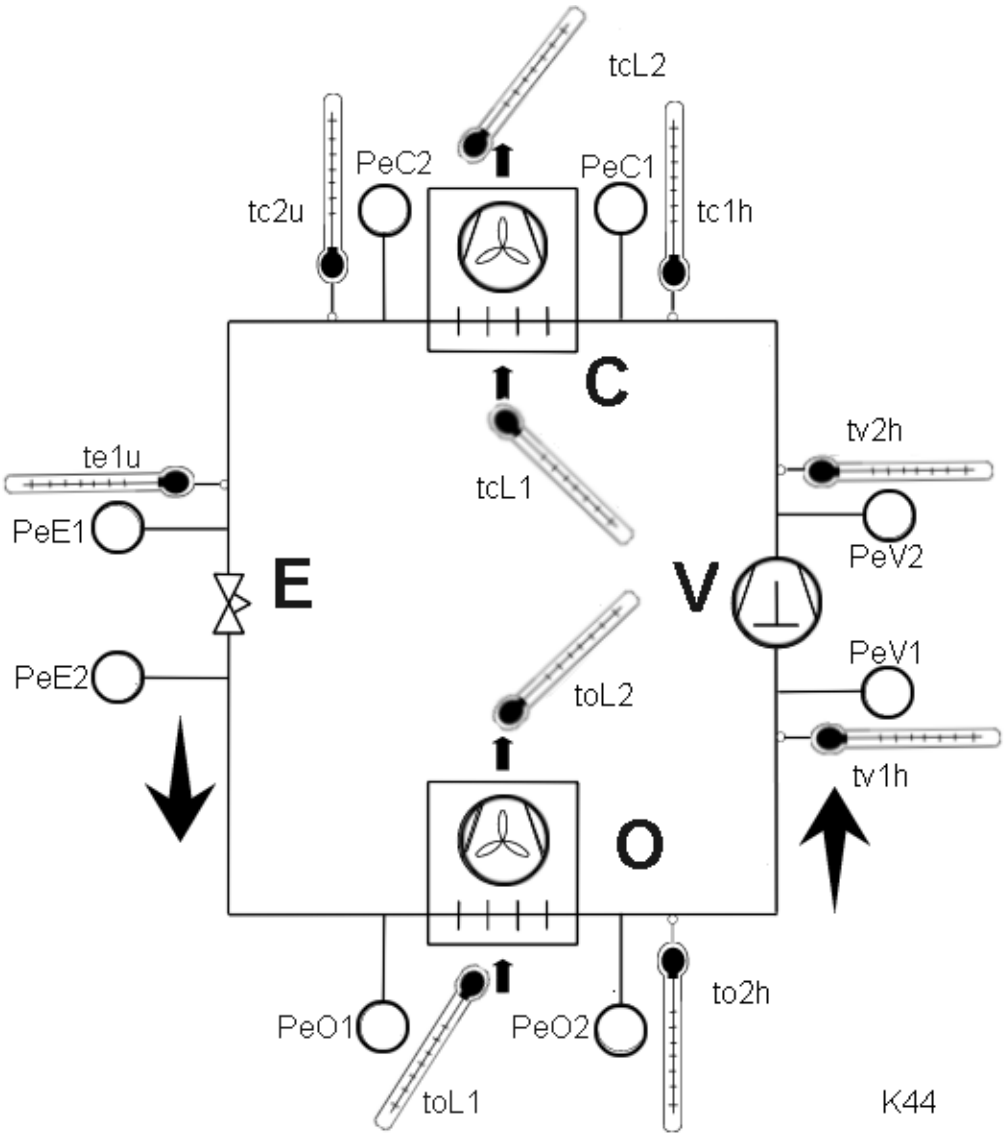


Fig. 2 Flow diagram with measuring points

- C, condenser measuring points
- E, expansion valve measuring points
- O, evaporator measuring points
- V, compressor measuring points

The flow diagram contains "Minimum Requirements" which must be fulfilled to be able to check the system or perform trouble shooting.

Temperature and pressure at the evaporator outlet can be used to derive the overheating of the evaporator. Overheating is a clear indicator for the evaporator filling level. In case of excessive overheating the refrigerant quantity fed into the evaporator is too low, in case of insufficient overheating it is too high. In individual cases one must then check if this situation is caused by the expansion element or by insufficient filling. A differentiation is only possible if there is a clear indicator for the refrigerant filling quantity.

Pressure and temperature at the condenser outlet can be used to derive the supercooling. This can be used to assess the filling quantity. In systems with fluid container the inspection glass is most suitable to check the minimum filling quantity. Supercooling is in this case the between indicator for overfilling.

The hot gas temperature can be used to check whether the compressor runs in the permissible operating range.

Example: Measurement of overheating

- a) Which measuring equipment is required ?
- b) Where to measure with which size ?
- c) A pressure gauge connected to the evaporator indicates "P_{eo2} = 1.7 bar". How high is the evaporator pressure "P_o" ?
- d) How high is the evaporator temperature "t_o" ?
- e) A thermal sensor attached to the evaporator outlet measures the temperature "t_{o2h} = +3 °C". How high is the overheating „Δt_{o2h}“ ?
- f) Evaluation of the measured overheating.

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Solution:

- a) Pressure gauge, thermometer, steam table
- b) Evaporation pressure "P_{eo2}" and temperature "t_{o2h}" are measured at the same point on the evaporator outlet.
- c) $P_o = P_{eo2} + P_{amb}$, "Evaporation pressure = pressure on evaporator + atmospheric pressure" = 1.7 bar + 1 bar = 2.7 bar.
- d) "P_c" = 2,7 bar can then be used to derive an condensing temperature "t_o" of -2,2 °C from the steam table for R134a.
- e) $\Delta t_{o2h} = t_{o2h} - t_o$, „Overheating at evaporator outlet = evaporator outlet temperature - evaporation temperature" = 3 °C - (-2.2 °C) = 5.2 Kelvin.
- f) The determined overheating is within the usual range of 4 - 12 Kelvin.

Example: Measuring supercooling

- a) Which measuring equipment is required ?
- b) Where to measure with which size ?
- c) A pressure gauge connected to the condenser indicates "P_{ec2} = 15 bar". How high is the condensing pressure "P_c" ?
- d) How high is the condensing temperature "t_c" ?
- e) A thermal sensor attached to the condenser outlet measures the temperature "t_{c2u} = 58 °C". How high is the supercooling "Δt_{c2u}" ?
- f) Evaluation of the measured supercooling.

Solution:

- a) Pressure gauge, thermometer, steam table
- b) Condensing pressure "P_{ec2}" and temperature "t_{c2u}" are measured at the same point on the condenser.
- c) $P_c = P_{ec2} + P_{amb}$, "Evaporation pressure = pressure on evaporator + atmospheric pressure" = 15 bar + 1 bar = 16 bar.
- d) "P_cc = 16 bar can then be used to derive an condensing temperature "t_c" of 57.9 °C from the steam table for R134a.
- e) $\Delta t_{c2u} = t_c - t_{c2u}$, "Supercooling at condenser outlet = condensing temperature - condenser outlet temperature" = 57.9°C - 58 °C) = -0.1 Kelvin.
- f) The determined overheating is within the usual range of approx. "0" Zero Kelvin.

Typical faults and possible causes

Most faults in the refrigerant side of the system can be clearly assigned with the help a checklist. r Occurring faults frequently have a similar appearance, but different causes. An evaporator showing hoarfrost may be quite normal. However, there may also be a defect in the expansion valve or problems in the oil recirculation.

The following list contains pressure values in a system, that can be expected at various ambient temperatures (measured at medium speeds).

Suction pressure (low pressure gauge)

Ambient temperature in °C	Excess pressure in bar
25	approx. 2,0
30	approx. 2,5
35	approx. 3

High pressure (high pressure gauge)

Ambient temperature in °C	Excess pressure in bar
25	approx. 8,0
35	approx. 13
40	approx. 16
45	approx. 18

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Values effecting the operating pressures

Since the pressures occurring in a refrigeration system are highly dependent on environmental conditions, it is mandatory to know these dependencies. The following table contains some of these dependencies.

Measuring value		**Suction pressure**		**High pressure**	
		increases	drops	increases	drops
Compressor speed	increases		**X**	**X**	
	drops	**X**			**X**
Vehicle interior temperature	increases	**X**		**X**	
	drops		**X**		**X**
Ambient temperature	increases	**X**		**X**	
	drops		**X**		**X**
Humidity	increases	**X**		**X**	
	drops		**X**		**X**

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Suction pressure too low (1), high pressure too low to normal (2)

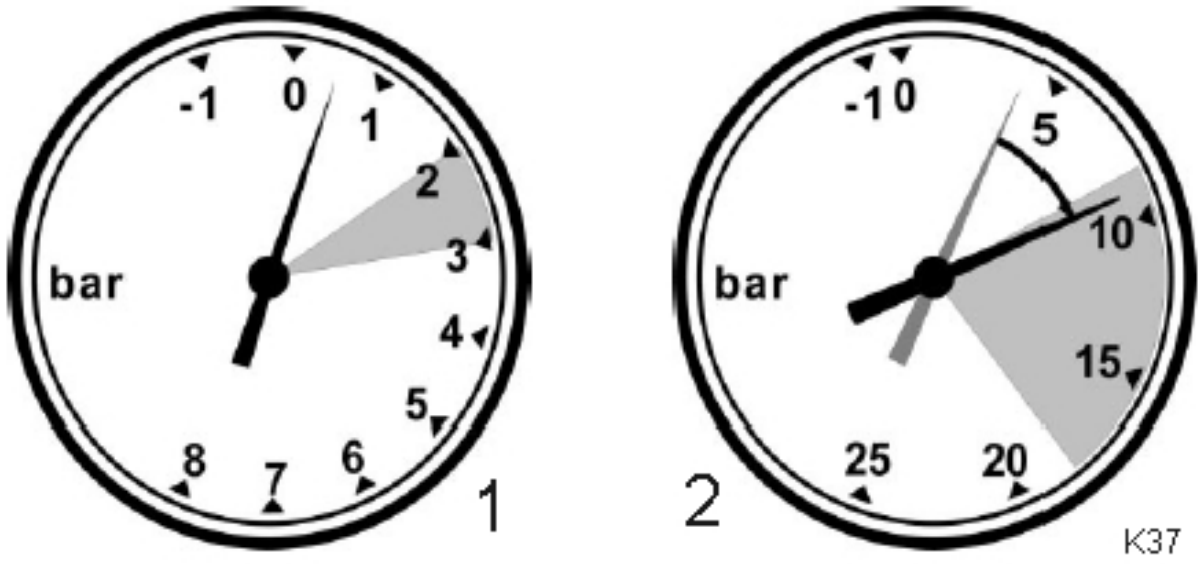


Fig. 3

Cause	Possible effect	Remedy
Lack of refrigerant	no supercooling, bubbles in inspection glass, high overheating, hoarfrost on evaporator	Check for leaks, refill
Evaporator fins or air filter soiled	Cooling power too low	clean
Evaporator fan failed	Low pressure shut off	Repair the fan
Expansion valve defective	Suction pressure gauge shows vacuum, because the valve has closed	Replace the valve
Screen or nozzle in expansion valve clogged	high overheating	clean
Filter dryer clogged	Bubbles in inspection glass, high overheating, filter dryer cold	Change filter dryer
Heat power too low	Frequent low pressure shut off, thawing thermostat / rotary thermostat switching too frequently	Check the control

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Suction pressure normal (1), high pressure too high (2)

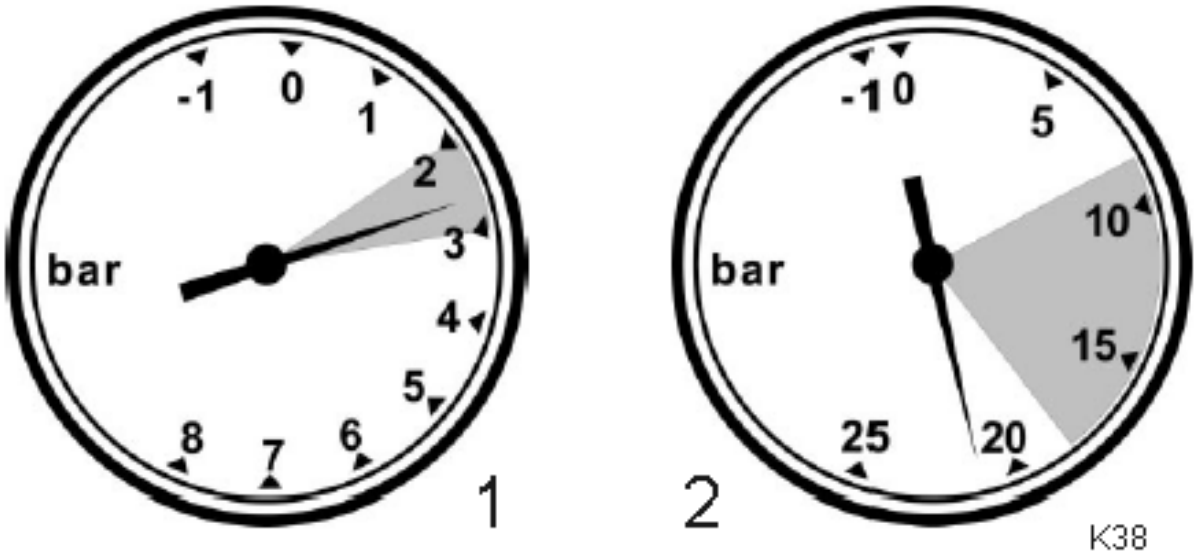


Fig. 4

Cause	Possible effect	Remedy
Condenser dirty	high hot gas temperature, low cooling power	clean
Condenser fan failed	high hot gas temperature, high pressure shut down	repair
overfilled	high hot gas temperature, low supercooling, low cooling power	Correct the filling capacity
Leak gas (air)	high hot gas temperature, low measured supercooling, low cooling power	renew filling
Restriction between compressor and condenser	high hot gas temperature, low cooling power	Check lines and valves

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Suction pressure too high (1), high pressure too low to normal (2)

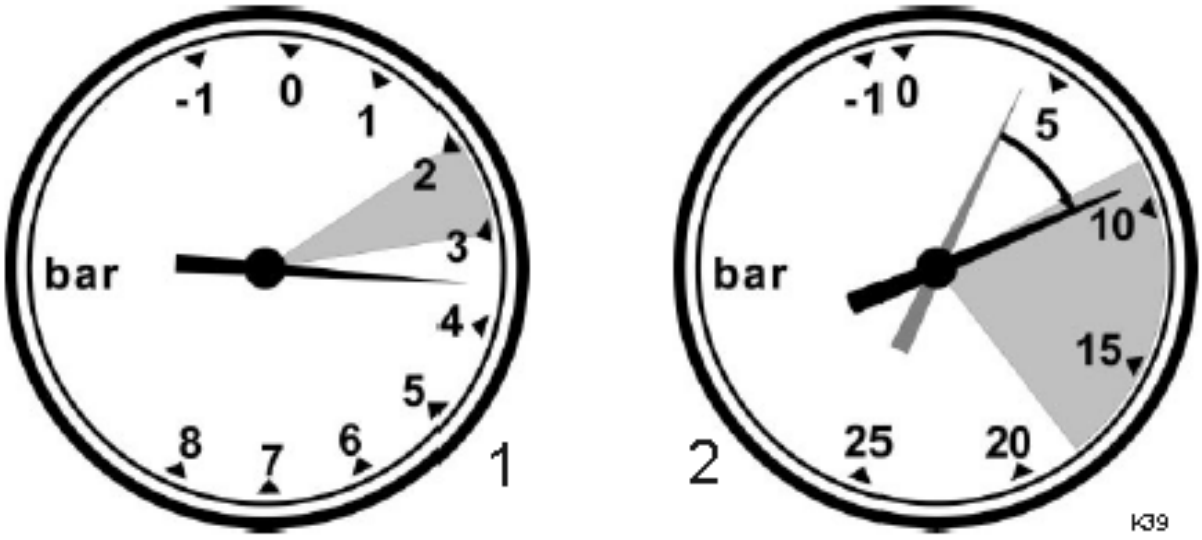


Fig. 5

Cause	Possible effect	Remedy
Compressor defective	Cooling power too low	Replace the compressor

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Suction pressure too high (1), high pressure too high (2)

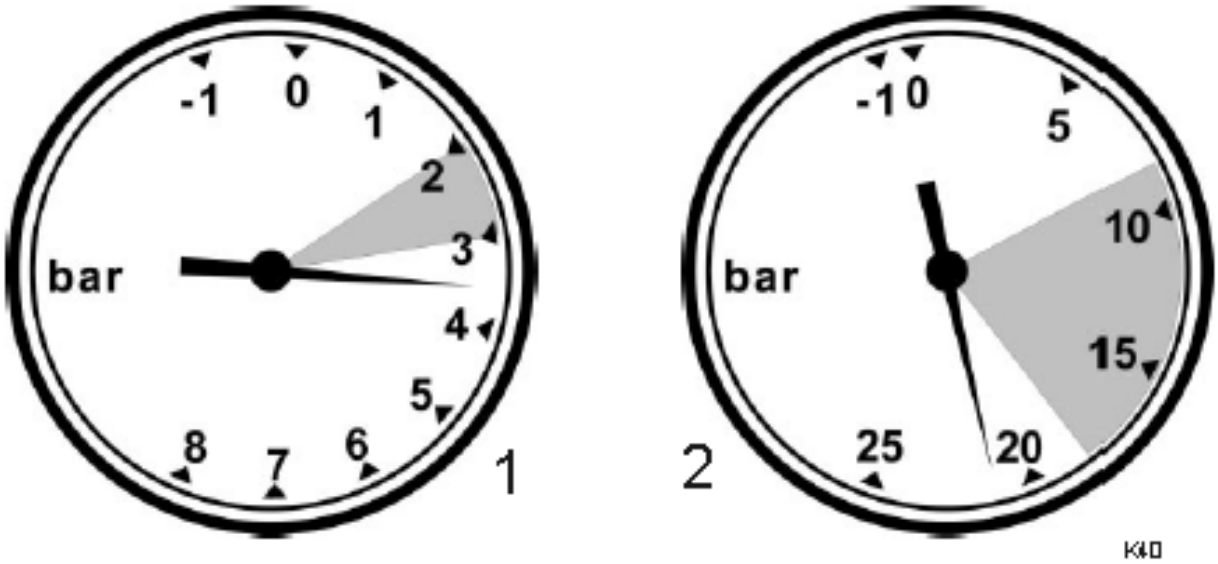


Fig. 6

Cause	Possible effect	Remedy
Expansion valve defective	overheating too low, wet operation of compressor	Replace the valve

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Other faults

Symptom	Cause	Possible effect	Remedy
Hot gas temperature too high, the hot gas line becomes so hot that it cannot be touched long with a hand	Lack of refrigeration oil	increased compressor wear	Refill refrigeration oil
Compressor does not start	Pressure switch or any other safety feature has triggered, electrical fault, cylinder filled with liquid refrigerant	System stopped	Check the control units, check cause for switching and rectify
Compressor switches continuously	Switching difference too small, triggering of a switching element (overpressure switch, low pressure switch), lack of refrigerant, fan defective, overfilled	Cycling of compressor, increased wear, too low cooling power	Check the control units, check cause for switching and rectify
Excessive overheating	Expansion valve deadjusted or screen blocked, lack of refrigerant	low cooling power, hot gas temperatures too high	Replace the expansion valve, clean the screen, fill in refrigerant, leak test
Hoarfrost on inlet side of evaporator	incorrectly working expansion valve, lack of refrigerant	too low infeed of refrigerant into the evaporator	Check the expansion valve, check the refrigerant filling
Evaporator fully covered with hoarfrost	Load problem, too low air flow volume	low cooling power of system	Clean the evaporator, check the evaporator fan
Fluid line is warm and shows condensation	Pressure drop in fluid line, filter dryer clogged	low cooling power	Eliminate the pressure drop, replace the filter dryer
Exceptionally cold pressure lines	"Wet intake" of the compressor due to insufficient overheating of evaporator	low cooling power, excessive wear of compressor	Clean the compressor, replace if necessary, replace the expansion valve if necessary

Noise in system

Faults	Possible cause	Remedy
V-belt loose or excessively worn	V-belt slips and generates noise	Retention or renew the V-belt
Magnetic clutch loud	Magnetic clutch runs until high pressure builds up, then the clutch starts to slip	Repair or replace the magnetic clutch
Refrigerant compressor is loud	Mounting bracket is loose, internal parts worn, low oil level in compressor	Repair the mounting bracket, replace the compressor, renew the refrigeration oil
Fan is loud, fan motor excessively worn		Replace the fan motor
Whistling and rattling noise in operation, noticeable unevenness when turning by hand	V-belt pulley and bearing worn	Replace the bearing, check V-belt pulley for wear
Rattling noise or vibration of high pressure line, knocking noise in compressor, ball in inspection glass floating at the top	System overfilled	Draw out refrigerant
Expansion valve loud	excessive moisture in system	Replace the dryer
Hissing noise in evaporator housing, on expansion valve, turbidity in inspection glass or ball does not float	refrigerant level in system too low	Perform a leak test, fill up the system

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Inspection glass

Faults	Possible cause	Remedy
Steam bubbles in inspection glass	No supercooling before expansion valve, lack of refrigerant in system, pressure loss in system, supercooling caused by excessively soiled filter dryer	Fill up the system, replace the filter dryer, perform a leak test
Discolouration of inspection glass (black from inside)	Lubricant destroyed by excessive operating temperatures	Replace the refrigeration oil, examine the temperature increase
Moisture indicator changes to pink	Moisture level of drying agent too high	Replace the filter dryer
Ball floats at bottom	lack of refrigerant	Fill the system

Monitoring devices

Faults	Possible cause	Remedy
The high pressure contact has switched off the magnetic clutch	System pressure exceeded, condenser excessively soiled, condenser fan defective, expansion valve defective	Clean the condenser, replace the expansion valve, check the condenser fan
The low pressure contact has switched off the magnetic clutch	System pressure fallen short of, refrigerant level too low, expansion valve defective, evaporator fan defective, heat load too low, ambient temperature below 1.5 °C	Clean the evaporator, replace the expansion valve, check the evaporator fan
The thermostat has switched off the magnetic clutch	Ambient temperature below 1°C, expansion valve defective, thermostat defective, air flow volume too low	Check the thermostat switching point, replace the expansion valve, clean the evaporator, check the evaporator fan

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Tempera-ture	Pres-sure	Density		spec. volume		spec. enthalpy		Evapora-tion heat
		of the fluid	of the steam	of the fluid	of the steam	of the fluid	of the steam	

Tempe-ratur t °C	Druck p bar	Dichte		spez. Volumen		spez. Enthalpie		Verdamp-fungs-wärme r kJ/kg
		der Flsskt. ρ´ kg/dm^3	des Dampfes ρ´´ kg/m^3	der Flsskt. v´ dm^3/kg	des Dampfes v´´ dm^3/kg	der Flsskt. h´ kJ/kg	des Dampfes h´´ kJ/kg	
-60	0,16	1,469	0,92	0,681	1082,60	123,17	359,85	236,68
-55	0,22	1,456	1,24	0,687	803,83	129,49	362,99	233,50
-50	0,29	1,443	1,65	0,693	606,45	135,75	366,14	230,39
-45	0,39	1,429	2,15	0,700	464,29	141,98	369,28	227,30
-40	0,51	1,415	2,78	0,707	360,30	148,21	372,41	224,19
-35	0,66	1,401	3,53	0,714	283,08	154,47	375,52	221,05
-30	0,84	1,387	4,45	0,721	224,97	160,78	378,61	217,84
-25	1,06	1,373	5,53	0,728	180,67	167,14	381,68	214,55
-24	1,11	1,370	5,78	0,730	173,12	168,42	382,29	213,88
-23	1,16	1,367	6,03	0,732	165,95	169,70	382,90	213,20
-22	1,22	1,364	6,28	0,733	159,14	170,98	383,51	212,53
-21	1,27	1,361	6,55	0,735	152,66	172,27	384,12	211,85
-20	1,33	1,358	6,83	0,736	146,50	173,56	384,72	211,16
-19	1,39	1,355	7,11	0,738	140,64	174,86	385,33	210,47
-18	1,45	1,352	7,40	0,740	135,06	176,15	385,93	209,78
-17	1,51	1,349	7,71	0,741	129,75	177,45	386,53	209,08
-16	1,57	1,346	8,02	0,743	124,68	178,75	387,13	208,38
-15	1,64	1,343	8,34	0,745	119,86	180,06	387,73	207,67
-14	1,71	1,340	8,68	0,746	115,26	181,37	388,33	206,96
-13	1,78	1,337	9,02	0,748	110,87	182,68	388,93	206,25
-12	1,85	1,334	9,37	0,750	106,68	183,99	389,52	205,53
-11	1,93	1,331	9,74	0,752	102,68	185,31	390,11	204,80
-10	2,01	1,328	10,12	0,753	98,86	186,63	390,71	204,07
-9	2,09	1,324	10,50	0,755	95,21	187,96	391,30	203,34
-8	2,17	1,321	10,90	0,757	91,73	189,28	391,88	202,60
-7	2,26	1,318	11,31	0,759	88,39	190,61	392,47	201,86
-6	2,34	1,315	11,74	0,760	85,21	191,94	393,06	201,11
-5	2,43	1,312	12,17	0,762	82,16	193,28	393,64	200,36
-4	2,53	1,309	12,62	0,764	79,24	194,62	394,22	199,60

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Tempe-ratur	Druck	Dichte		spez. Volumen		spez. Enthalpie		Verdamp-fungs-wärme
		der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	
t °C	p bar	ρ´ kg/dm³	ρ´´ kg/m³	v´ dm³/kg	v´´ dm³/kg	h´ kJ/kg	h´´ kJ/kg	r kJ/kg
-3	2,62	1,305	13,08	0,766	76,44	195,96	394,80	198,84
-2	2,72	1,302	13,56	0,768	73,77	197,30	395,38	198,08
-1	2,82	1,299	14,04	0,770	71,20	198,65	395,96	197,31
0	2,93	1,296	14,55	0,772	68,75	200,00	396,53	196,53
1	3,04	1,292	15,06	0,774	66,39	201,35	397,10	195,75
2	3,15	1,289	15,59	0,776	64,13	202,71	397,68	194,97
3	3,26	1,286	16,14	0,778	61,96	204,07	398,24	194,18
4	3,38	1,282	16,70	0,780	59,88	205,43	398,81	193,38
5	3,50	1,279	17,27	0,782	57,89	206,79	399,38	192,58
6	3,62	1,276	17,87	0,784	55,97	208,16	399,94	191,78
7	3,75	1,272	18,47	0,786	54,13	209,53	400,50	190,97
8	3,88	1,269	19,10	0,788	52,36	210,90	401,06	190,16
9	4,01	1,265	19,74	0,790	50,66	212,28	401,62	189,34
10	4,15	1,262	20,40	0,792	49,03	213,66	402,17	188,51
11	4,29	1,259	21,07	0,795	47,45	215,04	402,72	187,68
12	4,43	1,255	21,77	0,797	45,94	216,42	403,27	186,85
13	4,58	1,252	22,48	0,799	44,49	217,81	403,82	186,01
14	4,73	1,248	23,21	0,801	43,08	219,20	404,36	185,17
15	4,89	1,245	23,96	0,804	41,74	220,59	404,91	184,32
16	5,04	1,241	24,73	0,806	40,44	221,99	405,45	183,46
17	5,21	1,237	25,52	0,808	39,19	223,38	405,98	182,60
18	5,37	1,234	26,33	0,811	37,98	224,78	406,52	181,73
19	5,54	1,230	27,16	0,813	36,82	226,19	407,05	180,86
20	5,72	1,226	28,01	0,815	35,70	227,60	407,58	179,98
21	5,90	1,223	28,89	0,818	34,62	229,01	408,11	179,10
22	6,08	1,219	29,78	0,820	33,58	230,42	408,63	178,21
23	6,27	1,215	30,70	0,823	32,57	231,83	409,15	177,32
24	6,46	1,212	31,65	0,825	31,60	233,25	409,67	176,41
25	6,66	1,208	32,61	0,828	30,66	234,68	410,18	175,51
26	6,86	1,204	33,60	0,831	29,76	236,10	410,69	174,59
27	7,06	1,200	34,62	0,833	28,88	237,53	411,20	173,67

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Tempe-ratur	Druck	Dichte		spez. Volumen		spez. Enthalpie		Verdamp-fungs-wärme
		der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	
t °C	p bar	ρ´ kg/dm^3	ρ´´ kg/m^3	v´ dm^3/kg	v´´ dm^3/kg	h´ kJ/kg	h´´ kJ/kg	r kJ/kg
28	7,27	1,196	35,66	0,836	28,04	238,96	411,71	172,75
29	7,48	1,192	36,73	0,839	27,22	240,40	412,21	171,81
30	7,70	1,189	37,83	0,841	26,44	241,83	412,71	170,87
31	7,93	1,185	38,95	0,844	25,67	243,28	413,20	169,92
32	8,16	1,181	40,10	0,847	24,94	244,72	413,69	168,97
33	8,39	1,177	41,28	0,850	24,22	246,17	414,18	168,00
34	8,63	1,173	42,49	0,853	23,53	247,63	414,66	167,03
35	8,87	1,169	43,74	0,856	22,86	249,08	415,14	166,05
36	9,12	1,164	45,01	0,859	22,22	250,55	415,61	165,07
37	9,37	1,160	46,31	0,862	21,59	252,01	416,08	164,07
38	9,63	1,156	47,65	0,865	20,99	253,48	416,55	163,07
39	9,90	1,152	49,02	0,868	20,40	254,96	417,01	162,05
40	10,17	1,148	50,43	0,871	19,83	256,44	417,47	161,03
41	10,44	1,143	51,87	0,875	19,28	257,92	417,92	160,00
42	10,72	1,139	53,35	0,878	18,74	259,41	418,37	158,96
43	11,01	1,135	54,87	0,881	18,23	260,90	418,81	157,90
44	11,30	1,130	56,42	0,885	17,72	262,40	419,24	156,84
45	11,60	1,126	58,02	0,888	17,24	263,91	419,68	155,77
46	11,90	1,121	59,65	0,892	16,76	265,42	420,10	154,68
47	12,21	1,117	61,33	0,895	16,30	266,94	420,52	153,58
48	12,53	1,112	63,06	0,899	15,86	268,46	420,93	152,47
49	12,85	1,108	64,82	0,903	15,43	269,99	421,34	151,35
50	13,18	1,103	66,64	0,907	15,01	271,53	421,74	150,21
51	13,51	1,098	68,50	0,910	14,60	273,07	422,14	149,06
52	13,85	1,094	70,41	0,914	14,20	274,62	422,52	147,90
53	14,20	1,089	72,38	0,919	13,82	276,18	422,90	146,72
54	14,55	1,084	74,39	0,923	13,44	277,75	423,28	145,53
55	14,91	1,079	76,47	0,927	13,08	279,32	423,64	144,32
56	15,28	1,074	78,59	0,931	12,72	280,91	424,00	143,09
57	15,66	1,069	80,78	0,936	12,38	282,50	424,35	141,85
58	16,04	1,064	83,03	0,940	12,04	284,10	424,69	140,58

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Tempe-ratur	Druck	Dichte		spez. Volumen		spez. Enthalpie		Verdamp-fungs-wärme
		der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	
t °C	p bar	ρ´ kg/dm^3	ρ´´ kg/m^3	v´ dm^3/kg	v´´ dm^3/kg	h´ kJ/kg	h´´ kJ/kg	r kJ/kg
59	16,42	1,059	85,34	0,945	11,72	285,71	425,02	139,30
60	16,82	1,053	87,72	0,949	11,40	287,34	425,34	138,00
61	17,22	1,048	90,16	0,954	11,09	288,97	425,65	136,68
62	17,63	1,043	92,68	0,959	10,79	290,61	425,95	135,34
63	18,04	1,037	95,27	0,964	10,50	292,26	426,24	133,97
64	18,47	1,032	97,94	0,969	10,21	293,93	426,51	132,58
65	18,90	1,026	100,69	0,975	9,93	295,61	426,78	131,17
66	19,34	1,020	103,53	0,980	9,66	297,30	427,03	129,74
67	19,78	1,014	106,45	0,986	9,39	299,00	427,27	128,27
68	20,24	1,009	109,46	0,992	9,14	300,72	427,50	126,78
69	20,70	1,003	112,58	0,997	8,88	302,45	427,71	125,26
70	21,17	0,996	115,79	1,004	8,64	304,19	427,90	123,71
71	21,65	0,990	119,11	1,010	8,40	305,95	428,08	122,13
72	22,14	0,984	122,55	1,016	8,16	307,73	428,25	120,52
73	22,63	0,977	126,11	1,023	7,93	309,52	428,39	118,87
74	23,13	0,971	129,79	1,030	7,70	311,33	428,51	117,19
75	23,65	0,964	133,60	1,037	7,48	313,15	428,62	115,46
76	24,17	0,957	137,56	1,045	7,27	315,00	428,70	113,70
77	24,70	0,950	141,67	1,052	7,06	316,86	428,76	111,90
78	25,23	0,943	145,95	1,060	6,85	318,74	428,79	110,05
79	25,78	0,936	150,40	1,069	6,65	320,64	428,80	108,15
80	26,34	0,928	155,03	1,078	6,45	322,57	428,77	106,21
81	26,90	0,920	159,87	1,087	6,26	324,51	428,72	104,21
82	27,48	0,912	164,92	1,096	6,06	326,48	428,63	102,15
83	28,06	0,904	170,22	1,106	5,87	328,47	428,50	100,04
84	28,66	0,895	175,77	1,117	5,69	330,48	428,34	97,86
85	29,26	0,887	181,60	1,128	5,51	332,52	428,12	95,61
86	29,88	0,878	187,75	1,140	5,33	334,58	427,86	93,29
87	30,51	0,868	194,25	1,152	5,15	336,67	427,55	90,88
88	31,14	0,858	201,14	1,165	4,97	338,78	427,17	88,39
89	31,79	0,848	208,48	1,179	4,80	340,92	426,72	85,80

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Tempe-ratur	Druck	Dichte		spez. Volumen		spez. Enthalpie		Verdamp-fungs-wärme
		der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	der Flsskt.	des Dampfes	
t °C	p bar	ρ´ kg/dm^3	ρ´´ kg/m^3	v´ dm^3/kg	v´´ dm^3/kg	h´ kJ/kg	h´´ kJ/kg	r kJ/kg
90	32,45	0,837	216,31	1,195	4,62	343,09	426,20	83,10
91	33,12	0,826	224,73	1,211	4,45	345,29	425,58	80,29
92	33,80	0,813	233,84	1,229	4,28	347,53	424,86	77,33
93	34,49	0,801	243,77	1,249	4,10	349,79	424,00	74,21
94	35,19	0,787	254,71	1,271	3,93	352,08	422,99	70,91
95	35,91	0,771	266,92	1,296	3,75	354,41	421,78	67,37
96	36,64	0,755	280,84	1,325	3,56	356,77	420,30	63,53
97	37,39	0,736	297,17	1,359	3,37	359,17	418,44	59,27
98	38,14	0,714	317,43	1,400	3,15	361,60	415,97	54,37
99	38,92	0,687	346,24	1,455	2,89	364,07	412,16	48,09
100	39,71	0,650	636,32	1,537	1,57	366,58	375,04	8,46
101,06	40,56	0,515	515,30	1,941	1,94	390,05	390,05	0,00

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12.20Heating control / air conditioning control

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Installation and servicing instructions for air conditioning control

KS20.01 – without air conditioning function
KS20.02 – with air conditioning function



KS20.01



KS20.2

General description

- The control unit has the size of a radio and is made of plastic material with fastening clamps.
- The 12-pole plug on the back serves the purpose of connection.
- For removal of the unit two conventional unlocking brackets are required.
- Depending on the design the unit comes with 2 buttons and 2 rotary knobs with several functions to control the air conditioning system.

Klimasteuerung

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Hardware

KS20.01

- Fan control via 3-stage switch
- Heater control via cycle time
- without air conditioning function

KS20.02

- Fan control via 3-stage switch
- Heater control via cycle time
- Manual air conditioning function via push button

Description of switches



Button S1
To switch on the air conditioning compressor manually (only on KS20.02)

Rotary knob (1)
3 stage switch for evaporator fan

Rotary knob (2)
Adjustment of heating power

Klimasteuerung

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Description of function

Version KS20.01

- The unit is ready for operation after power has been applied.
- The heater control is active after the ignition and the rotary button (1) (min. stage 1) have been switched on. Depending on the switch position the solenoid valve is triggered in a time raster of 45 seconds.
- With rotary knob (1) the fan can be switched in three stages.
- With rotary button (1) in stage **"0"** the heater is automatically deactivated.

Version KS20.02

- The unit is ready for operation after power has been applied.
- After switching the ignition on and activating the rotary knob (1) (min. stage 1) the heater control is active and the compressor can be manually switched on with button S1. Depending on the switch position the solenoid valve is triggered in a time raster of 45 seconds.
- With rotary knob (1) the fan can be switched in three stages
- With rotary button (1) in stage **"0"** the heater and the air conditioning compressor are automatically deactivated.

Overview of inputs and outputs

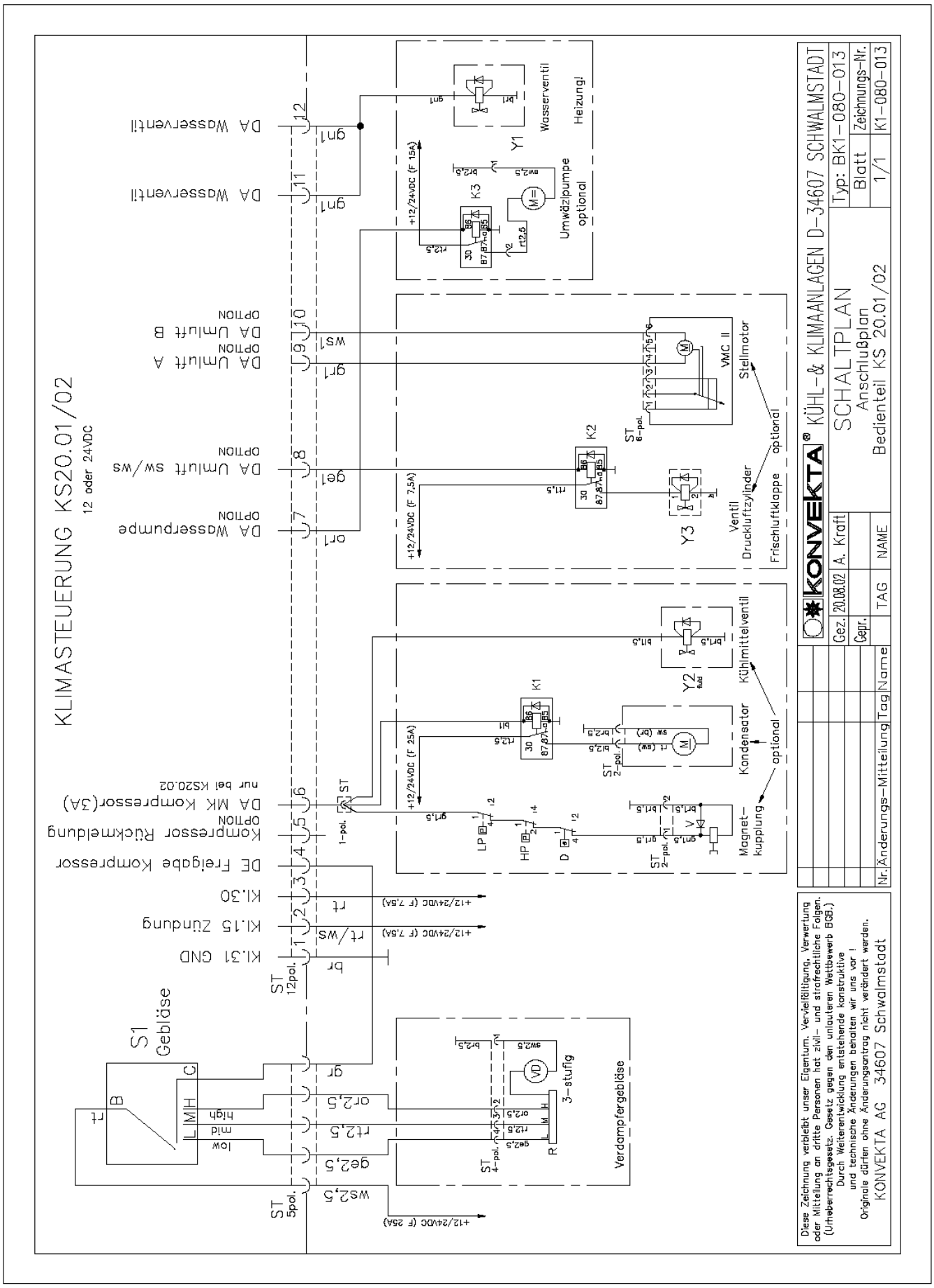
6 digital outputs of 200 mA each
1 digital output 3 A.
3 digital inputs
1 analog input
1 0-24 V signal to trigger speed modules via the rotary knob.

Plug assignment

Plug 12-pole socket
-01- GND GND terminal 31
-02- VCC 12 VDC (ignition) terminal 15
-03- VCCL 12 VDC load for relay terminal 30
-04- DE02 Release for compressor (+ from rotary knob)
-05- DE03 Feedback from compressor (option)
-06- DA 07 MK Compressor (3 A))
-07- DA 01 Water pump (option)
-08- DA 02 Air circulation flap sw/ws (option)
-09- DA 03 Air circulation flap A (option)
-10- DA 04 Air circulation flap B (option)
-11- DA 05 Heater valve A / for sw/ws connect DA06 + DA07
-12- DA 05 Heater valve B / for sw/ws connect DA06 + DA07

Klimasteuerung

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13 Replacing the cab window panes

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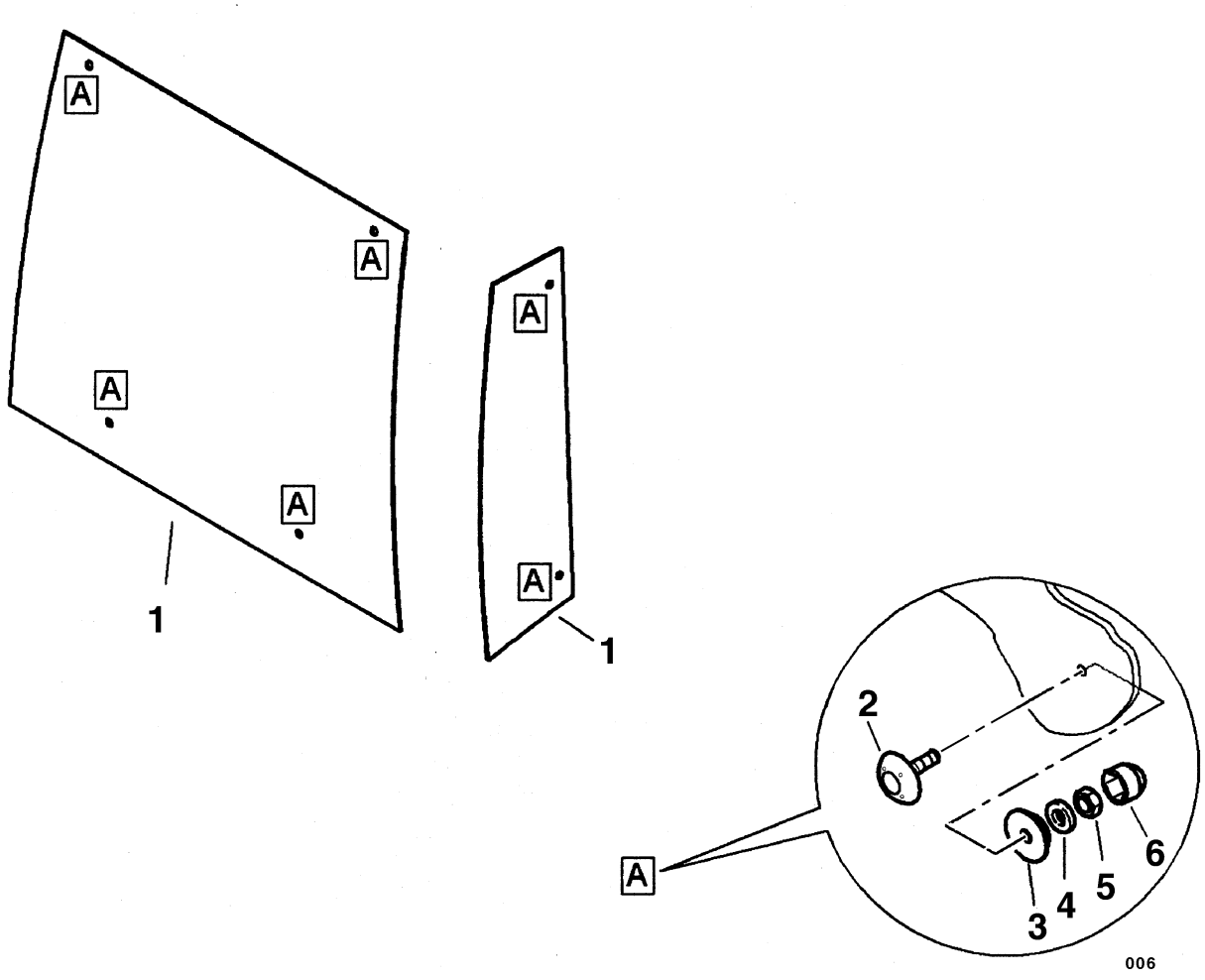


Fig. 1

1 Glass panes
2 Fastening element
3 Fixing washer and spacer
4 Washer
5 Hexagon nut, self locking
6 Protective cap

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13.2 Special tools

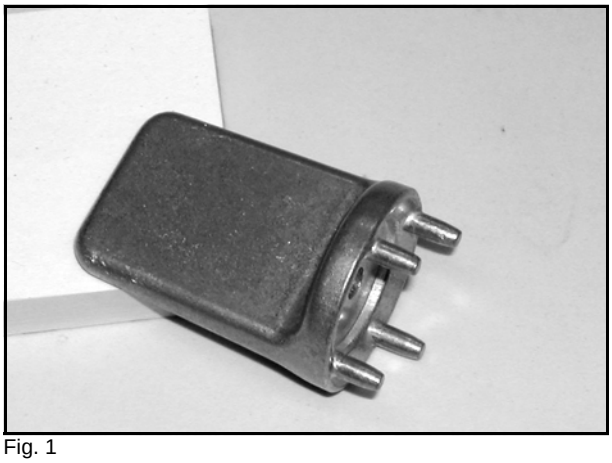


Fig. 1

1. Locking handle for fastening element

   BOMAG part-no.: 055 705 84

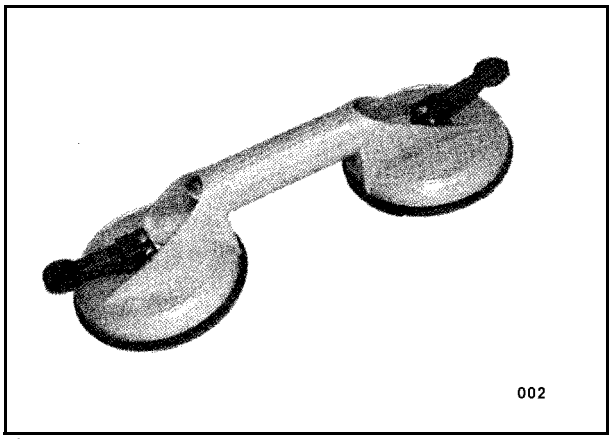


Fig. 2

2. Suction lifter

   commercial

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13.3 Auxiliary materials

Safety gloves

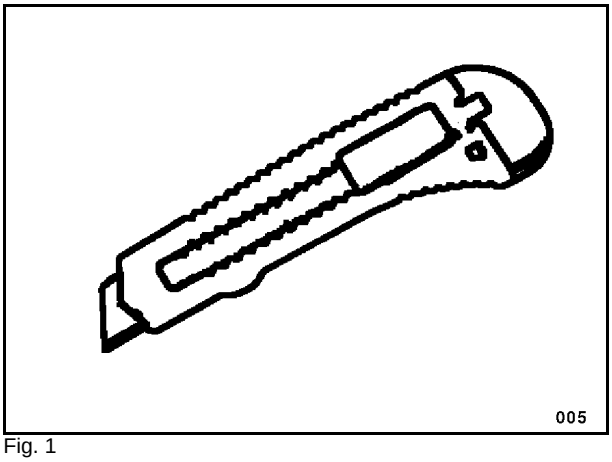


Fig. 1

3. Cutter

Commercial

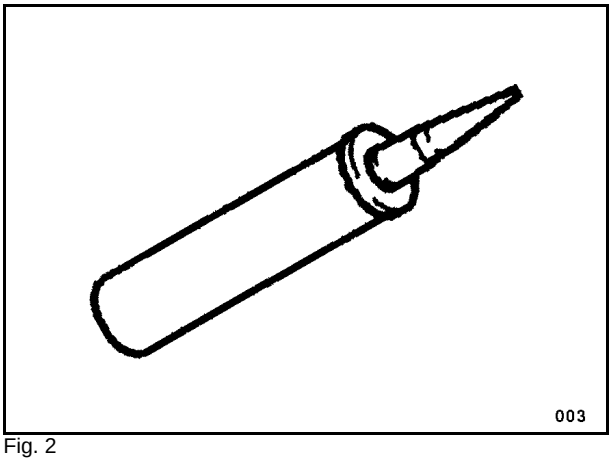


Fig. 2

4. Window glass bonding agent

BOMAG part-no.: 009 780 34

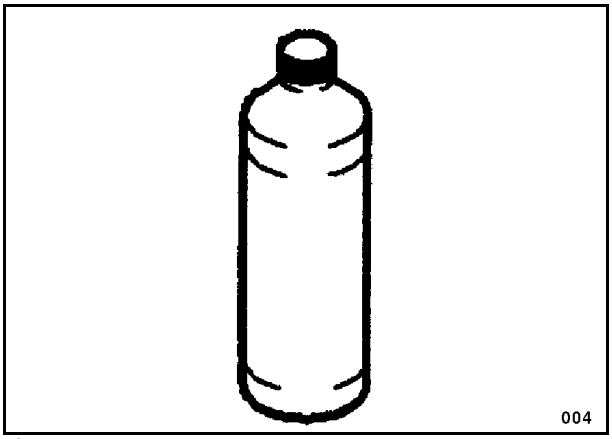


Fig. 3

5. Activator

BOMAG part-no.: 009 780 33

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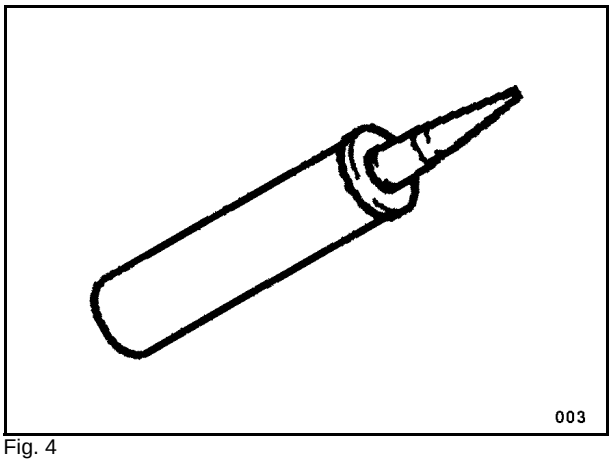


Fig. 4

6. Silicone sealant

   BOMAG part-no.: 009 700 36

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13.4 Removing and installing the window pane

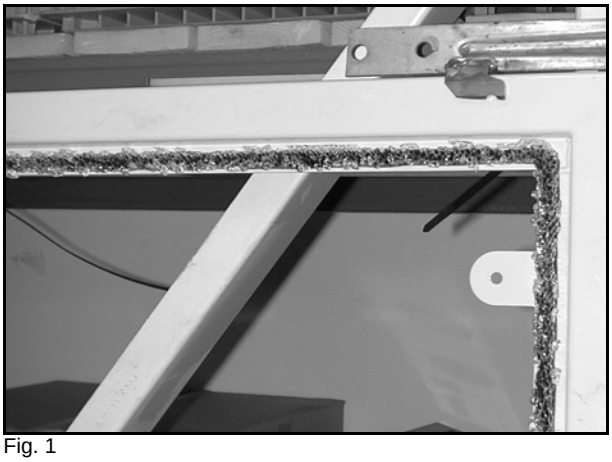


Fig. 1



Fig. 2

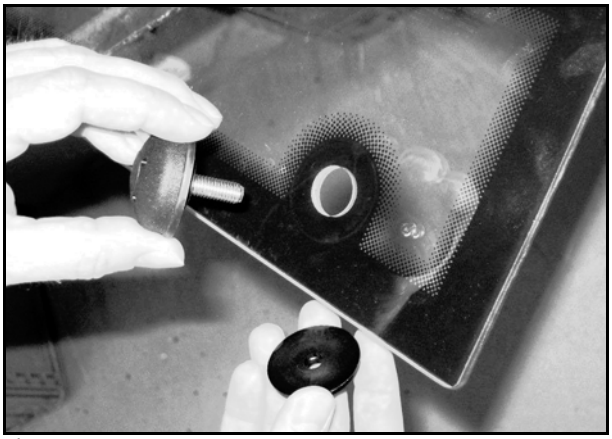


Fig. 3

Environment

Environmental damage

Dispose of glass splinters fro0m machine and cabin or inside cabin in an environmentally friendly way.

Danger

Danger of cutting

Wear safety gloves.

1. Pull large glass rests off the bonding strip (Fig. 1).
2. Clean the sealing surfaces from any adhesive material (Fig. 2).
3. Use a cutter to remove adhesive residues with glass rests.
4. Cover places without adhesive residues with an activator.
5. Insert the fastening element with washer into the bore in the glass pane (Fig. 3).

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Fig. 4

6. Turn the fixing and spacer washer hand-tight onto the thread of the fastening element (Fig. 4).

i Note
Do not overtighten the thread.


Fig. 5

7. Lay an approx. 1 cm high triangular bead of glass pane bonding agent on the inside of the pane, approx. 1.5 cm away from the edge (Fig. 5).

i Note
Apply window pane bonding agent only to the sides (sealing areas) which have contact with the cabin.


Fig. 6

8. Attach the suction lifter to the outside of the pane (Fig. 6).
9. Install the window pane so that the fastening elements fit into the bores of the fastening bars.
10. Press the glass pane against the sealing surface.


Fig. 7

11. Assemble the washer and the self-locking hexagon nut.
12. Fasten the window pane to the fastening bar using a locking handle and a ring spanner (Fig. 7).

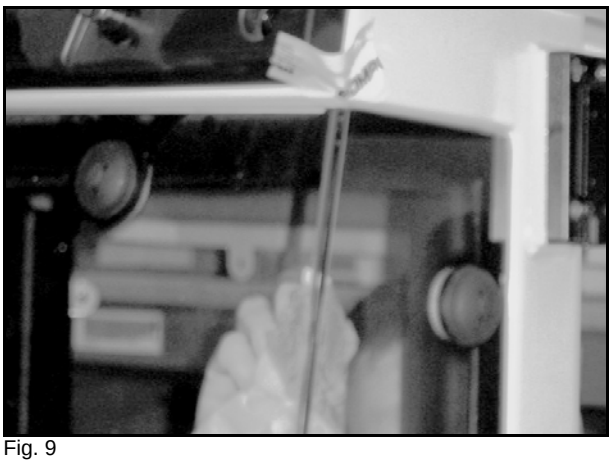
i Note
Only use the locking handle to counter.

13. Press the protective cap onto the hexagon nut.

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Fig. 8

14. Remove the suction lifter (Fig. 8).


Fig. 9

15. Clean the joining edges on the window pane (Fig. 9).

i Note

The joint flanks must be solid, dry and free of dirt, dust, grease, oil and other foreign substances.

16. Mask the upper and lower contact areas to the cabin.



Fig. 10

17. Apply silicone sealant evenly and under pressure first to the inside joint edge (Fig. 10).

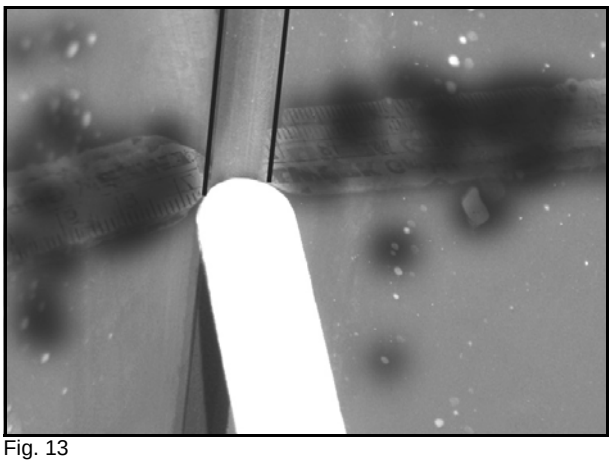

Fig. 11

18. Then apply silicone sealant evenly and under pressure to the outside joint edge (Fig. 11).

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Fig. 12

19. Then spray the joints from inside and outside with water containing washing up liquid (Fig. 12).


Fig. 13

20. Treat the inside joint (Fig. 13)


Fig. 14

21. and the outside joint (Fig. 14) with a scraper or a spattle.

i Note

Once the silicone sealing agent has cured it can only be removed mechanically.

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14 Drum

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14.1 Special tools, drum, single drum rollers

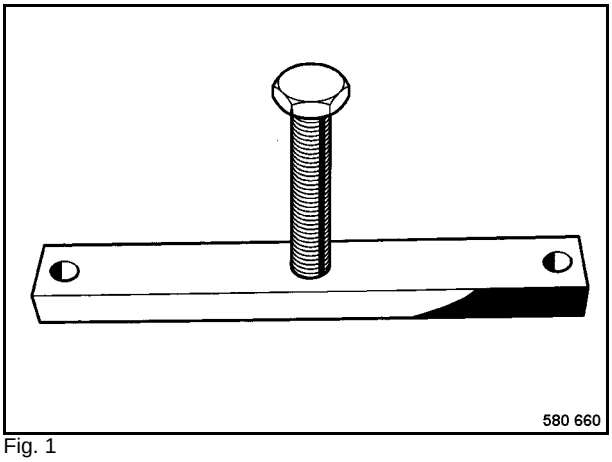


Fig. 1

1. Disassembly device for side plate

   BOMAG part-no.: 007 211 55

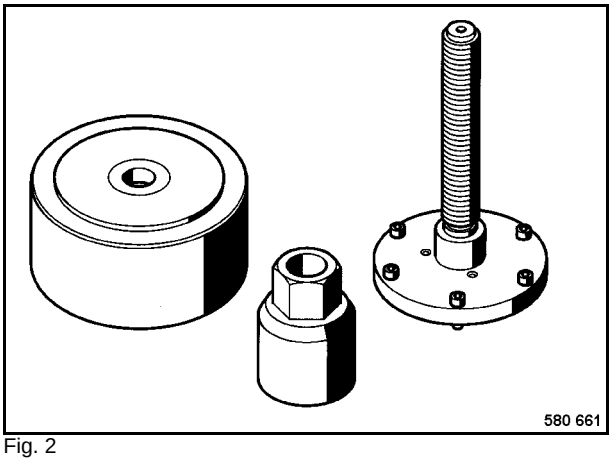


Fig. 2

2. Assembly device for side plate

   BOMAG part-no.: 971 079 21

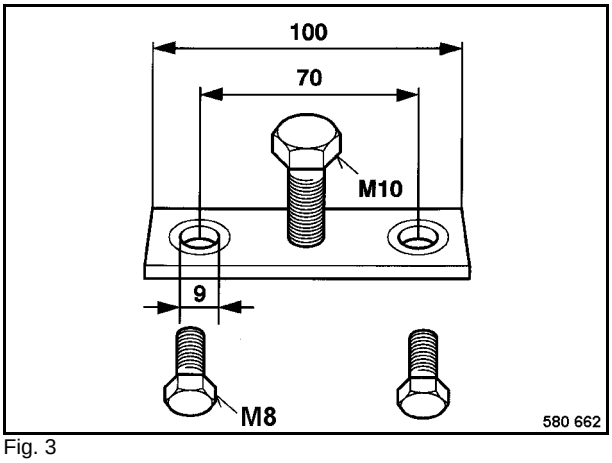


Fig. 3

3. Assembly device for coupling hub and flanged hub

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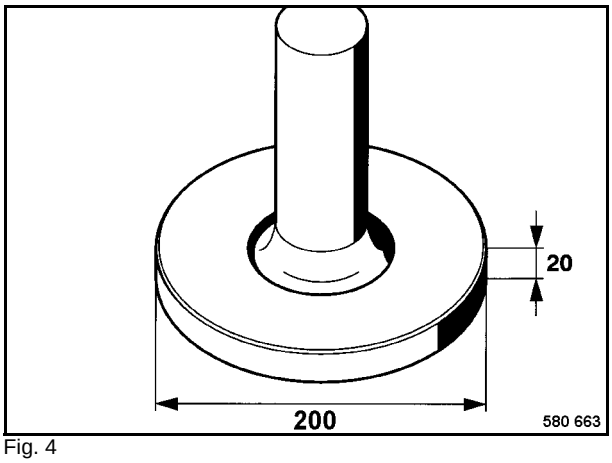


Fig. 4

4. Pressing plate for cylinder roller bearing

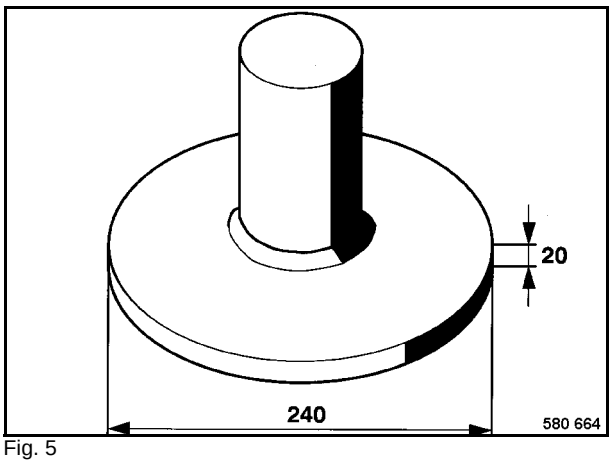


Fig. 5

5. Pressing plate for travel bearing

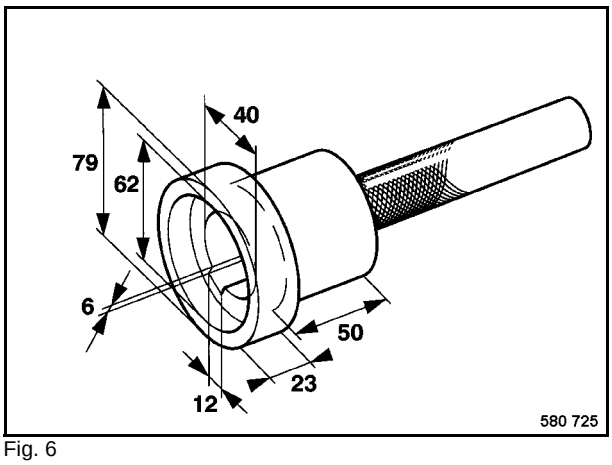


Fig. 6

6. Pressing bushing for radial seal

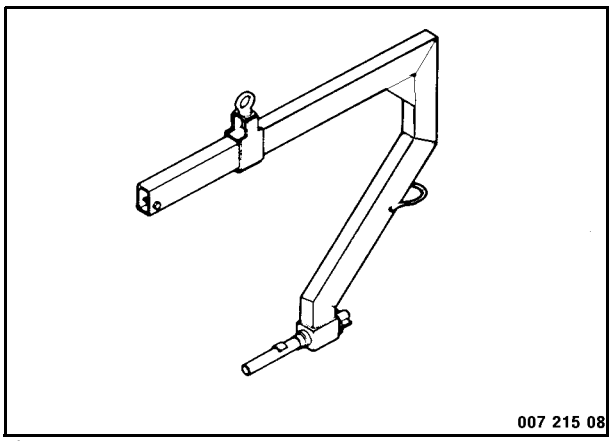
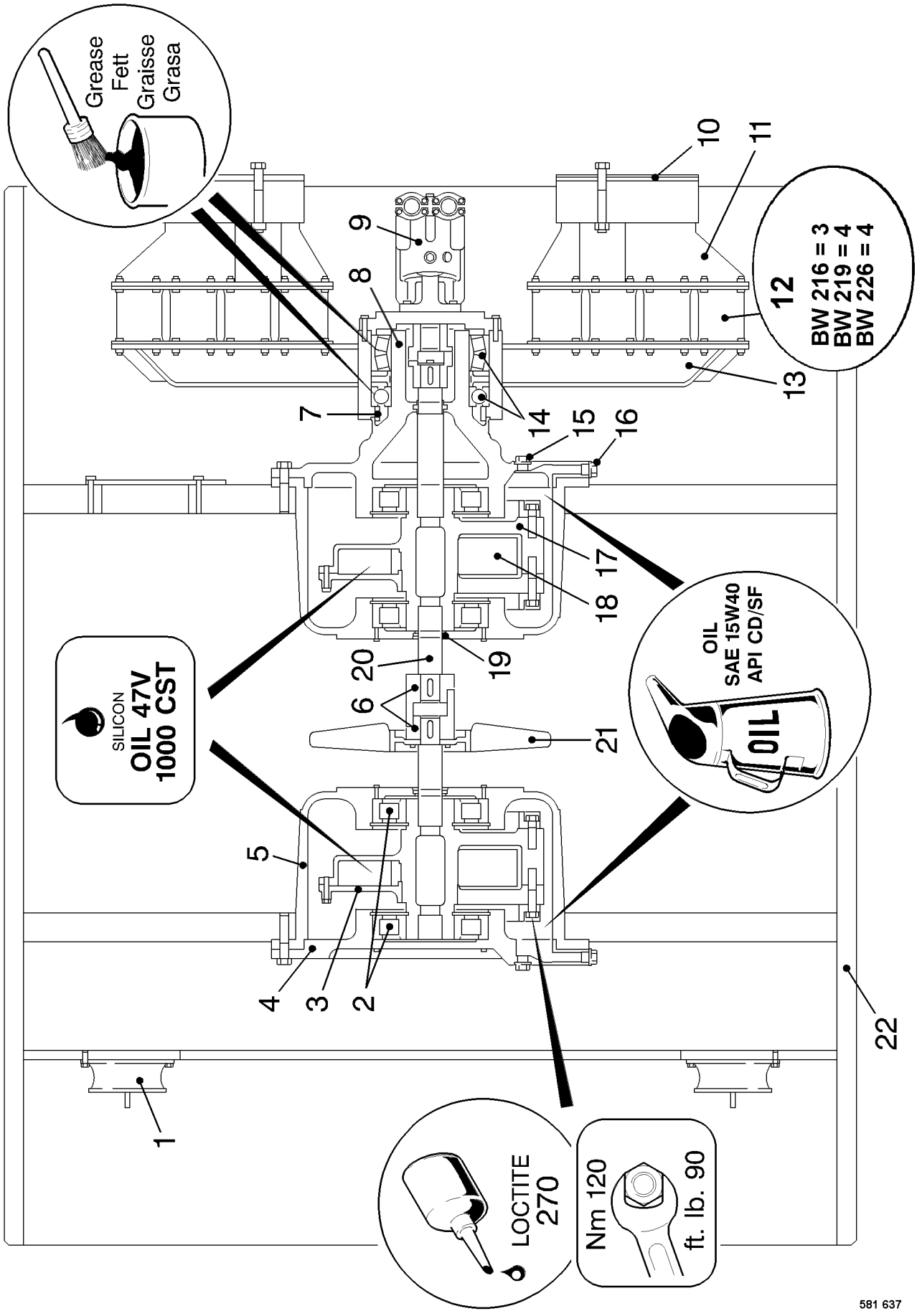


Fig. 7

7. Lifting device for exciter unit

   BOMAG part-no.: 007 215 08

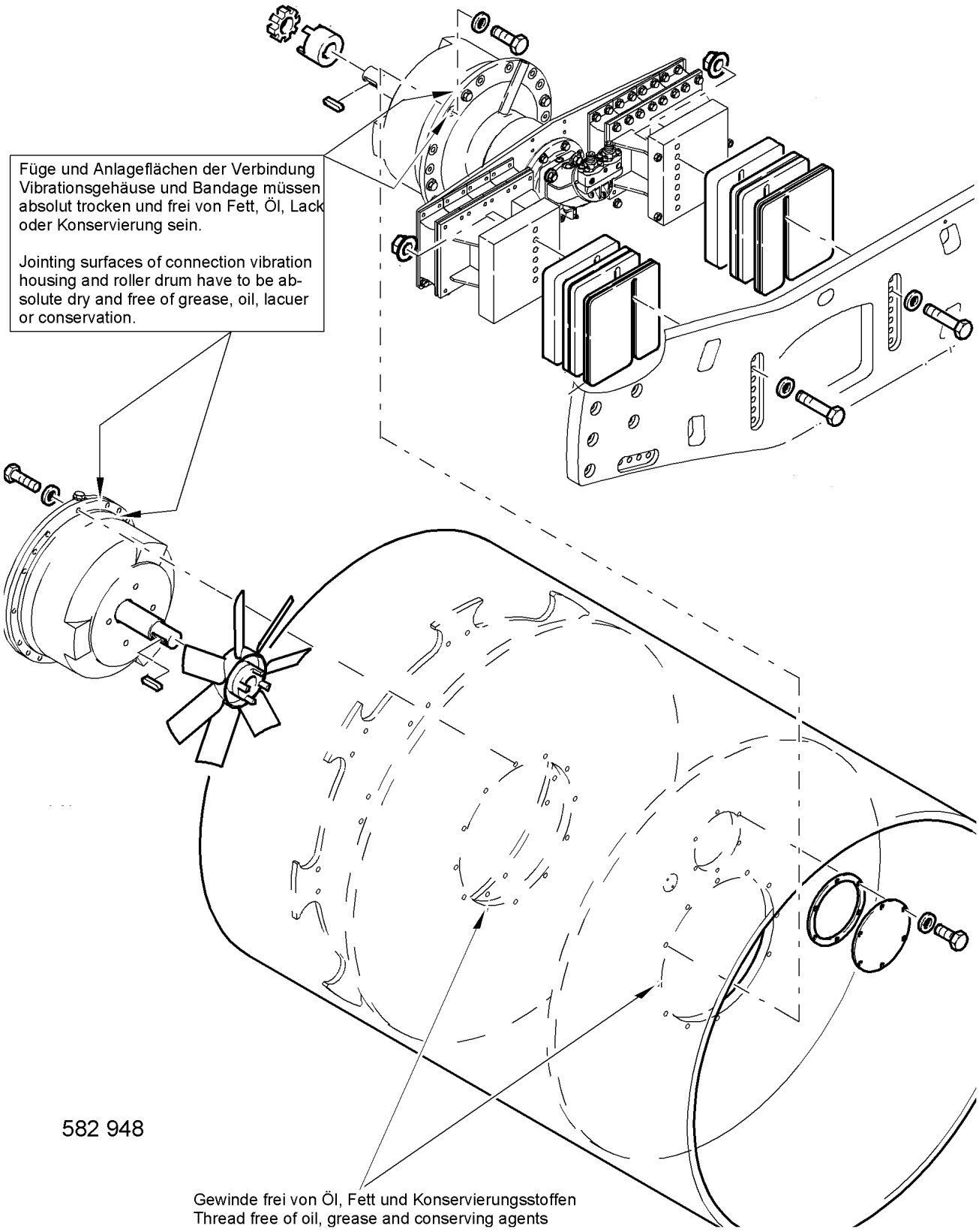
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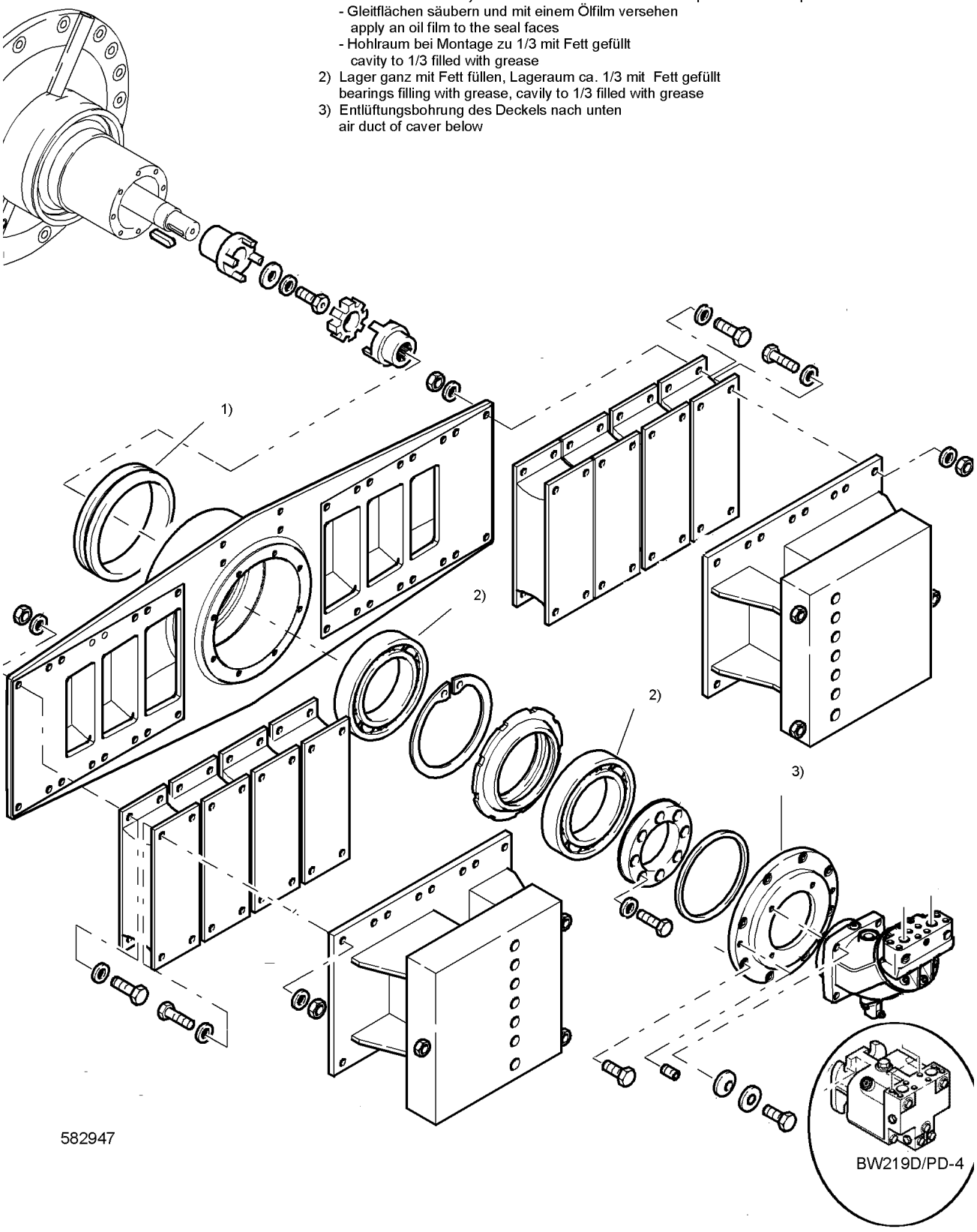
1 Rubber buffer
2 Vibration bearings
3 Housing cover, basic weight
4 Flange
5 Flanged housing
6 Coupling hub
7 Mechanical seal
8 Flanged hub
9 Vibration motor
10 Compensation plates
11 Spacer block
12 Rectangular rubber buffer
13 Side plate
14 Travel bearings
15 Oil level inspection plug
16 Oil drain plug
17 Basic weight
18 Change-over weight
19 Radial seal
20 Vibrator shaft
21 Fan
22 Drum shell

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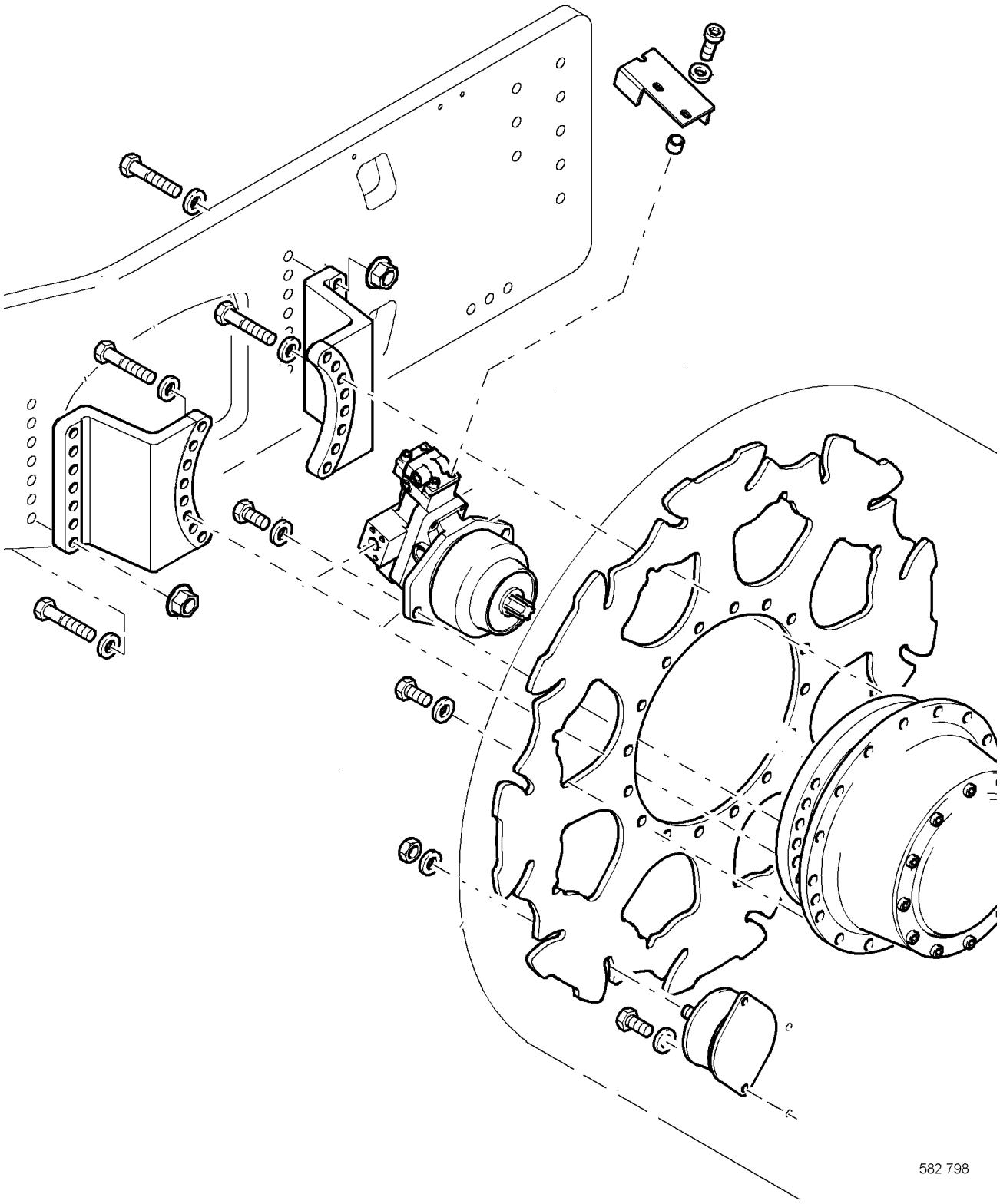


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1) - zur Montageerleichterung Elastomerteil + Bohrung mit Spiritus benetzen (nicht mit Öl o. ä.)
for easier assembly moisten the bore and elastomeric part with white spirit
- Gleitflächen säubern und mit einem Ölfilm versehen
apply an oil film to the seal faces
- Hohlraum bei Montage zu 1/3 mit Fett gefüllt
cavity to 1/3 filled with grease
2) Lager ganz mit Fett füllen, Lageraum ca. 1/3 mit Fett gefüllt
bearings filling with grease, cavily to 1/3 filled with grease
3) Entlüftungsbohrung des Deckels nach unten
air duct of caver below



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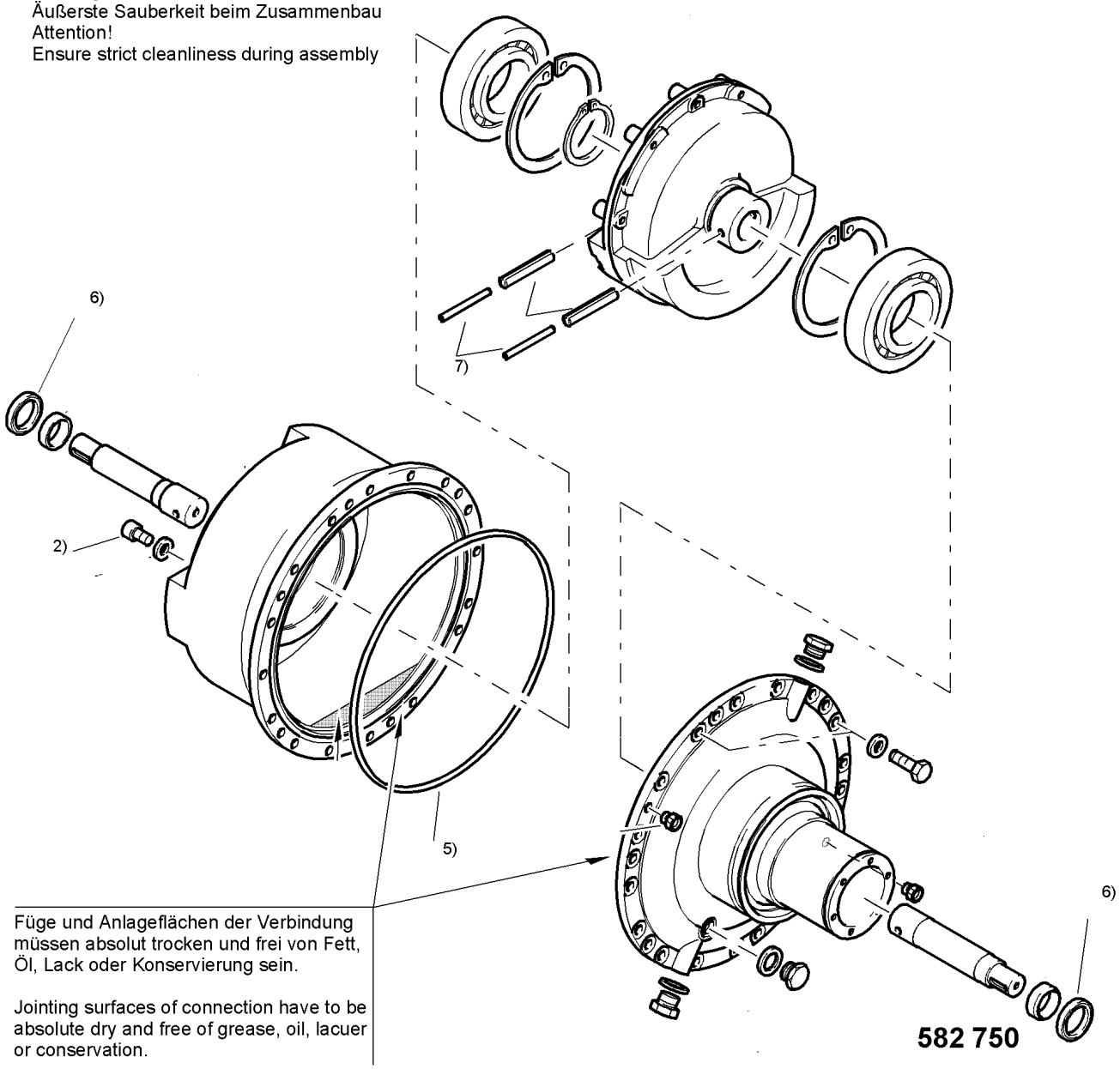
https://truckmanualshub.com/

2) Flüssige Schraubensicherung Loctite CVX stark, blau, Kenn.-Nr. 582, Anziehmoment Ma = 59 Nm
secured with Loctite blue ident no. 582, torque value: 59 Nm
5) O-Ring gefettet einsetzen
o-ring inserted with grease
6) Wellendichtring + Laufstellen auf der Welle vor der Montage einfetten
oil seal inserted with grease
7) Kerben der Spannstifte 180° versetzt und Senkrecht zur Achse der Welle
Slots of dowelpins on oposite side and vertical to shaft axle

Axialspiel der Welle min + 0,6 / max + 1,8

Axial clearance of the schaft min + 0,6 / max + 1,8

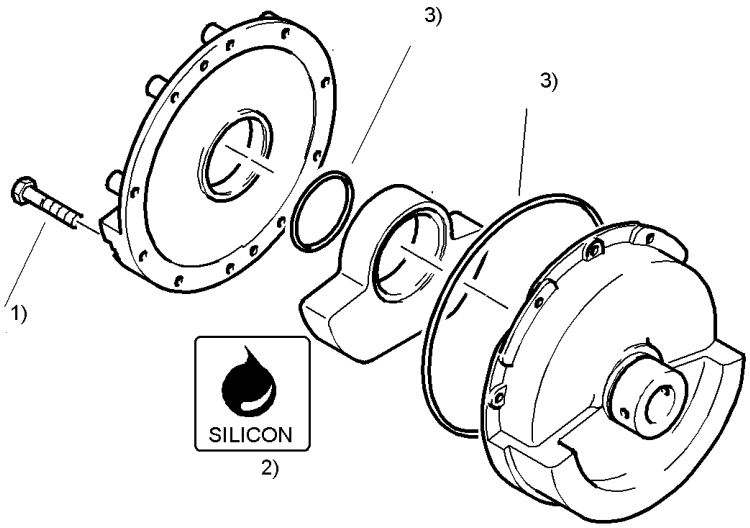
Achtung!
Äußerste Sauberkeit beim Zusammenbau
Attention!
Ensure strict cleanliness during assembly



Füge und Anlageflächen der Verbindung müssen absolut trocken und frei von Fett, Öl, Lack oder Konservierung sein.

Jointing surfaces of connection have to be absolute dry and free of grease, oil, lacuer or conservation.

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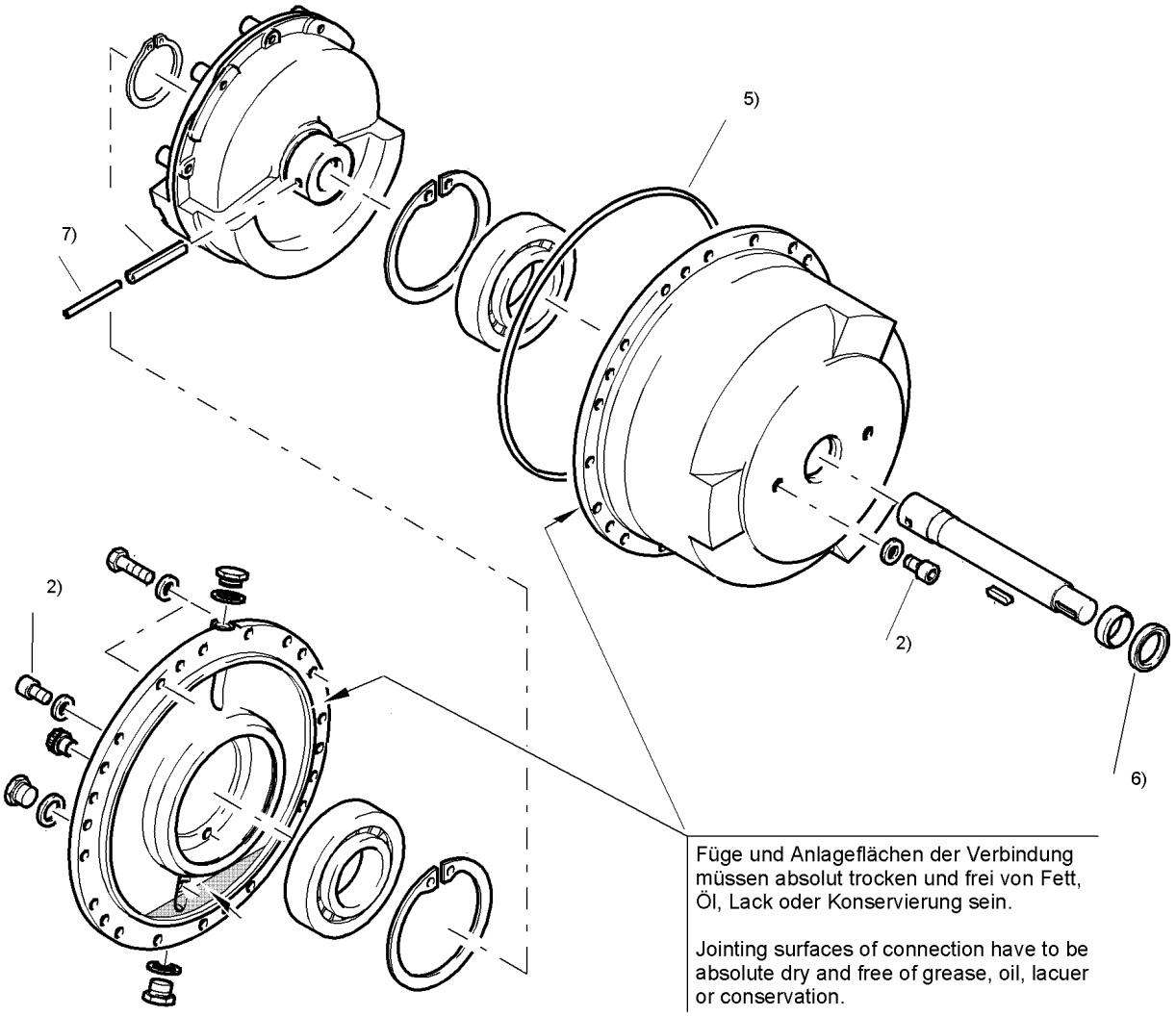


1) Anzugsmoment: 120 Nm mit Loctite blau, Kenn.-Nr 243 gesichert
   Torque value: 120 Nm secured with Loctite blue, ident no. 243
2) mit Siliconöl 47V 1000 cSt befüllt
   filled with Silicone oil 47V 1000 cSt
3) O-Ring gefettet einsetzen
   o-ring inserted with grease

Achtung!
Äußerste Sauberkeit beim Zusammenbau
Attention!
Ensure strict cleanliness during assembly

582 754

https://truckmanualshub.com/



Füge und Anlageflächen der Verbindung müssen absolut trocken und frei von Fett, Öl, Lack oder Konservierung sein.

Jointing surfaces of connection have to be absolute dry and free of grease, oil, lacuer or conservation.

Achtung!
Äußerste Sauberkeit beim Zusammenbau
Attention!
Ensure strict cleanliness during assembly

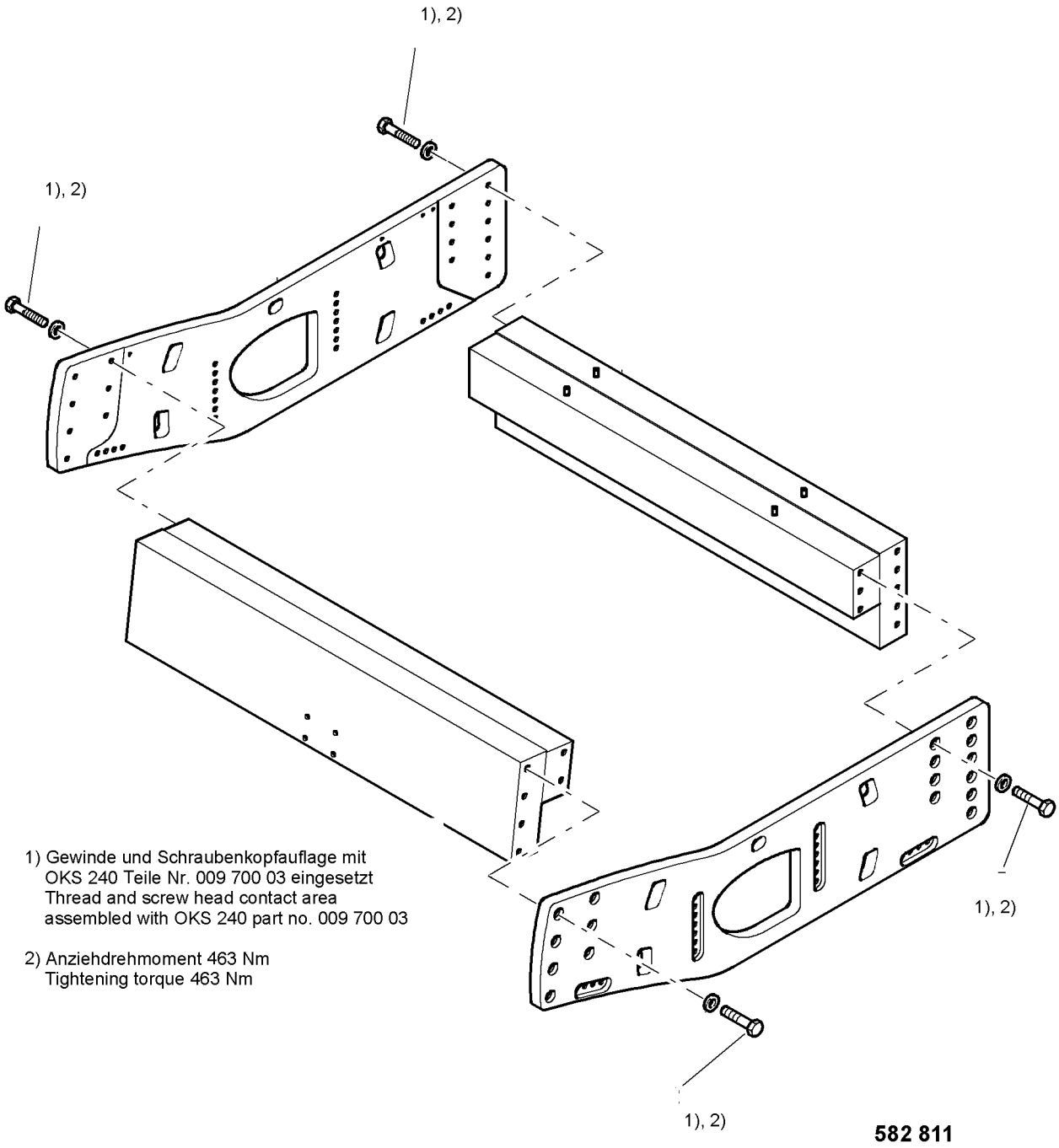
Axialspiel der Welle min + 0,6 max + 1,8

Axial clearance of the schaft min + 0,6 max + 1,8

2) Flüssige Schraubensicherung Loctite CVX stark, blau, Kenn.-Nr. 582, Anziehmoment Ma = 58 Nm
secured with Loctite blue ident no. 582, torque value: 59 Nm
5) O-Ring gefettet einsetzen
o-ring inserted with grease
6) Wellendichtring + Laufstellen auf der Welle vor der Montage einfetten
oil seal inserted with grease
7) Kerben der Spannstifte 180° versetzt und Senkrecht zur Achse der Welle
Slots of dowelpins on oposite side and vertical to shaft axle

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14.3 Removing and installing the drum

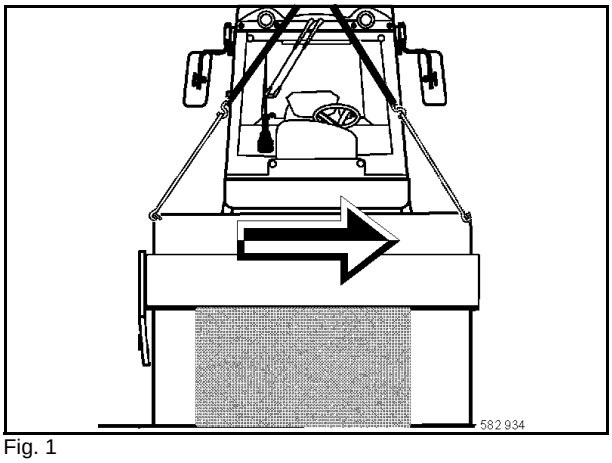


Fig. 1

i Note

After disassembling the side plate (vibration motor side) the drum can be lifted sideways out of the frame (Fig. 1).

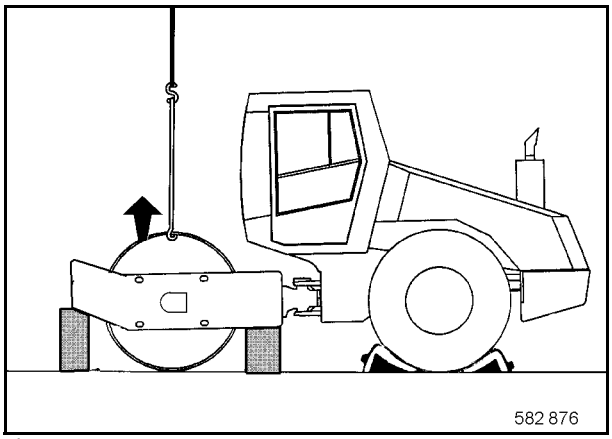


Fig. 2

i Note

However, the drum can also be removed without having to disassemble the side plate, if it is lifted up and out of the frame (Fig. 2).

Removing the drum

i Note

The following section describes the procedure for lifting the frame sideways out of the drum.

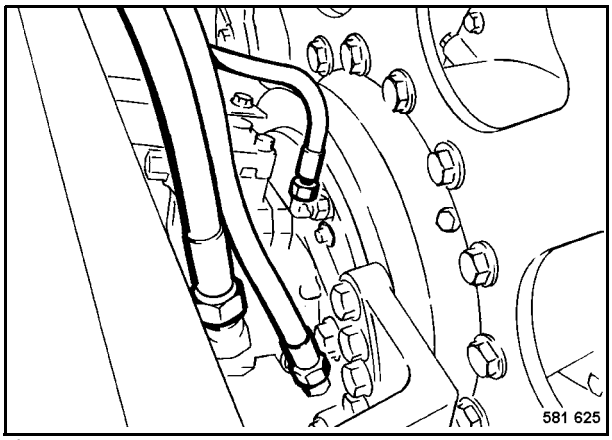


Fig. 3

Environment

Environmental damage

Catch running out hydraulic oil and dispose of environmentally.

8. Mark the hydraulic hoses (Fig. 3)on the travel motor and disconnect them from the ports.
9. Close all hydraulic hoses and motor ports with suitable plugs.

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Fig. 4

10. Mark the hydraulic hoses on the vibration motor (Fig. 4) and disconnect them from the ports.
11. Close all hydraulic hoses and motor ports with suitable plugs.

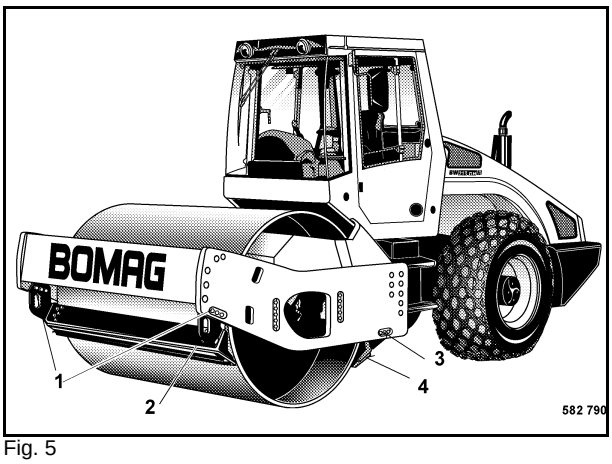


Fig. 5

⚠ Danger

Danger of squashing! Do not stand or step under loads being loaded.

Always secure the machine against unintended rolling!

12. Unscrew bolts 1 (Fig. 5) and nuts and remove the front scraper (2).
13. Unscrew bolts 3 and nuts and remove the front scraper (4).

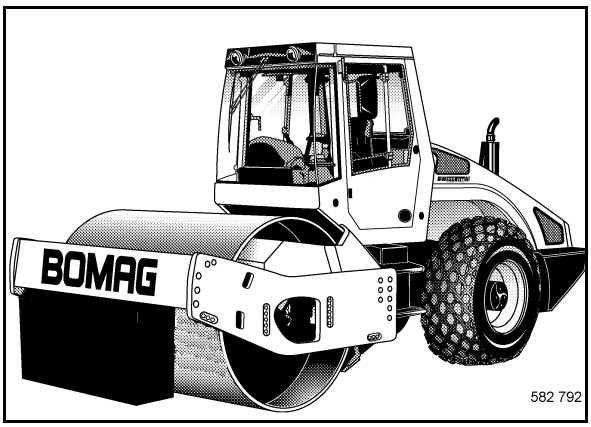


Fig. 6

14. Support the front cross-member safely with suitable trestles or wooden blocks (Fig. 6).

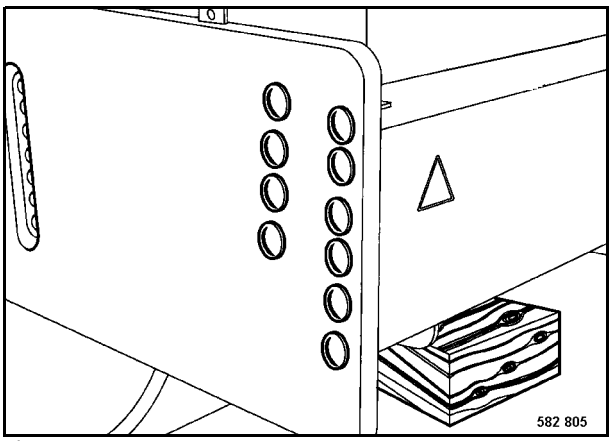


Fig. 7

15. Support the rear cross-member safely with suitable trestles or wooden blocks (Fig. 7).

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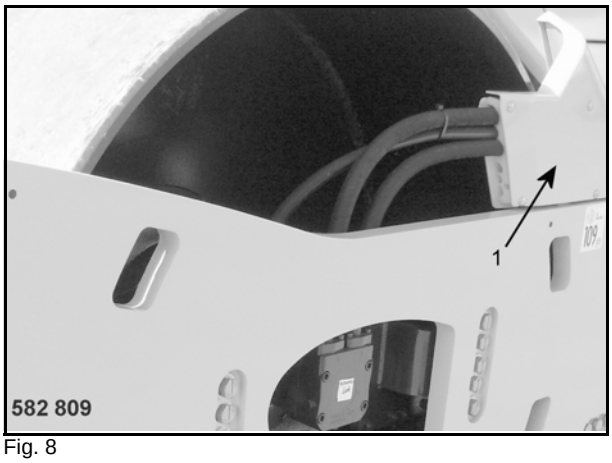


Fig. 8

16. Disassemble bracket 1 (Fig. 8) for the hydraulic hoses.

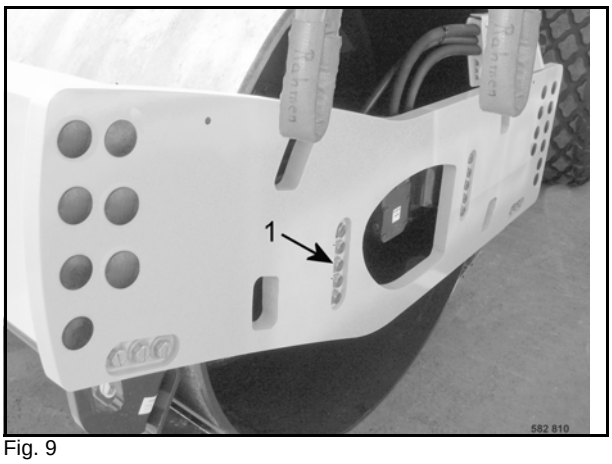


Fig. 9

17. Fasten the lifting gear to the side plate on the vibration motor side.
18. Unscrew bolts 1 (Fig. 9) from the spacer blocks on vibration and travel motors.

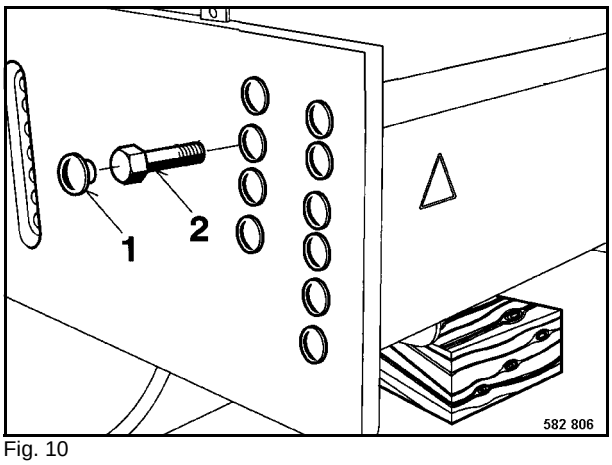


Fig. 10

⚠ Danger

Danger of squashing! Do not stand or step under loads being loaded.

19. Force out plug 1 (Fig. 10) and unscrew the bolts (2) from the front and rear cross-members.
20. Take off the side plate.

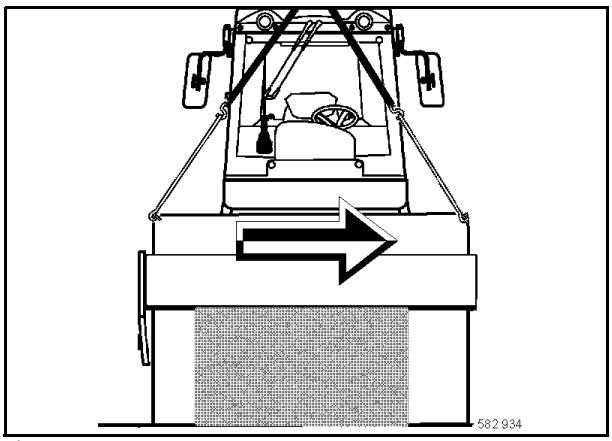


Fig. 11

21. Fasten the lifting tackle to the drum and lift the drum carefully sideways out of the front frame (Fig. 11).

⚠ Danger

Danger of squashing! Do not stand or step under loads being loaded.

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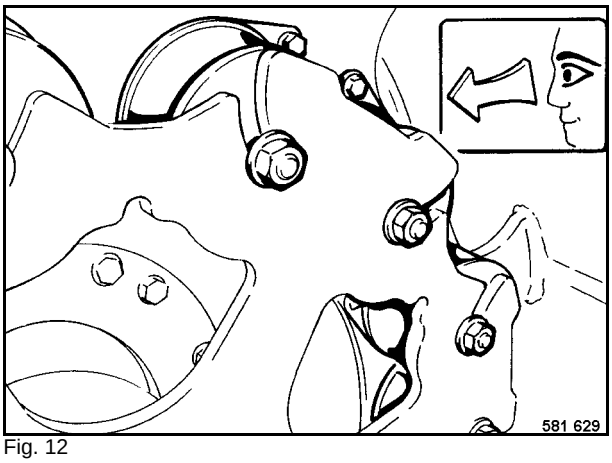


Fig. 12

22. Check all rubber buffers (Fig. 12), replace if necessary (see corresponding chapter).

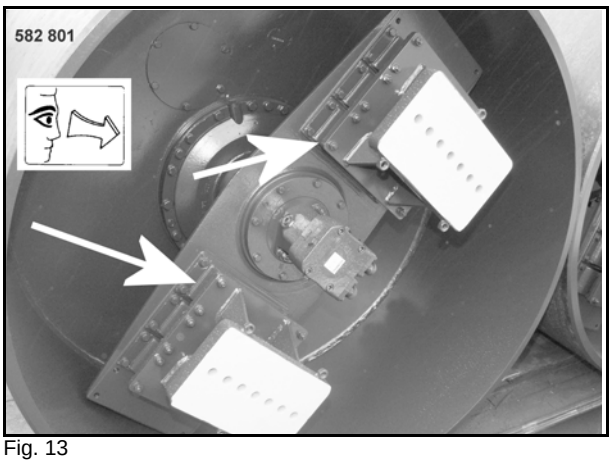


Fig. 13

23. Check rectangular rubber buffers (Fig. 13), replace if necessary.

Installing the drum

⚠ Danger

Danger of squashing!

Do not stand or step under loads being loaded.

1. Place the drum into the frame and align it parallel to the frame (Fig. 14).

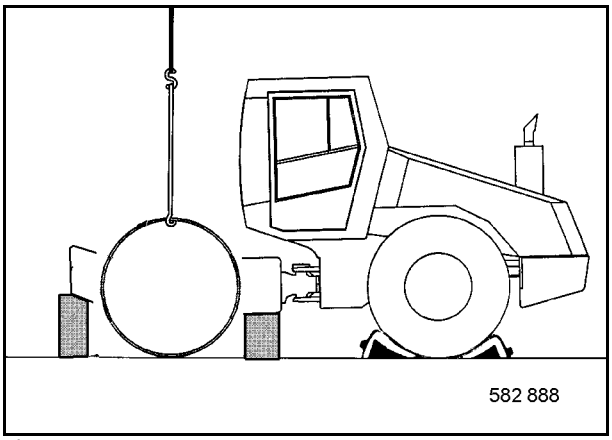


Fig. 14

i Note

Apply sliding lacquer OKS 240 to threads and screw head contact face to ease assembly.

2. Attach the side plate, insert the bolts 2 (Fig. 15) into rear and front cross-members and tighten with 463 Nm.
3. Close the screw holes with plugs (1).

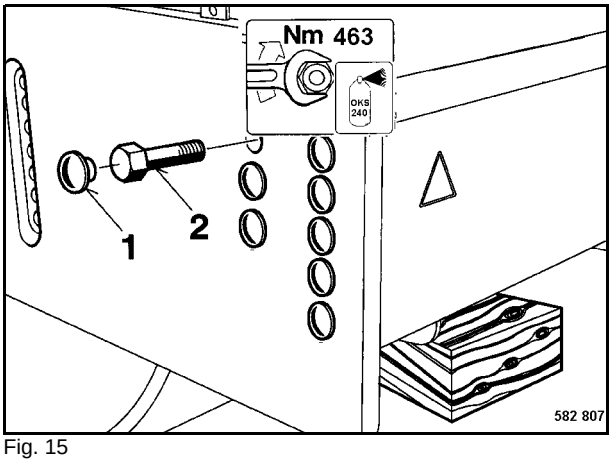


Fig. 15

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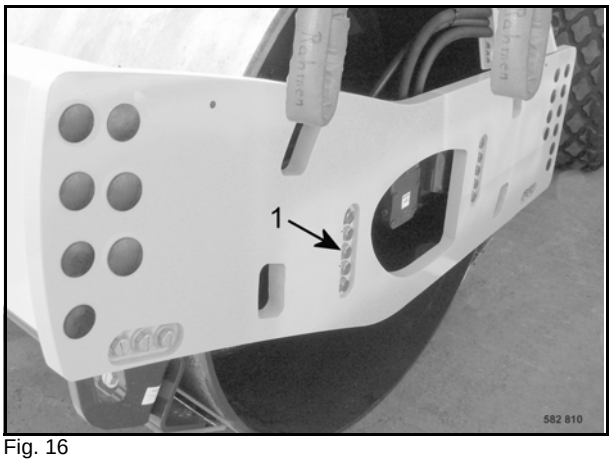


Fig. 16

4. Fasten the spacer blocks on travel and vibration motor sides with bolts 1 (Fig. 16) and nuts to the side plates.

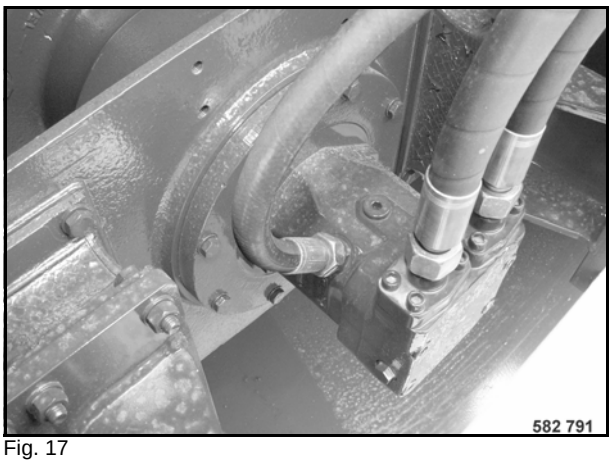


Fig. 17

5. Connect hydraulic hoses to the connections on travel motor and vibration motor according to the marking (Fig. 17).

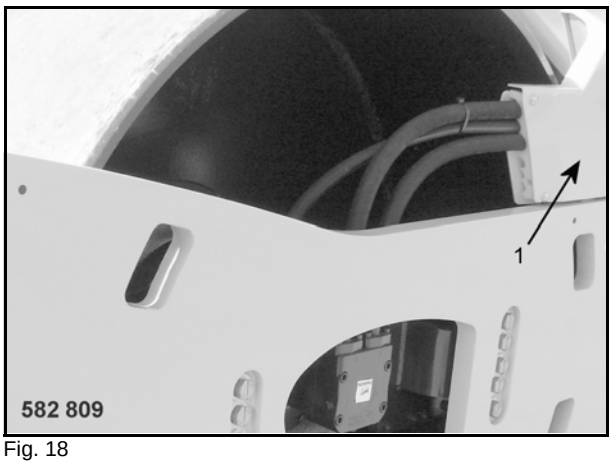


Fig. 18

6. Fasten bracket 1 (Fig. 18) for the hydraulic hoses.

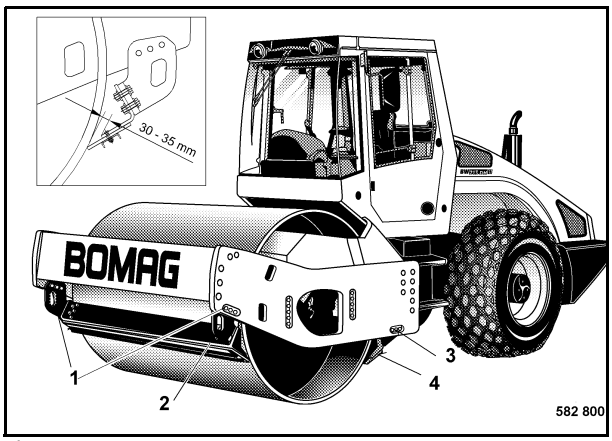


Fig. 19

7. Assemble the front scraper 2 (Fig. 19), fasten with bolts (1), washers and nuts.
8. Assemble the rear scraper (4), fasten with bolts (3), washers and nuts.

i Note

Observe the adjustment measurement 30-35 mm

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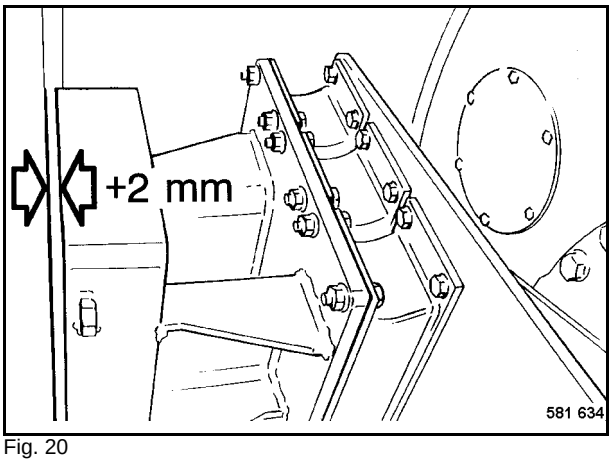


Fig. 20

⚠ Caution

Before resuming operation of the machine:

Bleed the hydraulic system and check for function and leaks.

Adjust the pretension of the rubber buffers.

9. On the vibration drive side measure the distance "X" between spacer block and side plate (Fig. 20).
10. Calculate the thickness of the compensation plates.

Nominal value:

Distance "X" + 2 mm

i Note

Compensation plates of 2 and 5 mm thickness are available.

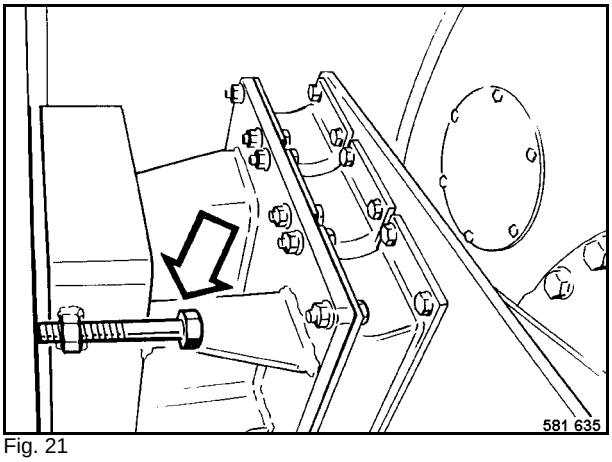


Fig. 21

11. Turn in screws into each welded nut (Fig. 21) and provide sufficient space to insert the compensation plates.

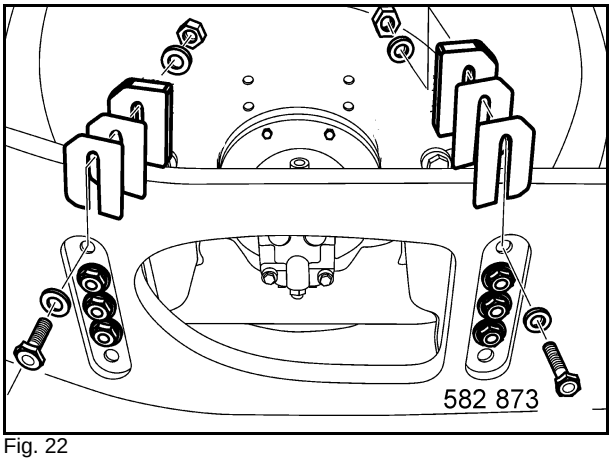


Fig. 22

12. Insert the compensation plates (Fig. 22).
13. Turn in the fastening screws.
14. Unscrew the screws from the welded nuts.
15. Tighten the fastening screws.

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14.4 Repairing the drum

Removing the travel motor

⚠ Danger

Danger of squashing!

Do not stand or step under suspended loads.

1. Attach the lifting tackle to travel drive 3 (Fig. 3).
2. Unscrew all nuts (1) from the rubber buffers.
3. Take drive disc (2) with travel drive off the rubber buffers and lay it down.

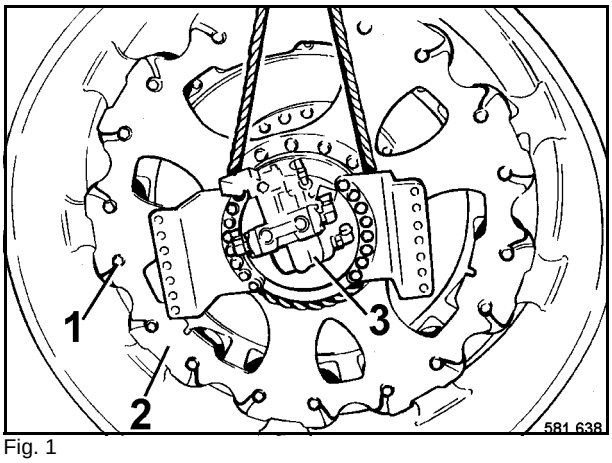


Fig. 1

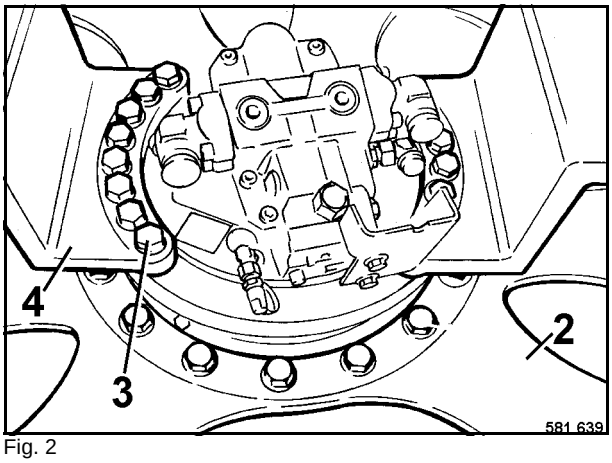


Fig. 2

4. Unscrew fastening screws 3 (Fig. 4) and take off support legs (4).
5. Unscrew fastening screws 1 and take off drive disc (2).

Disassembling the exciter unit (travel motor side)

1. Unscrew both socket head cap screws from the flange (Fig. 3).

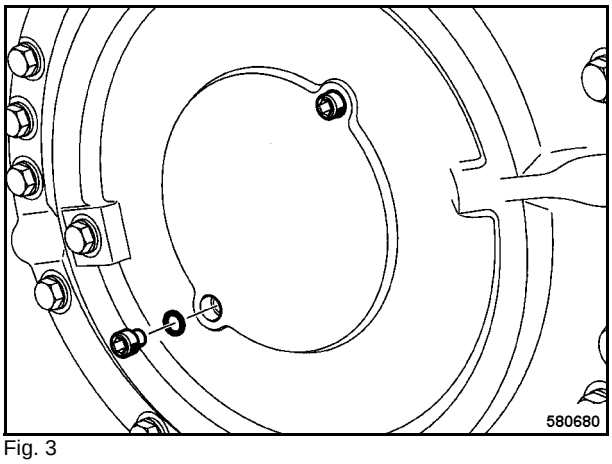


Fig. 3

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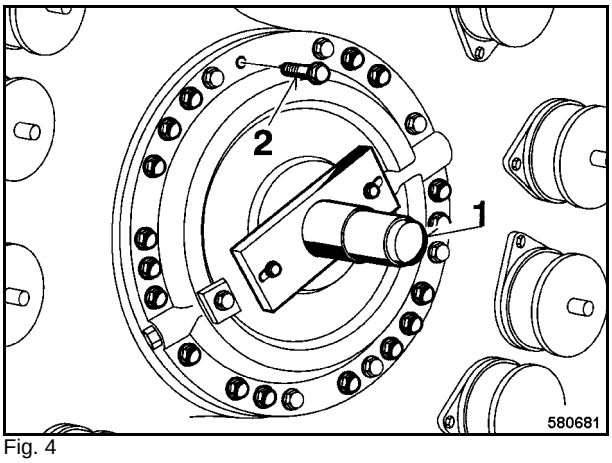


Fig. 4

2. Mount bracket 1 (Fig. 10) for the lifting device to the flange.
3. Unscrew screws (2) from the flange.

i Note

Do not unscrew the thin drawn screws.

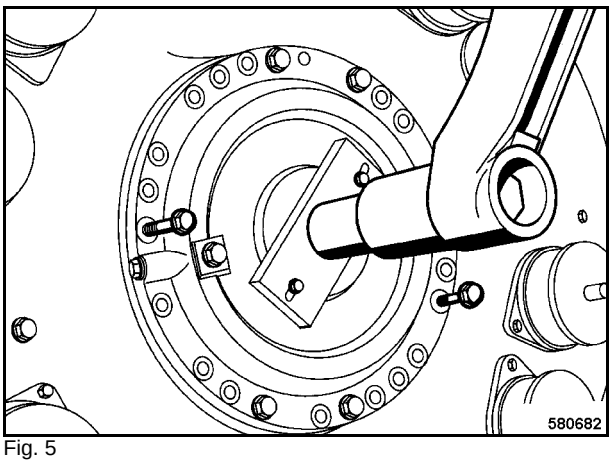


Fig. 5

4. Slide the lifting device over the bracket.
5. Force the exciter unit off with two forcing screws (Fig. 5).

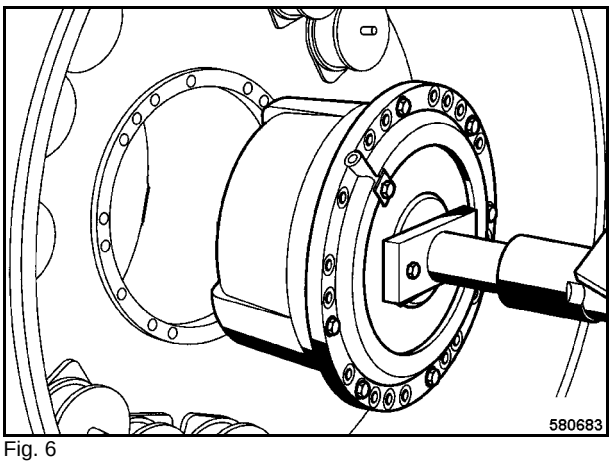


Fig. 6

⚠ Danger

Danger of squashing!

Do not stand or step under suspended loads.

6. Pull the exciter unit out of the drum (Fig. 6).
7. Take the coupling element off the coupling half.

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Disassembling the exciter unit (travel motor side)

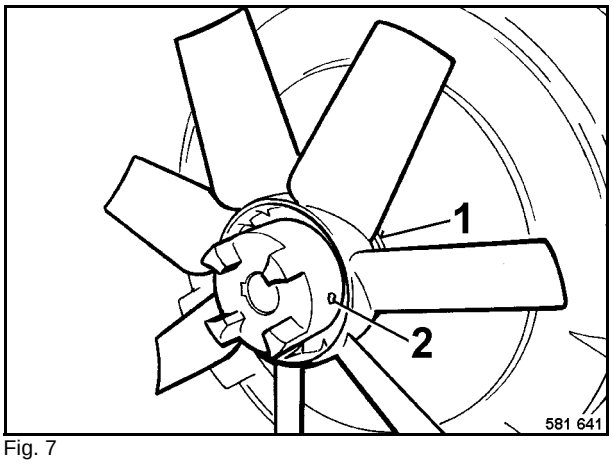


Fig. 7

1. Unscrew fastening screws 1 (Fig. 7) for the fan.
2. Loosen clamping screw (2).
3. Pull the coupling hub off the shaft.

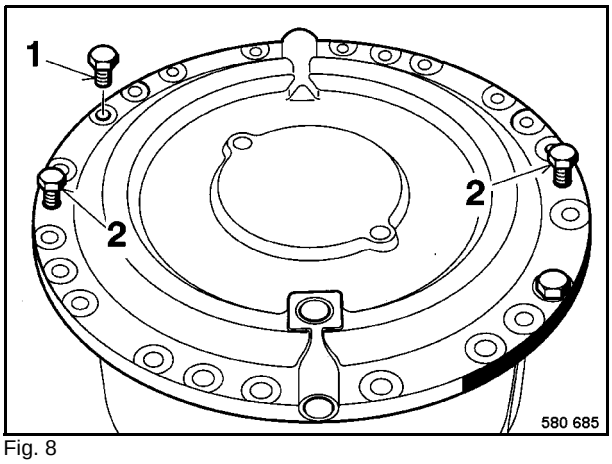


Fig. 8

4. Unscrew all other fastening screws 1 (Fig. 8) from the flange.
5. Press the flange off the flanged housing with forcing screws (2).

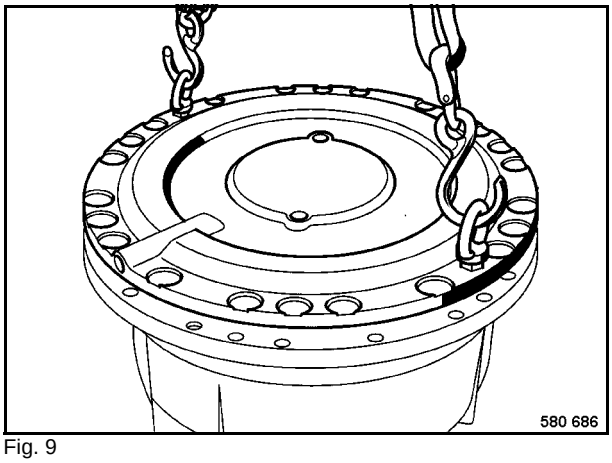


Fig. 9

Environment

Environmental damage!

Catch running out oil and dispose of environmentally.

6. Lift the flange off the flanged housing (Fig. 9).
7. Take the O-ring out of the groove in the flanged housing.

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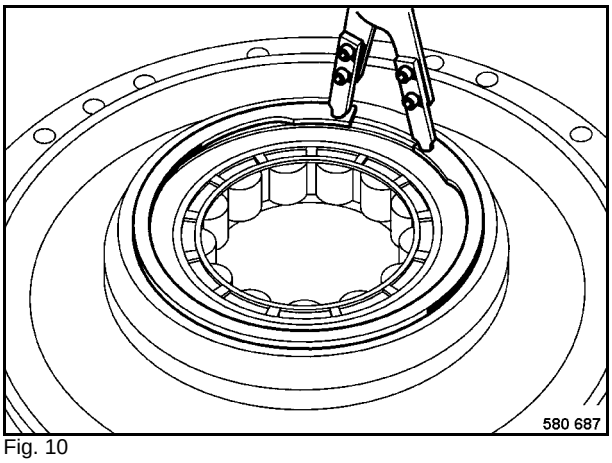


Fig. 10

8. Unclip the circlip from the groove in the flange (Fig. 10).

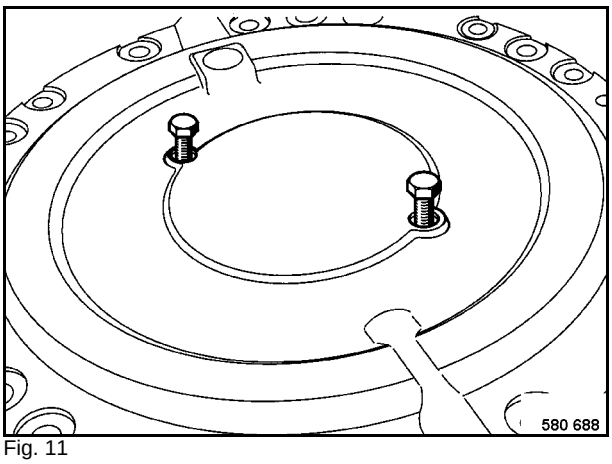


Fig. 11

9. Press the cylinder roller bearing with forcing screws out of the flange (Fig. 11).

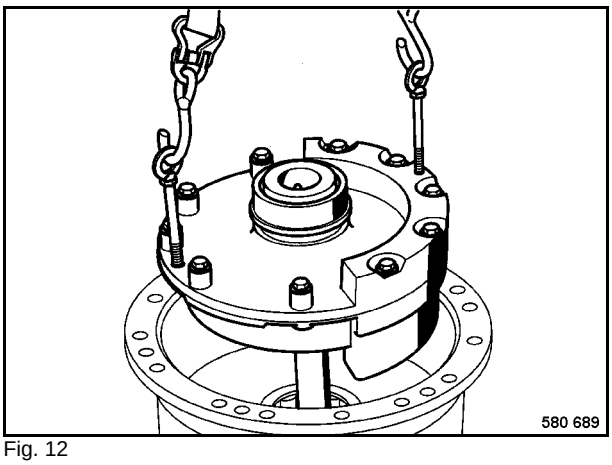


Fig. 12

10. Take the exciter unit (Fig. 12) out of the flanged housing.

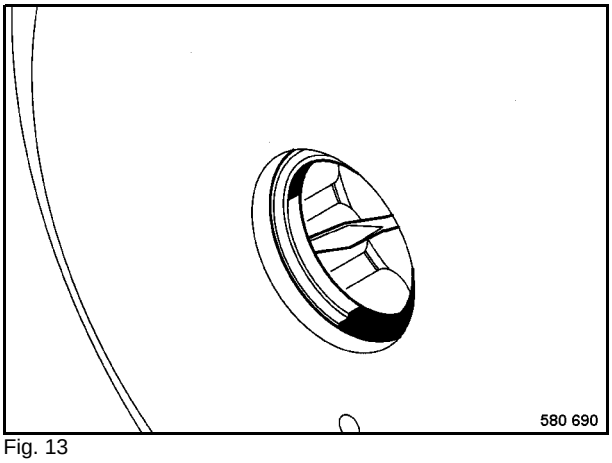


Fig. 13

11. Knock the radial seal (Fig. 13) out of the flanged housing.

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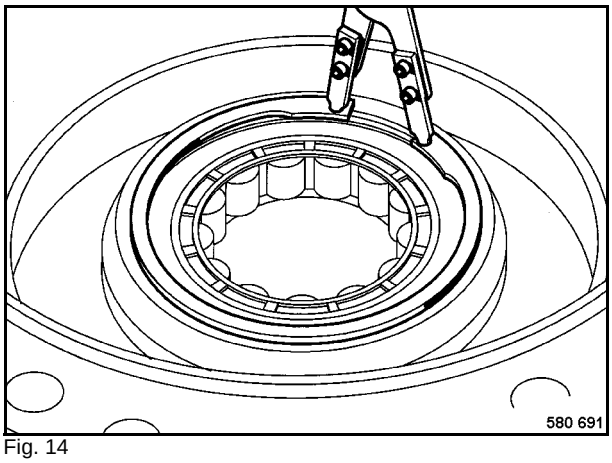


Fig. 14

12. Unclip the circlip from the groove in the flanged housing (Fig. 14).

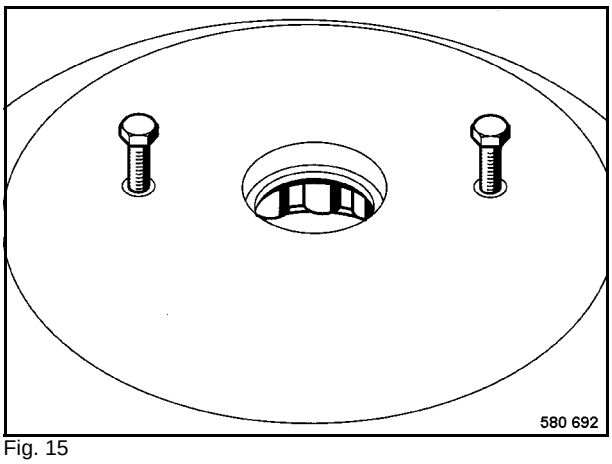


Fig. 15

13. Press the cylinder roller bearing with forcing screws out of the flanged housing (Fig. 15).

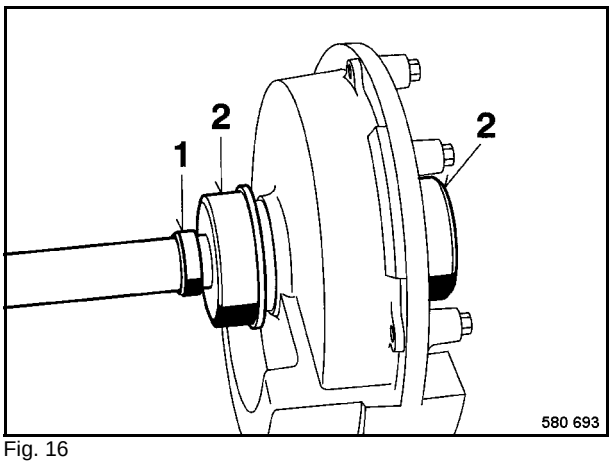


Fig. 16

14. Extract inner ring 1 (Fig. 16) for the radial seal and inner bearing races (2).

⚠ Danger

Danger of burning!

Wear safety gloves.

i Note

If the rings are very tight, heat them up with a torch.

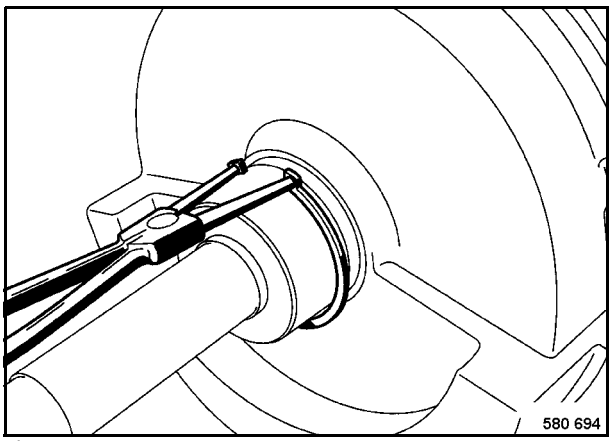


Fig. 17

15. Unclip the circlip from the basic weight (Fig. 17).

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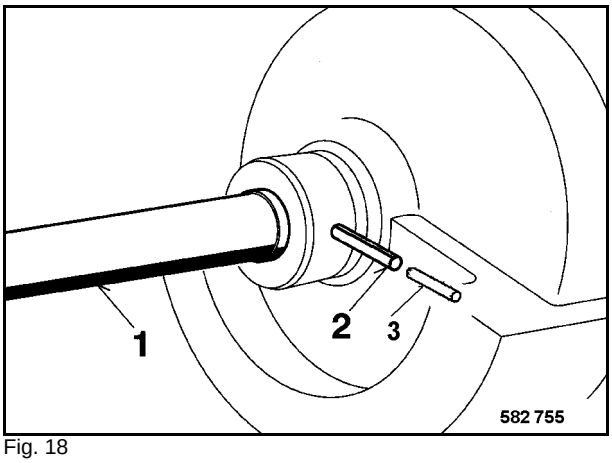


Fig. 18

16. To change shaft 1 (Fig. 18) knock out dowel pins (2 and 3) and press the shaft out of the basic weight.

i Note
If necessary disassemble, assemble the change-over weight (see corresponding chapter).

Disassembling the exciter unit (vibration motor side)

1. Unscrew fastening screw 1 (Fig. 19).
2. Take rectangular rubber buffer (2) with spacer block (3) off the side plate.

i Note
Remove both rectangular rubber buffers.

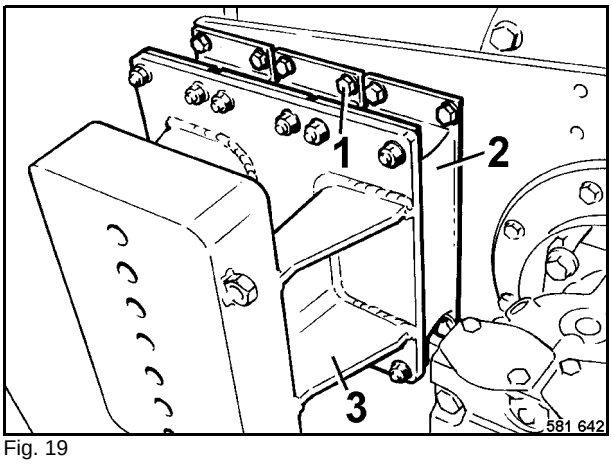


Fig. 19

3. Unscrew fastening screws 1 (Fig. 20).
4. Force cover (2) together with the attached vibration motor off the side plate with forcing screws.

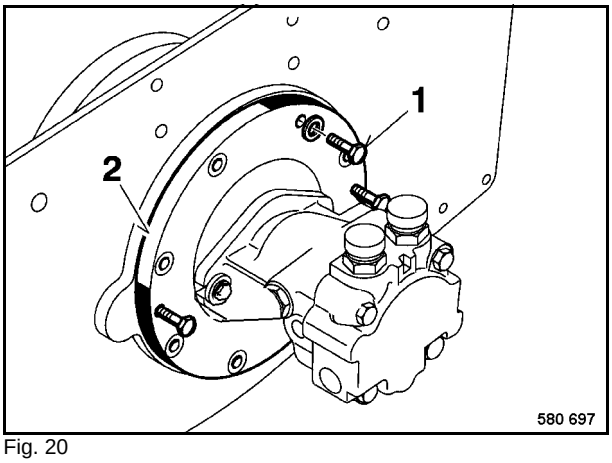


Fig. 20

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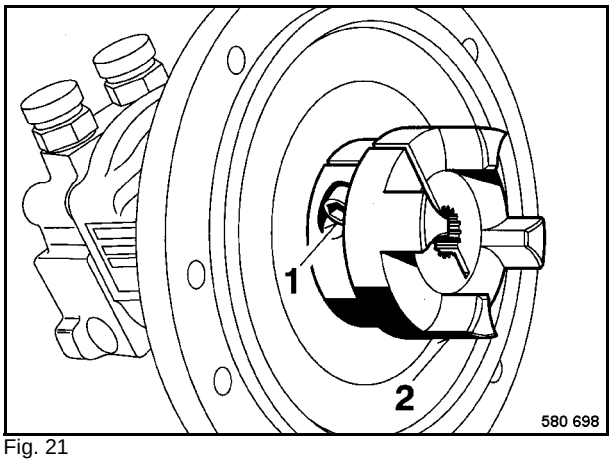


Fig. 21

5. To change the vibration motor loosen clamping screw 1 (Fig. 21) and pull off coupling half (2).

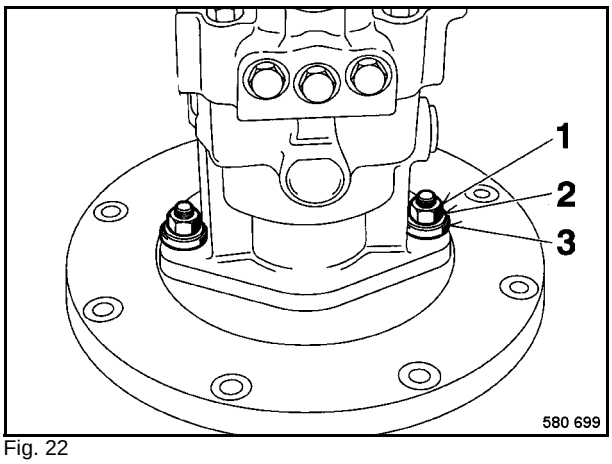


Fig. 22

6. Unscrew nut 1 (Fig. 22), take off conical socket (2) and conical disc (3).
7. Take the vibration motor off the cover.

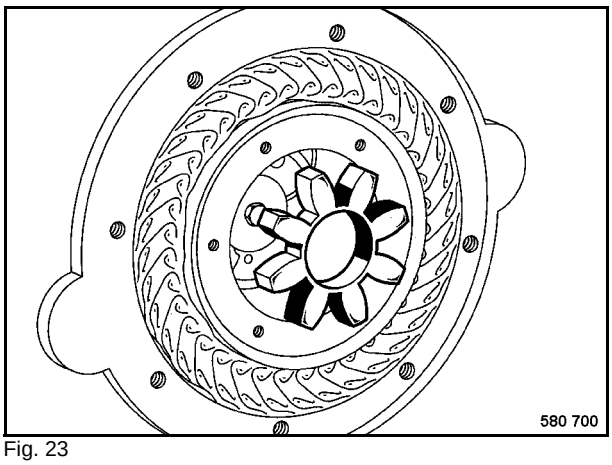


Fig. 23

8. Remove the coupling element (Fig. 23).

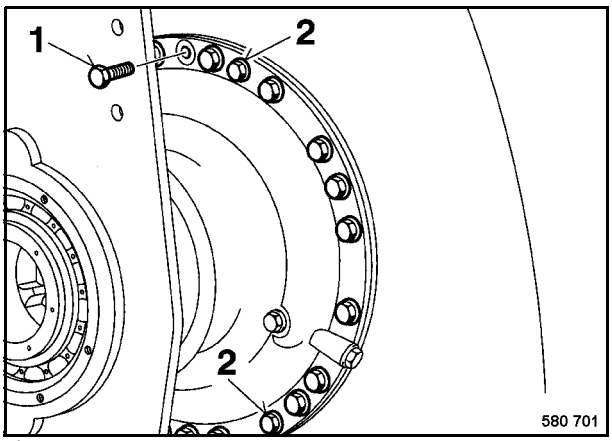


Fig. 24

9. Fasten the lifting device.
10. Unscrew fastening screws 1 (Fig. 24).

⚠ Caution

The four short fastening screws (2) must remain screwed in (the two others are not visible).

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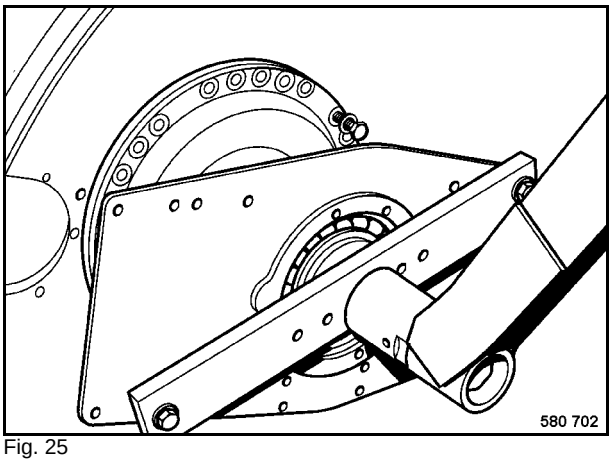


Fig. 25

11. Press the exciter unit out of the drum with forcing screws (Fig. 25).

i Note

The second forcing screw is covered by the side plate.

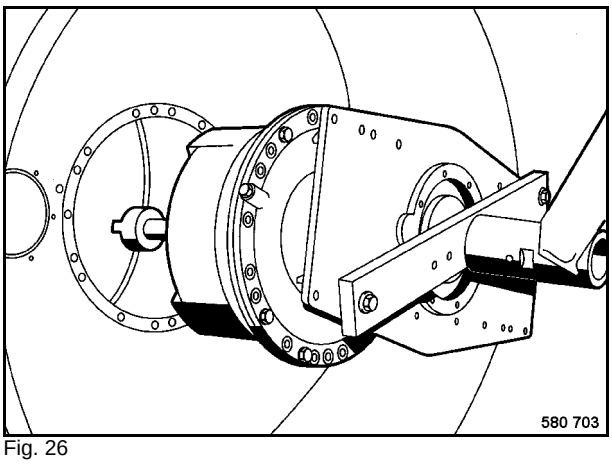


Fig. 26

⚠ Caution

Danger of squashing!

Do not stand or step under suspended loads.

12. Pull the exciter unit out of the drum (Fig. 26).

Removing, dismantling the side plate

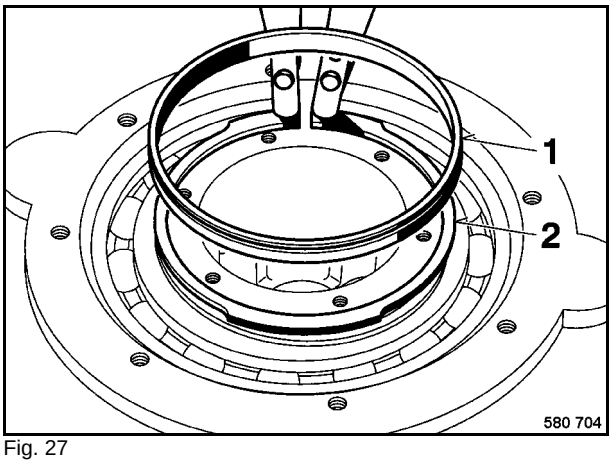


Fig. 27

1. Take off V-ring 1 (Fig. 27).
2. Unclip circlip (2).

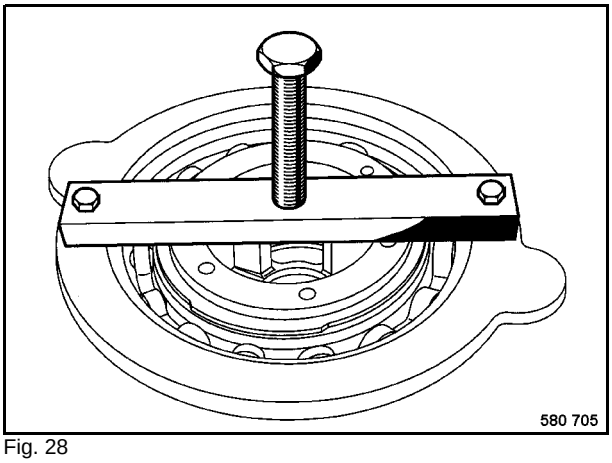


Fig. 28

3. Attach the disassembly device to the side plate (Fig. 28) and force off the side plate.

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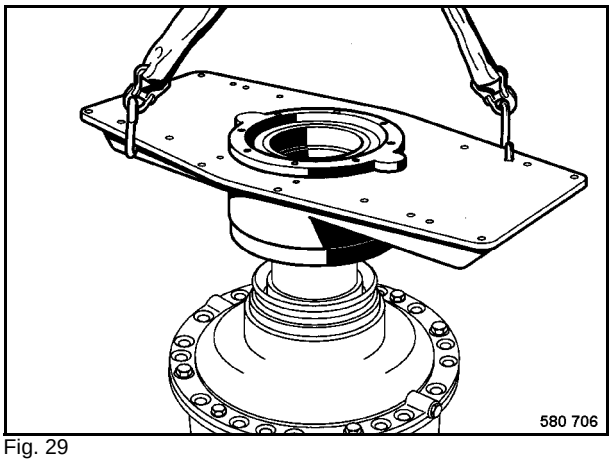


Fig. 29

4. Lift the side plate of the flanged hub (Fig. 29).

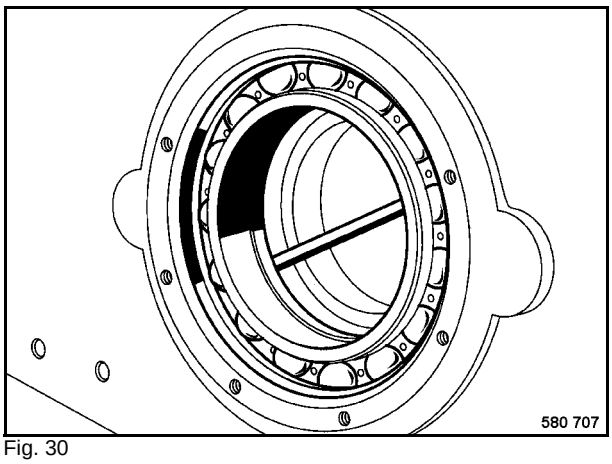


Fig. 30

5. Knock the grooved roller bearing out of the side plate (Fig. 30) and take out the spacer ring.

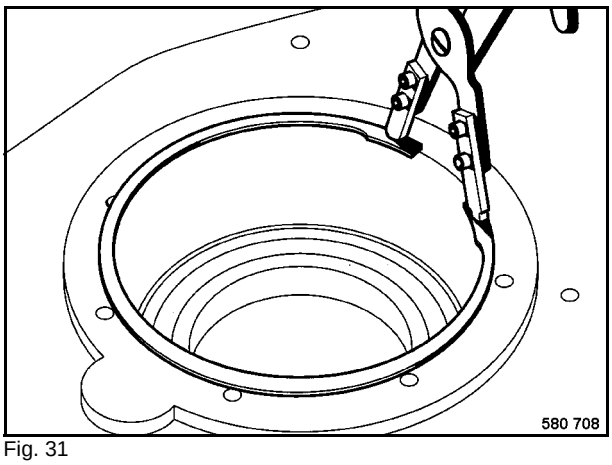


Fig. 31

6. Unclip the circlip from the side plate (Fig. 31).

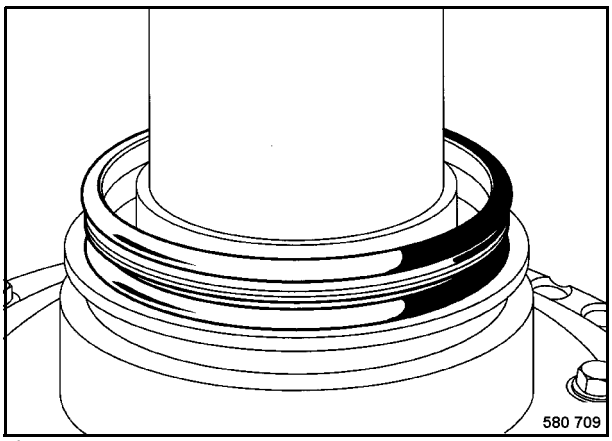


Fig. 32

7. Take the mechanical seal off the flanged hub (Fig. 32).

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Dismantling the exciter unit (vibration motor side)

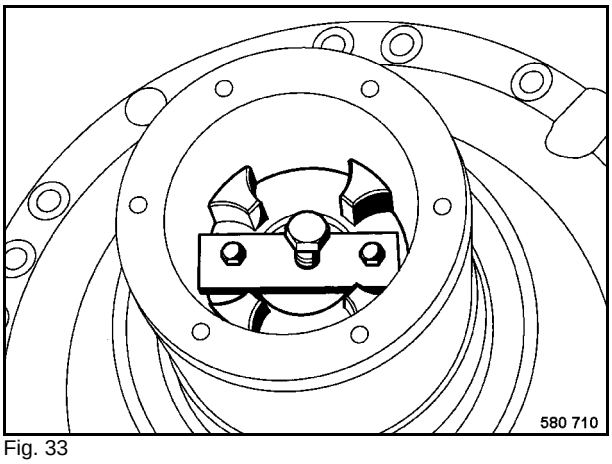


Fig. 33

1. Unscrew the fastening from the coupling hub.
2. Pull coupling hub (2) off the shaft using a pulling device (Fig. 33).

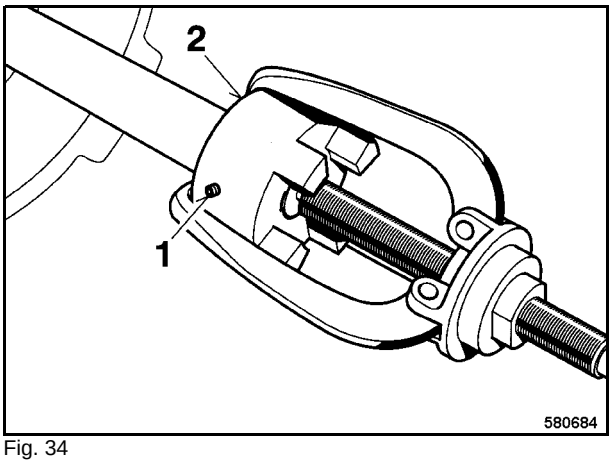


Fig. 34

3. Loosen hose clamp 1 (Fig. 34).
4. Pull coupling hub (2) off the shaft.

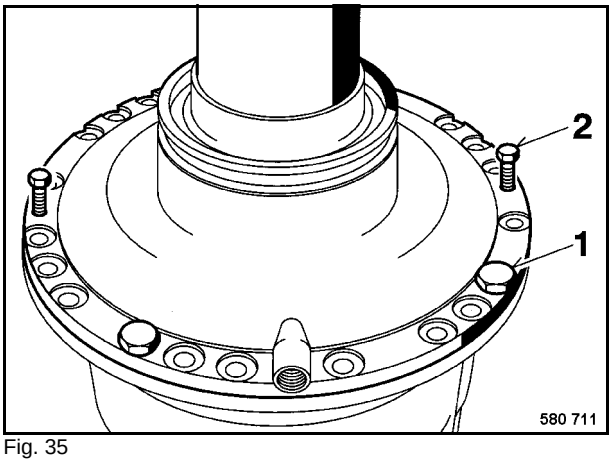


Fig. 35

5. Unscrew all other fastening screws 1 (Fig. 35) and press the flanged hub off the flanged housing with forcing screws (2).
6. Take off the flanged hub.
7. Take the O-ring out of the groove in the flanged housing.

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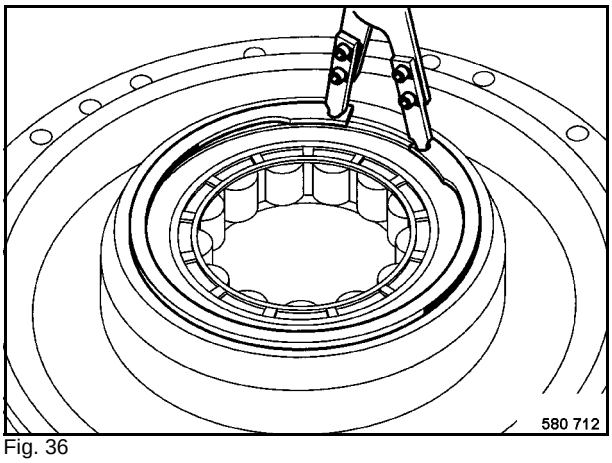


Fig. 36

8. Unclip the circlip from the groove in the flanged hub (Fig. 36).

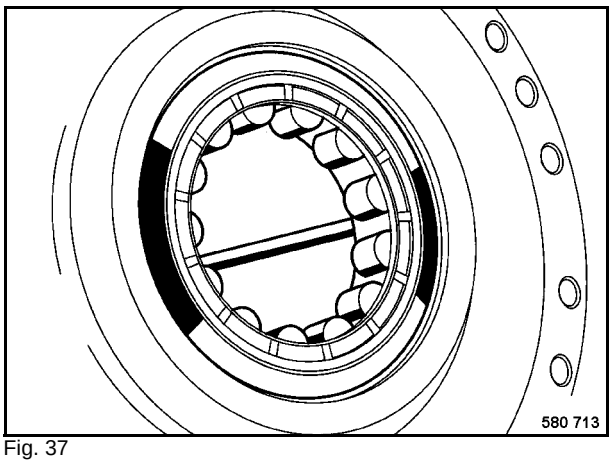


Fig. 37

9. Knock the cylinder roller bearing out of the flanged hub (Fig. 37).

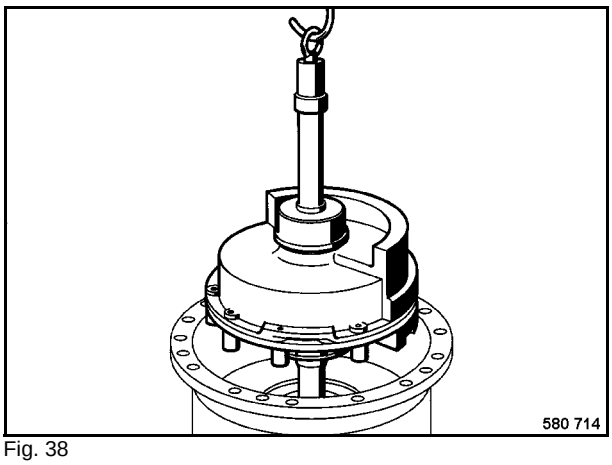


Fig. 38

Environment

Environmental damage!

Catch running out oil and dispose of environmentally.

10. Lift the exciter unit out of the flanged housing (Fig. 38).

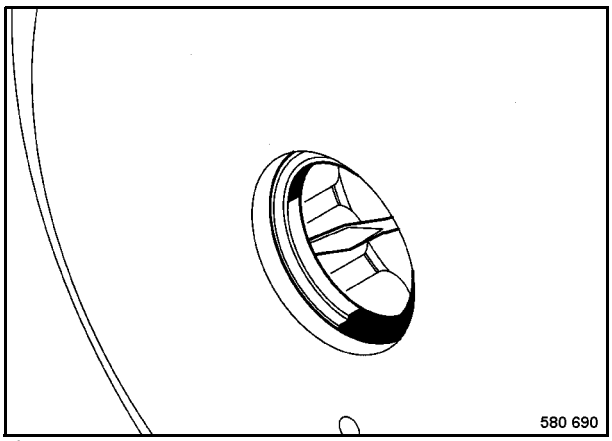


Fig. 39

11. Knock the radial seal (Fig. 39) out of the flanged housing.

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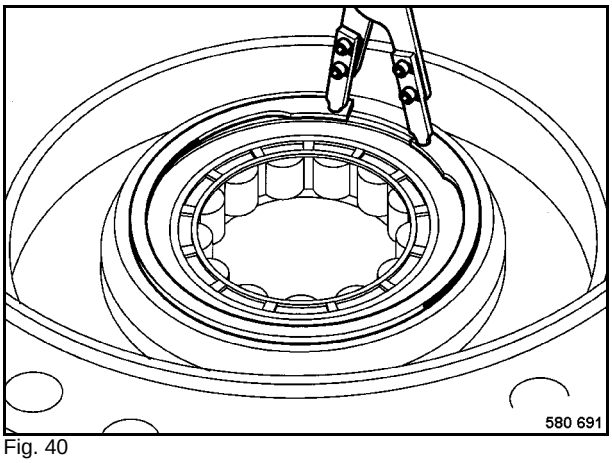


Fig. 40

12. Unclip the circlip from the groove in the flanged housing (Fig. 40).

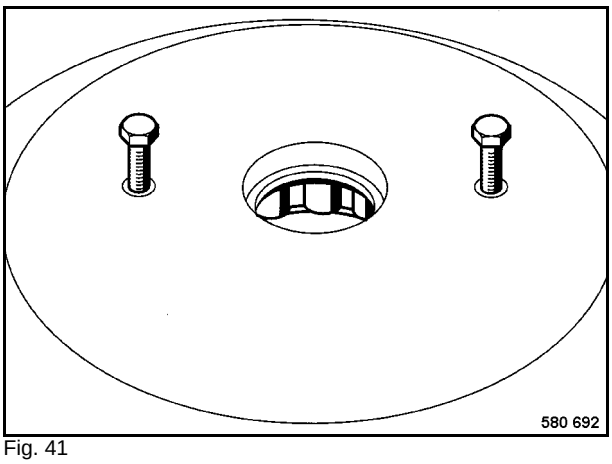


Fig. 41

13. Press the cylinder roller bearing with forcing screws out of the flanged housing (Fig. 41).

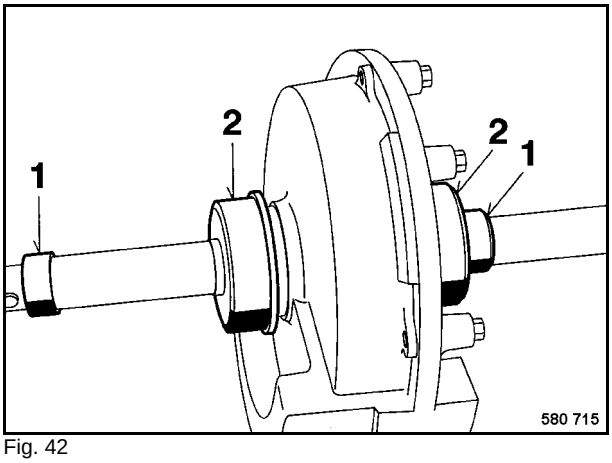


Fig. 42

14. Extract inner rings 1 (Fig. 42) for the radial seals and inner bearing races (2) from the shaft.

⚠ Danger

Danger of burning!

Wear protective gloves.

i Note

If the rings are very tight, heat them up with a torch.

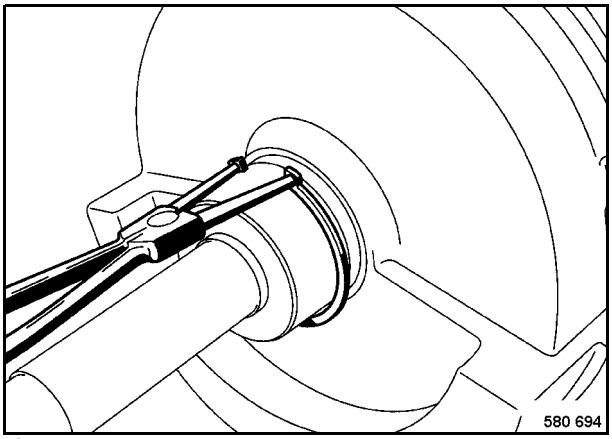


Fig. 43

15. Unclip the circlip from the basic weight and remove the cover (Fig. 43).

i Note

The shafts cannot be pressed out. If damaged they must be replaced with basic weight and cover.

If necessary disassemble, assemble the change-over weight (see corresponding chapter).

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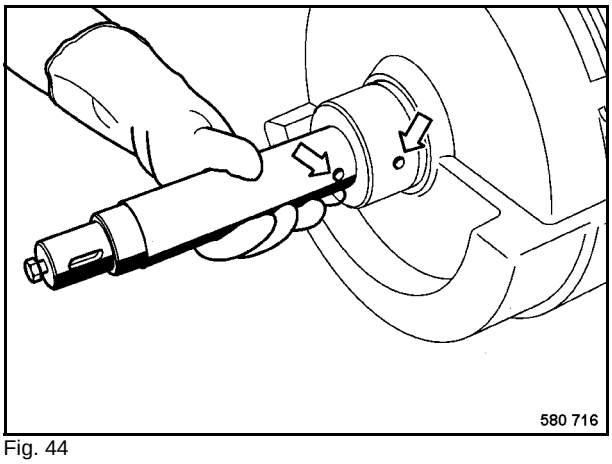


Fig. 44

Assembling the exciter unit (vibration motor side)

⚠ Caution

Ensure strict cleanliness.

i Note

If the shafts are damaged they must be inserted into the basic weight or the cover as follows.

⚠ Danger

When working with liquid nitrogen protect your face and wear gloves.

Do not place any unintended parts into liquid nitrogen.

Observe the safety instructions for the handling of liquid nitrogen.

⚠ Caution

Close the bores on the short shaft with a screw.

1. Cool the shaft down in liquid nitrogen.
2. Slide the cooled down shaft with the bores aligned into the basic weight until it bottoms (Fig. 44).
3. Secure shaft 1 (Fig. 45) with dowel pins (2 and 3).

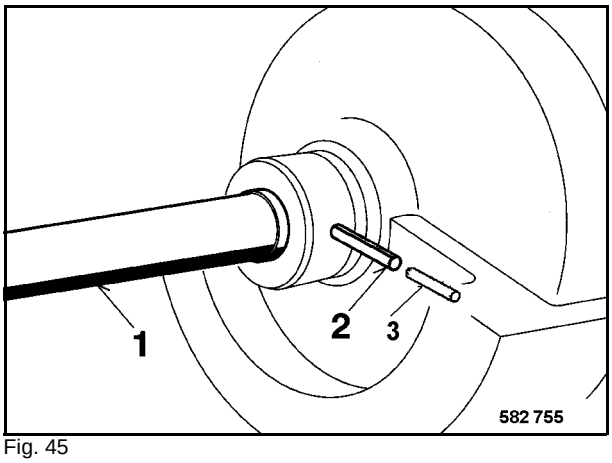


Fig. 45

⚠ Caution

Assemble the dowel pins with the grooves offset by 180° to each other, but in line with the axis of the shaft.

i Note

Unscrew the screw from the shaft.

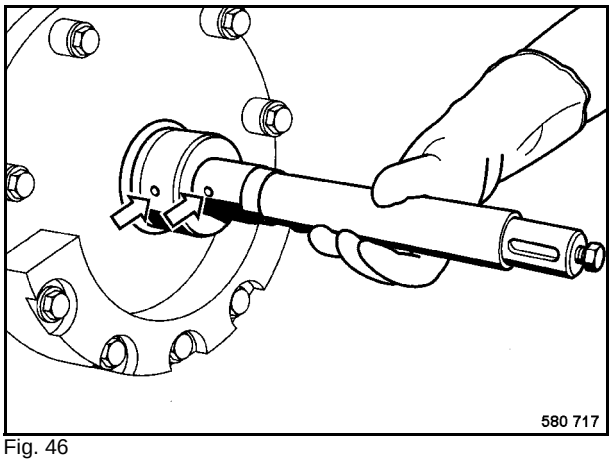


Fig. 46

⚠ Caution

Close the bores on the short shaft with a screw.

4. Cool the shaft down in liquid nitrogen.
5. Slide the cooled down shaft with the bores aligned into the basic weight until it bottoms (Fig. 46).

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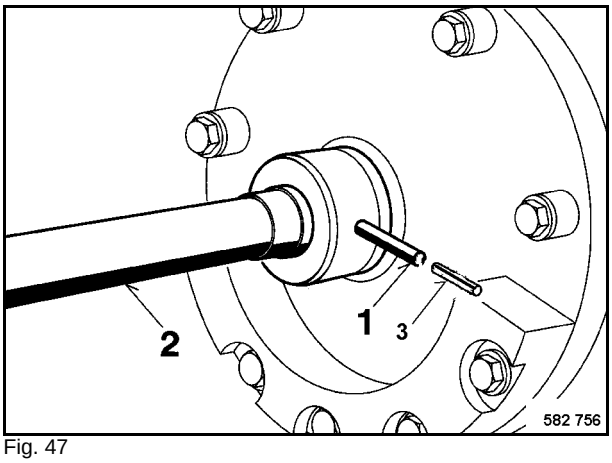


Fig. 47

6. Secure shaft 2 (Fig. 47) with dowel pins (1 and 3).

⚠ Caution

Assemble the dowel pins with the grooves offset by 180° to each other, but in line with the axis of the shaft.

i Note

Unscrew the screw from the shaft.

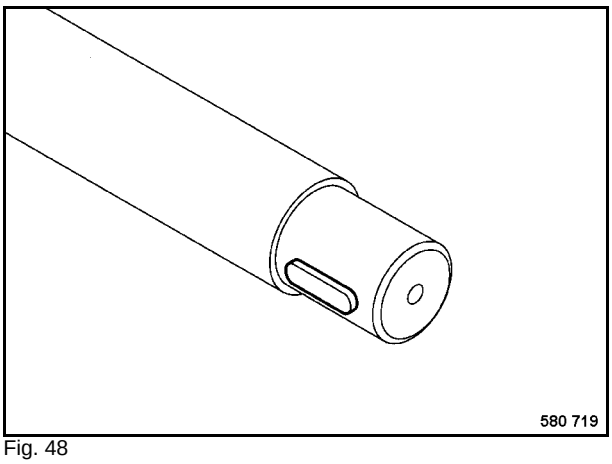


Fig. 48

7. Insert the fitting key into the keyway in the respective shaft (Fig. 48).

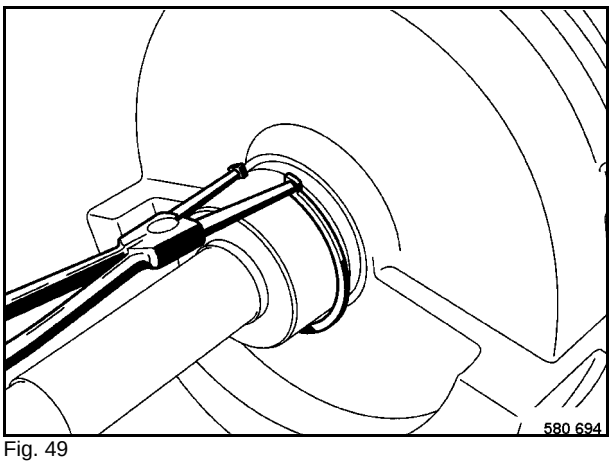


Fig. 49

8. Insert the circlip into the groove in the basic weight and on the cover (Fig. 49).

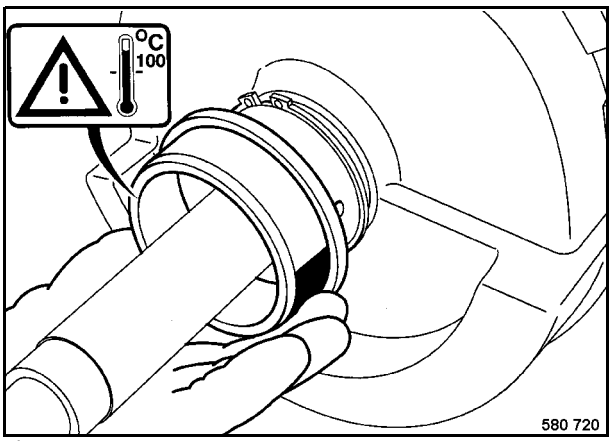


Fig. 50

⚠ Danger

Danger of burning!

Wear safety gloves.

9. Heat the inner bearing race up to approx. 100° C and press it onto the basic weight against the shoulder with the larger outer diameter forward (Fig. 50).

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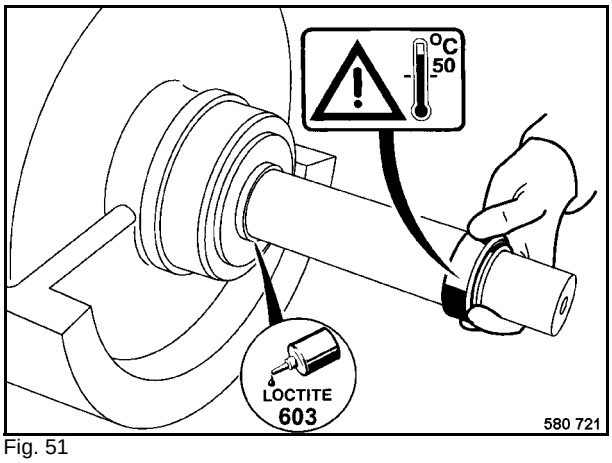


Fig. 51

⚠ Danger

Danger of burning!

Wear safety gloves.

10. Heat the inner ring up to approx. 50° C and slide it onto the short shaft against the shoulder with the wider chamfer facing towards the outside (Fig. 51).

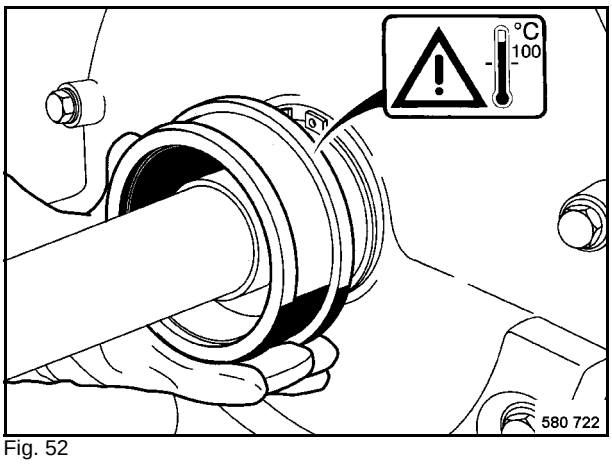


Fig. 52

⚠ Danger

Danger of burning!

Wear safety gloves.

11. Heat the inner bearing race up to approx. 100° C and press it onto the cover against the shoulder with the larger outer diameter forward (Fig. 52).

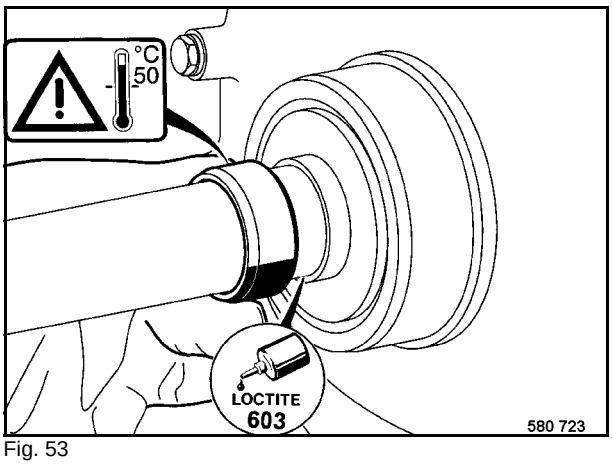


Fig. 53

⚠ Danger

Danger of burning!

Wear safety gloves.

12. Heat the inner ring up to approx. 50° C and slide it onto the longer shaft against the shoulder with the wider chamfer facing towards the outside (Fig. 53).

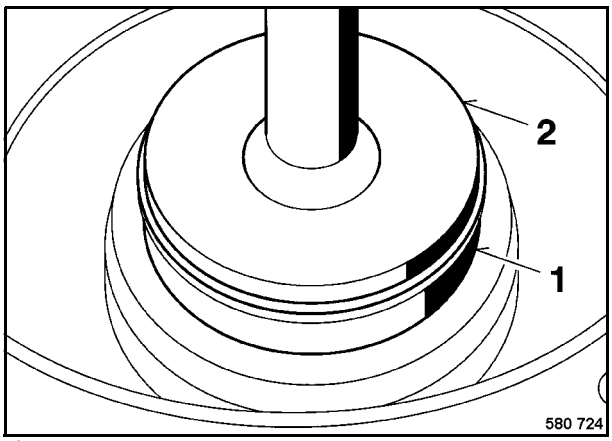


Fig. 54

13. Press cylinder roller bearing 1 (Fig. 54) with pressing plate (2) into the flanged housing until it bottoms.

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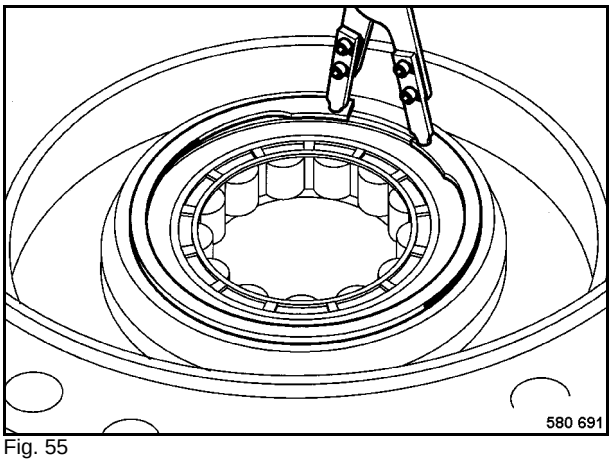


Fig. 55

14. Insert the circlip into the groove in the flanged housing (Fig. 55).

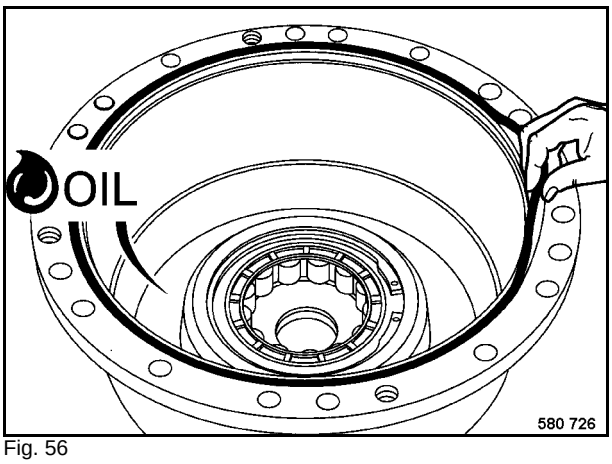


Fig. 56

15. Fit the new radial seal with some grease into the groove in the flanged housing (Fig. 56).
16. Fill approx. 1.2 l oil SAE-15W/40 into the flanged housing.

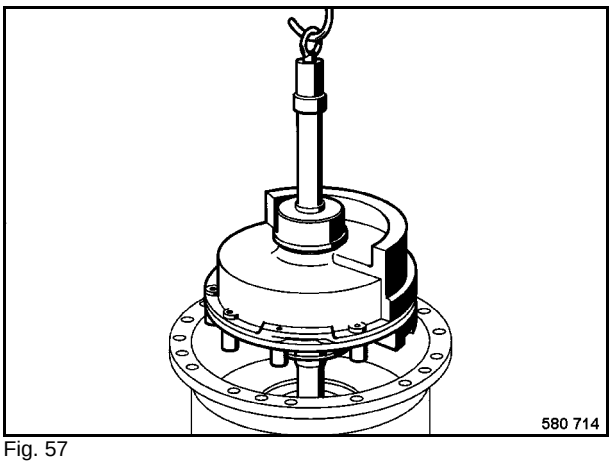


Fig. 57

⚠ Caution

Danger of squashing!

Do not stand or step under suspended loads.

17. Insert the exciter unit with the longer shaft forward into the flanged housing (Fig. 57).

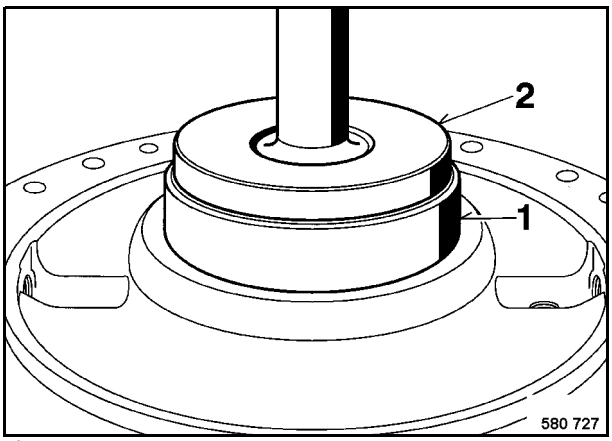


Fig. 58

18. Press cylinder roller bearing 1 (Fig. 58) with pressing plate (2) into the flanged hub until it bottoms.

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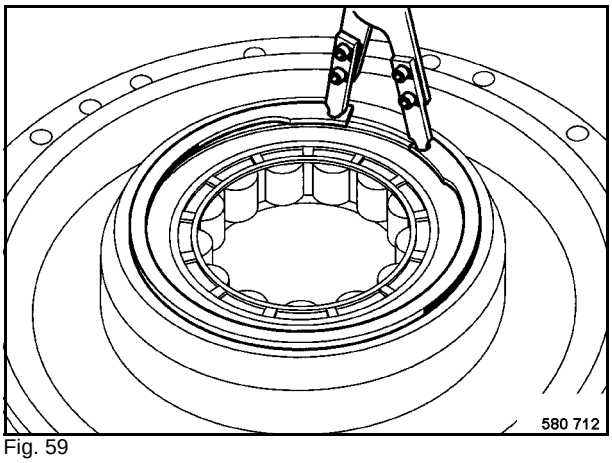


Fig. 59

19. Insert the circlip into the groove in the flanged hub (Fig. 59).

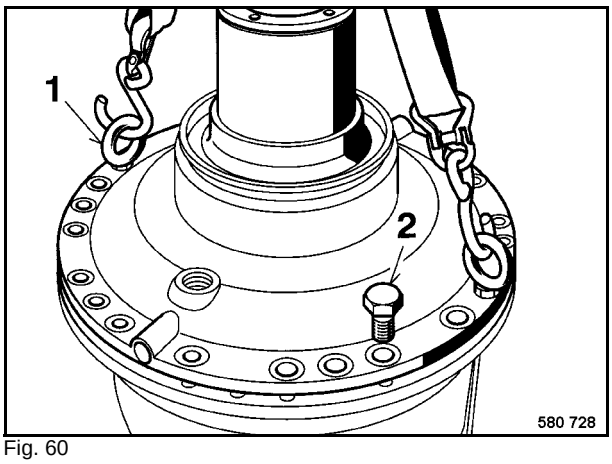


Fig. 60

20. Attach the flanged hub to the flanged housing (Fig. 60).

⚠ Caution

Fitting and contact surfaces must be absolutely dry and free of grease, paint and conserving agents.

21. Unscrew eye bolts (1) and replace them with short screws.
22. Turn short screws (2) into the tapped bores in the flanged housing (four screws) and tighten them.

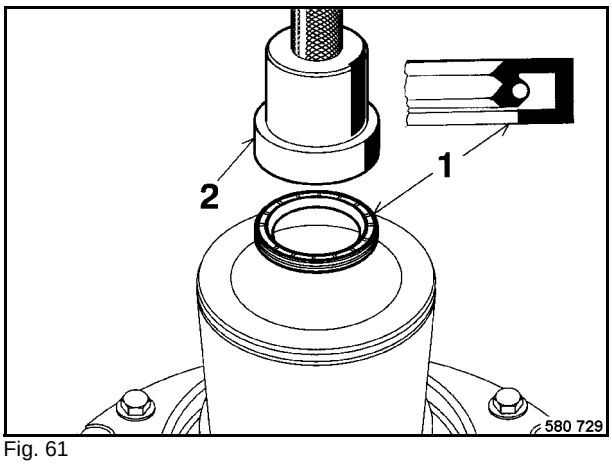


Fig. 61

23. Apply some grease to the sealing lip of radial seal 1 (Fig. 61).
24. Insert the radial seal into the flanged hub with the sealing lip facing down and press it down against the stop with pressing bushing (2).

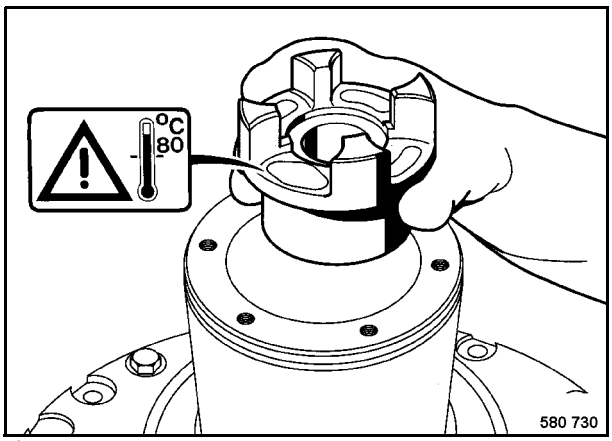


Fig. 62

⚠ Danger

Danger of burning!

Wear protective gloves.

25. Heat the coupling hub up to approx. 80 °C and slide it onto the shaft against the stop (Fig. 62).

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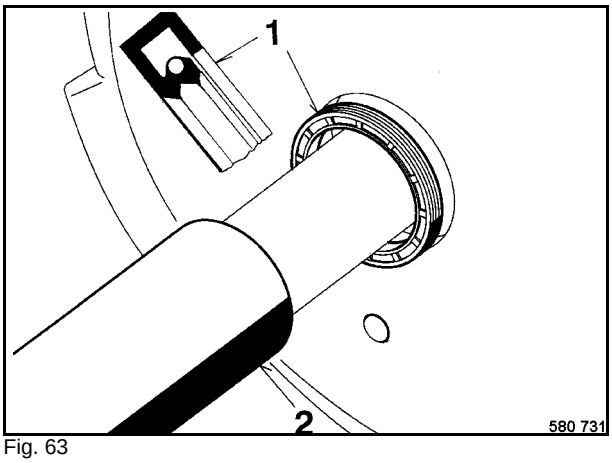


Fig. 63

26. Apply some grease to the sealing lip of radial seal 1 (Fig. 63).
27. Slide the radial seal with the sealing lip forward over the shaft and drive it completely into the flanged housing, using a suitable tube (2).

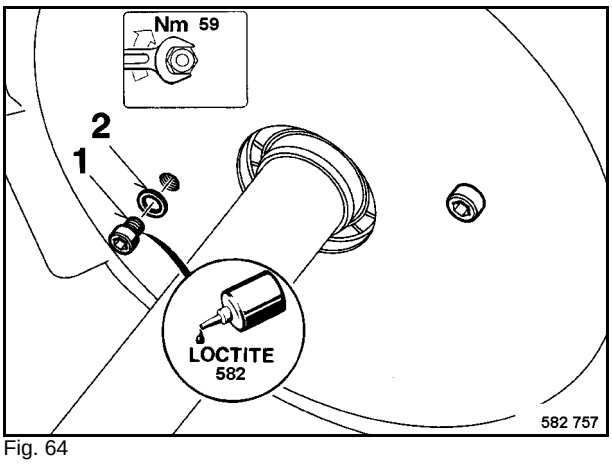


Fig. 64

28. Cover the thread of screw 1 (Fig. 64) with a screw retention agent (e.g. Loctite CVX strong, blue, 582).
29. Slide on the new U-seal ring (2), turn in and tighten the screws.

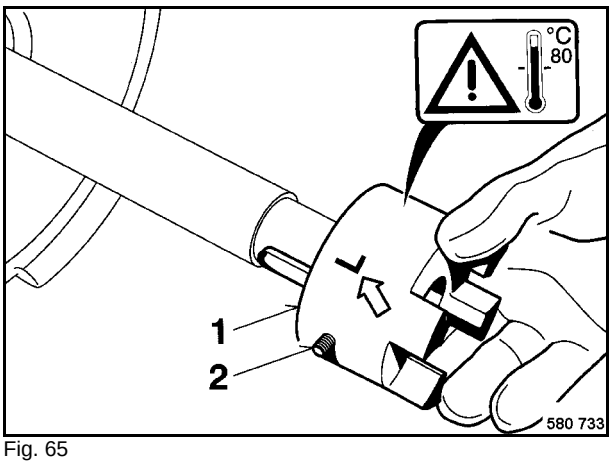


Fig. 65

⚠ Danger

Danger of burning!

Wear safety gloves.

30. Heat coupling hub 1 (Fig. 65) with marking letter “L“ up t approx. 80° C and slide it over the shaft against the shoulder.
31. Turn in and tighten clamping screw (2).

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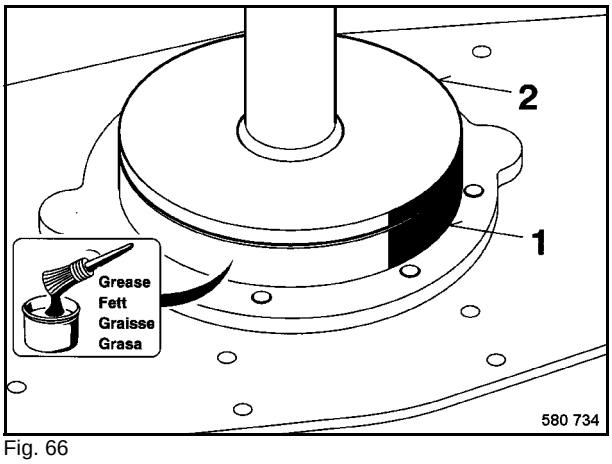


Fig. 66

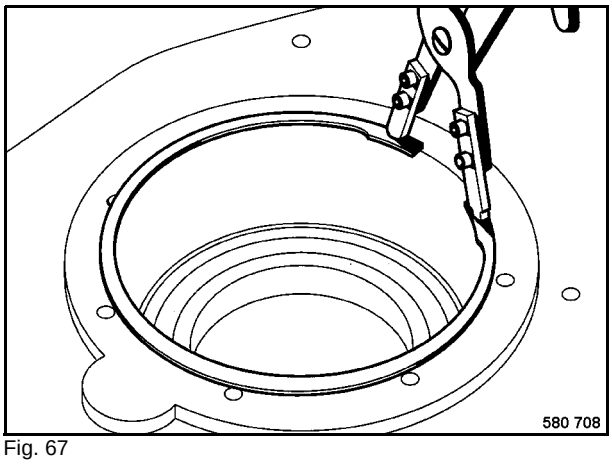


Fig. 67

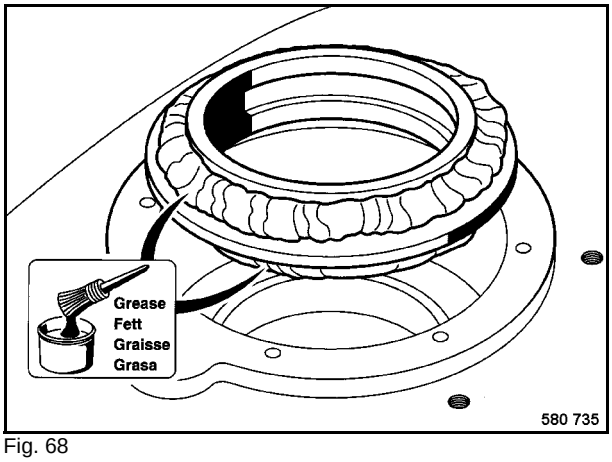


Fig. 68

Assembling and installing the side plate

1. Fill grooved ball bearing 1 (Fig. 66) on both sides with grease.
2. Press the grooved ball bearing completely in using pressing plate (2).
3. Insert the circlip into the groove in the side plate (Fig. 67).
4. Apply a thick coat of grease to the spacer ring on both sides and insert it into the side plate (Fig. 68).

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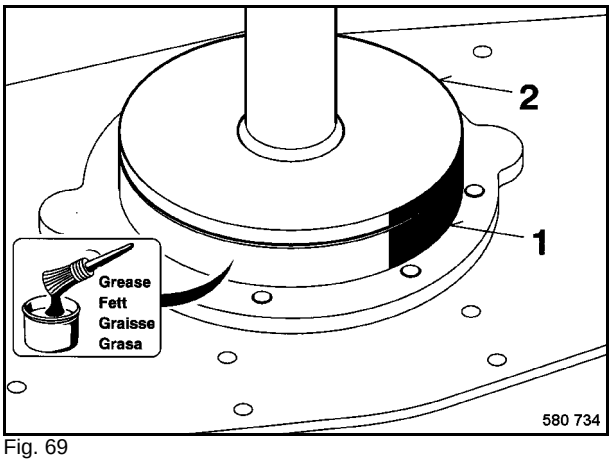


Fig. 69

5. Fill grooved ball bearing 1 (Fig. 69) on one sides with grease.
6. Insert the grooved ball bearing with the grease side forward and press it completely in with pressing plate (2).

i Note
Grease the other side after installing the exciter unit.

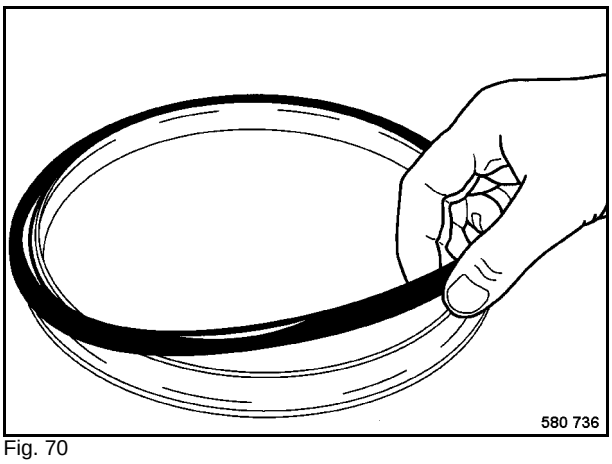


Fig. 70

7. Insert the oiled loop-ring into the mechanical seal (Fig. 70).
8. Clean the sliding surfaces of the mechanical seal and cover them with oil.

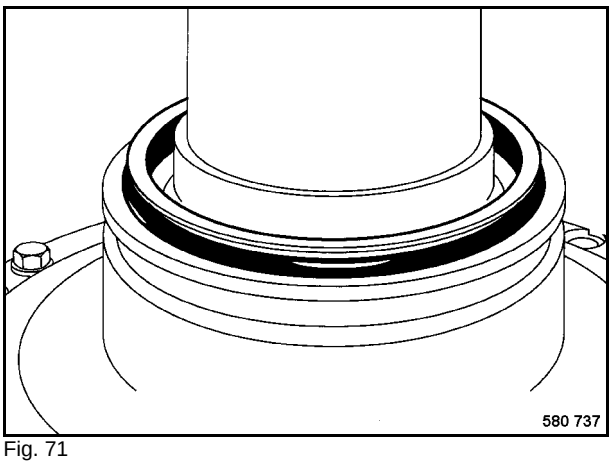


Fig. 71

9. Lay one half of the radial seal on the flanged hub with the sliding surface pointing up (Fig. 71).

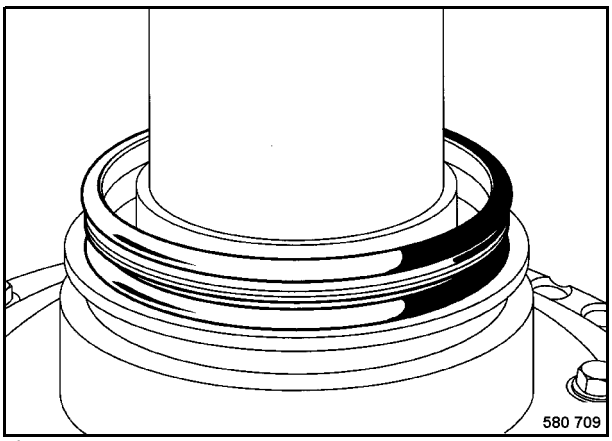


Fig. 72

10. Lay the second half of the mechanical seal down with the sliding face pointing down (Fig. 72).

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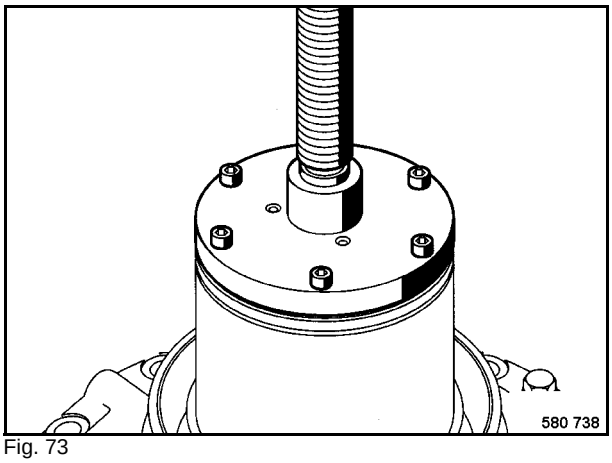


Fig. 73

11. Bolt the threaded section of the assembly device to the flanged hub (Fig. 73).

⚠ Caution

Danger of squashing! Do not stand or step under suspended loads.

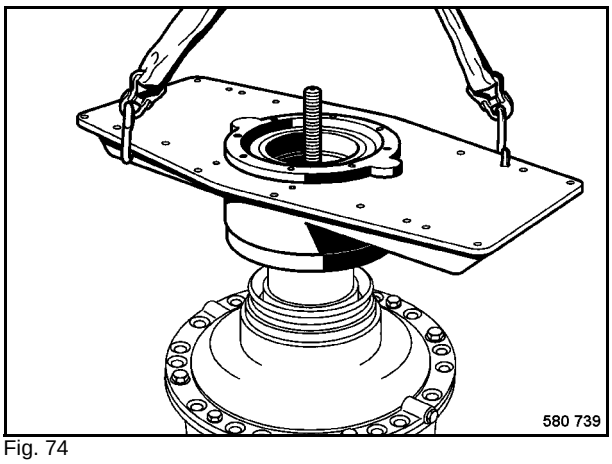


Fig. 74

12. Lay the side plate on the flanged hub (Fig. 74).

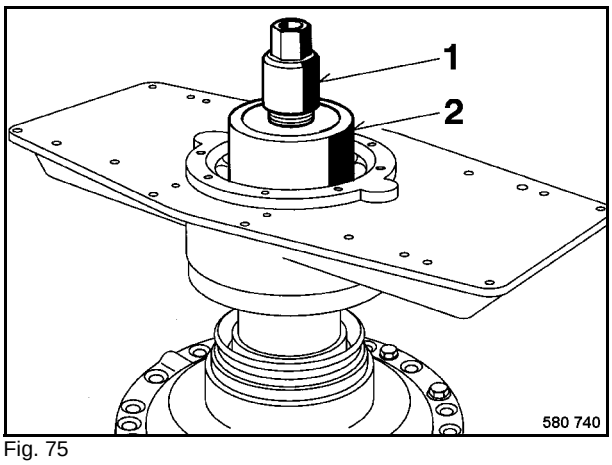


Fig. 75

13. Attach bushing 2 (Fig. 75) of the assembly device and turn on nut (1).

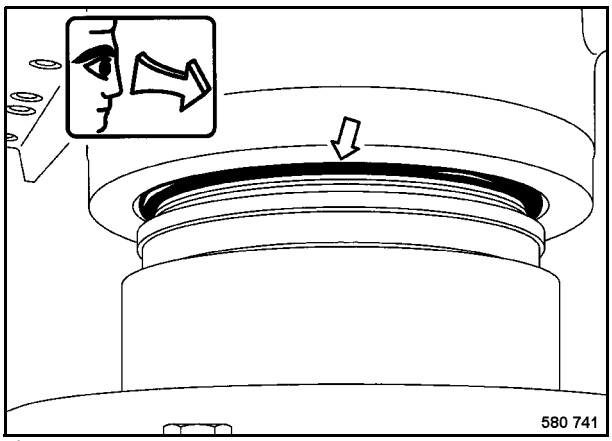


Fig. 76

14. Pull the side plate with the assembly device onto the flanged hub.

⚠ Caution

During assembly make sure that the mechanical seal slides correctly into the side plate and the loop rings are not damaged (Fig. 76).

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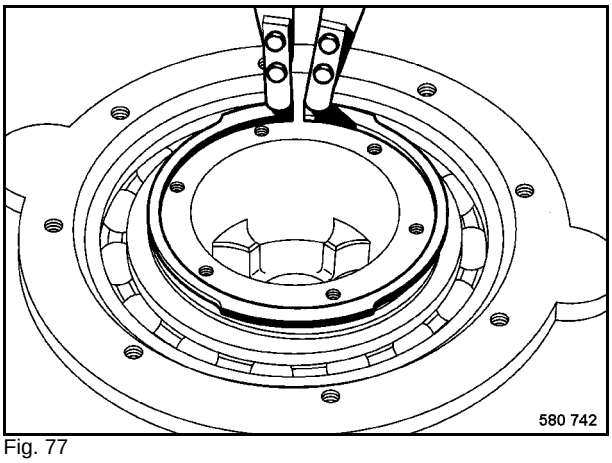


Fig. 77

15. Remove the assembly device.
16. Insert the circlip into the groove in the flanged hub (Fig. 77).

Assembling the exciter unit (travel motor side)

⚠ Danger

When working with liquid nitrogen protect your face and wear gloves.

Do not place any unintended parts into liquid nitrogen.

Observe the safety instructions for the handling of liquid nitrogen.

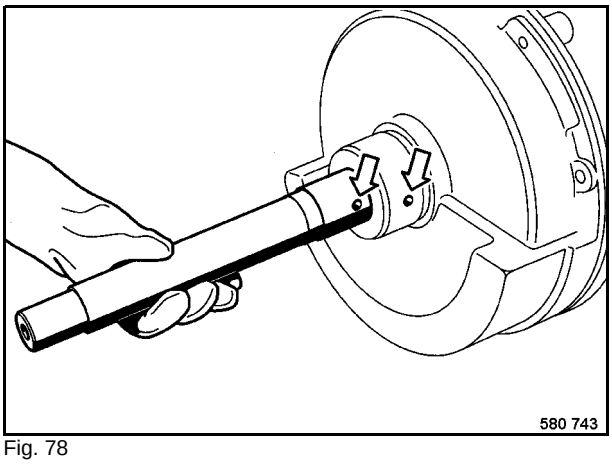


Fig. 78

⚠ Caution

Ensure strict cleanliness.

1. Cool the shaft down in liquid nitrogen.
2. Slide the cooled down shaft with the bores aligned into the basic weight until it bottoms (Fig. 78).
3. Secure shaft 1 (Fig. 79) with dowel pins (2 and 3).

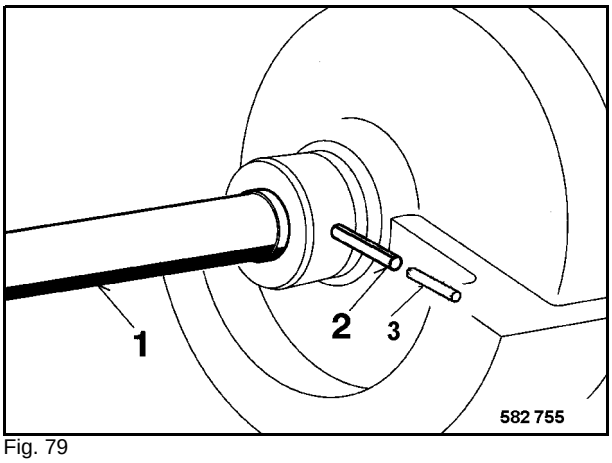


Fig. 79

⚠ Caution

Assemble the dowel pins with the grooves offset by 180° to each other, but in line with the axis of the shaft.

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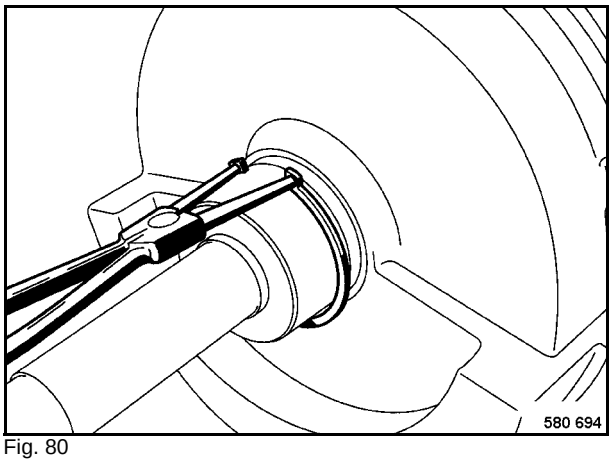


Fig. 80

4. Insert the circlip into the groove in the basic weight and on the cover (Fig. 80).

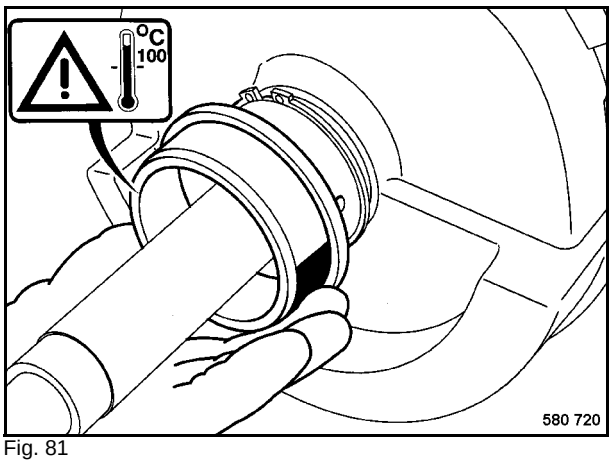


Fig. 81

⚠ Danger

Danger of burning!

Wear safety gloves.

5. Heat the inner bearing race up to approx. 100° C and press it onto the basic weight against the shoulder with the larger outer diameter forward (Fig. 81).

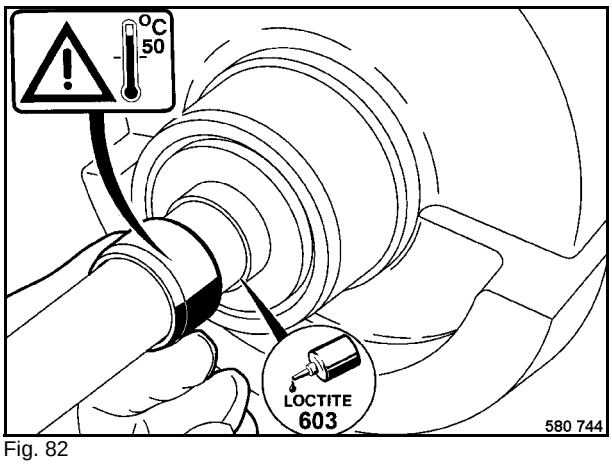


Fig. 82

⚠ Danger

Danger of burning!

Wear safety gloves.

6. Heat the inner ring up to approx. 50° C and slide it onto the shaft against the shoulder with the wider chamfer facing towards the outside (Fig. 82).

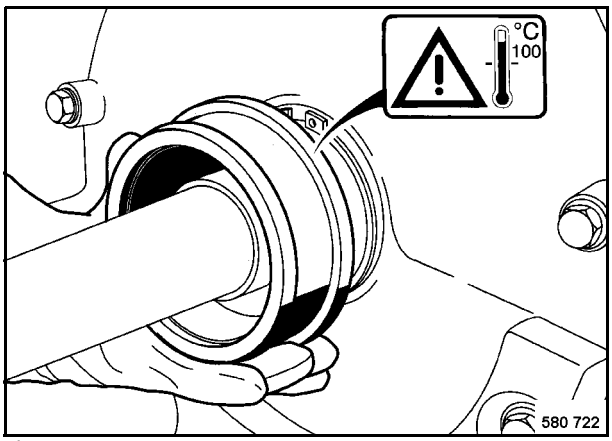


Fig. 83

⚠ Danger

Danger of burning!

Wear safety gloves.

7. Heat the inner bearing race up to approx. 100° C and press it onto the cover against the shoulder with the larger outer diameter forward (Fig. 83).

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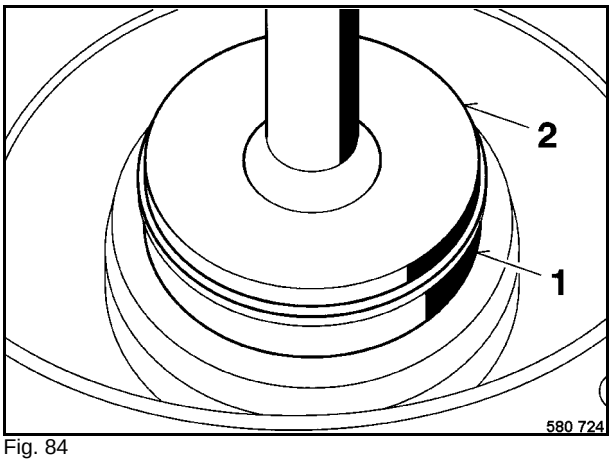


Fig. 84

8. Press cylinder roller bearing 1 (Fig. 84) with pressing plate (2) into the flanged housing until it bottoms.

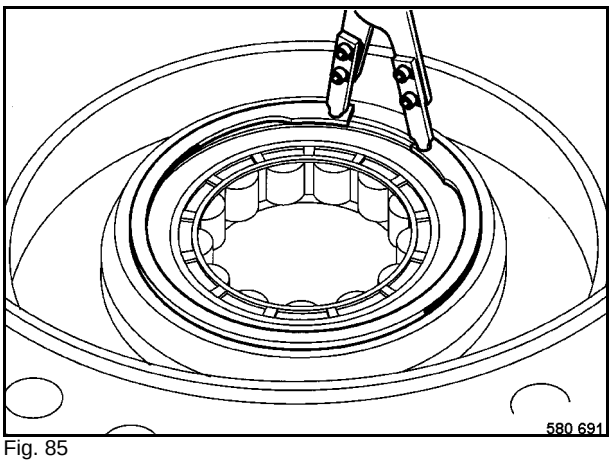


Fig. 85

9. Insert the circlip into the groove in the flanged housing (Fig. 85).

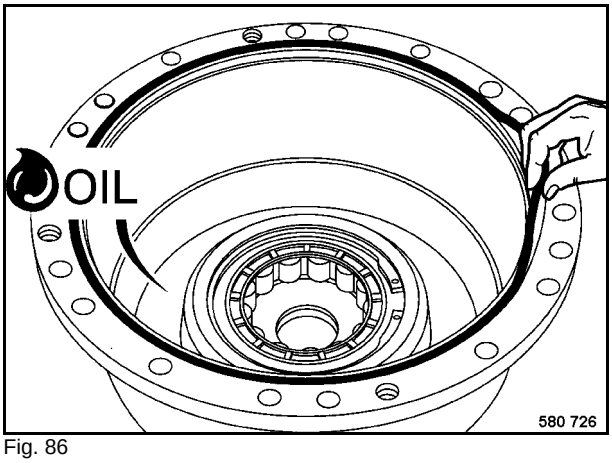


Fig. 86

10. Fit the new radial seal with some grease into the groove in the flanged housing (Fig. 86).
11. Fill approx. 1.2 l oil SAE-15W/40 into the flanged housing.

⚠ Caution

Danger of squashing! Do not stand or step under suspended loads.

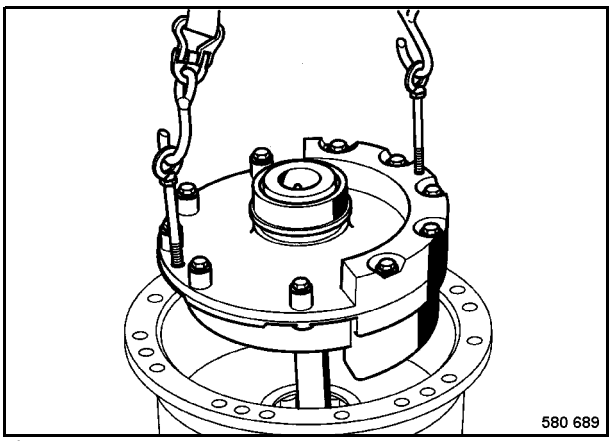


Fig. 87

12. Insert the exciter unit into the flanged housing (Fig. 87).

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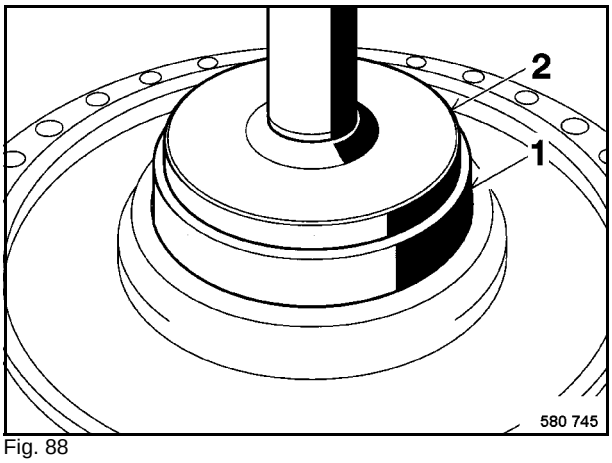


Fig. 88

13. Press cylinder roller bearing 1 (Fig. 88) with pressing plate (2) into the flange until it bottoms.

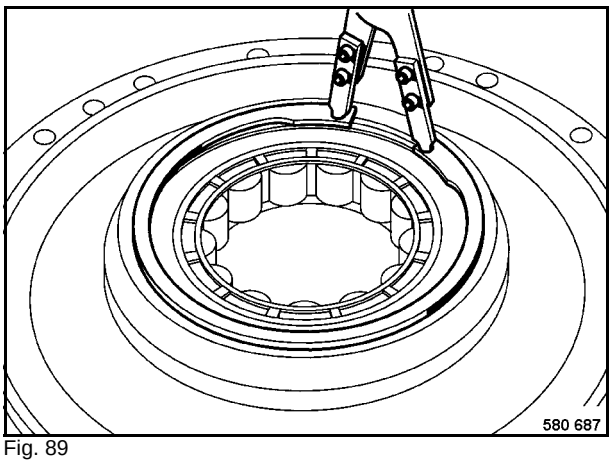


Fig. 89

14. Insert the circlip into the groove in the flange (Fig. 89).

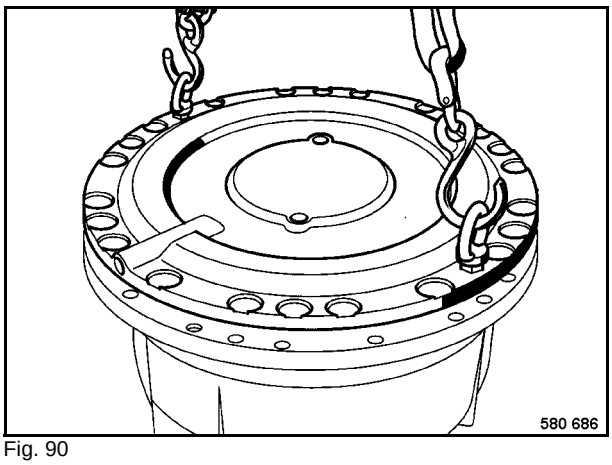


Fig. 90

15. Lift the flange onto the flanged housing and align it the bores (Fig. 90).

⚠ Caution

Fitting and contact surfaces must be absolutely dry and free of grease, paint and conserving agents.

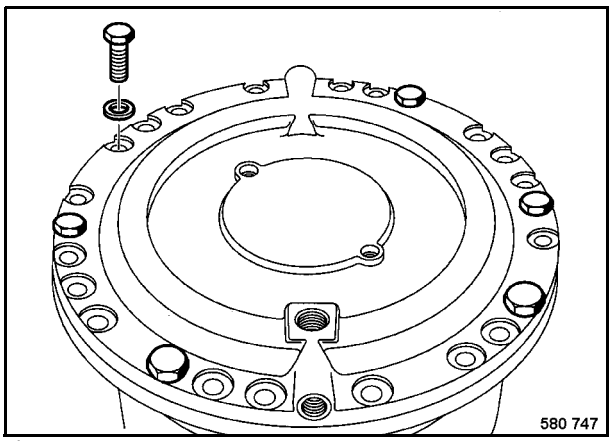


Fig. 91

16. Turn the screws into the tapped bores of the flanged housing and tighten them (Fig. 91).

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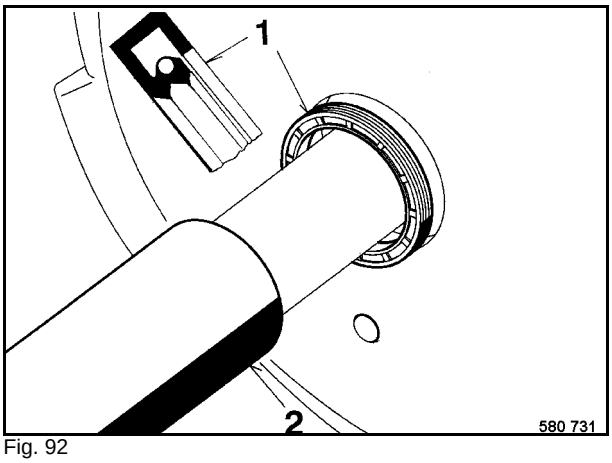


Fig. 92

17. Apply some grease to the sealing lip of radial seal 1 (Fig. 92).
18. Slide the radial seal with the sealing lip forward over the shaft and drive it completely into the flanged housing, using a suitable tube (2).

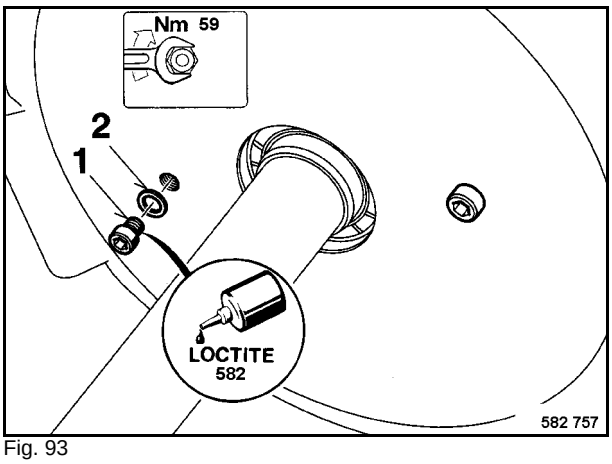


Fig. 93

19. Cover the thread of screw 1 (Fig. 93) with a screw retention agent (e.g. Loctite CVX strong, blue, 582).
20. Slide on the new U-seal ring (2), turn in and tighten the screws.

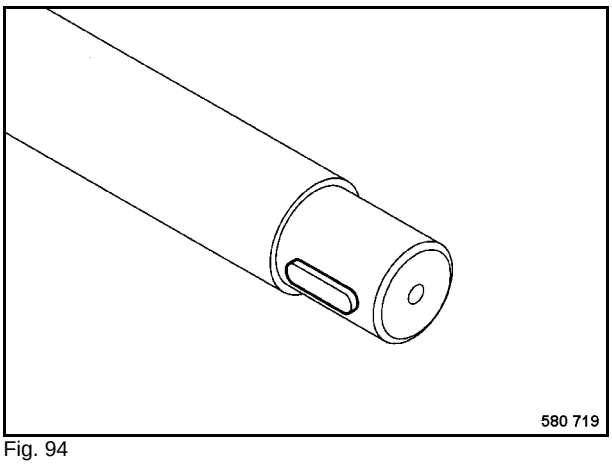


Fig. 94

21. Insert the fitting key into the keyway of the shaft (Fig. 94).

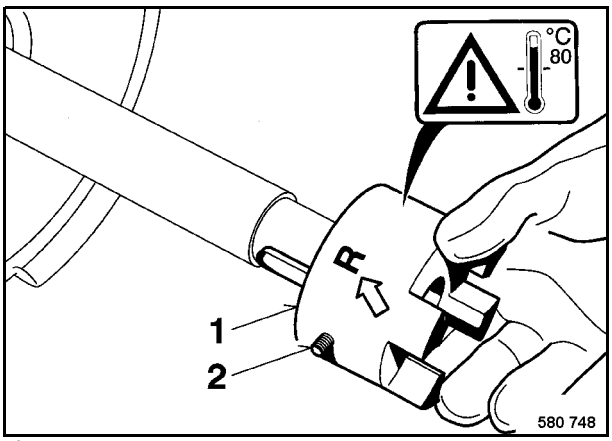


Fig. 95

⚠ Danger

Danger of burning!

Wear safety gloves.

22. Slide the fan with assembly disc over the shaft.
23. Heat coupling hub 1 (Fig. 95) with marking letter “R“ up to approx. 80° C and slide it over the shaft against the shoulder.
24. Turn in and tighten clamping screw (2).
25. Assemble the fan to the coupling hub.

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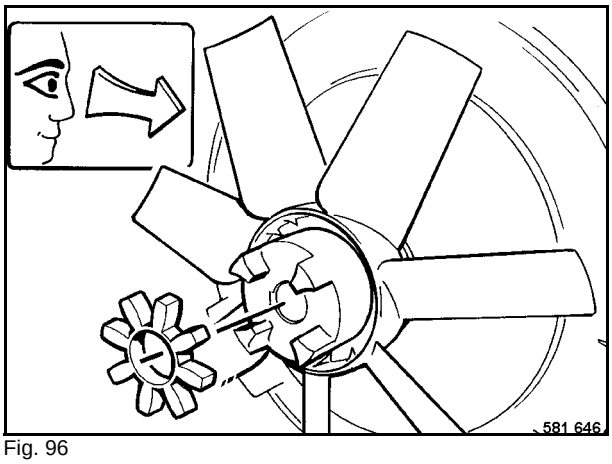


Fig. 96

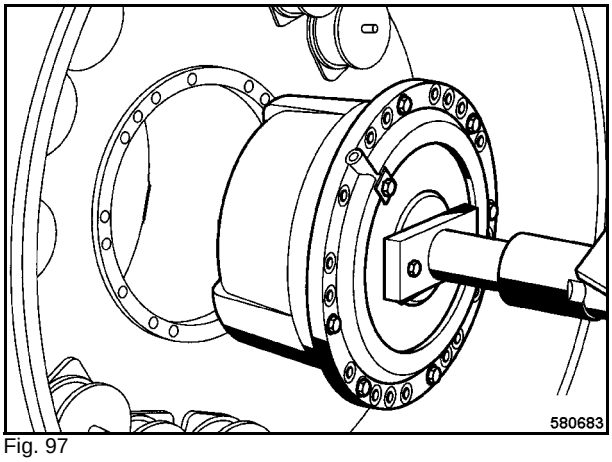


Fig. 97

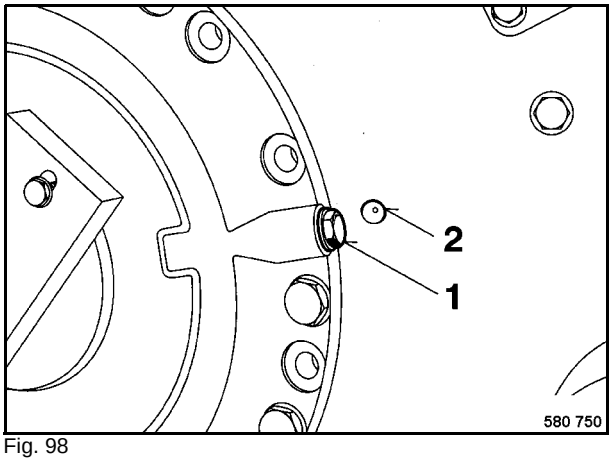


Fig. 98

Assembling the exciter unit (travel motor side)

1. Check coupling elements, replace if necessary.
2. Insert the coupling element into the coupling hub (Fig. 96).

⚠ Caution

Fitting and contact surface of the connection between exciter unit and drum must be absolutely dry and free of grease, oil, paint and conserving agent.

3. Fasten the lifting device to the exciter unit.

⚠ Caution

Danger of squashing! Do not stand or step under suspended loads.

4. Insert the vibrator unit into the drum (Fig. 97).

i Note

Insert the exciter unit so that oil filler plug 1 (Fig. 98) is in line with bore (2) in the drum.

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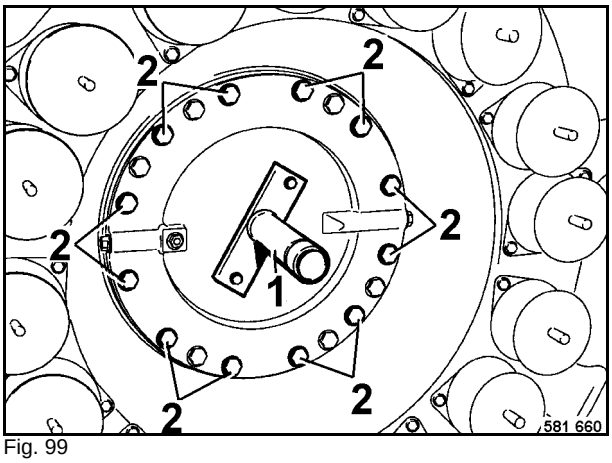


Fig. 99

5. Turn in and tighten screws 2 (Fig. 99).
6. Remove bracket (1) for the lifting device.

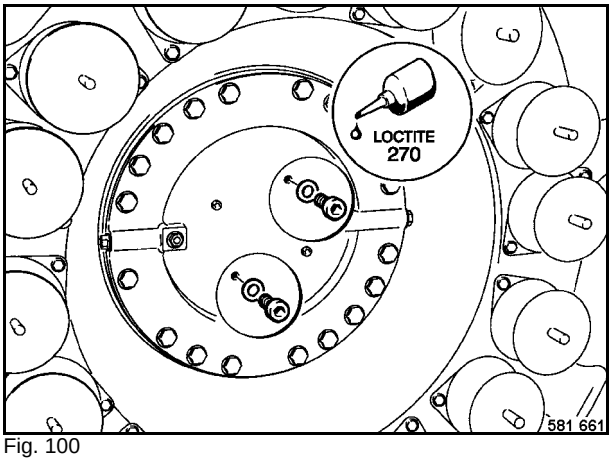


Fig. 100

7. Cover the thread of screws (Fig. 100) with a screw retention agent (e.g. Loctite green 270).
8. Slide on the new U-seal ring, turn in and tighten the screws.

Installing the travel motor

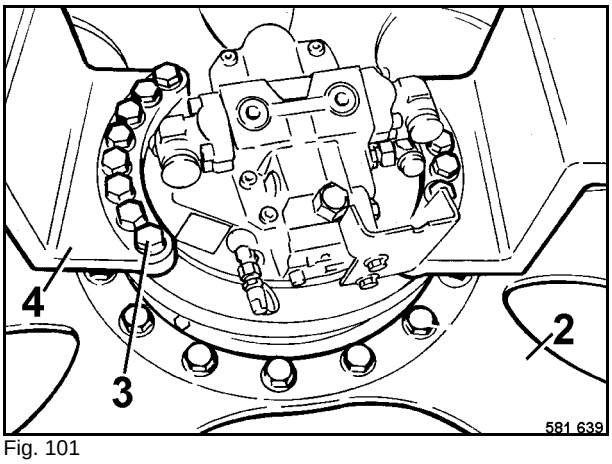


Fig. 101

1. Assemble drive disc 2 (Fig. 101) and support (4) with screws (3).

⚠ Danger

Danger of squashing!

Do not stand or step under suspended loads.

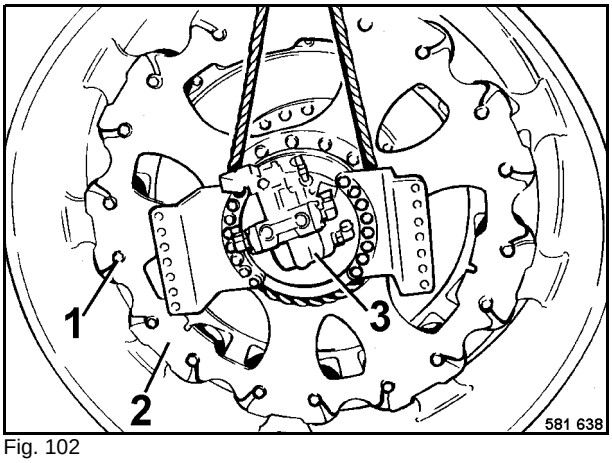


Fig. 102

2. Attach the drive disc 2 (Fig. 102) with the assembled travel drive to the rubber buffers. Turn on and tighten the nuts (1).

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Installing the exciter unit (vibration motor side)

⚠ Caution

Fitting and contact surface of the connection between exciter unit and drum must be absolutely dry and free of grease, oil, paint and conserving agent.

⚠ Danger

Danger of squashing! Do not stand or step under suspended loads.

1. Fasten the lifting gear to the exciter unit and insert it into the drum (Fig. 103).

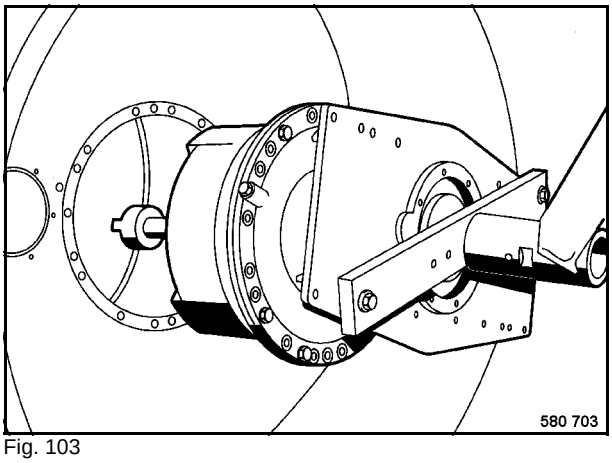


Fig. 103

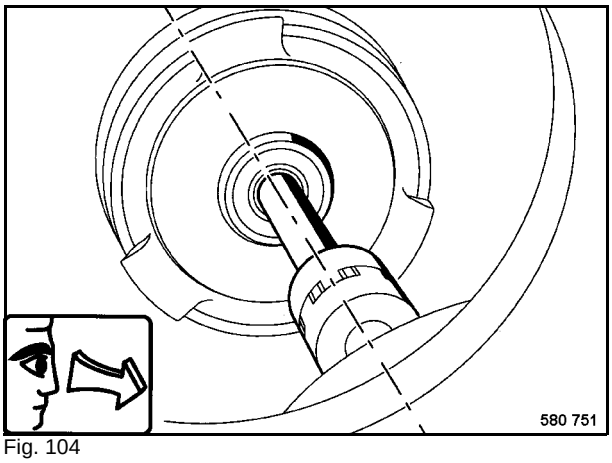


Fig. 104

⚠ Caution

Ensure correct engagement of coupling and alignment of shaft (Fig. 104).

If the shafts are not correctly in line determine the cause, if necessary measure the drum.

2. Turn in and tighten screws 1 (Fig. 105).
3. Remove the lifting gear.
4. Fit cover (2) to the drum.

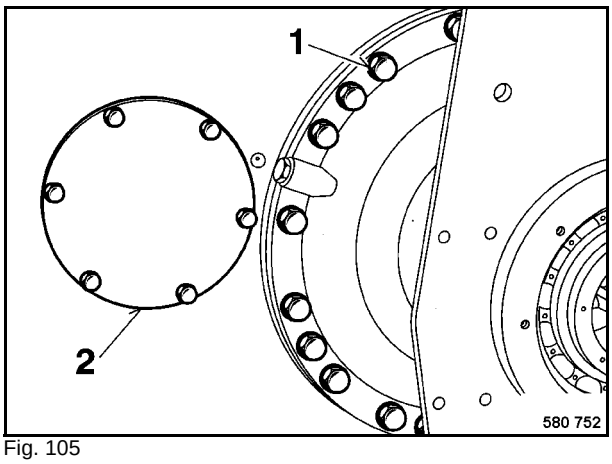


Fig. 105

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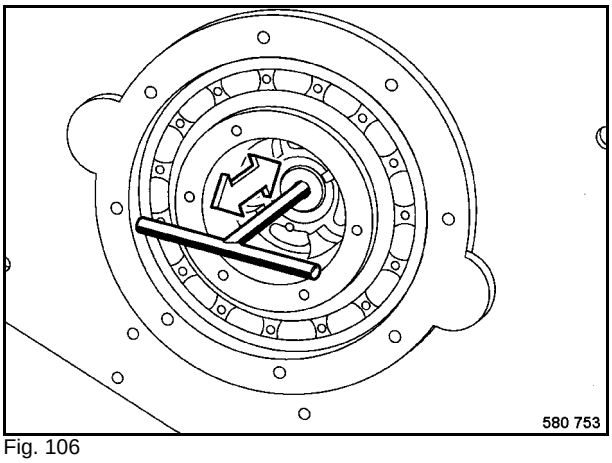


Fig. 106

5. Check the end float of the exciter shafts (Fig. 106).

   Nominal value: 0.6...1.8 mm

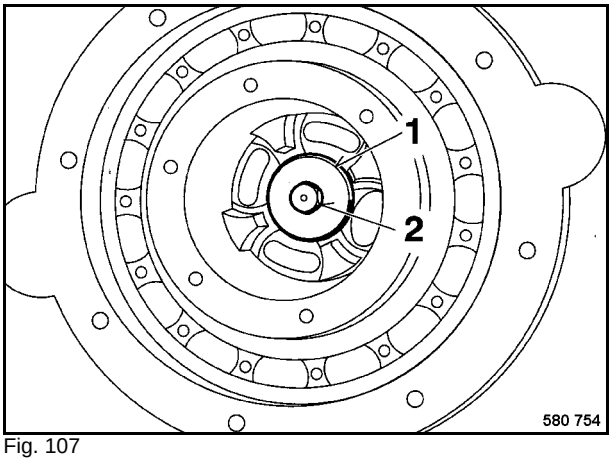


Fig. 107

6. Attach disc 1 (Fig. 107), turn in and tighten the fastening screws (2).

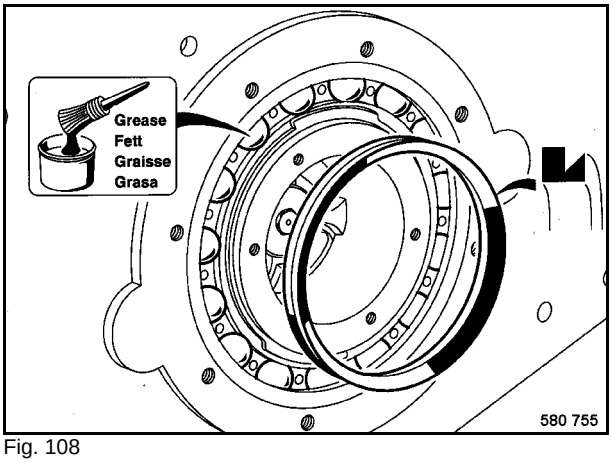


Fig. 108

7. Lay a new V-ring over the journal of the flanged hub (Fig. 108).
8. Fill the grooved ball bearing with grease.

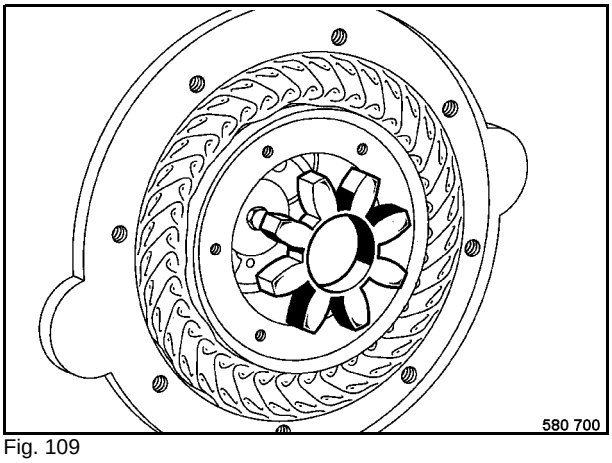


Fig. 109

9. Check coupling element, replace if necessary.
10. Insert the coupling element into the coupling hub (Fig. 109).

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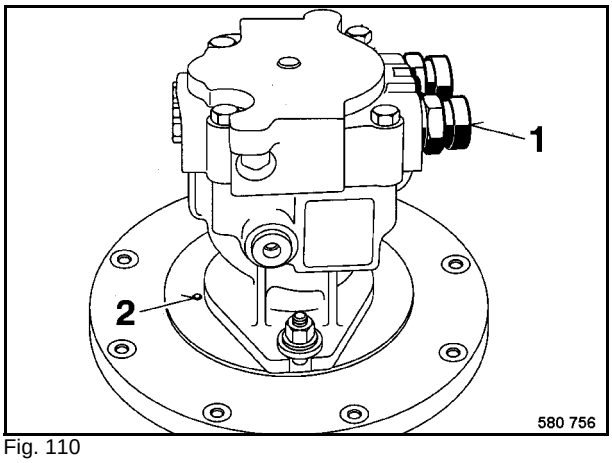


Fig. 110

11. Fasten the vibration motor to the cover so that sockets 1 (Fig. 110) and ventilation bore (2) are opposite each other.

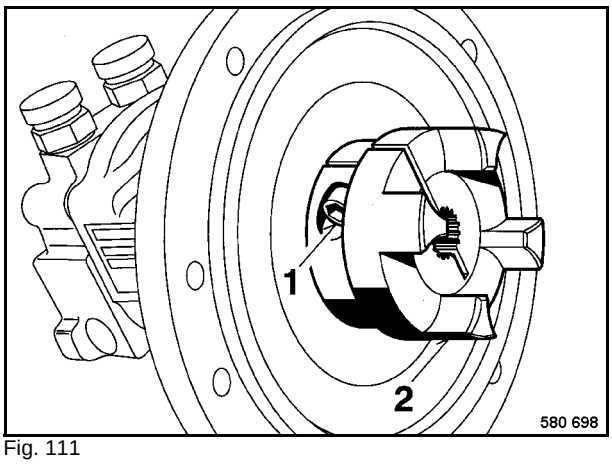


Fig. 111

12. Slide on coupling half 2 (Fig. 111) and secure with clamping screw (1).

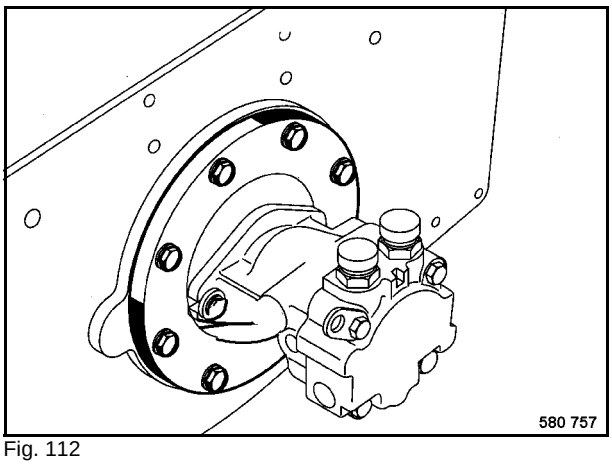


Fig. 112

13. Attach the cover with the installed vibration motor, turn in and tighten the screws (Fig. 112).

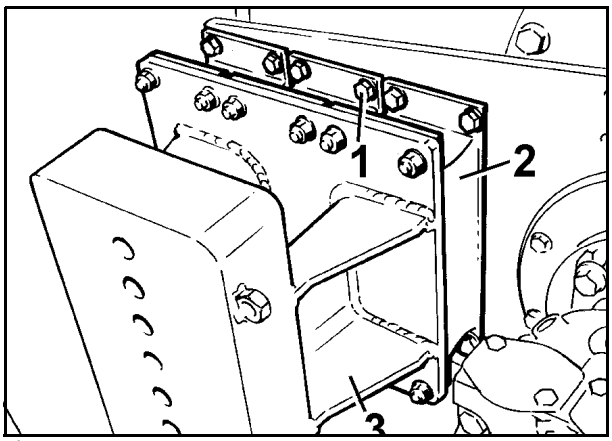


Fig. 113

14. Install rectangular rubber buffers 2 (Fig. 113) with attached spacer block (3) and screws (1) to the side plate.

i Note

Assemble both rectangular rubber buffers.

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14.5 Dismantling, assembling the change-over weights

Dismantling the change-over weight

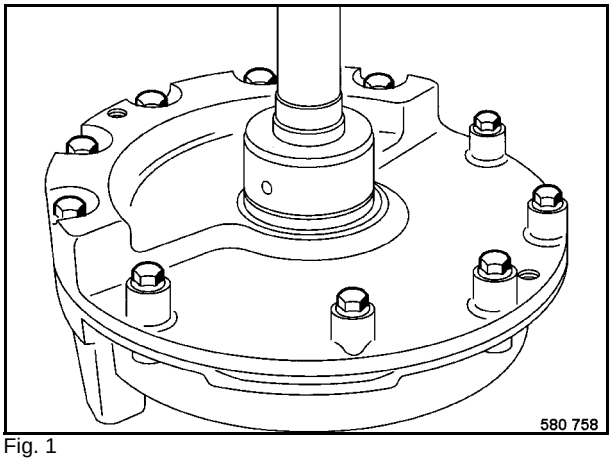


Fig. 1

1. Unscrew all screws (Fig. 3).

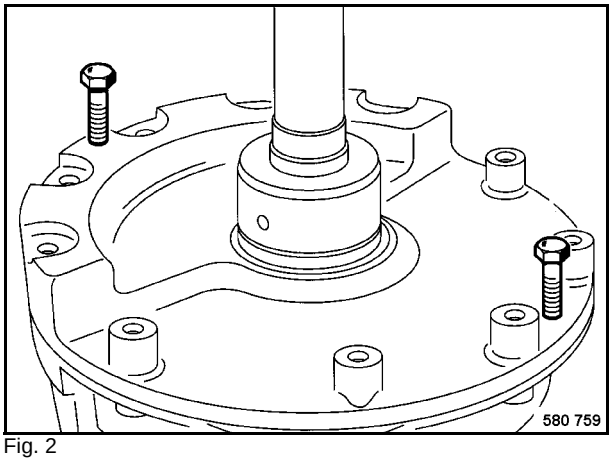


Fig. 2

2. Force the cover off the basic weight with forcing screws (Fig. 4).

Environment

Environmental damage!

Catch running out oil and dispose of environmentally.

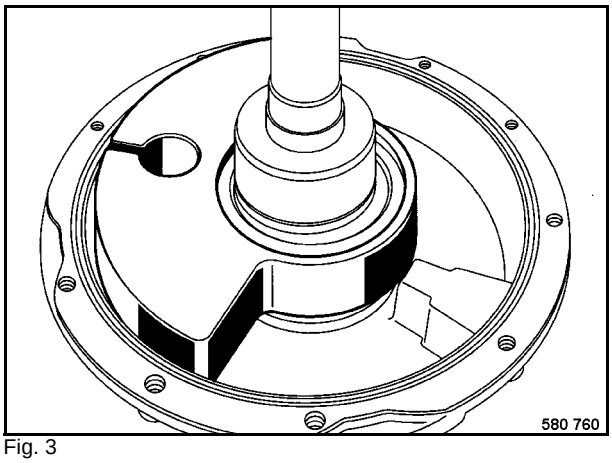


Fig. 3

3. Take the change-over weight out of the basic weight (Fig. 5).

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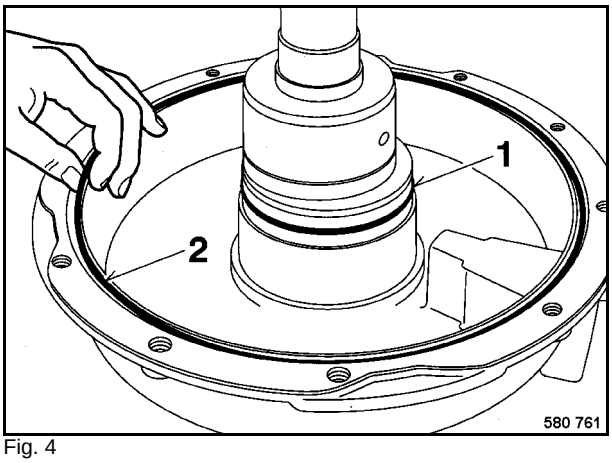


Fig. 4

4. Pull O-rings 1 and 2 (Fig. 4) out of the grooves.

Assembling the change-over weights

⚠ Caution

Ensure strict cleanliness.

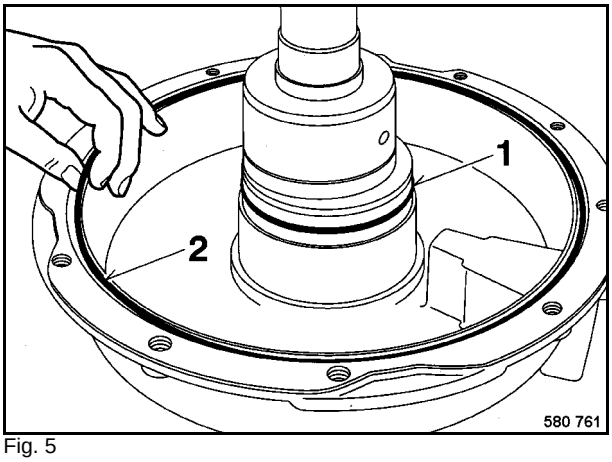


Fig. 5

1. Install new O-rings 1 and 2 (Fig. 5) with grease.

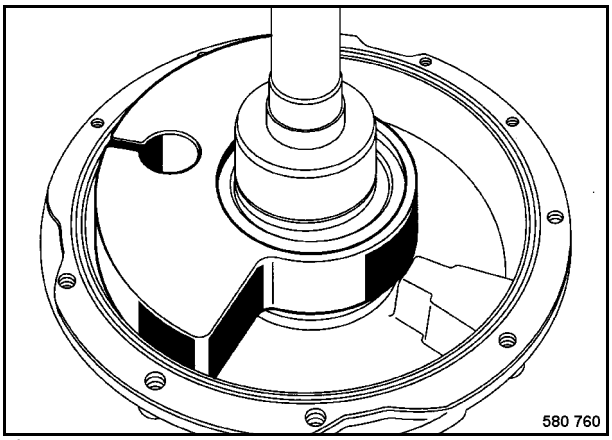


Fig. 6

2. Insert the change-over weight into the basic weight (Fig. 6).

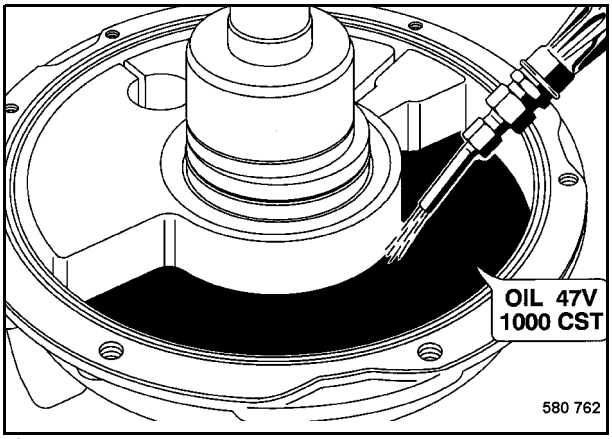


Fig. 7

3. Fill silicon oil 47 V 1000 cst up to the upper edge of the change-over weight (approx. 2,5 litres) into the basic weight (Fig. 12).

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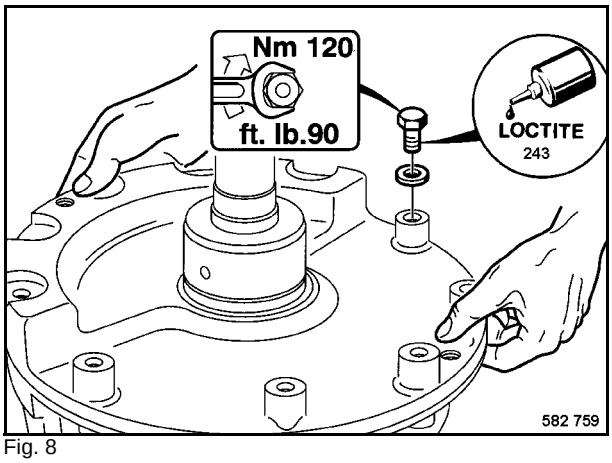


Fig. 8

4. Attach the cover (Fig. 13), so that the raised areas are in line.
5. Turn in screws with screw retention agent (e.g. Loctite blue 243) and tighten with 120 Nm.
6. Check the end float of the shaft.

i Note

There must be play.

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14.6 Changing the rubber buffers and adjusting the pretension

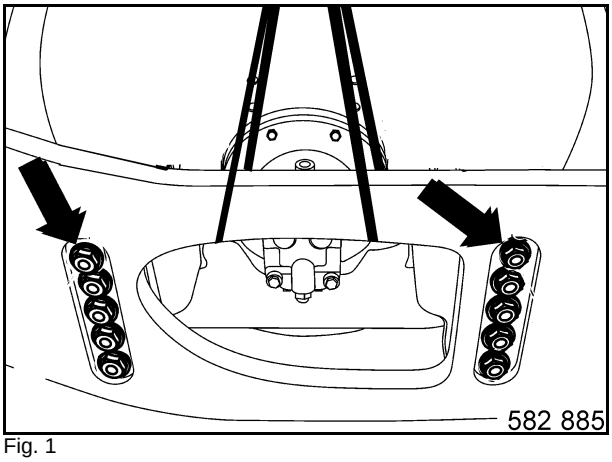


Fig. 1

Relieve the rubber buffers

1. Lift the frame up by both sides, until rubber buffers and rectangular buffers are relieved of any load (Fig. 1).
2. Loosen all fastening screws.

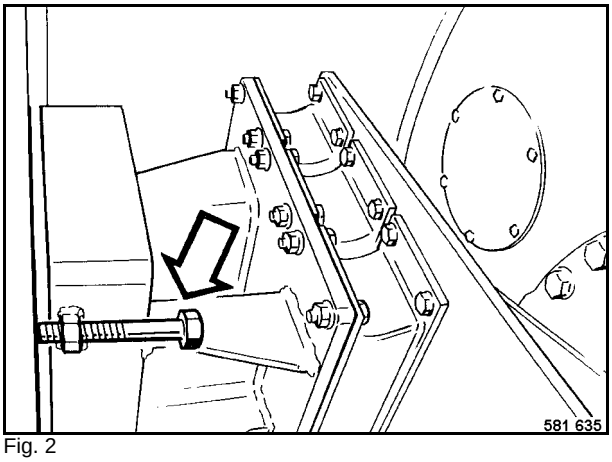


Fig. 2

3. Turn one screw each into the welded nuts (Fig. 2) on the spacer blocks.

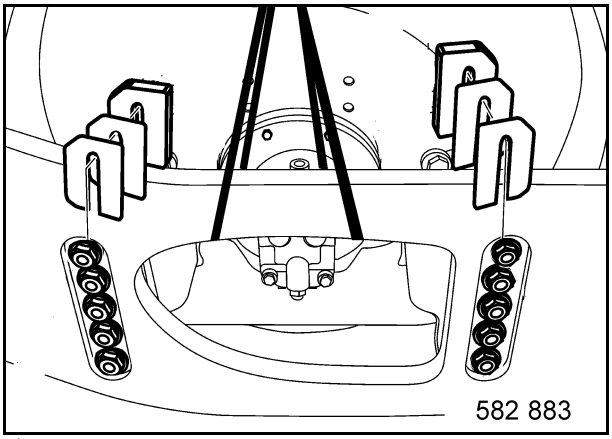


Fig. 3

4. Remove the compensation shims (Fig. 3).

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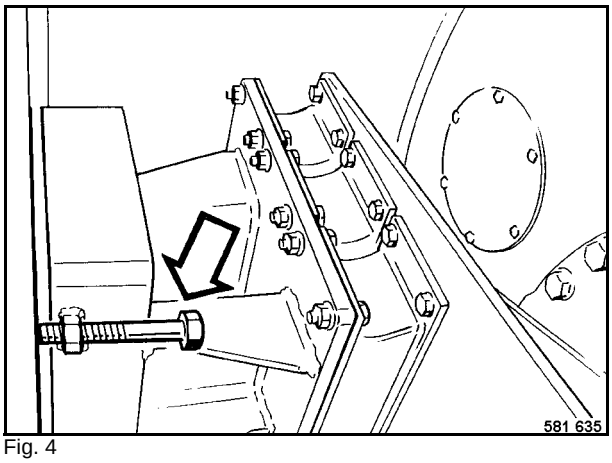


Fig. 4

5. Unscrew the screws (Fig. 4) from the welded nuts.

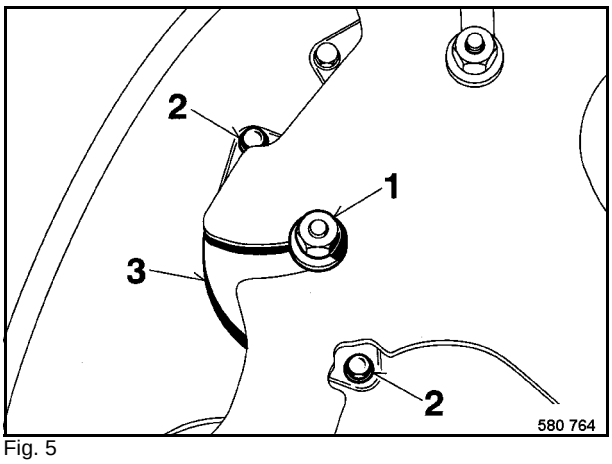


Fig. 5

Changing the rubber buffers

6. Unscrew nut 1 (Fig. 3) and remove the washer.
7. Unscrew screws (2).
8. Take off rubber buffer (3).
9. Attach the new rubber buffer to the drive disc and align the bores to the tapped bores in the drum.
10. Turn in and tighten the fastening screws.
11. Assemble the washer, turn on and tighten the nut.

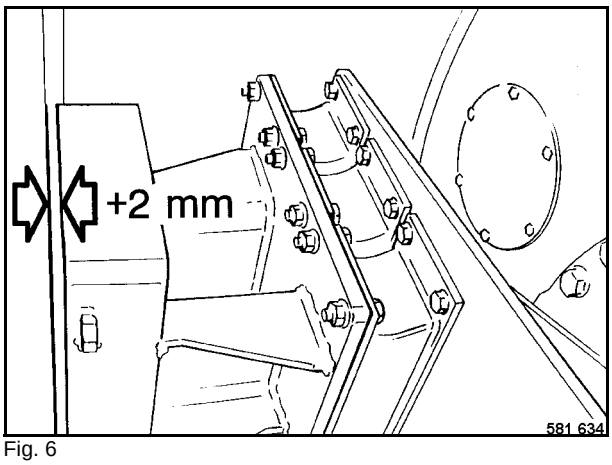


Fig. 6

Adjusting the pre-load

12. Measure distance „X“ between spacer piece and side plate (Fig. 6).
13. Calculate the thickness of the compensation plates.

    Nominal value:
    Distance „X“ + 2 mm

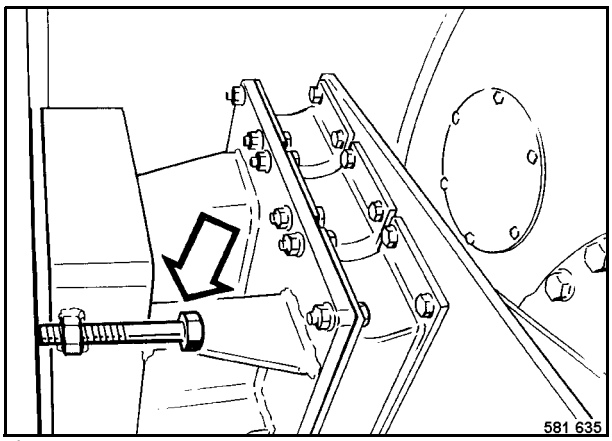


Fig. 7

14. Turn in screws into each welded nut and provide sufficient space to insert the compensation plates (Fig. 7).

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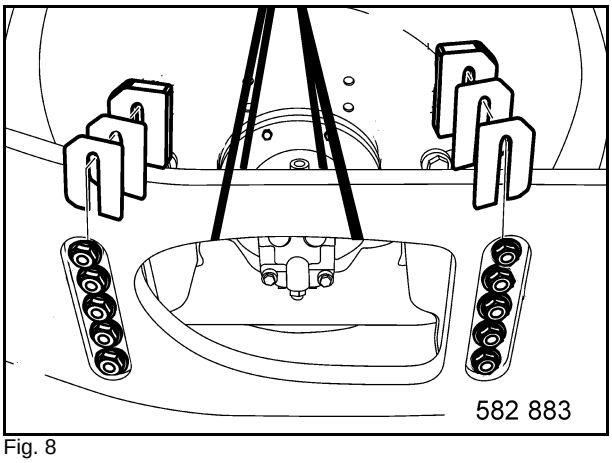


Fig. 8

15. Assemble the compensation shims (Fig. 8).

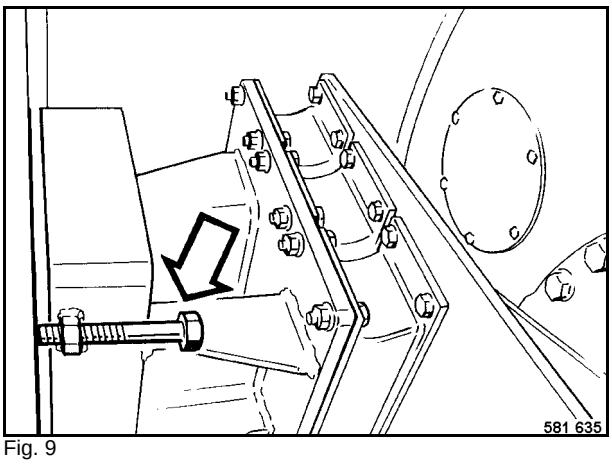


Fig. 9

16. Unscrew the screws (Fig. 9) from the welded nuts.

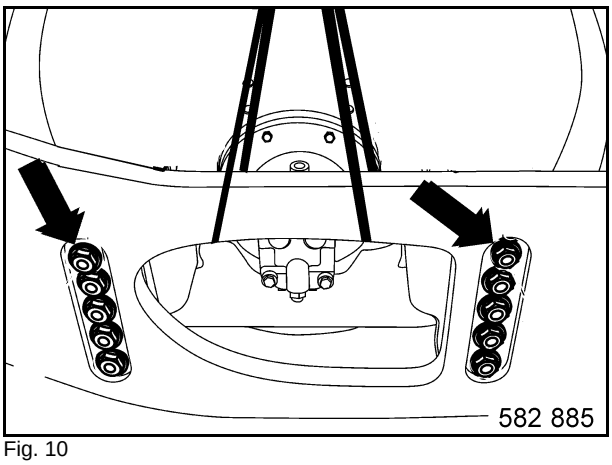


Fig. 10

17. Tighten the fastening screws (Fig. 10).
18. Lower the frame again.

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15 Oscillating articulated joint

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15.1 Special tools

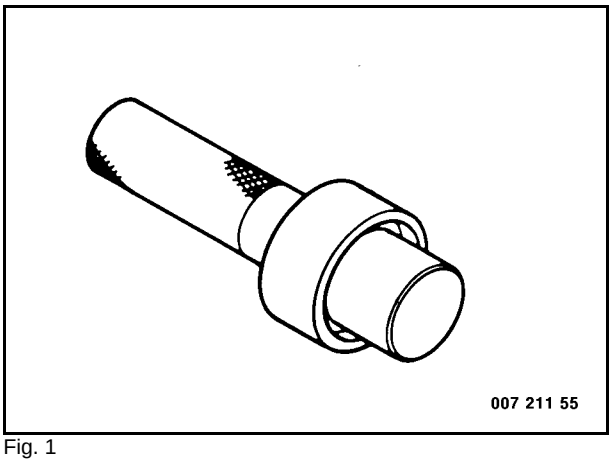


Fig. 1

1. Assembly mandrel for rocker bearings (console of articulated joint).

   BOMAG part-no.: 007 211 55

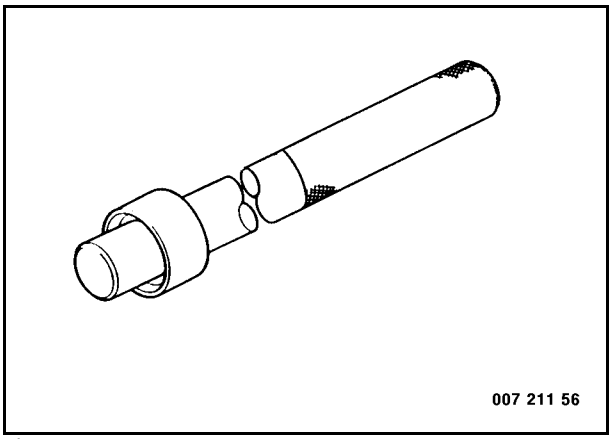


Fig. 2

2. Assembly mandrel for rocker bearings (steering cylinders).

   BOMAG part-no.: 007 211 56

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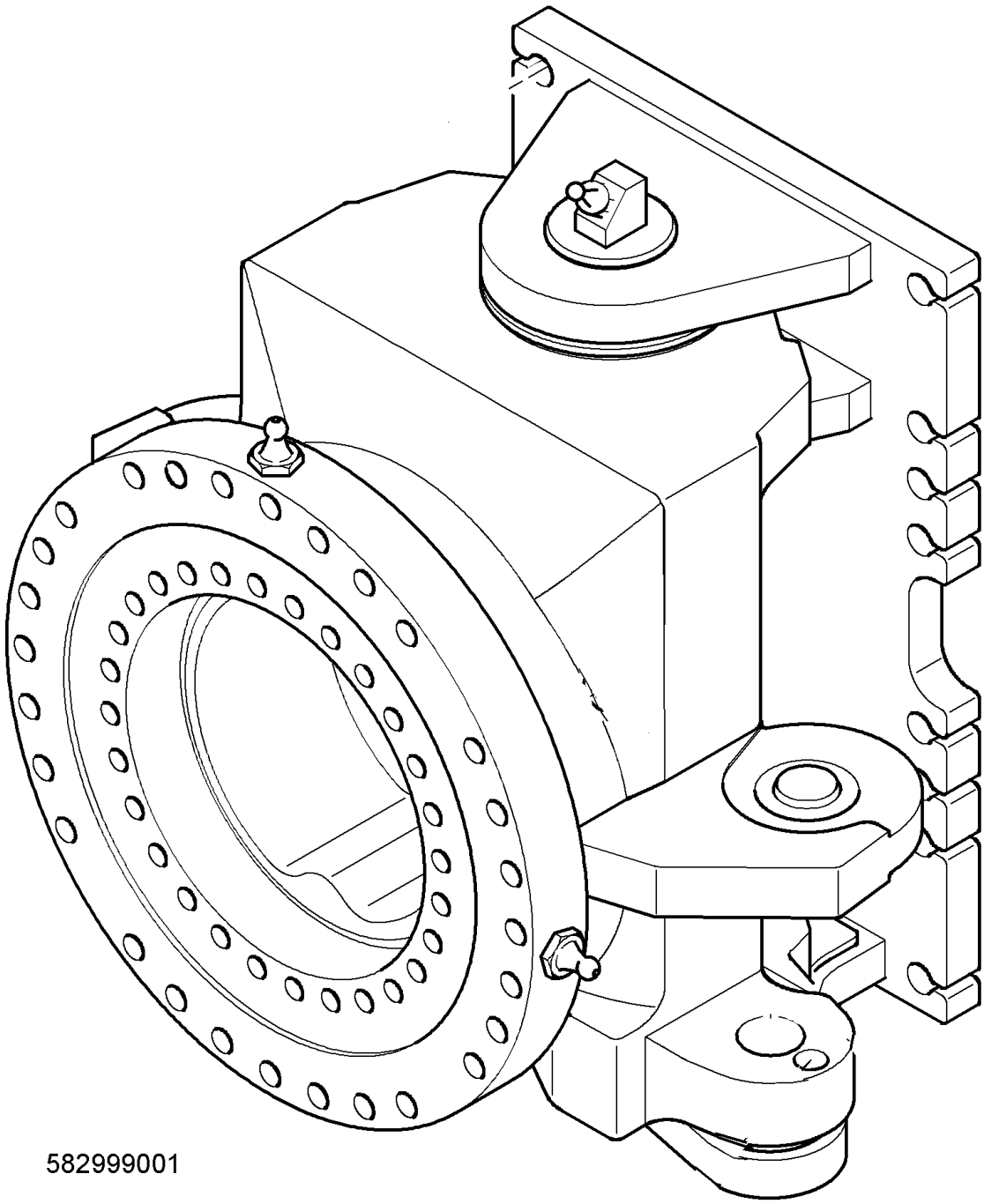


Fig. 1 Oscillating articulated joint

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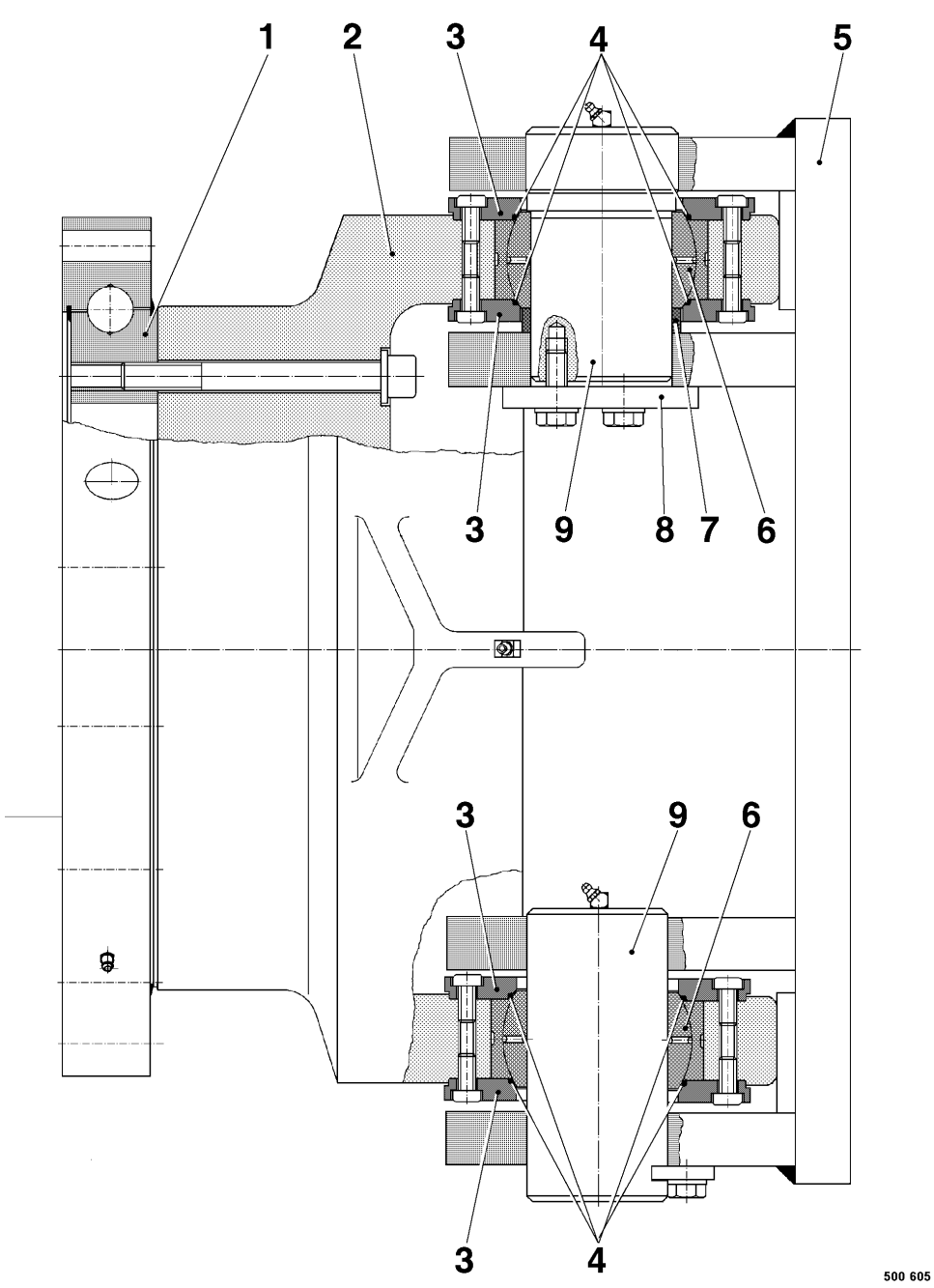


Fig. 2 Cross-sectional drawing

1 Four-point bearing
2 Console, front
3 Centring disc
4 O-ring
5 Console, rear
6 Self-aligning bearing
7 Spacer ring
8 Washer
9 Bolt

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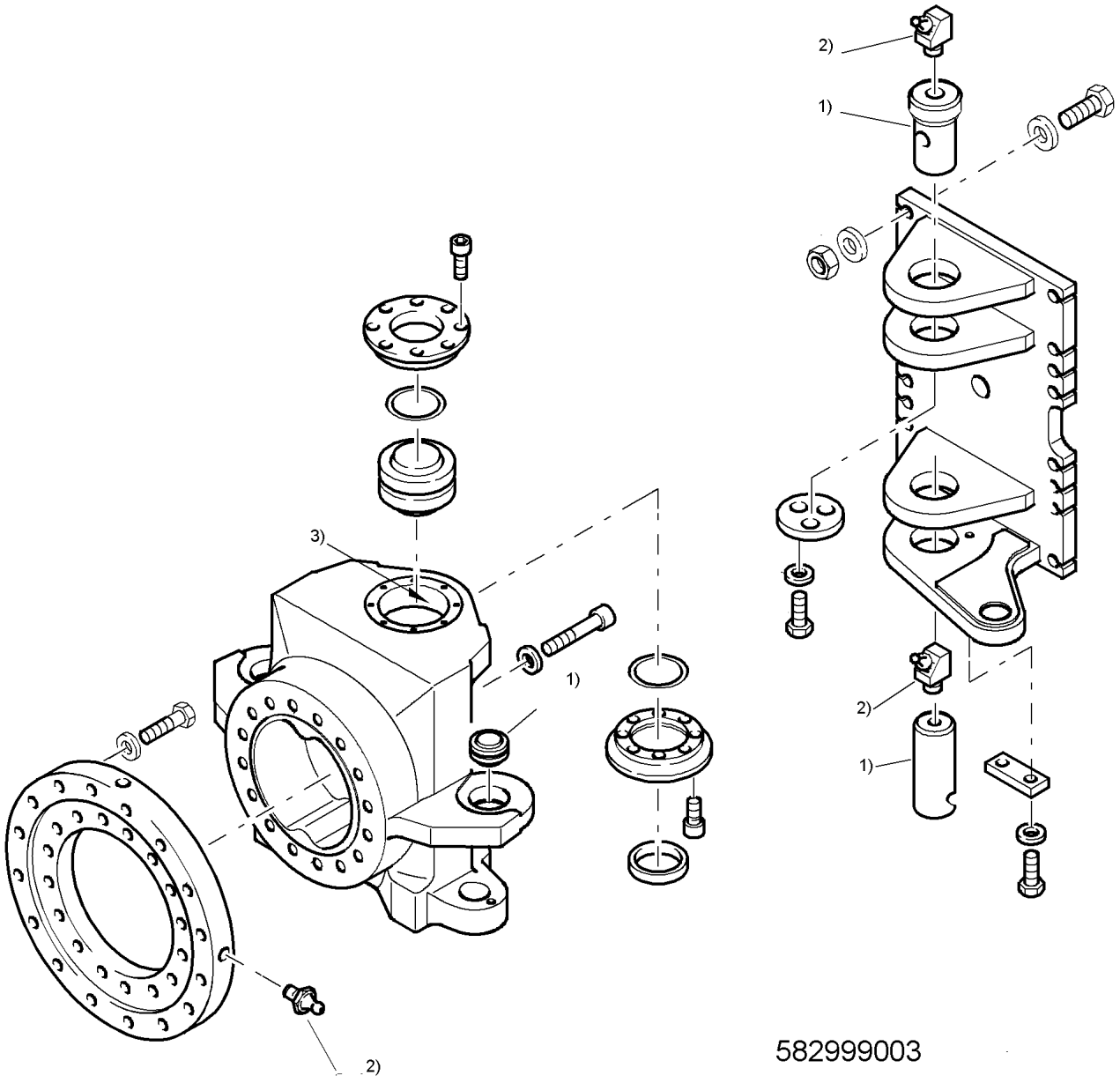


Fig. 3

1) Assemble with sliding agent OKS 571 00970026 (Fig. 3).

2) Clean the grease nipples and lubricate with approx. 10 shots from the grease gun.

3) Slightly oil the bearing seat

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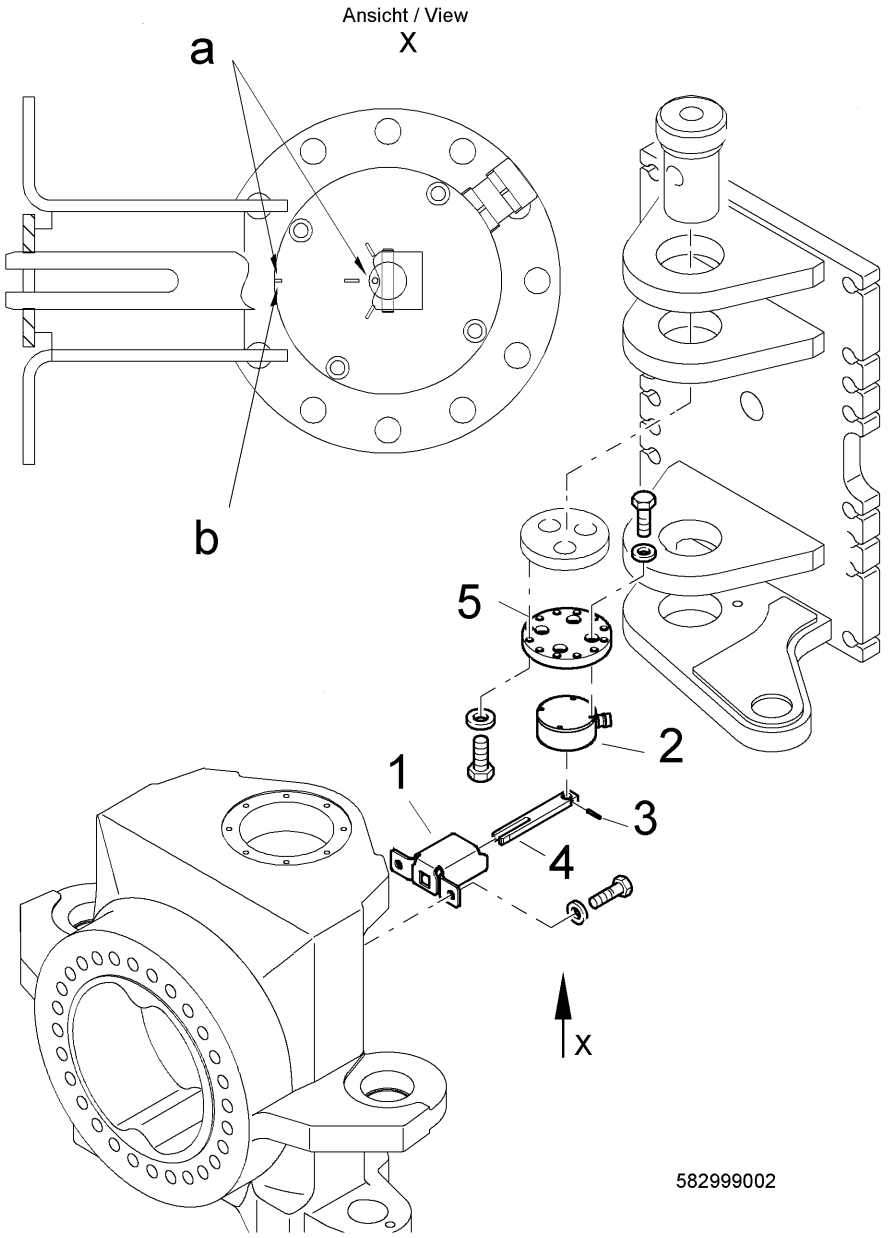


Fig. 4 electric steering

Assembly of steering angle sensor for electric steering (BVC machines) (Fig. 4).

a) Align the marks for assembly.

b) The marks must face in travel direction forward (± 15°)

1) Mounting plate

2) Steering angle sensor

3) Roll pin

4) Control lever

5) Adapter plate

i Note

After assembly perform teaching of the end stops for the steering angle sensor (see electrics of the machine).

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15.3 Removing and installing the oscillating articulated joint

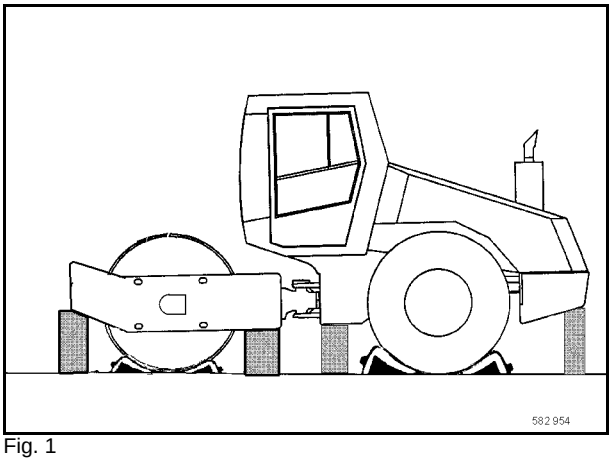


Fig. 1

1. Jack the back of the frame (Fig. 1) up and secure it with trestles or wooden blocks.
2. Jack the front frame up and secure it with trestles or wooden blocks.
3. Block drums and wheels with suitable chocks .

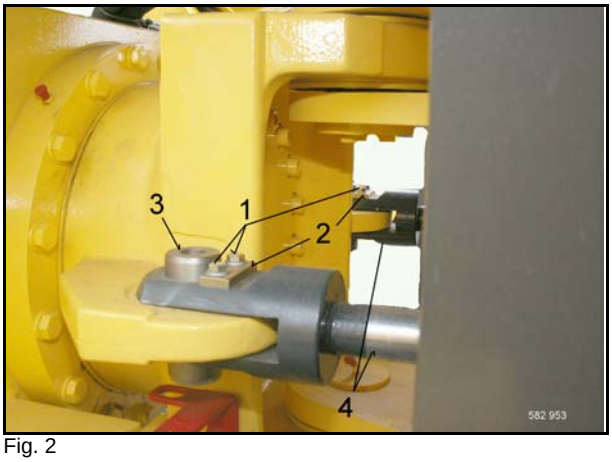


Fig. 2

4. Unscrew fastening screws 1 (Fig. 2) and take off axle holder (2).
5. Knock out bearing bolt (3).
6. Retract steering cylinder (4).

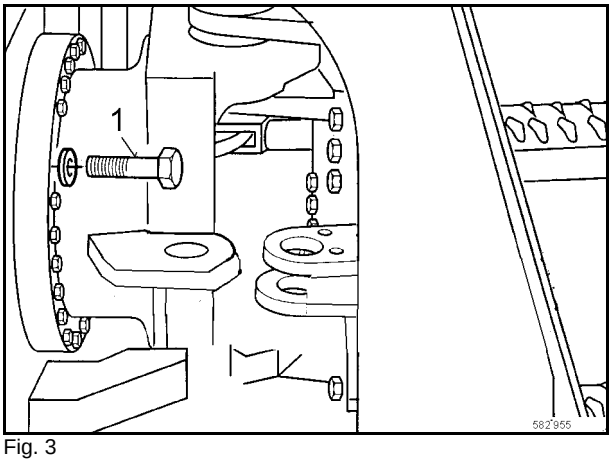


Fig. 3

⚠ Danger

Danger of accident!

7. Support the oscillating articulated joint in the middle with a suitable jack or a similar device.
8. Unscrew fastening screws 1 (Fig. 3).

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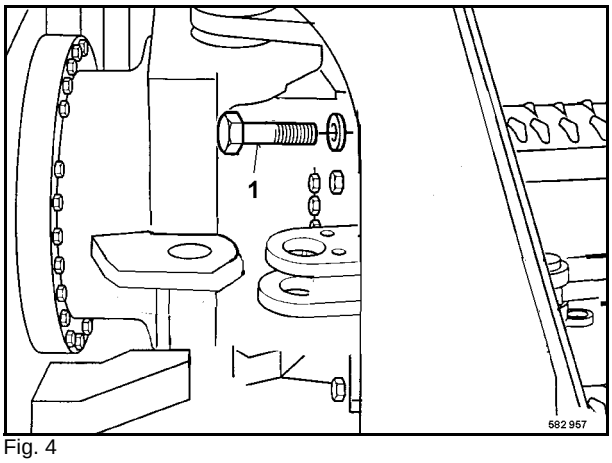


Fig. 4

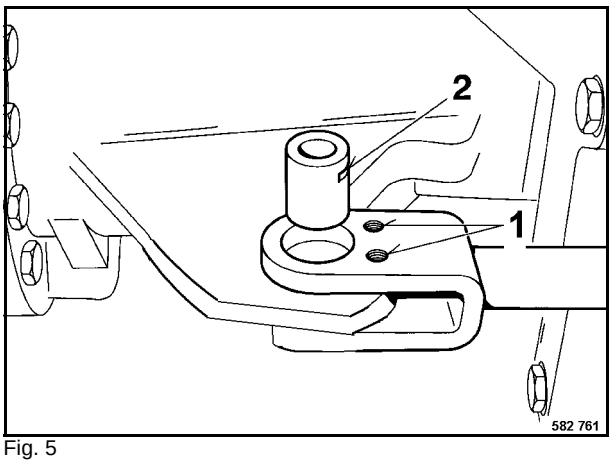


Fig. 5

9. Unscrew fastening screws 1 (Fig. 4).
10. Pull out the oscillating articulated joint.

Note on assembly

11. Insert the bolt for the steering cylinder so that groove 2 (Fig. 5) is in line with tapped bores (1).

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15.4 Dismantling the oscillating articulated joint

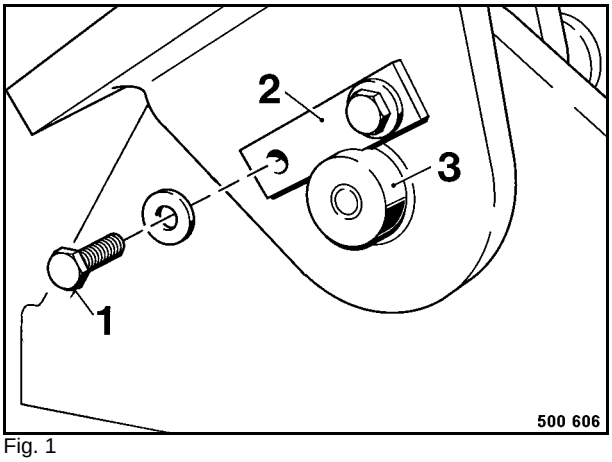


Fig. 1

1. Unscrew fastening screws 1 (Fig. 1) and take off axle holder (2).

⚠ Danger

Danger of squashing!

2. Take out bolt (3).

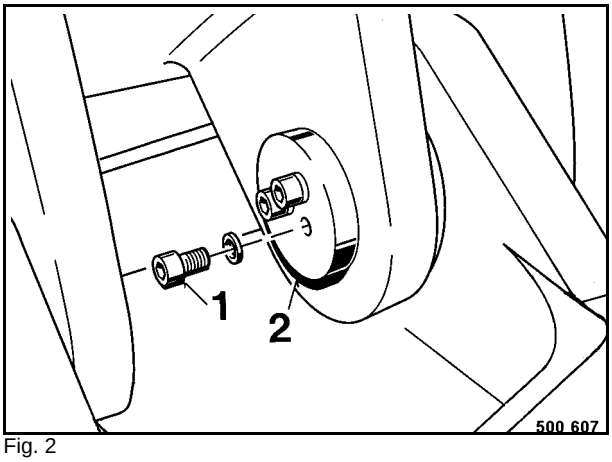


Fig. 2

3. Unscrew fastening screws 1 (Fig. 2) and take off axle holder (2).

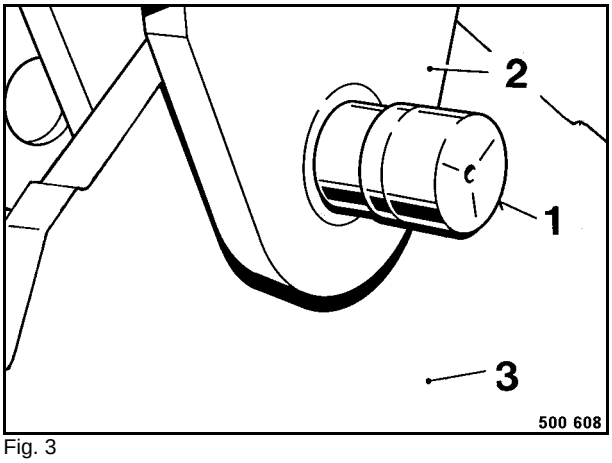


Fig. 3

⚠ Danger

Danger of squashing!

4. Turn out bolt 1 (Fig. 3) and separate consoles (2 and 3).

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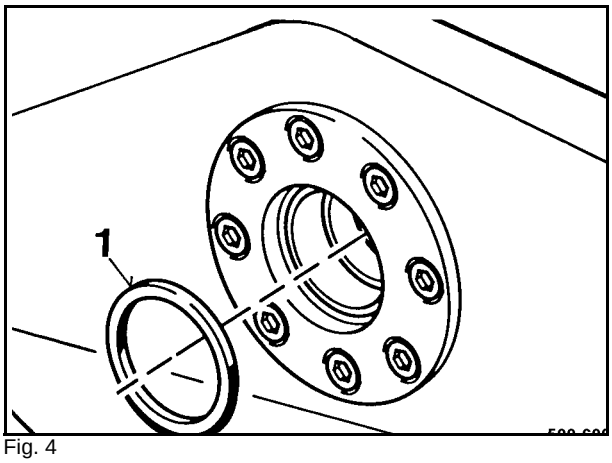


Fig. 4

5. Take spacer ring 1 (Fig. 2) out of the centring disc.

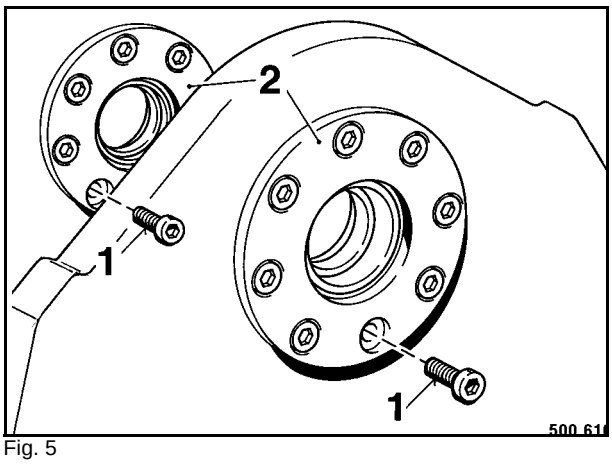


Fig. 5

6. Unscrew fastening screws 1 (Fig. 3) and take off the centring disc (2).

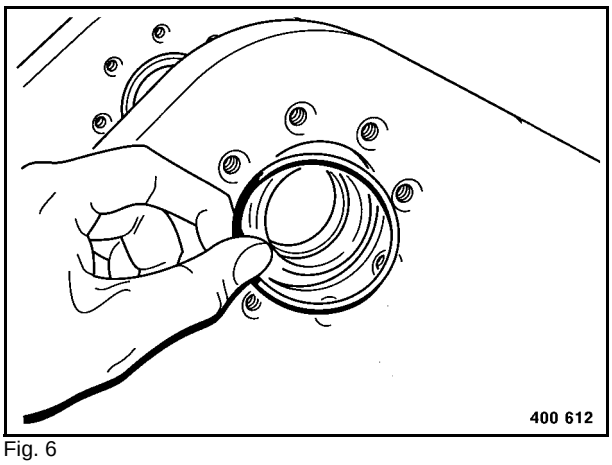


Fig. 6

7. Take the O-ring out of the rocker bearing (Fig. 4).

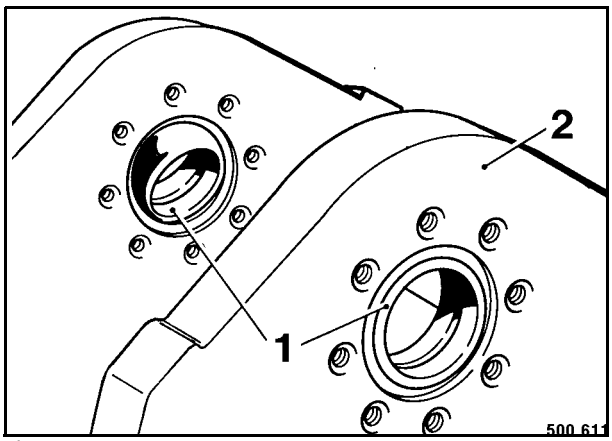


Fig. 7

8. Knock both rocker bearings 1 (Fig. 5) out of console (2).

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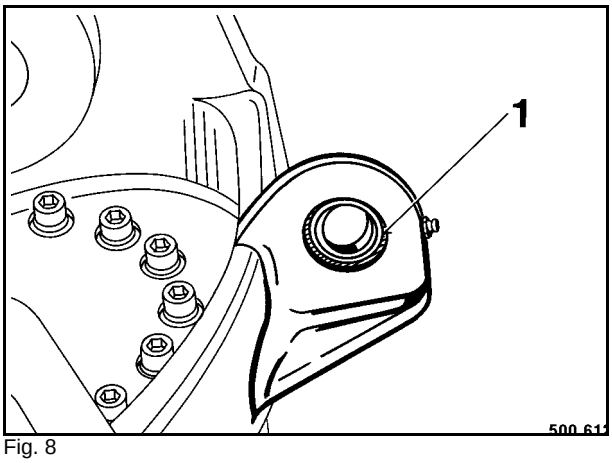


Fig. 8

9. Knock rocker bearings 1 (Fig. 8) out of the steering cylinder receptacles.

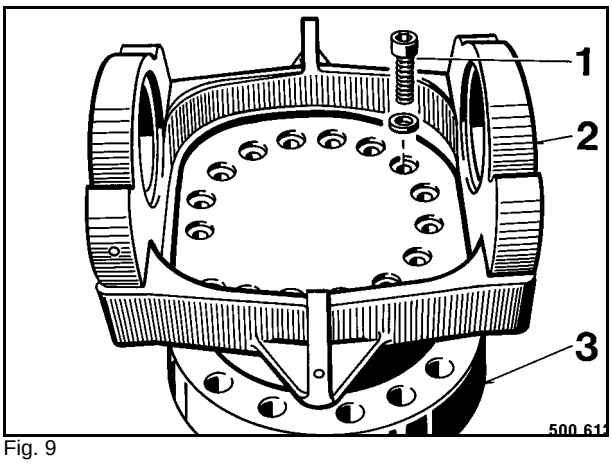


Fig. 9

10. Unscrew fastening screws 1 (Fig. 9) and lift the front console (2) off the four point bearing (3).
11. Check four point bearing for wear , replace if necessary.

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15.5 Assembling the oscillating articulated joint

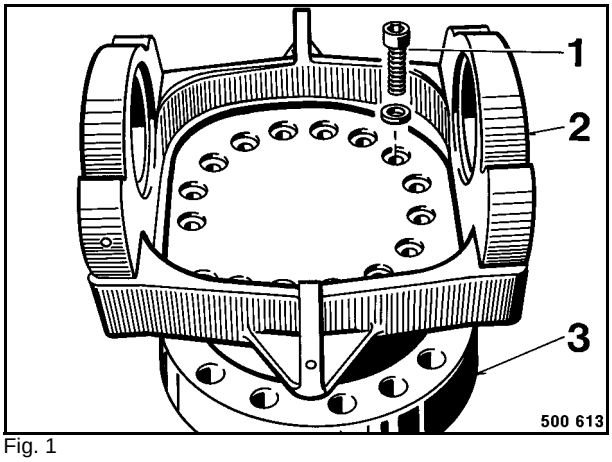


Fig. 1

1. Lay the four point bearing 3 (Fig. 1) on a level surface, insert console (2) and fasten with screws (1) and washers.

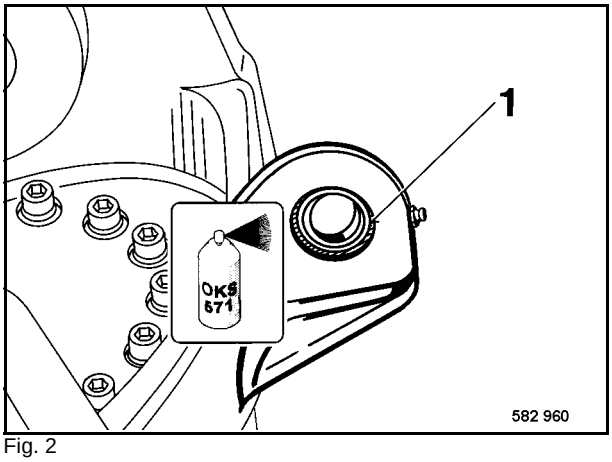


Fig. 2

2. Spray the rocker bearings 1 (Fig. 2) with sliding lacquer OKS 571 and knock them into the corresponding boreholes in the steering cylinder.

   Special tools:

   Assembly mandrel for rocker bearings (steering cylinders).

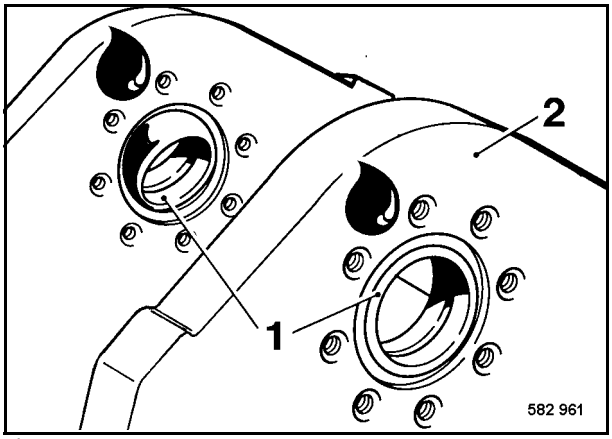


Fig. 3

3. Slightly lubricate the bearings seats and knock rocker bearings 1 (Fig. 3) into console (2).

   Special tools:

   Assembly mandrel for rocker bearings (console of articulated joint).

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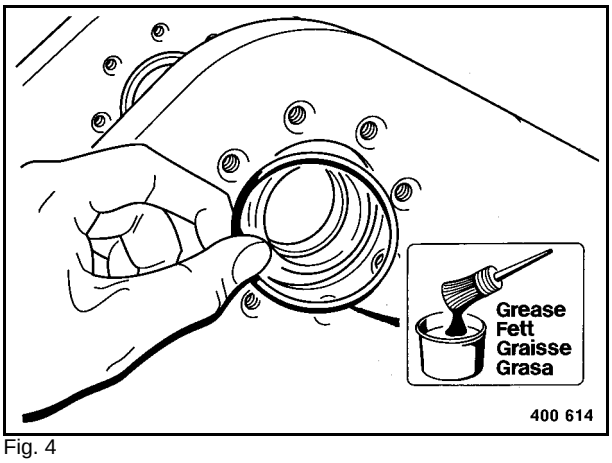


Fig. 4

4. Grease the new O-rings and insert them into the rocker bearings (Fig. 2).

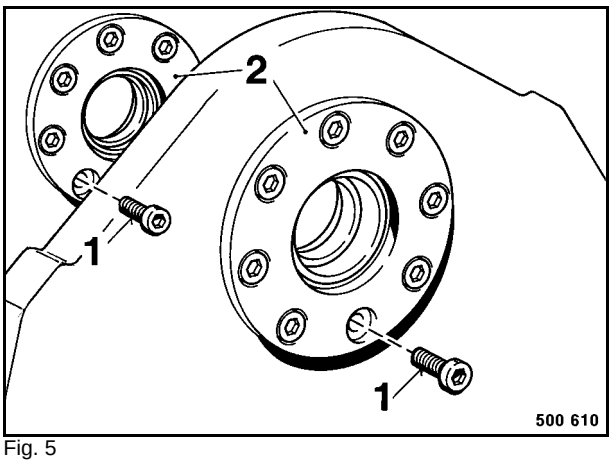


Fig. 5

5. Fasten centring discs 2 (Fig. 3) with screws (1).

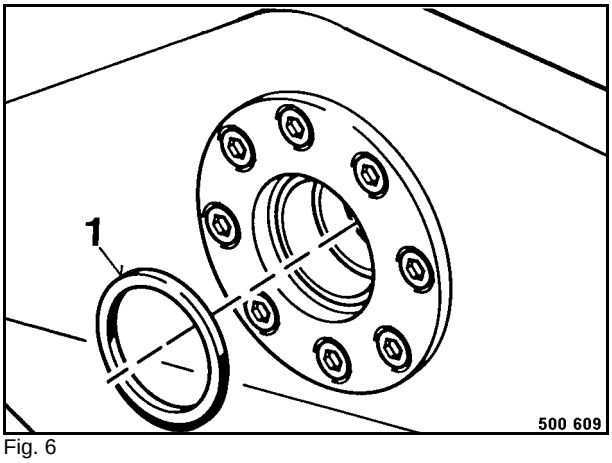


Fig. 6

6. Insert spacer ring 1 (Fig. 4) into one of the centring discs.

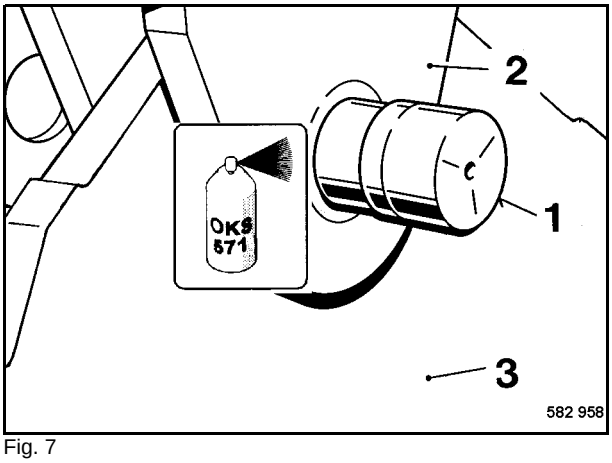


Fig. 7

7. Spray pin 1 (Fig. 5) with sliding agent OKS 571.

⚠ Caution

Bolt (1) must be knocked in on the side with spacer ring 1 (Fig. 4).

8. Join both consoles (2 and 3) together and knock in bolt (1).

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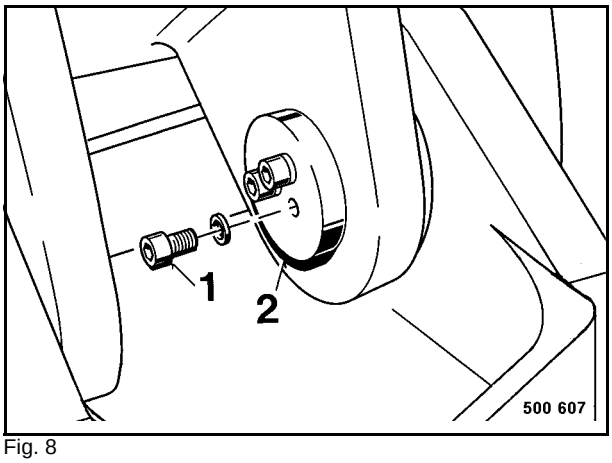


Fig. 8

9. Assemble disc 2 (Fig. 8) with screws (1) and washers.

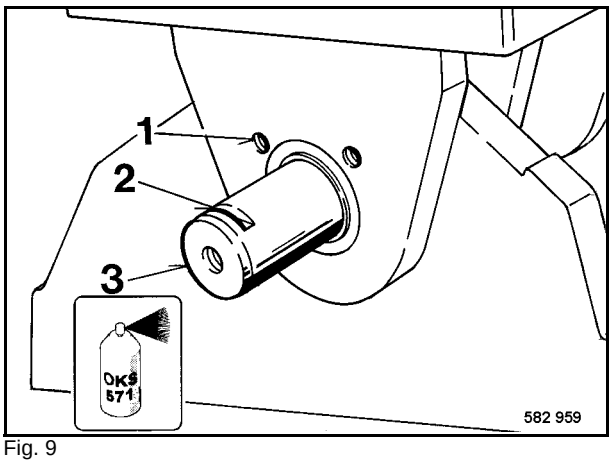


Fig. 9

10. Spray bolt 3 (Fig. 9) with sliding lacquer OKS 571 and insert it so that groove (2) is in line with tapped bores (1).

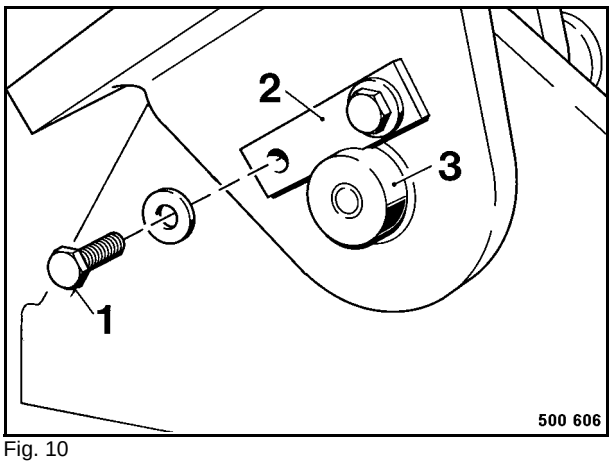


Fig. 10

11. Secure bolt 3 (Fig. 10) with axle holder (2), screws (1) and washers.

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16 Suppliers documentation

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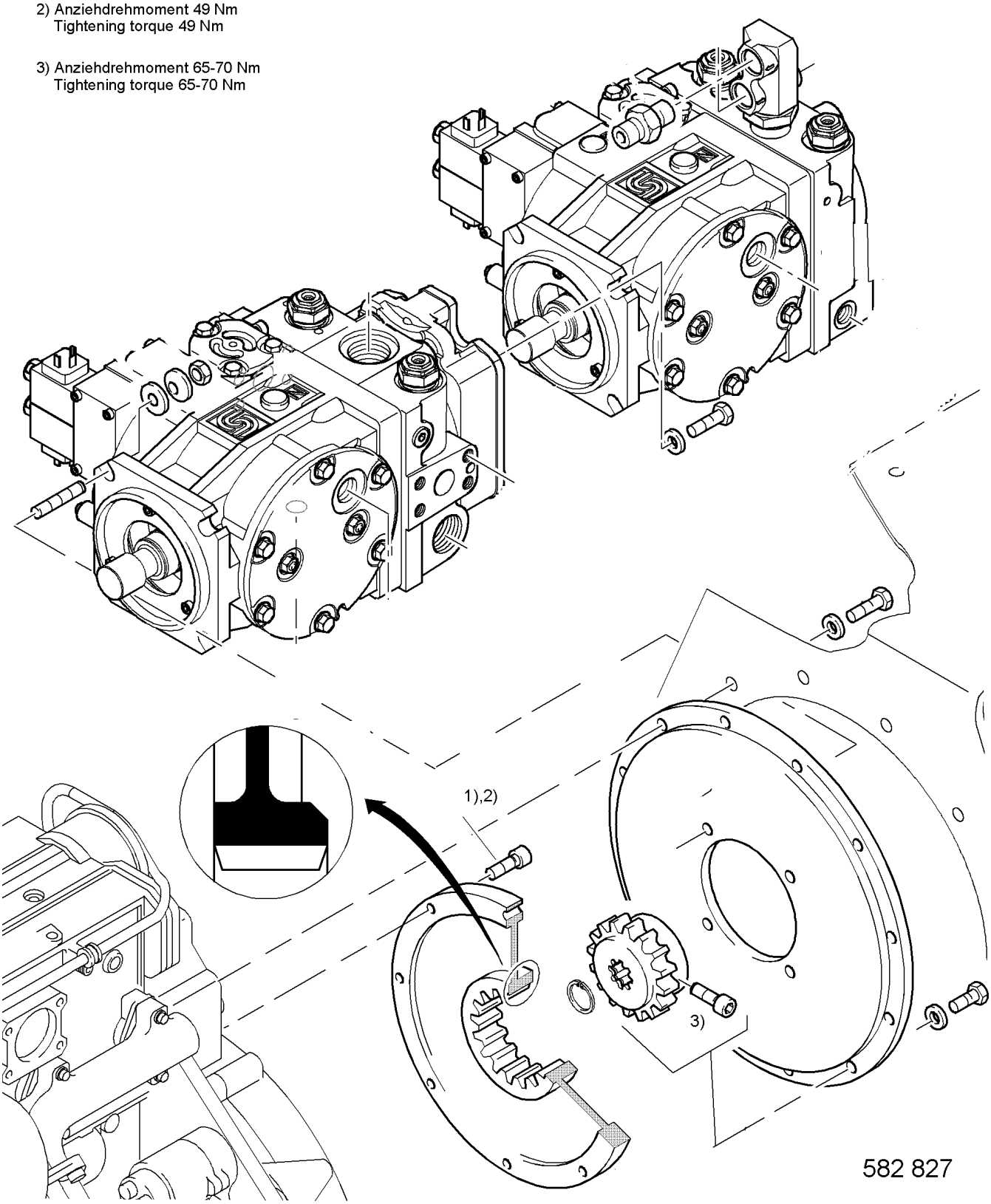
16.1 Travel pump / vibration pump series 90R

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1) Mit Loctite 270 eingesetzt
With Loctite 270 inserted

2) Anziehdrehmoment 49 Nm
Tightening torque 49 Nm

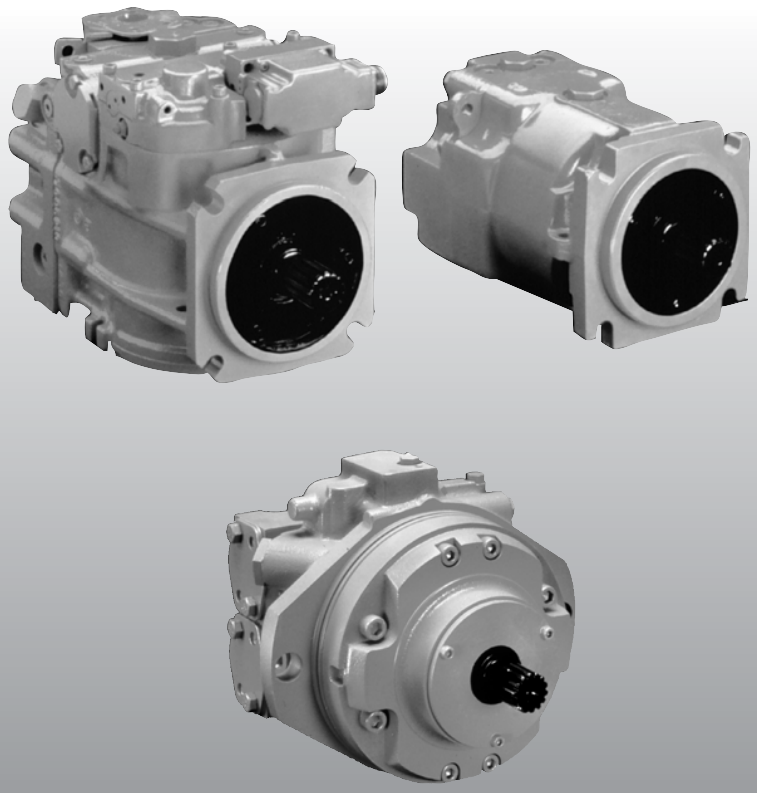
3) Anziehdrehmoment 65-70 Nm
Tightening torque 65-70 Nm



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SAUER DANFOSS

Series 90



Axial Piston
Pumps and Motors
Service Manual

https://truckmanualshub.com/

Introduction

Use of this Manual

This manual includes information for the normal operation, maintenance, and servicing of the Series 90 family of hydrostatic pumps and motors.

The manual also includes the description of the units and their individual components, troubleshooting information, adjustment instructions, and minor repair procedures. Unit warranty obligations should not be affected if maintenance, adjustment, and minor repairs are performed according to the procedures described in this manual.

Many service and adjustment activities can be performed without removing the unit from the vehicle or machine. However, adequate access to the unit must be available, and the unit must be thoroughly cleaned before beginning maintenance, adjustment, or repair activities.

Since dirt and contamination are the greatest enemies of any type of hydraulic equipment, cleanliness requirements must be strictly adhered to. This is especially important when changing the system filter and during adjustment and repair activities.

For further information refer to Series 90 Technical Information. For information about fluid requirements refer to SAUER-SUNDSTRAND BLN 9887 or SDF (Id No. 697581).

A worldwide network of SAUER-SUNDSTRAND Authorized Service Centers is available should repairs be needed. Contact any SAUER-SUNDSTRAND Authorized Service Center for details. A list of all Service Centers can be found in bulletin BLN-2-400527, or in brochure SAW (Ident. No. 698266).

Safety Precautions

Observe the following safety precautions when using and servicing hydrostatic products.

Loss of Hydrostatic Braking Ability

WARNING
The loss of hydrostatic drive line power in any mode of operation (e.g., forward, reverse, or "neutral" mode) may cause the loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.

S000 001E

Fluid under High Pressure

WARNING
Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.

S000 003E

Disable Work Function

WARNING
Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.

S000 005E

Flammable Cleaning Solvents

WARNING
Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

S000 004E

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Functional Description

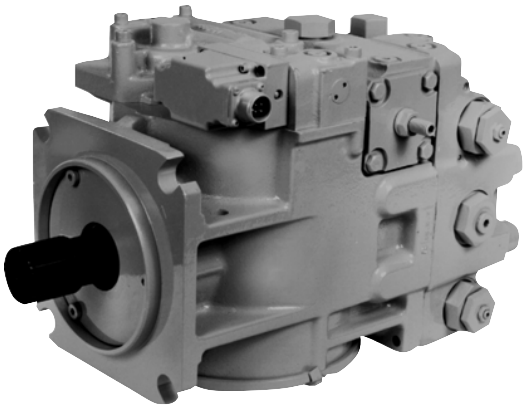
This section describes the operation of pumps, motors, and their various serviceable features. It is a useful reference for readers unfamiliar with the functioning of a specific system.

General Description and Cross Sectional Views

Variable Displacement Pumps

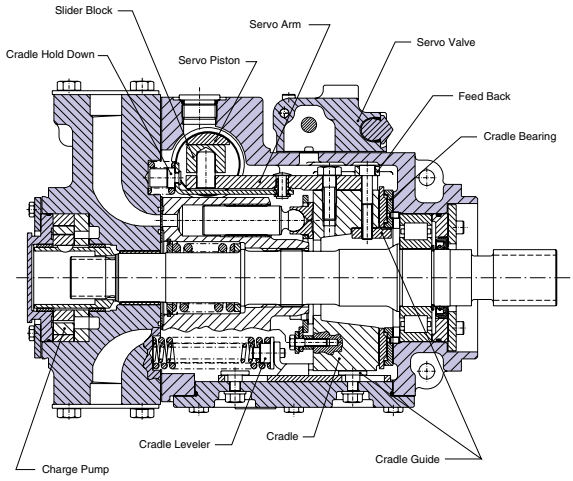
The Variable Displacement Pump (PV) is designed to convert an input torque into hydraulic power. The input shaft turns the pump cylinder which contains a ring of pistons. The pistons run against a tilted plate, called the swashplate. This causes the pistons to compress the hydraulic fluid which imparts the input energy into the hydraulic fluid. The high pressure fluid is then ported out to provide power to a remote function.

The swashplate angle can be varied by the control piston. Altering the swashplate angle varies the displacement of fluid in a given revolution of the input shaft.



F000 539

Series 90 Variable Displacement Pump (PV)

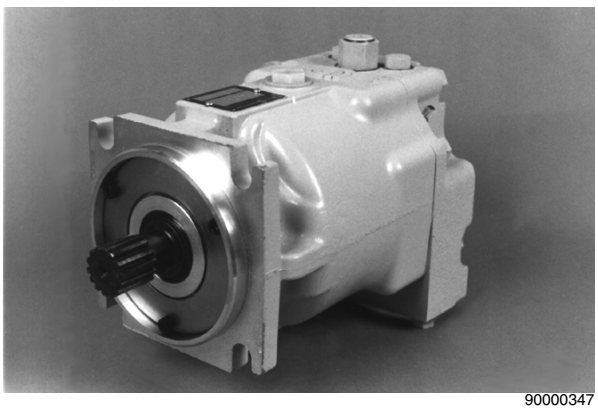


P001 413E

Series 90 PV Cross Section

Fixed Displacement Motor

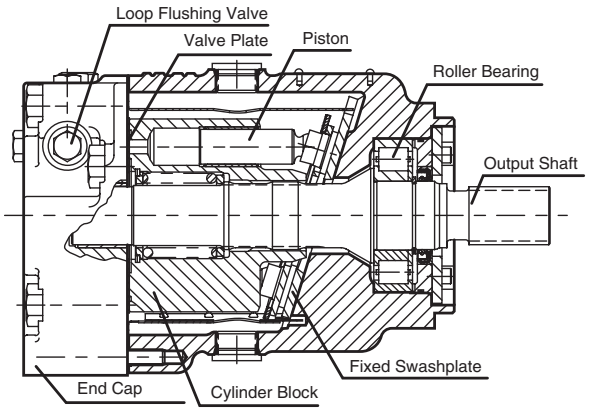
The Fixed Displacement Motor (MF) is designed to convert an input of hydraulic power into an output torque. It operates in the reverse manner of the pump. The high pressure hydraulic fluid enters through the input port. The fluid pressure builds behind the pistons causing them to move down the swashplate (the path of least resistance). As the piston returns up the swashplate again, the fluid is allowed to exit through the exit port. The spinning pistons are housed in a cylinder which is connected to the output shaft. The output torque can be applied to a mechanical function.



90000347

Series 90 Fixed Displacement Motor (MF)

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90000190E

Series 90 MF Cross Section

In the Fixed Displacement Motor the "swashplate" is fixed, so any variation in motor speed and torque must be made by the input mechanism, i.e. the pump.

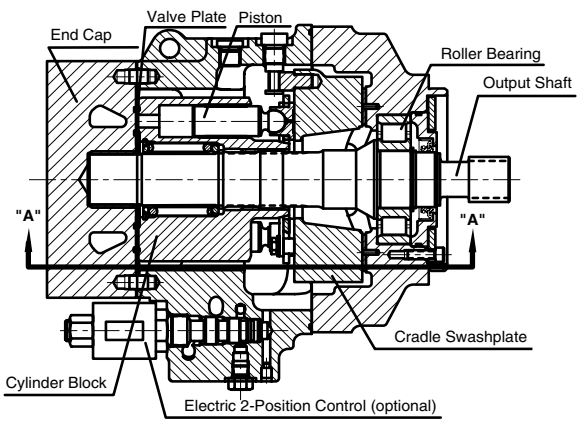


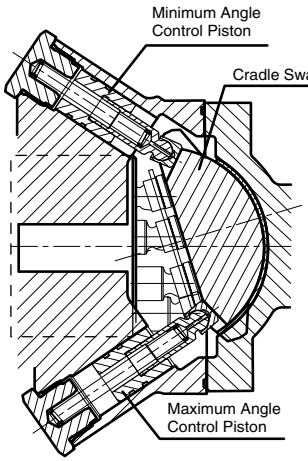
90000348

Series 90 Variable Displacement Motor (MV)

Variable Displacement Motor

The Variable Displacement Motor (MV) operates in the same manner as the fixed motor. However, its swashplate is not fixed; it can be switched between minimum and maximum angle to amplify torque or speed like the Variable Displacement Pump.





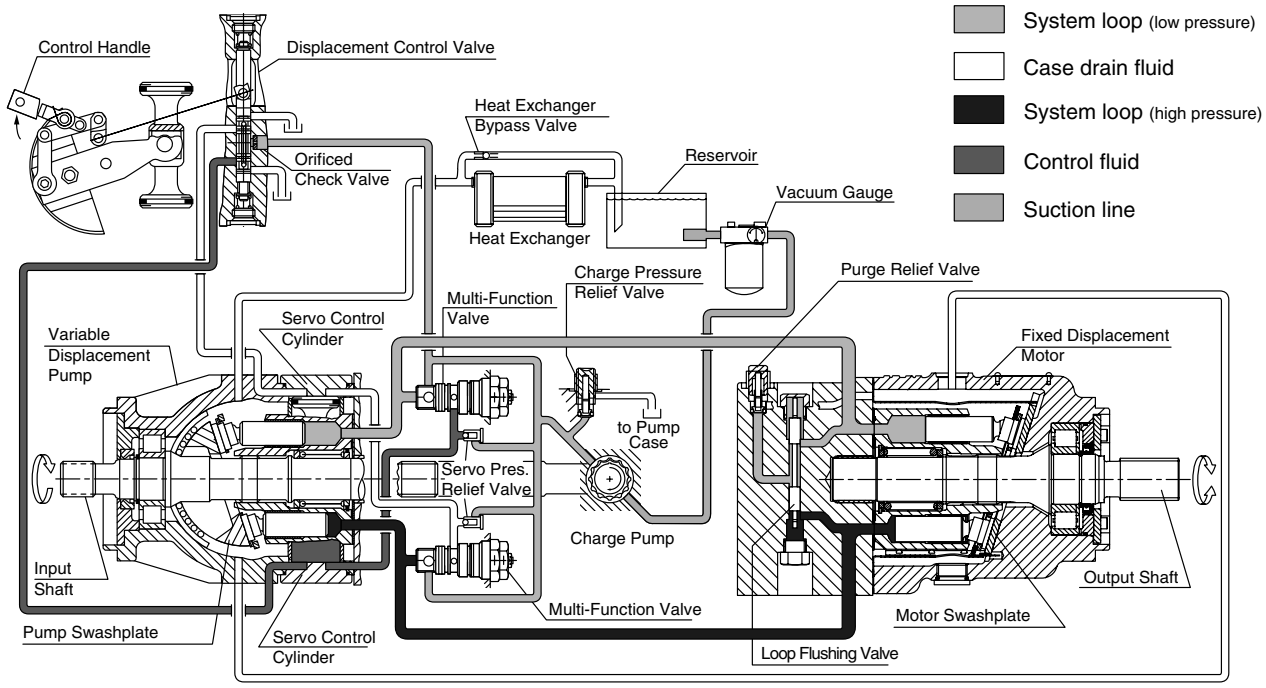
**Partial Section "A-A"
Cradle Swashplate in Full
Displacement Position**

90000234E

Series 90 MV Cross Section

https://truckmanualshub.com/

The System Circuit



90000800E

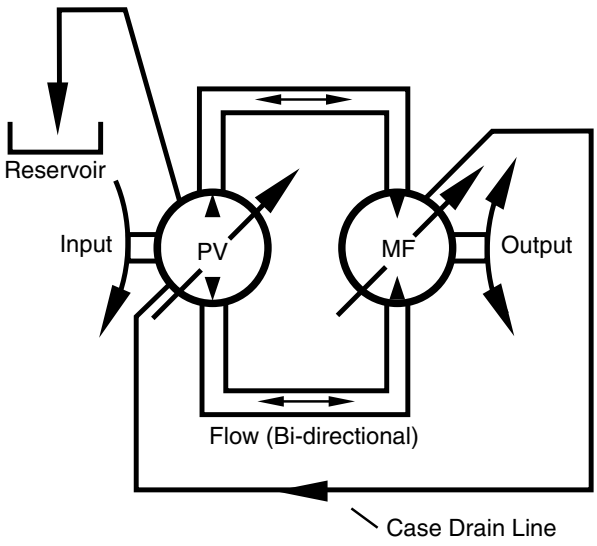
Circuit Diagram for Series 90 PV and 90 MF

The Basic Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows, in either direction, from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. In pumping mode the position of the pump swashplate determines which line is high pressure as well as the direction of fluid flow.

Case Drain and Heat Exchanger

The pump and motor require case drain lines to remove hot fluid from the system. The motor should be drained from its topmost drain port to ensure the case remains full of fluid. The motor case drain can then be connected to the lower drain port on the pump housing and out the top most port. A heat exchanger, with a bypass valve, is required to cool the case drain fluid before it returns to the reservoir.



90000803E

Basic Closed Circuit

https://truckmanualshub.com/

Common Features of Pumps and Motors

End Caps and Shafts

Series 90 pumps and motors can be supplied with a variety of end caps and shafts to allow for almost any configuration. For pumps, end caps are available with system ports on either side ("side ports") or both ports on one side ("twin ports"). Motors have end caps with ports on the face of the end cap ("axial ports") or both ports on one side ("twin ports"). See the Series 90 Technical Information manuals (BLN-10029 and BLN-10030) or the Series 90 Price Book (BLN-2-40588) for information on available options.

Removing the end cap will void the warranty on a Series 90 pump or motor.

Speed Sensors

An optional speed sensor can be installed on Series 90 pumps and motors to provide unit speed information. The sensor reads a magnetic ring wrapped about the unit's cylinder. See the corresponding Section to locate, install and adjust the sensor.



90000810

Speed Sensor

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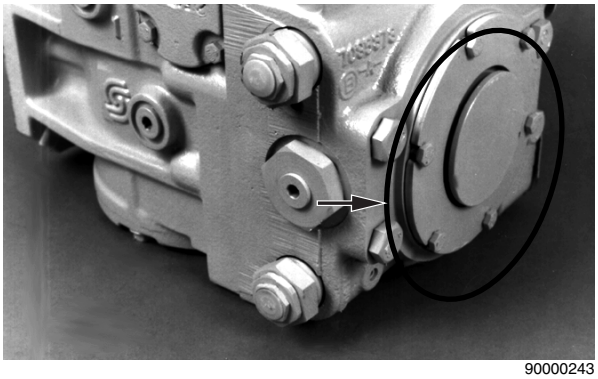
Pump Features

Charge Pump

The charge pump is necessary to supply cool fluid to the system, to maintain positive pressure in the main system loop, to provide pressure to operate the control system, and to make up for internal leakage. Charge pressure must be at its specified pressure under all conditions of driving and braking to prevent damage to the transmission.

The charge pump is a fixed-displacement, gerotor type pump installed in the variable displacement pump and driven off the main pump shaft. Charge pressure is limited by a relief valve.

The standard charge pump will be satisfactory for most applications. However, if the charge pump sizes available for the given main pump size are not adequate, a gear pump may be mounted to the auxiliary mounting pad and supply the required additional charge flow.

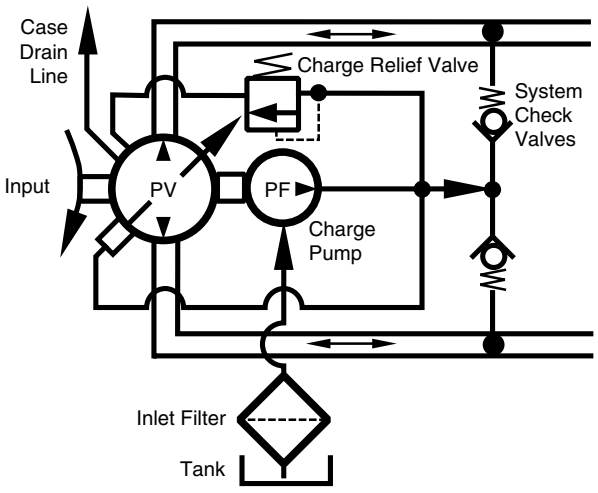


90000243

PV with Charge Pump

Charge Relief Valve

The charge relief valve on the pump serves to maintain charge pressure at a designated level. A direct-acting poppet valve relieves charge pressure whenever it surpasses a certain level. This level is nominally set referencing case pressure at 1500 rpm. This nominal setting assumes the pump is in neutral (zero flow); in forward or reverse charge pressure will be lower. The charge relief valve setting is specified on the model code of the pump.



90000804E

Pump Charge System

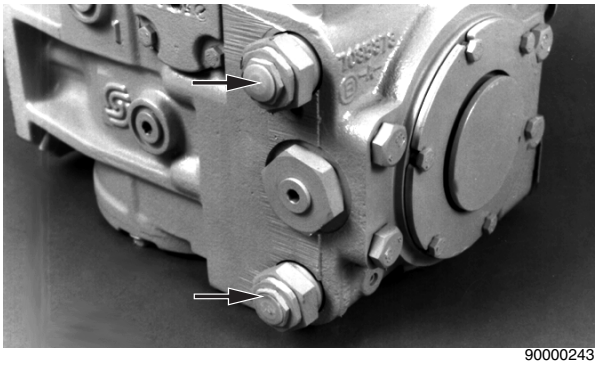
Multi-Function Valves

The multi-function valve incorporates
the system check valve,
the pressure limiter valve,
the high pressure relief valve and
the bypass valve

in a replaceable cartridge.

These functions are described separately. There are two multi-function valve cartridges in each Series 90 pump to handle functions in either direction. See corresponding Sections for adjustments and repairs.

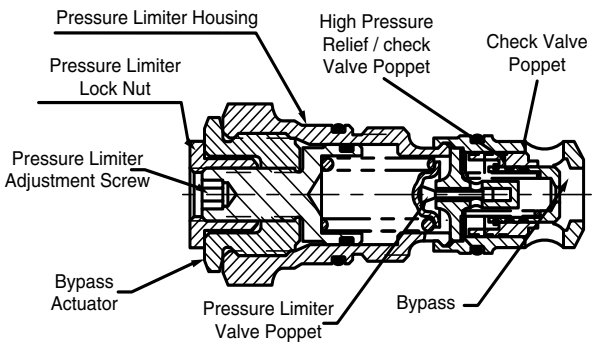
NOTE: Some multi-function valves do not include a pressure limiter valve.



90000243

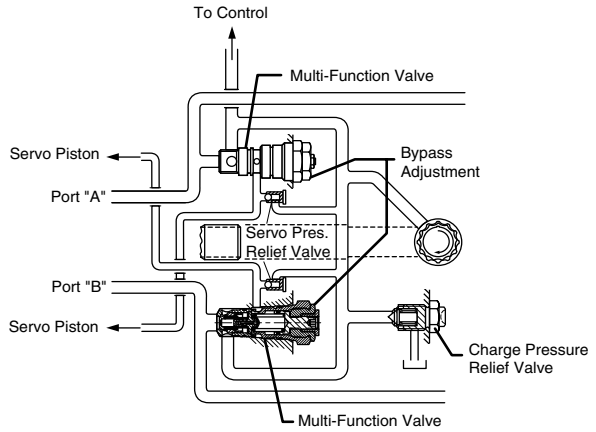
Multi-Function Valve

https://truckmanualshub.com/



90000806E

Cross Section of Multi-Function Valve



90000801E

Circuit Diagram showing Pressure Control Mechanism

Pressure Limiter and High Pressure Relief Valves

Series 90 pumps are designed with a sequenced pressure limiting system and high pressure relief valves. When the preset pressure is reached, the pressure limiter system acts to rapidly destroke the pump so as to limit the system pressure. For unusually rapid load application, the high pressure relief valve acts to immediately limit system pressure by cross-porting system flow to the low pressure side of the loop. The pressure limiter valve acts as the pilot for the high pressure relief valve spool. The high pressure relief valve is sequenced to operate at approximately 35 bar (500 psi) above the level that initiates the pressure limiter valve.

Both the pressure limiter sensing valves and relief valves are built into the multi-function valves (see above).

NOTE: For some applications, such as dual path vehicles, the pressure limiter function may be defeated so that only the high pressure relief valve function remains.

System Check Valves

The system check valves allow pressurized flow from the charge pump to enter the low pressure side of the loop whenever system pressure dips below a certain level. This is needed as the pump will generally lose system pressure due to leakage and other factors. Since the pump can operate in either direction, two system check valves are used to direct the charge supply into the low pressure lines. The system check valves are poppet valves located in the multi-function valve assembly.

Bypass Valves

The bypass valves ("tow") can be operated when it is desired to move the vehicle or mechanical function when the pump is not running. The valve is opened by manually resetting the valve position.

The bypass valves are built into the multi-function valves.

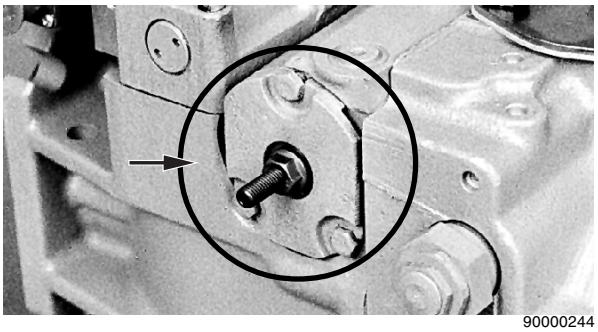
https://truckmanualshub.com/

Displacement Limiters

All Series 90 pumps are designed for optional mechanical displacement (stroke) limiters. The maximum displacement of the pump can be limited in either direction.

The setting can be set as low as 0° in either direction.

For instructions on adjustment see corresponding Section.

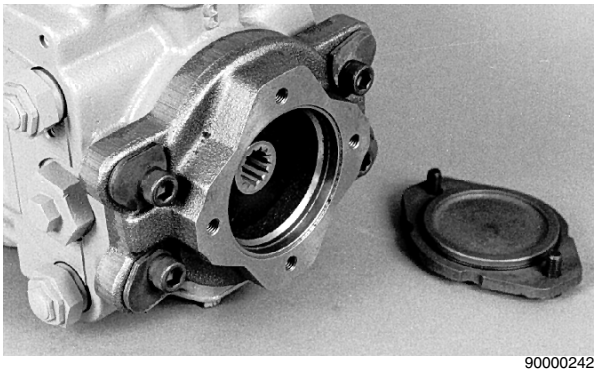


90000244

PV with Displacement Limiters

Auxiliary Mounting Pads

Auxiliary mounting pads are available on all Series 90 pumps. SAE A through E mounts are available (availability varies by pump size). This pad is used for mounting auxiliary hydraulic pumps and for mounting additional Series 90 pumps to make tandem pumps. The pads allow for full through-torque capability.



90000242

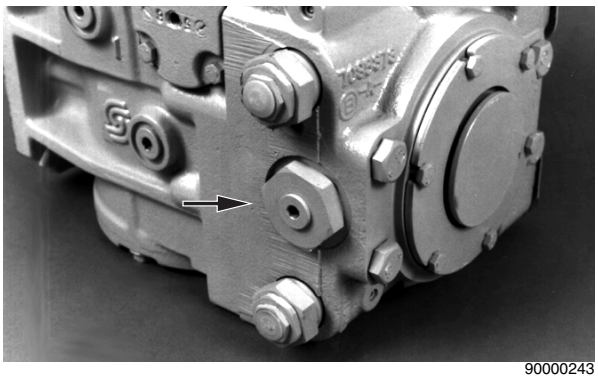
PV with Auxillary Mounting Pad

Filtration Options

All Series 90 pumps are available with provisions for either suction or charge pressure filtration (integral or remote mounted) to filter the fluid entering the charge circuit.

Suction Filtration

The suction filter is placed in the circuit between the reservoir and the inlet to the charge pump. When suction filtration is used, a reducer fitting is placed in the charge pressure gauge port (M3). Filtration devices of this type are provided by the user.



90000243

PV with Suction Filtration
(No filtration device attached)

Charge Pressure Filtration

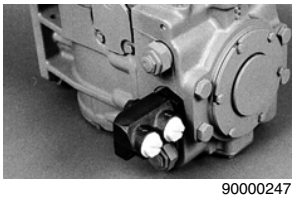
The pressure filter may be integrally mounted directly on the pump or a filter may be remotely mounted for ease of servicing.

A 125 m screen, located in the reservoir or the charge inlet line, is recommended when using this filtration option.



90000246

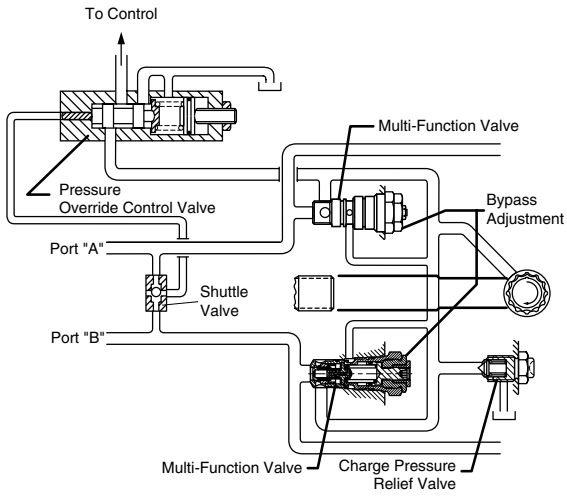
PV with Integral Charge Pump



90000247

PV with Remote Charge Pump

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POR-Valve (180 Frame Size only)

Pressure Override (POR) - 180 Frame Size Only

The pressure override valve (POR) modulates the control pressure to the displacement control to maintain a pump displacement which will produce a system pressure level less than or equal to the POR setting. For unusually rapid load application, the high pressure relief valve function of the multifunction valves is available to also limit the pressure level.

The pressure override consists of a three-way normally open valve which operates in series with the pump displacement control. Control supply pressure is normally ported through the pressure override valve to the displacement control valve for controlling the pump's displacement. If the system demands a pressure above the override setting, the POR valve will override the control by reducing the control pressure supplied to the displacement control. As the control pressure reduces, the internal forces tending to rotate the swashplate overcome the force of the servo pistons and allow the pump's displacement to decrease.

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Pump Control Options

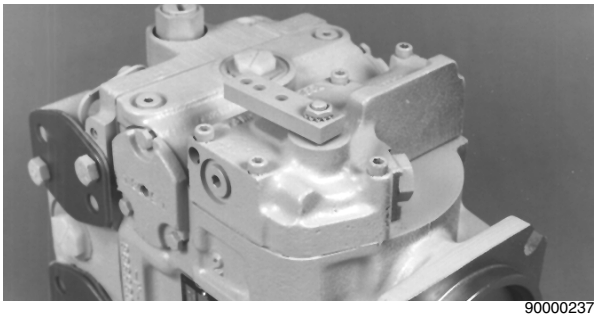
Manual Displacement Control (MDC)

The manual displacement control converts a mechanical input signal to a hydraulic signal using a spring- centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

The MDC is designed so the angular position of the pump swashplate is proportional to the rotation of the control input shaft.

Non-Linear MDC

The non-linear manual displacement control operates in the same manner as the regular MDC except that it is designed so the change in the angular position of the pump swashplate *progressively* increases as the control input shaft is rotated toward its maximum displacement position.



90000237

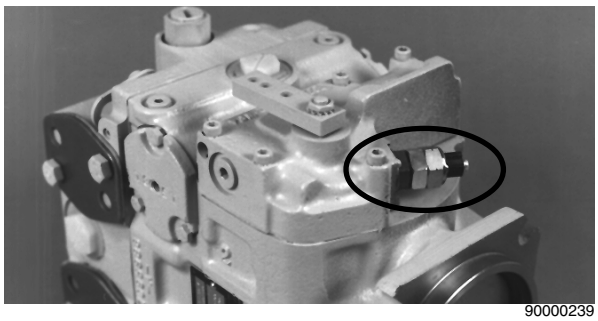
PV with Manual Displacement Control

Solenoid Override Valve for MDC

A solenoid override valve option (not shown here) is available for MDC. This safety feature will return the swashplate to zero displacement position when activated. The valve may be set in either a normally open or normally closed mode.

Neutral Start Switch (NSS)

The neutral start switch is an optional feature available with MDC. When connected properly with the vehicle's electrical system, the neutral start switch ensures that the prime mover can be started only when the control is in a neutral position.

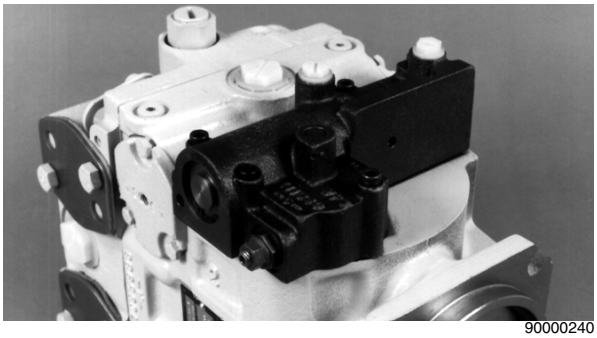


90000239

PV with Manual Displacement Control and Neutral Start Switch

Hydraulic Displacement Control (HDC)

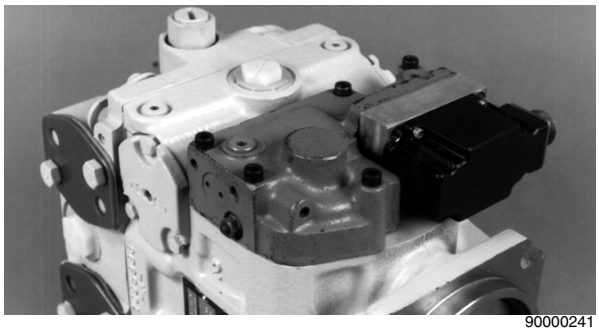
The hydraulic displacement control uses a hydraulic input signal to operate a spring-centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction. The HDC is designed so the angular position of the pump swashplate is proportional to input pressure.



90000240

PV with Hydraulic Displacement Control

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90000241

PV with Electric Displacement Control

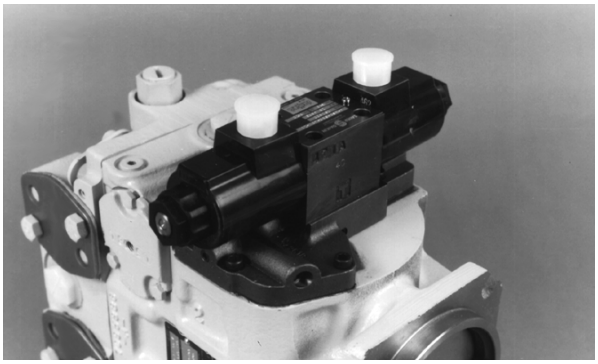
Electric Displacement Control (EDC)

The electric displacement control is similar to the hydraulic displacement control with the input signal pressure controlled by a pressure control pilot (PCP) valve. The PCP valve converts a DC electrical input signal to a hydraulic signal which operates a spring- centered four-way servo valve. This valve ports hydraulic pressure to either side of a dual-acting servo piston. The servo piston rotates the cradle swashplate through an angular rotation of ±17°, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction. The control is designed so the angular position of the swashplate is proportional to the EDC input.

Automotive Control (FBA II B)

Automotive Control allows a vehicle to be driven in a manner similar to an automobile with an automatic transmission.

The Automotive Control includes a three-position electric control to provide direction control.



90000354

PV with 3-Position (FNR) Electric Control

3-Position (FNR) Electric Control

This control utilizes a 12 or 24 VDC electrically operated spool valve to port pressure to either side of the pump displacement control piston. Energizing one of the solenoids will cause the pump to go to its maximum displacement in the corresponding direction.

All functions of the three-position (FNR) electric control are preset at the factory.

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Motor Features

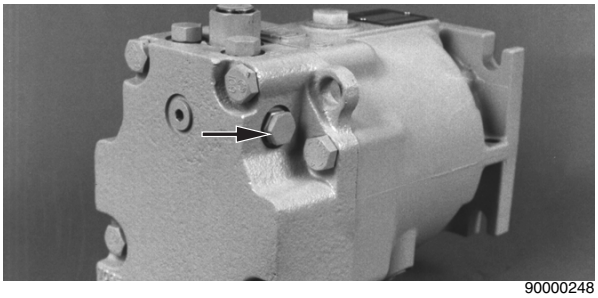
Motor Loop Flushing Valve and Charge Relief Valve

All Series 90 motors are designed to accommodate a loop flushing valve. The loop flushing valve is used in installations which require additional fluid to be removed from the main hydraulic circuit because of transmission cooling requirements, or unusual circuits requiring additional loop flushing to remove excessive contamination in the high pressure circuit.

A shuttle valve and charge relief valve are installed in the motor end cap to provide the loop flushing function. The shuttle valve provides a circuit between the low pressure side of the closed loop and the charge relief valve in the motor end cap.

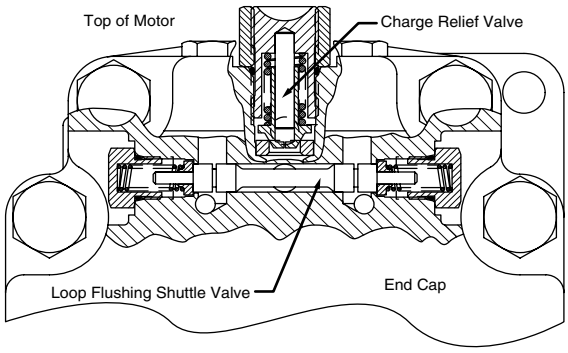
The motor charge relief valve regulates the charge pressure level only when there is a pressure differential in the main loop. The shuttle valve is spring centered to the closed position so that no high pressure fluid is lost from the circuit when reversing pressures.

For charge relief valve adjustment see corresponding Section.



90000248

Loop Flushing Valve (MF)



90000238E

Motor Charge Relief Valve and Loop Flushing Shuttle Valve

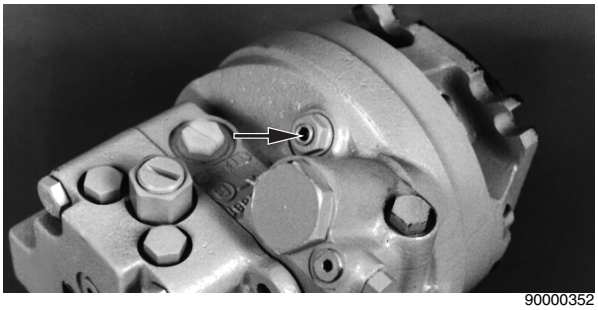
Variable Motor Displacement Limiters

All Series 90 variable motors include mechanical displacement (stroke) limiters. Both the maximum and minimum displacement of the motor can be limited.

The range of the settings is as follows:

	055 MV	075 MV
Minimum Displacement	**19 - 40 cm³** 1.2 - 2.4 in³	**26 - 54 cm³** 1.6 - 3.3 in³
Maximum Displacement	65 - 100 %	65 - 100 %

T002 251E

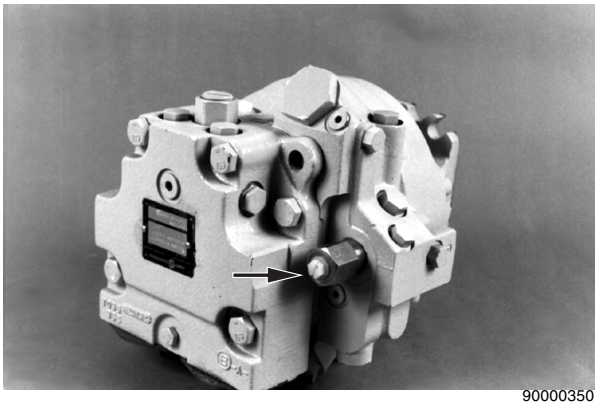


90000352

MV Maximum Displacement Limiter (Minimum Displacement Limiters on opposite side)

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Variable Motor Controls

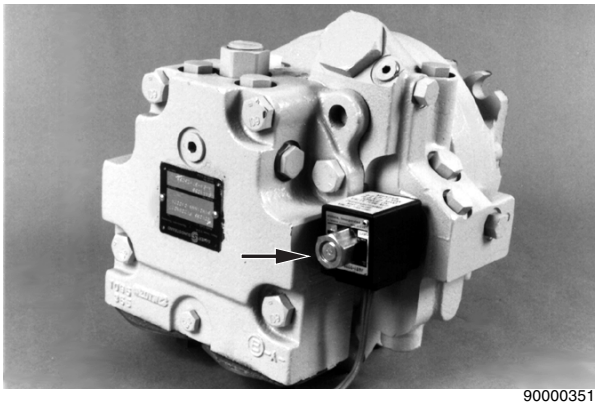


90000350

MV with Hydraulic 2-Position Control

Hydraulic 2-Position Control

This control utilizes a hydraulically operated three-way hydraulic valve to port system pressure to either of the motor displacement control pistons. The motor is normally held at its maximum displacement. Supplying pilot hydraulic pressure to the valve will cause the motor to go to its minimum displacement.



90000351

MV with Electric 2-Position Control

Electric 2-Position Control

This control utilizes an electric solenoid operated three-way hydraulic valve to port system pressure to either of the motor displacement control pistons. The motor is normally held at its maximum displacement. Energizing the solenoid will cause the motor to go to its minimum displacement.

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Technical Specifications

General Specifications

Design

Variable Pumps and Motors: Axial piston pump of variable displacement, cradle swashplate design.

Fixed Motors: Axial piston motor with fixed displacement, fixed swashplate design.

Type of Mounting (per SAE J744)

SAE flange, Size "B", 2 bolts,
SAE flange, Size "C and E", 4 bolts.

Cartridge flange, 2 bolts (for motor only).

Port Connections
(for details see chapter "Pressure Measurement")

Main pressure ports: SAE flange, Code 62,
Remaining ports: SAE straight thread O-ring boss.

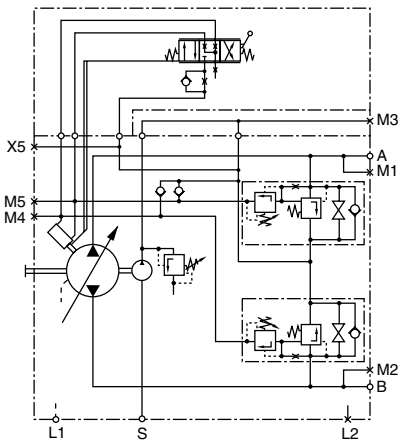
Direction of Rotation

Clockwise or counterclockwise (motors are bi-directional)

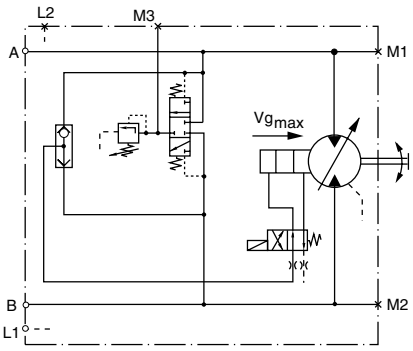
Recommended Installation Position

Pump installation recommended with control position on the top or side. Consult SAUER-SUNDSTRAND for non-conformance guidelines. The housing must always be filled with hydraulic fluid.

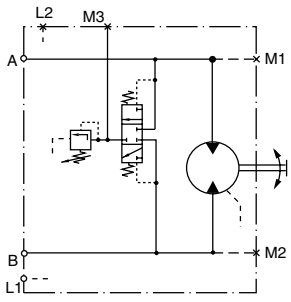
Circuit Diagrams



PV with Charge Pump and Manual Displacement Control



MV with Electrohydraulic 2-Position Control



MF

90000811
90000812
90000813

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Hydraulic Parameters

System Pressure Range	bar	psi
Rated Pressure	420	6000
Maximum Pressure	480	6960
		T002 252E

Temperature Range[1]			
	°C	[°F]	
Minimum	-40	[-40]	intermittent, cold start
Rated	104	[220]	
Maximum	115	[240]	intermittent
			T002 006E

[1] At the hottest point, normally the case drain port.

Charge Pump Inlet Vacuum (on pumps only)	bar abs	in Hg
Minimum Vacuum (continuous)	0.7	10
Minimum Vacuum during Cold Start (Intermittent)	0.2	25
		T002 253E

Viscosity			
	mm²/s	[SUS]	
Minimum	7	[49]	intermittent
Recommended operating range	12-60	[70-278]	
Maximum	1600	[7500]	intermittent, cold start
			T002 010E

Case Pressure	bar	psi
Maximum (Continuous)	3	44
Maximum during Cold Start (Intermittent)	5	73
		T002 254E

Cleanliness Level and β_x-Ratio	
Required fluid cleanliness level	ISO 4406 Class 18/13
Recommended β_x-ratio for suction filtration	$\beta_{35-45}=75$ ($\beta_{10}\geq 2$)
Recommended β_x-ratio for charge pressure filtration	$\beta_{15-20}=75$ ($\beta_{10}\geq 10$)
Recommended inlet screen size for charge pressure filtration	100 m-125 m
	T002 007E

Hydraulic Fluid

Refer to SAUER-SUNDSTRAND BLN 9887 or SDF (Id No. 697581). Also refer to publication ATI-E 9101 for information relating to biogradable fluids.

Cleanliness

Refer to SAUER-SUNDSTRAND Publications BLN 9887 or SDF (NO. 697581) and ATI-E 9201.

Refer to Series 90 technical information for definitions.

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Size Specific Data

Variable Displacement Pumps

	Dimension	030 PV	042 PV	055 PV	075 PV	100 PV	130 PV	180 PV	250 PV
Displacement (maximum)	cm^3 in^3	**30** 1.83	**42** 2.56	**55** 3.35	**75** 4.57	**100** 6.10	**130** 7.93	**180** 10.98	**250** 15.25
Minimum Speed	min^{-1} (rpm)	500	500	500	500	500	500	500	500
Rated Speed	min^{-1} (rpm)	4200	4200	3900	3600	3300	3100	2600	2300
Maximum Speed	min^{-1} (rpm)	4600	4600	4250	3950	3650	3400	2850	2500
Maximum attainable Speed at max. Displacement	min^{-1} (rpm)	5000	5000	4700	4300	4000	3700	3150	2750
Theoretical Torque at max. Displacement	Nm/bar lbf in/1000 psi	**0.48** 290	**0.67** 380	**0.88** 530	**1.19** 730	**1.59** 870	**2.07** 1260	**2.87** 1750	**3.97** 2433
Weight (only base unit)	kg lb	**28** 62	**34** 75	**40** 88	**49** 108	**68** 150	**88** 195	**136** 300	**154** 340

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Fixed and Variable Displacement Motors

		Einheit	030 MF	042 MF	055 MF	075 MF	100 MF	130 MF	055 MV	075 MV
Displacement (maximum)		cm^3 in^3	**30** 1.83	**42** 2.56	**55** 3.35	**75** 4.57	**100** 6.10	**130** 7.93	**55** 3.35	**75** 4.57
Displacement (minimum)		cm^3 in^3	--	--	--	--	--	--	19	26
Rated speed	at maximum displacement	min^{-1} (rpm)	4200	4200	3900	3600	3300	3100	3900	3600
	at minimum displacement	min^{-1} (rpm)	--	--	--	--	--	--	4600	4250
Maximum speed	at maximum displacement	min^{-1} (rpm)	4600	4600	4250	3950	3650	3400	4250	3950
	at minimum displacement	min^{-1} (rpm)	--	--	--	--	--	--	5100	4700
Max. attainable speed at max. displacement		min^{-1} (rpm)	5000	5000	4700	4300	4000	3700	4700	4300
Theoretical torque at max. displacement		Nm/bar lbf in/1000 psi	**0.48** 290	**0.67** 380	**0.88** 530	**1.19** 730	**1.59** 970	**2.07** 1260	**0.88** 530	**1.19** 730
Maximum flow ar max. displacement		l/min gal/min	**138** 36.5	**193** 51	**234** 62	**296** 78	**365** 96	**442** 117	**234** 62	**296** 78
Max. corner power		kW hp	**111** 149	**155** 208	**187** 251	**237** 318	**292** 392	**354** 475	224 300	282 378
Weight SAE-Flange		kg lb	**11** 24	**15** 34	**22** 49	**26** 57	**34** 74	**45** 99	**39** 86	**44** 98
Weight Cartridge Motor		kg lb	--	**21** 46	**26** 57	**33** 72	--	--	**40** 88	**46** 101

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Refer to Series 90 technical information for definitions.

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Pressure Measurement

Required Tools

The service procedures described in this manual for Series 90 pumps and motors can be performed using common mechanic's tools. Special tools, if required are shown.

Pressure gauges should be calibrated frequently to ensure accuracy. Snubbers are recommended to protect pressure gauges.

Port Locations and Pressure Gauge Installation

The following sections list the ports for each type of hydraulic unit. The recommended pressure gauge and fitting are also specified.

Outline drawings showing port locations follow the tables below.

Variable Pump

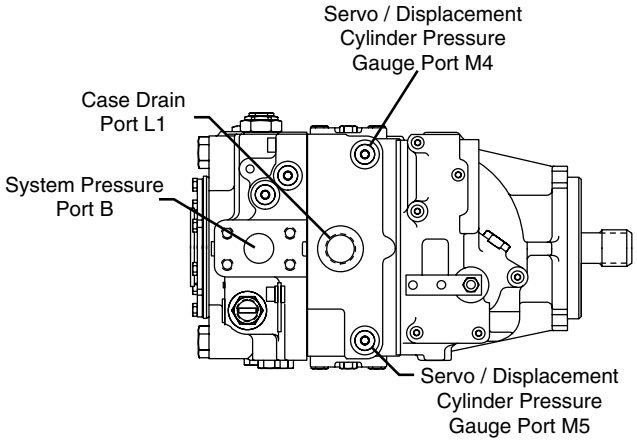
Port	Function	Gauge Size and Fitting
M1	System Pressure Port "A"	1000 bar or 10 000 psi 9/16-18 O-ring
M2	System Pressure Port "B"	1000 bar or 10 000 psi 9/16-18 O-ring fitting
M3 (M6)	Charge Pressure	50 bar or 1000 psi 9/16-18 O-ring
M4 M5	Servo Pressure	50 bar or 1000 psi 9/16-18 O-ring

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Port	Function	Gauge Size and Fitting	
L1 L2	Case Pressure	10 bar or 100 psi	
		030 042	7/8-14 O-ring
		055 075 100	1-1/16-12 O-ring
		130	1-5/16-12 O-ring
		180 250	1-5/8-12 O-ring
X1 X2	HDC / EDC Control Pressure	50 bar or 1000 psi 7/16-20 O-ring or 9/16-18 O-ring	
X3	External Control Pressure	50 bar or 1000 psi 9/16-18 O-ring	
S	Charge Pump Inlet	Vacuum Gauge, Tee into Inlet Line	
		030 042	1-1/16-12 O-ring
		055 075	1-5/16-12 O-ring
		100 130 180	1-5/8-12 O-ring
		250	1-1/2 SAE-Split Flange

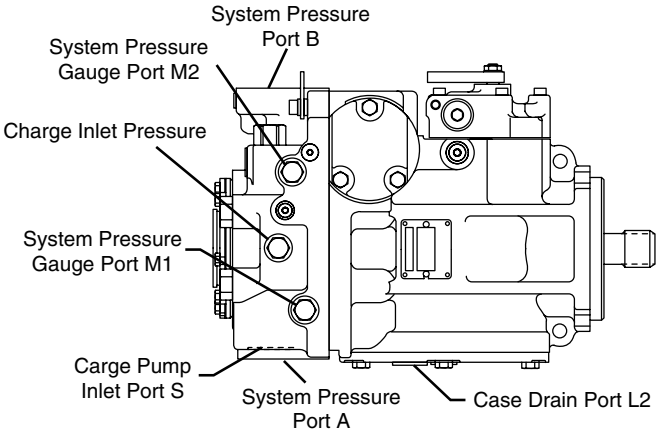
T002 260E

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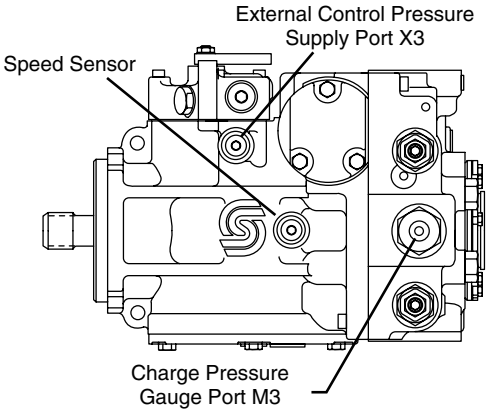


Top View

90000814E



Left Side View

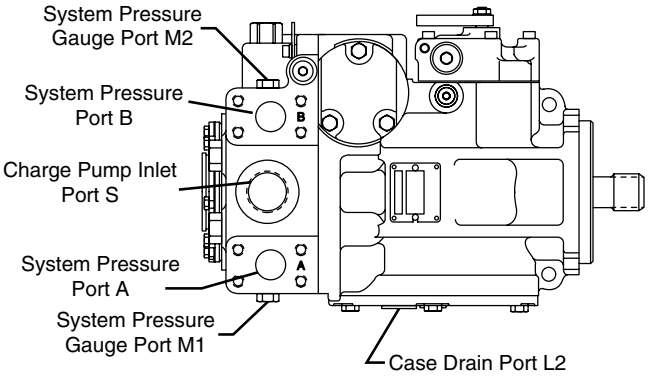


Right Side View

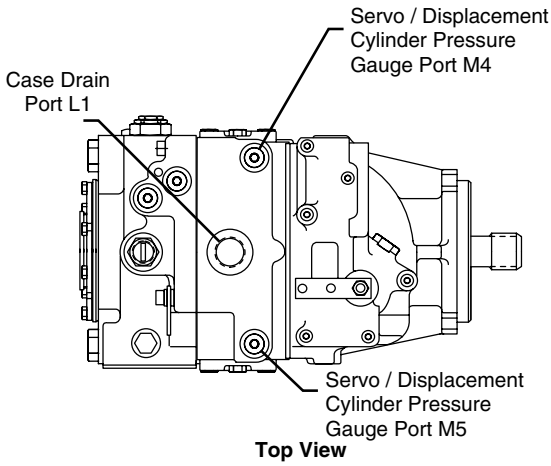
90000815E
90000816E

PV with Side Port End Cap and Manual Displacement Control

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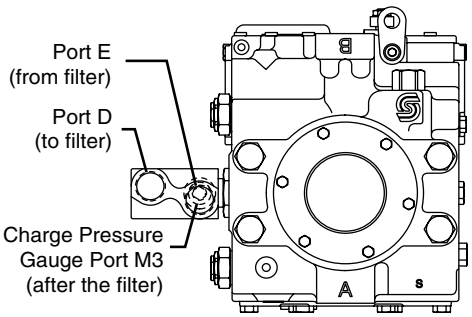
Left Side View



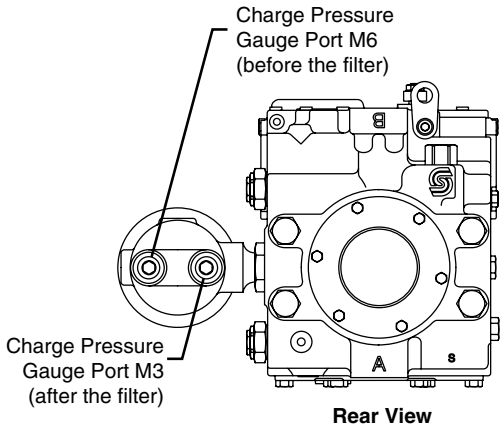
Top View

90000819E
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PV with Twin Port End Cap and Manual Displacement Control



Rear View



Rear View

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90000818E

PV with Side Port End Cap and Remote Pressure Filtration

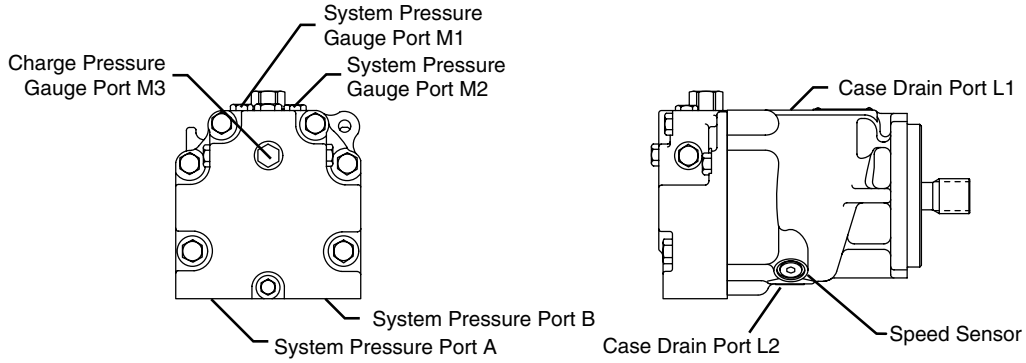
PV with Side Port End Cap and Integral Pressure Filtration

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Fixed Motor

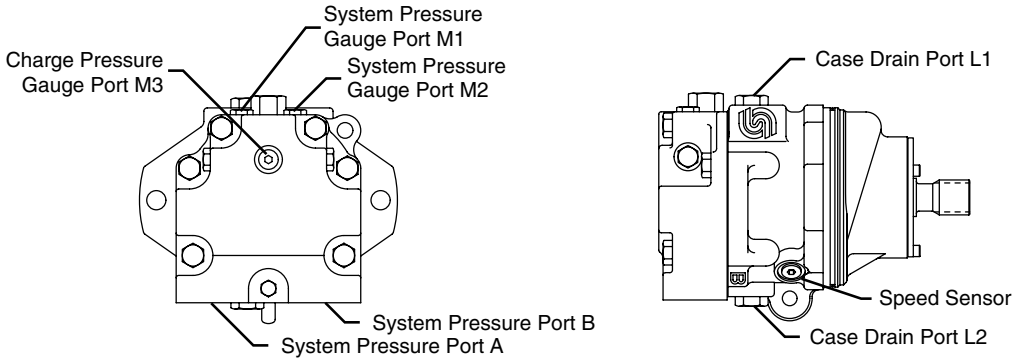
Port	Function	Gauge Size and Fitting
M1	System Pressure Port "A"	1000 bar or 10 000 psi 9/16-18 O-ring
M2	System Pressure Port "B"	1000 bar or 10 000 psi 9/16-18 O-ring
M3	Charge Pressure	50 bar or 1000 psi 9/16-18 O-ring
		T002 261E

Port	Function	Gauge Size and Fitting	
L1 L2	Case Pressure)	10 bar or 500 psi	
		030 042 055	7/8-14 O-ring
		075 100 130	1-1/16-12 O-ring
			T002 262E



Rear View **Left Side View**

MF with SAE Flange



Rear View **Left Side View**

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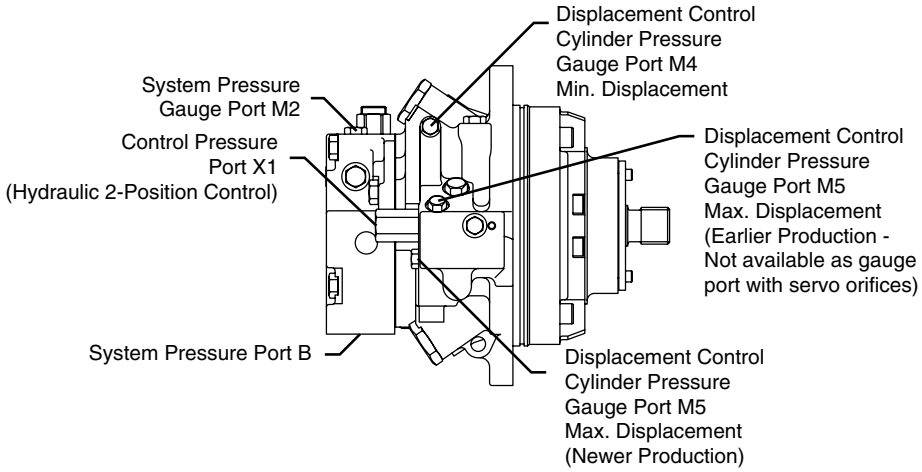
MF with Cartridge Flange

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Variable Motor

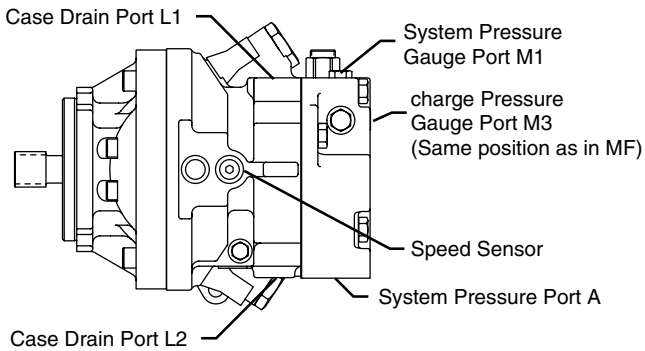
Port	Function	Gauge Size and Fitting
M1	Systempressure Port "A"	1000 bar or 10 000 psi 9/16-18 O-ring
M2	Systempressure Port "B"	1000 bar or 10 000 psi 9/16-18 O-ring
M3	Charge Pressure	50 bar or 1000 psi 9/16-18 O-ring
		T002 263E

Port	Function	Gauge Size and Fitting
M4	Control Cylinbder Pressure "Minimum Displacement"	1000 bar or 10 000 psi 7/16-20 O-ring
M5	Control Cylinbder Pressure"Maximum Displacement"	1000 bar or 10 000 psi 7/16-20 O-ring
L1 L2	Case Pressure	10 bar or 500 psi 1-1/16-12 O-ring
		T002 264E



Left Side View

MV with Cartridge Flange and Hydraulic 2-Position Control (SAE Flange Version Similar)



Right Side View

90000823E

MV with SAE Flange (Cartridge Flange Version Similar)

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Initial Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 90 installation or when restarting an installation in which either the pump or motor had been removed.

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.
S000007E

Prior to installing the pump and/or motor, inspect the units for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid. This fluid should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement. See the publications BLN-9887 and SDF 697581 for further related information.

The inlet line leading from the reservoir to the pump must be filled prior to start-up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up.

Fill the housing by pouring filtered oil into the upper case drain port.

Install a 50 bar (or 1000 psi) pressure gauge in the charge pressure gauge port to monitor the charge pressure during start-up.

It is recommended that the external control input signal (linkage for MDC, hydraulic lines for HDC, or electrical connections for EDC) be disconnected at the pump control until after initial start-up. This will ensure that the pump remains in its neutral position.

WARNING
Do not start prime mover unless pump is in neutral position (0° swashplate angle). Take precautions to prevent machine movement in case pump is actuated during initial start up.
S000008E

"Jog" or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure has been established. Excess air may be bled from the high pressure lines through the high pressure system gauge port.

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be as indicated in the pump model code. If charge pressure is inadequate, shut down and determine cause for improper pressure. Refer to Troubleshooting.

WARNING
Take necessary precautions that the motor shaft remains stationary during the adjustment procedure.
S000010E

Shut down the prime mover and connect the external control input signal. Also reconnect the machine function if disconnected earlier. Start the prime mover, checking to be certain the pump remains in neutral. With the prime mover at normal operating speed, slowly check for forward and reverse machine operation.

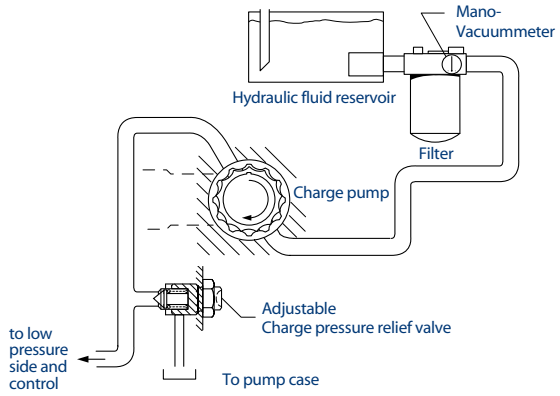
Charge pressure may slightly decrease during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five minutes.

Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add filtered fluid if needed.

The transmission is now ready for operation.

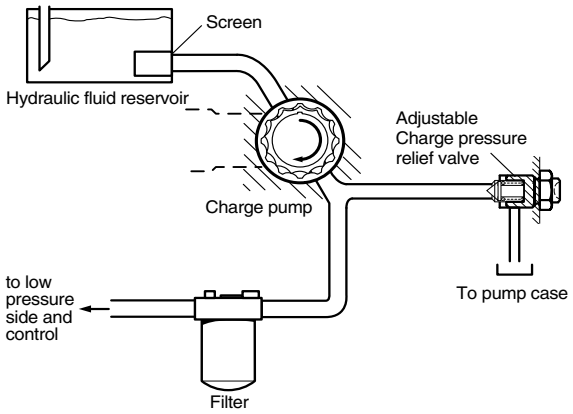
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Fluid and Filter Maintenance



P000 797E

Suction Filtration Schematic



P000 798E

Charge Pressure Filtration Schematic (Partial flow)

To ensure optimum service life of Series 90 products, regular maintenance of the fluid and filter must be performed. Contaminated fluid is the main cause of unit failure. Care should be taken to maintain fluid cleanliness while performing any service procedure.

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy to milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat). If either of these conditions occur, change the fluid and filter immediately.

It is recommended that the fluid and filter be changed per the vehicle/machine manufacturer's recommendations or at the following intervals:

First change

500 operating hours after start up

second and subsequent changes

every **2000** operating hours or once a year.

This recommendation applies for the most applications. High temperatures and pressures will result in accelerated fluid aging and an earlier fluid change may be required. At lower fluid loads longer change intervalls are possible. Therefore we suggest to check the fluid with the manufacturer for suitability. This should be done at latest half way between fluid changes.

It may be necessary to change the fluid more frequently than the above intervals if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been subjected to temperature levels greater than the recommended maximum. Never reuse fluid.

The filter should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter.

Cleanliness Level and β_x-Ratio	
Required fluid cleanliness level	ISO 4406 Class 18/13
Recommended β_x-ratio for suction filtration	$\beta_{35-45}=75$ ($\beta_{10}\geq 2$)
Recommended β_x-ratio for charge pressure filtration	$\beta_{15-20}=75$ ($\beta_{10}\geq 10$)
Recommended inlet screen size for charge pressure filtration	100 m-125 m

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Troubleshooting

This section provides general steps to follow if certain undesirable system conditions are observed. Follow the steps in a section until the problem is solved. Some of the items will be system specific. For areas covered in this manual, a section is referenced. **Always observe the safety precautions listed in the section "Introduction" and related to your specific equipment.**

"NEUTRAL" Difficult or Impossible to Find

Check	Description	Action
1. Input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
2. Pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Adjust, repair, or replace control module as necessary.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

System Operating Hot

Check	Description	Action
1. Oil level in reservoir.	Insufficient hydraulic fluid will not meet cooling demands of system.	Fill reservoir to proper level.
2. Heat exchanger.	Heat exchanger not sufficiently cooling the system.	Check air flow and input air temperature for heat exchanger. Clean, repair or replace heat exchanger.
3. Charge pressure.	Low charge pressure will overwork system.	Measure charge pressure. Inspect and adjust or replace charge relief valve. Or repair leaky charge pump.
4. Charge pump inlet vacuum.	High inlet vacuum will overwork system. A dirty filter will increase the inlet vacuum. Inadequate line size will restrict flow.	Check charge inlet vacuum. If high, inspect inlet filter and replace as necessary. Check for adequate line size, length or other restrictions.
5. System relief pressure settings.	If the system relief settings are too low, the relief valves will be overworked.	Verify settings of pressure limiters and high pressure relief valves and adjust or replace multi-function valves as necessary.
6. For internal leakage in motor.	Leakage will reduce low side system pressure and overwork the system.	Monitor motor case flow without loop flushing in the circuit (use defeat spool). If flow is excessive, replace motor.
7. System pressure.	High system pressure will overheat system.	Measure system pressure. If pressure is high reduce loads.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

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Transmission Operates Normally in One Direction Only

Check	Description	Action
1. Input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
2. Pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary.
3. Interchange system pressure limiters, high pressure relief valves, and system check valves.	Interchanging the multi-function valves will show if the problem is related to the valve functions contained in the multi-function valves.	Interchange multi-function valves. If the problem changes direction, repair or replace the valve on the side that does not operate.
4. Charge pressure.	If charge pressure decays in one direction the loop flushing valve may be "sticking" in one direction.	Measure charge pressure in forward and reverse. If pressure decays in one direction, inspect and repair the motor loop flushing valve.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

System Will Not Operate in Either Direction

Check	Description	Action
1. Oil level in reservoir.	Insufficient hydraulic fluid to supply system loop.	Fill reservoir to proper level.
2. Input to pump control.	Input to control module is operating improperly.	Check control input and repair or replace as necessary.
3. Pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary.
4. Ensure bypass valve(s) are closed.	If bypass valve(s) is open, the system loop will be depressurized.	Close bypass valves. Replace multi-function valve if defective.
5. Charge pressure with pump in neutral.	Low charge pressure insufficient to recharge system loop.	Measure charge pressure with the pump in neutral. If pressure is low, go to step 6; otherwise continue with step 5.
6. Charge pressure with pump in stroke.	Low charge pressure with the pump in stroke indicates a motor charge relief valve or system pressure relief valve may be improperly set.	Measure charge pressure with pump in stroke. If pressure is low, adjust or replace motor charge relief valve, otherwise go to step 9.
7. Pump charge relief valve.	A pump charge relief valve that is leaky or set too low will depressurize the system.	Adjust or replace pump charge relief valve as necessary.
8. Charge pump inlet filter.	A clogged filter will undersupply system loop.	Inspect filter and replace if necessary.
9. Charge pump.	A malfunctioning charge pump will provide insufficient charge flow.	Repair or replace the charge pump. If OK go to last step.

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10. Pump displacement control.	Control linkages are not secure, control orifices are blocked, etc.	Repair or replace control module as necessary.
11. System pressure.	Low system pressure will not provide power necessary to move load.	Measure system pressure. Continue with next step.
12. System multi-function valves.	Defective multi-function valves will cause system pressure to be low.	Repair or replace multi-function valve(s).

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

Low Motor Output Torque

Check	Description	Action
1. System pressure at motor.	Low system pressure at the motor will reduce torque.	Measure system pressure at motor. If pressure limiter setting is low, increase setting.
2. Variable motor stuck at minimum displacement.	Minimum motor displacement yields low output torque.	Check control supply pressure or repair displacement control. Check motor control orifices.
3. For internal leakage.	Internal leakage will reduce system pressure.	Check for leakage in O-rings, gaskets, and other fittings. Repair unit as required, or replace leaky unit.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

Improper Motor Output Speed

Check	Description	Action
1. Oil level in reservoir.	Insufficient hydraulic fluid will reduce motor speed.	Fill oil to proper level.
2. Pump output flow.	Incorrect outflow will affect output speed. Incorrect output flow indicates the swashplate is out of position.	Measure pump output and check for proper pump speed and see that the pump is in full stroke.
3. Variable motor displacement control.	If variable motor displacement control is not functioning correctly, variable motor swashplate may be in wrong position.	See if variable motor displacement control is responding. If not, repair or replace control.
4. For internal leakage.	Internal leakage will reduce system pressure.	Check for leakage in O-rings, gaskets, and other fittings. Repair unit as required, or replace leaky unit.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

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Excessive Noise and/or Vibration

Check	Description	Action
1. Oil in reservoir.	Insufficient hydraulic fluid will lead to cavitation.	Fill reservoir to proper level.
2. Air in system.	Air bubbles will lead to cavitation.	Look for foam in reservoir. Check for leaks on inlet side of system loop. Afterwards, let reservoir settle until bubbles are gone. Run system at low speed to move system fluid to reservoir. Repeat.
3. Pump inlet vacuum.	High inlet vacuum will create noise. A dirty filter will increase the inlet vacuum.	Inspect and replace filter as necessary. Check for proper suction line size.
4. Shaft couplings.	A loose shaft coupling will cause excessive noise.	Replace loose shaft coupling in charge pump or replace pump or motor.
5. Shaft alignment.	Unaligned shafts will create excessive frictional noise.	Align shafts.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

System Response is Sluggish

Check	Description	Action
1. Oil level in reservoir.	Insufficient hydraulic fluid will reduce output pressure.	Fill reservoir to proper level.
2. Multi-function valves' pressure settings.	Incorrect pressure settings will affect system reaction time.	Adjust or replace multi-function valves.
3. Pump inlet vacuum.	High pump inlet vacuum will reduce system pressure.	Measure charge inlet vacuum. If high replace inlet filter.
4. Prime mover speed.	Low engine speed will reduce system performance.	Adjust engine speed.
5. Charge and control pressures.	Incorrect charge or control pressures will affect system performance.	Measure charge and control pressures and correct if necessary.
6. System internal leakage.	Internal leakage will reduce system pressure.	Check for leakage in O-rings, gaskets, and other fittings.

If the above actions do not remedy the problem
contact a SAUER-SUNDSTRAND Authorized Service Center.

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Inspections and Adjustments

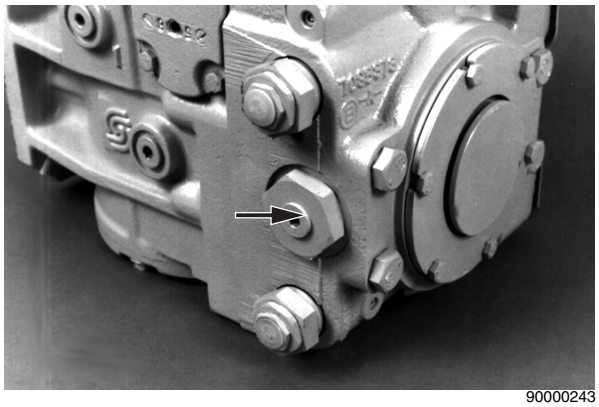
This section offers instruction on how to perform inspections and adjustments on pump and motor components. Read through the entire related section before beginning a service activity. Refer to the corresponding section for location of gauge ports and suggested gauge size.

Pump Adjustments

Charge Pressure Relief Valve Adjustment

The following procedure explains how to check and adjust the charge pressure relief valve.

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.
S000007E


90000243

Charge Pressure Gauge Port (Reducer fitting shown - if filtration device attached)

1. To measure pump charge pressure, install a pressure gauge in the pump charge pressure gauge port (M3). Also install a gauge to measure case pressure (tee into L1 or L2 or use servo gauge port). Operate the system with the pump in “neutral” (zero displacement) when measuring pump charge pressure.

2. The table shows the acceptable pump charge pressure range for some nominal charge relief valve settings (see sample model code at right). These pressures assume 1500 pump rpm and a reservoir temperature of 50°C (120°F), and are referenced to case pressure (see footnote on next page). Smaller displacement charge pumps will produce charge pressure readings in the lower portion of the range, while larger displacement charge pumps will produce readings in the higher portion of the range.

90L055 EA 1 N
6 S 3 C6 C 03
HNN 35 35 **24**

Nominal Charge Pressure

Model Code on Unit Name Plate (“24 bar”)

Model Code	Measured Charge Pressure *
20	18.1 bis 21.7 bar (262 to 315 psi)
24	22.0 bis 26.9 bar (319 to 390 psi)
28	25.8 bis 30.7 bar (374 to 445 psi)

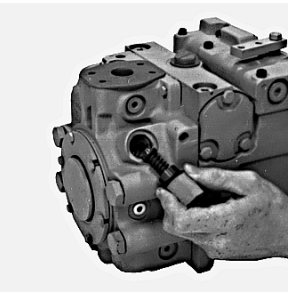
T002 266E

* This is the actual charge pressure port gauge reading minus the case pressure port gauge reading.

Note: These pressures assume a pump speed of 1450 - 1500 rpm. At higher pump input speeds (with higher charge flows) the charge pressure will rise over the rated setting.

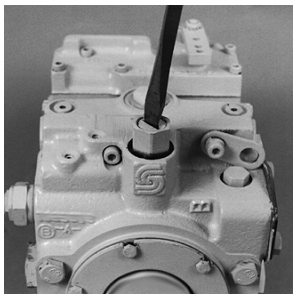
* This is the actual charge pressure port gauge reading minus the case pressure port gauge reading.

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90000262

Shim Adjustable Charge Pressure Relief Valve (Pump)



90000264

Screw Adjustable Charge Pressure Relief Valve (Pump)

3. Earlier production Series 90 pumps are equipped with a shim adjustable charge pressure relief valve. Shim kits are available from SAUER-SUNDSTRAND. Adjustment of charge pressure is accomplished by removing the plug [1 inch Hex] and changing the shim thickness behind the spring. The plug for this type of charge relief valve should be torqued to 68 Nm (50 lbf ft).

   Later production Series 90 pumps are equipped with an external screw adjustable charge pressure relief valve. Adjustment of the charge pressure is accomplished by loosening the lock nut -

Frame Size	Wrench Size
030 - 100	1-1/16 inch
130 - 250	1-5/8 inch
	T002 267E

   and turning the adjustment plug with a large screwdriver or a 1/2 inch hex wrench.

   Clockwise rotation of the plug increases the setting, and counterclockwise rotation decreases the setting (at a rate of approximately 3.9 bar (50 psi) per turn). The lock nut for this type of charge relief valve should be torqued to 52 Nm (39 lbf ft).

4. Once the desired charge pressure setting is achieved, remove the gauges.

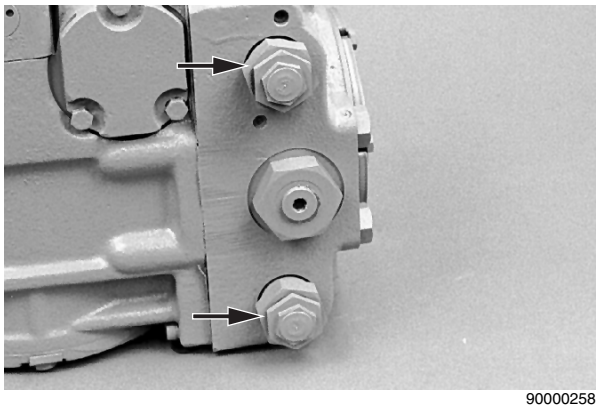
https://truckmanualshub.com/

Multi-Function Valve Pressure Adjustment

Adjustment of the pressure limiter setting and the high pressure relief valve setting is accomplished simultaneously. The latter is automatically set approximately 35 bar (500 psi) above the former.

In order to adjust the pressure limiter setting, the motor output shaft must be locked so it does not rotate. This may be accomplished by locking the vehicle's brakes or rigidly fixing the work function so it cannot rotate.

WARNING
Take necessary precautions that the motor shaft remains stationary during the adjustment procedure.
S000010E


90000258

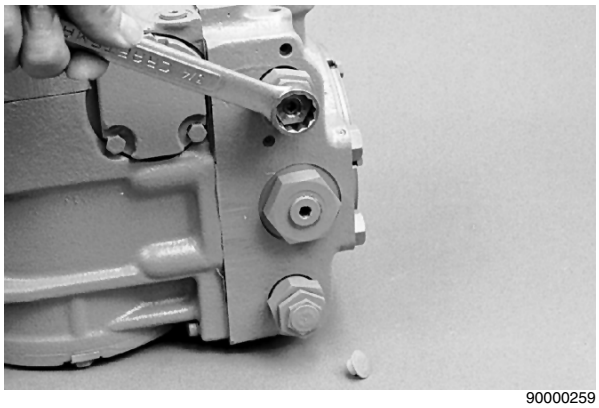
Multi-Function Valves on PV

1. Install two 1000 bar (or 10 000 psi) pressure gauges in the high pressure gauge ports (M1 and M2). Install a 50 bar (or 1000 psi) pressure gauge in the pump charge pressure gauge port (M3).

2. Start the prime mover and operate at normal speed.

3. Loosen locking nut.

Frame Size	Wrench Size
early 042 - 100	10 mm
newer 030 - 100	19 mm
early 130	13 mm
130 - 250	24 mm
	T002 268E


90000259

Loosen Pressure Adjusting Screw Lock Nut

4. Insert a internal hex wrench into the pressure adjusting screw.

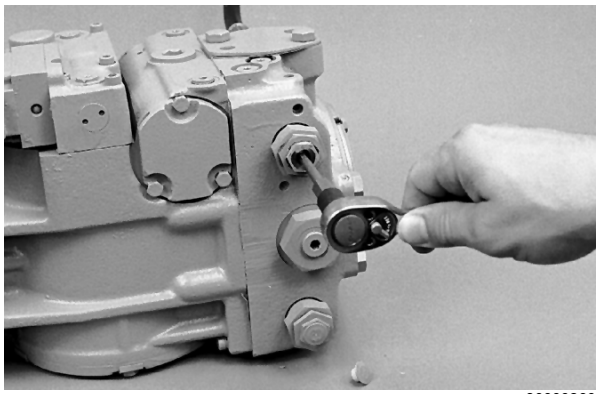
Frame Size	Internal Hex Wrench Size
early 042 - 100	3 mm
newer 030 - 100	5 mm
early 130	4 mm
130 - 250	8 mm
	T002 269E

Note: A plastic dust plug is installed in the adjusting screw on 030 and late 042 through 250 units.

https://truckmanualshub.com/

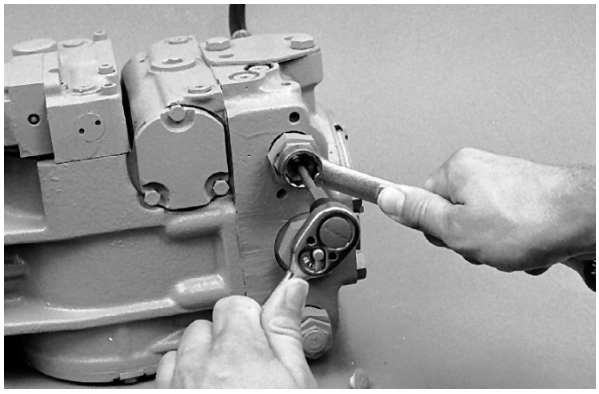
90L055 EA 1 N
6 S 3 C6 C 03
HNN **35** **35** 24

Pressure Limiter Setting
Ports A and B (differential
pressure in 10s of bars,
e.g. “35” = 350 bar)



90000260

Rotate Pressure Adjusting Screw



90000261

Tighten Lock Nut

5. The factory preset pressure limiter setting is shown on the model code as at right. It is referenced to charge pressure, so the pressure limiter setting is the difference between the high and low pressure sides of the system loop. Activate or move the control input so that pressure increases in the high pressure side of the closed circuit to the pressure limiter pressure setting. The pressure limiter setting is reached when the pressure stops increasing and remains steady at a given pressure level (as shown on the gauges).

6. Return the pump to its “neutral” (zero flow) position and adjust the pressure limiter setting by rotating the pressure adjusting screw with the internal hex wrench.

   Clockwise rotation of the pressure adjustment screw will increase the pressure setting, and counterclockwise rotation will decrease the pressure setting. Each complete rotation of the pressure adjusting screw changes the pressure as shown in the following table.

Frame Size	Approx Change per Rev of the Adjusting Screw
early 042 - 100	80 bar (1157 psi) per Rev
newer 030 - 100	90 bar (1300 psi) per Rev
130 - 250	80 bar (1157 psi) per Rev
	T002 270E

7. To verify the actual pressure setting, actuate or move the control input so that the pump again develops pressure in the high pressure circuit to the newly adjusted pressure limiter pressure setting, and read the high pressure gauge. Then allow the pump to return to its “neutral” position. The pressure in the high pressure circuit should return to the charge pressure setting.

8. While holding the pressure adjusting screw stationary, tighten the pressure adjusting screw lock.

Frame Size	Torque
early 042 - 100	3 Nm (26 lbf in)
newer 030 - 100	20 Nm (15 lbf ft)
130 - 250	40 Nm (30 lbf ft)
	T002 271E

   Do not overtorque.

9. Shut down the prime mover, remove the gauges and install the gauge port plugs. Replace the plastic dust plugs (if used).

The same procedure is used for setting the pressure limit of the other multi-function valve, but the control input signal must be activated or moved in the opposite direction so that high pressure develops in the opposite side of the closed circuit.

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Engaging the Bypass Function

The bypass function is performed by the multi-function valve cartridges. The prime mover should be shut down when opening or closing the bypass valves.

The bypass valves on both of the multi-function valves must be opened to engaged the bypass function.

1. Using a

Frame Size	Wrench Size
newer 030 - 100	1-1/16 inch
130 - 250	1-3/8 inch
	T002 272E

wrench on the middle sized hex of the multi-function valve cartridge, and a

Frame Size	Wrench Size
newer 030 - 100	1-1/4 inch
130 - 250	1-5/8 inch
	T002 273E

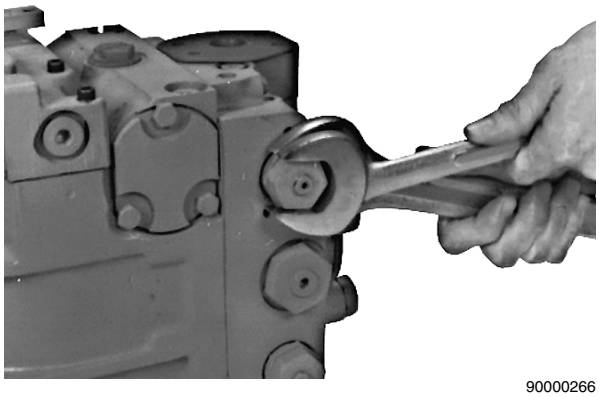
wrench on the large hex to prevent rotation of the cartridge assembly, rotate the middle hex three revolutions counterclockwise to open the bypass valve. **Do not rotate more than 3-1/2 revolutions, as additional rotation will permit external leakage.**

2. For units with an MDC-type control, prior to moving the vehicle or otherwise causing the motor shaft to turn, move the control handle of the manual displacement control on the pump to the maximum full forward position. Hold the handle in this position during bypass valve operation.

Caution
"Tow" at extremely low speeds and for short distances only.
S000011E

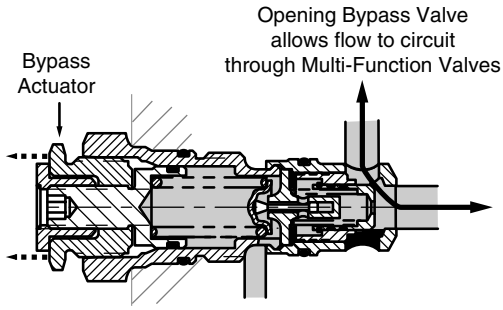
3. To close the bypass valve, rotate the middle hex clockwise until it is seated. Then torque the middle hex.

Frame Size	Torque
newer 030 - 100	41 Nm (30 lbf ft)
130 - 250	100 Nm (75 lbf ft)
	T002 274E



90000266

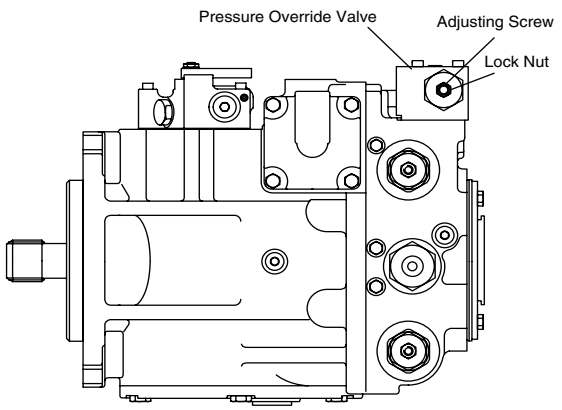
Loosening and Rotating Bypass Hex on Multi-Function Valve



90000827E

Multi-Function Valve with Bypass Function Engaged

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Right Side View

90000828E

Pressure Override Valve for 180 Frame Size

Pressure Override (POR) Valve Pressure Adjustment (Option for 180 Frame Size)

The Pressure Override Valve is explained in the corresponding section.

1. Install two 1000 bar (or 10 000 psi) pressure gauges in the high pressure gauge ports (M1 and M2). Install a 50 bar (or 1000 psi) pressure gauge in the pump charge pressure gauge port (M3).

2. Start the prime mover and operate at normal speed.

3. With the pump operating at approximately 20% displacement, load the work function and note the pressure as the POR valve operates (pump displacement reduces to “zero”).

4. Adjustment of the pressure override setting is made by loosening the lock nut with a 9/16 inch hex wrench and turning the adjustment screw with a 3/16 inch internal hex wrench. The POR setting should be at least 50 bar (750 psi) below the high pressure relief valve setting of the multi-function valves for proper operation.

5. Following the adjustment, torque the lock nut to 43 Nm (32 lbf ft).

6. Shut down the prime mover and remove the gauges and install the gauge port plugs.

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Displacement Limiter Adjustment

The maximum displacement can be limited in either direction.

1. Loosen the seal lock nut retaining the displacement limiter adjusting screw.

Frame Size	Wrench Size
030 - 100	13 mm
130	17 mm
180 - 250	19 mm
	T002 275E

2. Rotate the adjusting screw.

Frame Size	Internal Hex Wrench Size
030 - 100	4 mm
130	5 mm
180 - 250	6 mm
	T002 276E

Rotating the adjusting screw clockwise will decrease the maximum displacement of the pump while rotating the adjusting screw counterclockwise will increase the maximum displacement.

Caution
Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

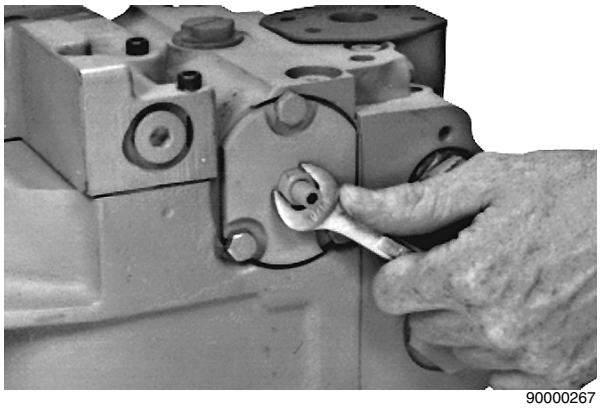
S000012E

3. After establishing the desired maximum displacement setting, tighten the lock nut on the adjusting screw as follows.

Frame Size	Torque
030 - 100	24 Nm (18 lbf ft)
130	48 Nm (35 lbf ft)
180 - 250	125 Nm (92 lbf ft)
	T002 278E

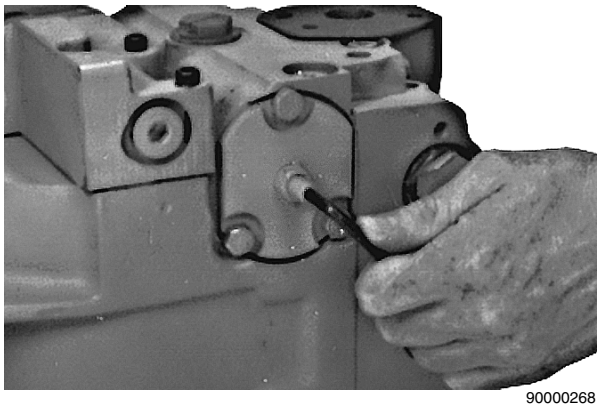
4. One turn of the adjusting screw will change the maximum displacement approximately as follows.

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
030	2.8 cm^3 / Rev (0.17 in^3 / Rev)
042	3.5 cm^3 / Rev (0.21 in^3 / Rev)
055	4.2 cm^3 / Rev (0.26 in^3 / Rev)
075	5.1 cm^3 / Rev (0.31 in^3 / Rev)
100	6.2 cm^3 / Rev (0.38 in^3 / Rev)
130	8.8 cm^3 / Rev (0.53 in^3 / Rev)
180	12.5 cm^3 / Rev (0.76 in^3 / Rev)
250	17.3 cm^3 / Rev (1.06 in^3 / Rev)
	T002 277E



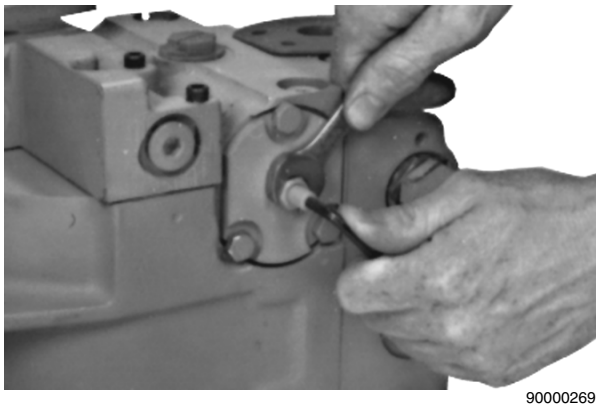
90000267

Loosen Displacement Limiter Lock Nut



90000268

Rotate Adjusting Screw

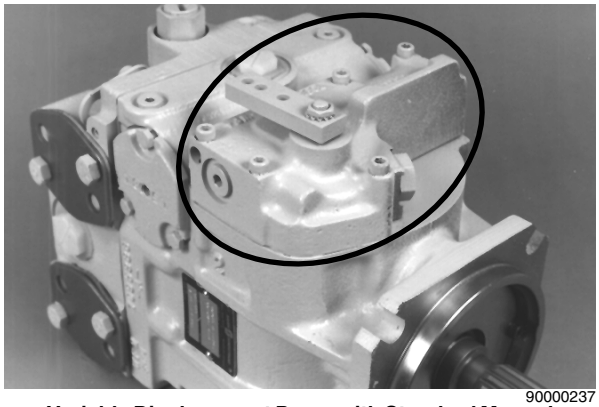


90000269

Tighten Lock Nut

https://truckmanualshub.com/

Pump Control Adjustments



90000237

Variable Displacement Pump with Standard Manual Displacement Control

Standard Manual Displacement Control (MDC) Adjustment

There are no adjustable elements in the manual displacement control. The control spool is held in its “neutral” position by centering springs and washers on each end of the spool. Since there is no centering spring on the control input shaft, the shaft will automatically assume the appropriate position when the control is installed on the pump.

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Non-Linear Manual Displacement Control (MDC)

A centering spring, located on the control input shaft, locates the control shaft in its “neutral” position. A bias spring on the control spool maintains a force on the spool and the control linkage to eliminate looseness (“free-play”) in the linkage.

The “neutral” adjustment is the only adjustment that can be made on the nonlinear manual displacement control. All other functions are preset at the factory.

This adjustment must be made on a test stand or on the vehicle/machine with the prime mover operating.

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.
S000 007E

1. Install two 50 bar (or 1000 psi) gauges in each of the displacement control cylinder gauge ports (M4 and M5). Disconnect the external control linkage from the control handle and make certain the control shaft is in its “neutral” position. Start the prime mover and operate at normal speed.

2. Loosen the lock nut on the neutral adjusting screw with a 13 mm hex wrench.

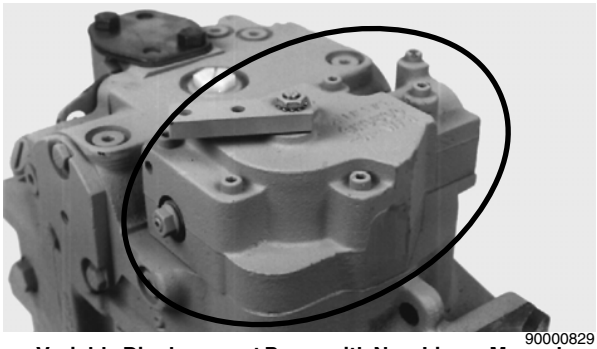
3. Using a 4 mm internal hex wrench, rotate the neutral adjusting screw clockwise until the pressure increases on one of the pressure gauges. Note the angular position of the wrench.

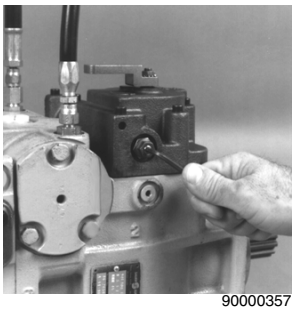
4. Rotate the adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Note the angular position of the wrench.

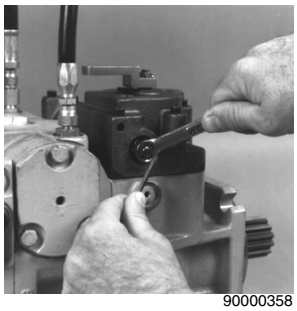
5. Rotate the adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure (case pressure), indicating that the control is in its “neutral” position.

6. Hold the adjusting screw stationary and tighten the lock nut to 13.5 Nm (10 lbf ft). **Do not overtorque the nut.**

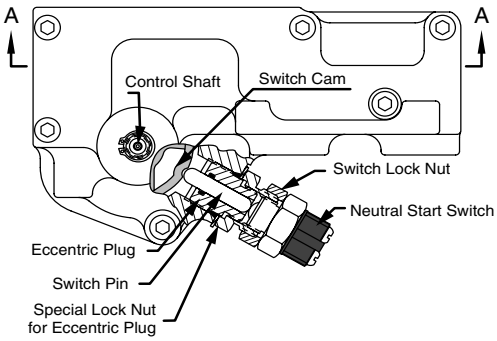
7. Once the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control linkage.


90000829
Variable Displacement Pump with Non-Linear Manual Displacement Control

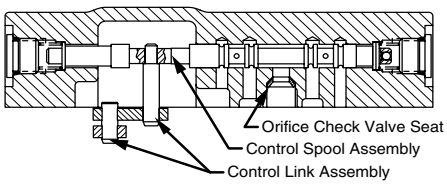

90000357
Rotate Neutral Adjusting Screw


90000358
Tighten Neutral Adjusting Screw Lock Nut

https://truckmanualshub.com/



MDC with Neutral Start switch



View at Section A-A

90000830E

Components of the Standard Manual Displacement Control with Neutral Start Switch

MDC Neutral Start Switch (NSS) Adjustments

The neutral start switch (NSS) provides a means to prevent the system prime mover from starting while the pump control handle and control input shaft are in a position which would command the pump to go “in-stroke” in either the “forward” or “reverse” direction.

When the control input shaft is in its “neutral” position, the inner end of the switch pin moves into a slot on the eccentric cam attached to the control shaft. This allows the spring loaded NSS to close, completing the electrical starting circuit for the prime mover.

When the control input shaft is NOT in its “neutral” position, the eccentric cam moves the switch pin out of the slot. This forces the NSS to open, breaking the electrical starting circuit for the prime mover.

The neutral start switch is threaded into the special lock nut for the eccentric plug.

Turning the NSS clockwise (CW) into the special nut will move the NSS closer to the switch cam on the control shaft, and will narrow the NSS deadband. Turning the NSS counterclockwise (CCW) out of the special nut will move the NSS farther from the switch cam on the control shaft, and will widen the NSS deadband.

The switch pin is located in an eccentric plug which is turned to move the center of the NSS deadband.

(continued)

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The NSS must be adjusted to meet the following three requirements:

i. The distance the control handle can be turned without opening the NSS is called the “NSS Deadband.” The distance the control handle can be moved without moving the control spool enough to port hydraulic fluid to the pump displacement control cylinders is called the “Control Deadband.” These deadbands **must** be centered in relation to each other.

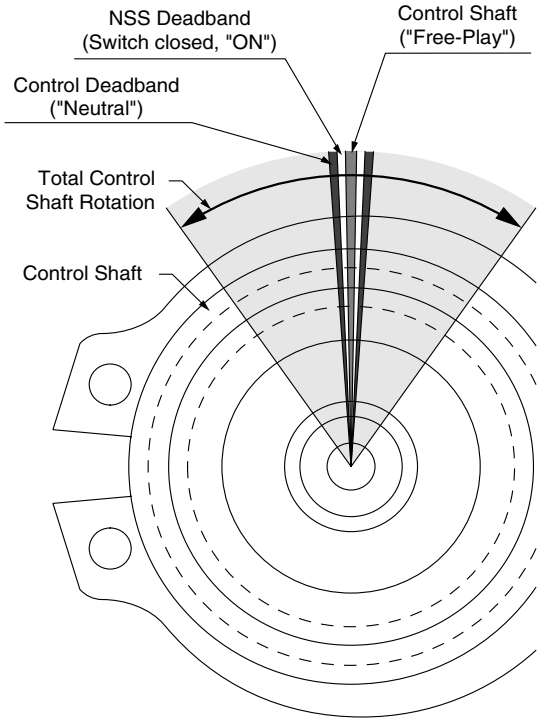
   Since the position of the control deadband cannot be adjusted, the position of the NSS deadband must be adjusted to match it.

ii. The NSS deadband must be wide enough so the NSS **will not** open within the loose area of control handle movement caused by normal operating clearances in the control linkage (control shaft “free-play”).

   By setting the NSS to open outside this area, the control spool springs or control shaft centering spring can always act to return the handle to “neutral” and re-close the NSS.

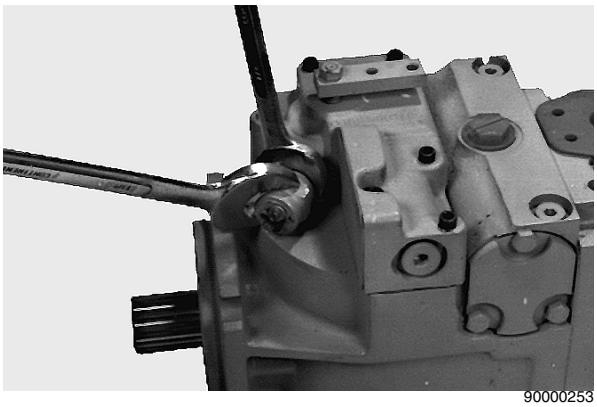
iii. The NSS deadband must be narrow enough so the NSS **will** open before the unit builds 7 bar (100 psi) differential system pressure in either direction.

(continued)



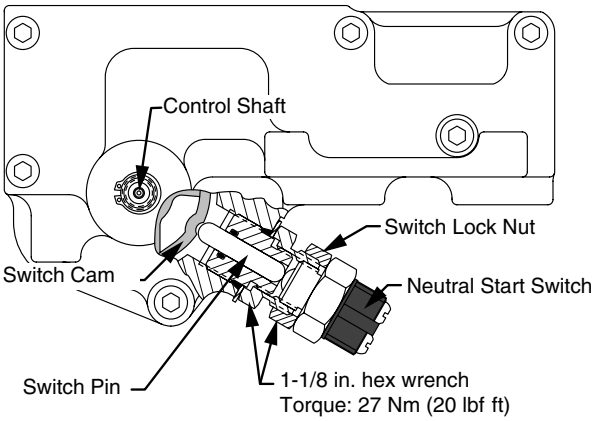
Neutral Start Switch Adjustment Requirements

https://truckmanualshub.com/



90000253

Loosening the NSS Lock Nut



90000832E

NSS



90000870

Checking Continuity of NSS (System Pressure Gauges installed on far side)

NSS Deadband Adjustment (Conditions ii & iii)

The NSS deadband must be wide enough so the NSS **will not** open within the control shaft “free-play” area, and it must be narrow enough so the NSS **will** open before the unit builds 7 bar (100 psi) differential system pressure in either direction.

1. Install two 1000 bar (10 000 psi) pressure gauges in the system pressure gauge ports M1 and M2.

2. Using two 1-1/8 inch wrenches, hold the neutral start switch from turning and loosen the locknut.

3. Disconnect the external control linkage and make certain the control shaft is in its “neutral” position.

4. Attach a continuity checker to the terminals of the switch. With the control shaft in its “neutral” position, turn the switch clockwise (CW) until electrical continuity is broken, then turn the switch counterclockwise (CCW) until electrical continuity is obtained. Turn the switch counterclockwise (CCW) an additional 1/4 turn (90°) after continuity has been obtained.

5. Hold the switch in place and tighten the locknut to 27 Nm (20 lbf ft) torque.

6. With the continuity checker attached to the switch, rotate the control handle (or the control shaft) in each direction to assure continuity is broken when the control is not in the “neutral” position.

7. If continuity is obtained in “neutral” and satisfactorily interrupted in each direction, proceed to check the switch with the prime mover running. The switch must open **before** the unit builds 7 bar (100 psi) differential system pressure in either direction.

   If the switch opens **after** the unit builds system pressure in either direction, loosen the switch lock nut and turn the switch clockwise (CW) 1/12 turn (30°). Tighten the switch lock nut and recheck the switch operation. Repeat this procedure if necessary.

8. If continuity is not interrupted with an **equal** movement of the control handle in each direction, turn off prime mover, remove the pressure gauges, and continue with the next section.

9. If neutral start switch operation is satisfactory, turn off the prime mover, remove the pressure gauges, and reconnect the external control linkage.

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Neutral Start Switch Eccentric Plug Adjustment (Condition i)

The NSS deadband and the control deadband **must** be centered in relation to each other.

Since the position of the control deadband cannot be adjusted, the position of the NSS deadband must be adjusted to match it. The switch pin is located in an eccentric plug which is turned to move the center of the NSS deadband.

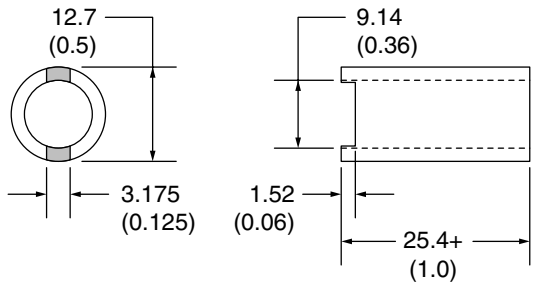
The MDC should be installed on the pump and be in its "neutral" position when adjusting the neutral start switch eccentric plug.

The accompanying drawing provides dimensions for an Eccentric Plug Adjustment Tool.

1. Hold the switch and eccentric plug from turning and use two 1-1/8 inch wrenches to loosen the locknut. Remove the neutral start switch.

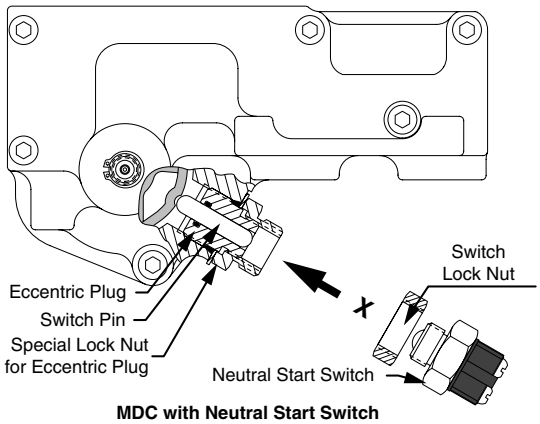
WARNING
Do not start the prime mover while the neutral start switch is removed from the control. Case pressure will force the pin out of the eccentric plug, causing oil loss.

S000032E

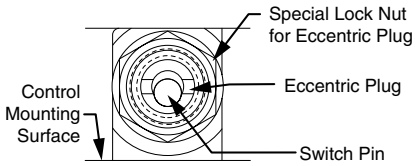


90000834E

Eccentric Plug Adjustment Tool



MDC with Neutral Start Switch



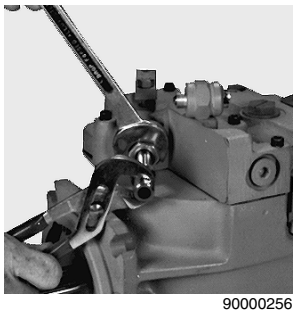
View in Direction X
(Switch and lock nut removed)

90000833E

NSS with Eccentric Plug

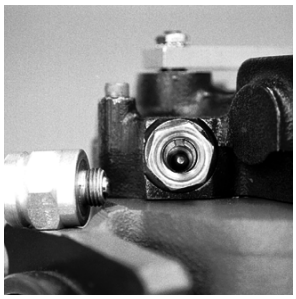
2. Note the slots on the eccentric plug for the adjustment tool. Hold the eccentric plug in place with the adjustment tool, and loosen the lock nut with a 1-1/8 inch wrench.

(continued)



90000256

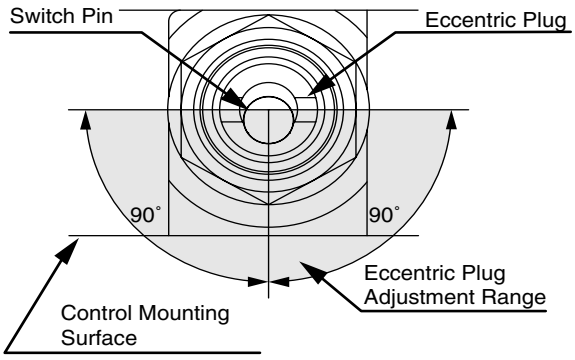
Loosen Eccentric Lock Nut



90000257

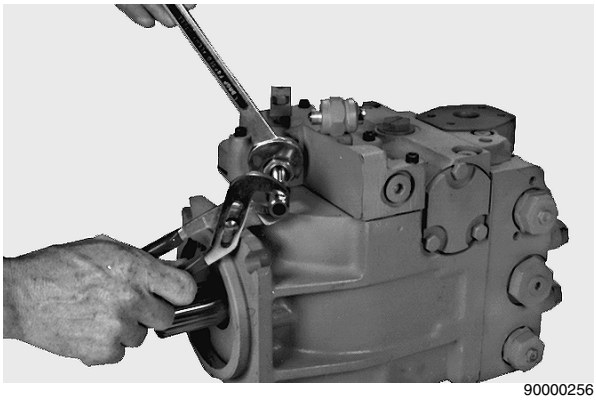
NSS Removed

https://truckmanualshub.com/



90000835E

Eccentric Plug Adjustment



90000256

Adjust the Eccentric Plug

3. Position the eccentric plug so the switch pin is offset toward the control mounting surface. This will provide the best contact between the pin and the cam on the control shaft.

4. Hold the control shaft in its “neutral” position (in the center of the control shaft “free-play” area). Locate the switch pin in the slot of the switch cam by turning the eccentric plug while checking the pin position (depth) in the plug. When the pin engages the cam slot, the pin will be at its maximum depth in the plug. Hand tighten the plug lock nut to hold the eccentric plug in position.

5. Turn the control shaft an equal amount in either direction from “neutral.” The switch pin should move out of the eccentric plug an equal distance when the control shaft is turned. Turn the eccentric plug to center the switch pin with the cam slot. Only a small amount of adjustment in either direction should be needed to center the pin.

6. While holding the eccentric plug in place, tighten the eccentric plug lock nut to 27 Nm (20 lbf ft). Reinstall and adjust the switch as outlined in the previous section.

Note: The eccentric plug normally requires between 5-1/2 and 6-1/2 turns to install into the control housing .

Caution
Do not turn the eccentric plug into or out of the housing beyond specifications.

S000014E

7. Once the switch is correctly adjusted, hold the switch in place and tighten the locknut to 27 Nm (20 lbf ft) torque.

(continued)

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Checking Switch Continuity

Recheck switch continuity to determine whether additional adjustment of the eccentric plug is necessary.

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.
S000007E

1. Install two 50 bar (or 1000 psi) gauges in each of the displacement control cylinder gauge ports (M4 and M5). Attach a continuity checker to the terminals of the neutral start switch.

2. Energize the starter circuit, and start the prime mover.

3. While operating at normal speed and with the pump in its “neutral” (zero flow) position, note the pressure reading on the gauges. This reading should be noted as the base pressure.

4. Slowly move the control handle in one direction while observing the pressure gauges and the continuity checker. Continuity **must** be broken before the pressure on either gauge increases more than 1 bar (12 psi) from the base pressure obtained at “neutral.”

5. Slowly move the control handle in the opposite direction. Again, continuity must be broken before the gauge pressure increases more than 1 bar (12 psi) from base pressure.

6. Continuity must again be verified when the control is returned to neutral.

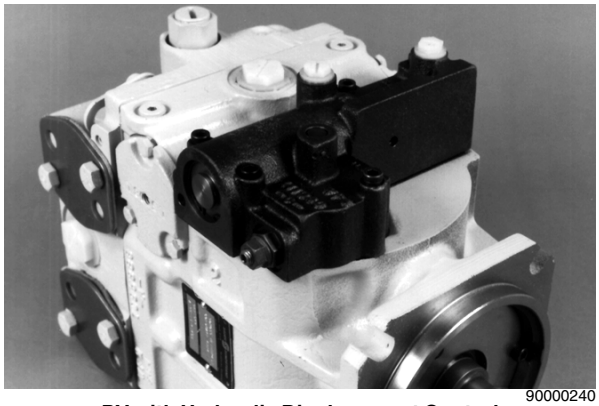
7. If continuity is not broken at base pressure plus 0 to 1 bar (0 to 12 psi) in either direction, stop the prime mover and readjust the eccentric plug as described in the previous section. If the pressure difference is equal in each direction but greater than 1 bar (12 psi), loosen the switch locknut and turn the switch clockwise 1/12 turn (30°) to increase the sensitivity. Retighten the locknut and recheck pressure differences and continuity.

8. After verifying proper control and switch operation, stop the prime mover. Remove the continuity checker and pressure gauges. Reinstall the servo pressure port plugs and reconnect the electrical leads from the machine starter circuit to the neutral start switch. Install and adjust, if necessary, the external control linkage.


90000255

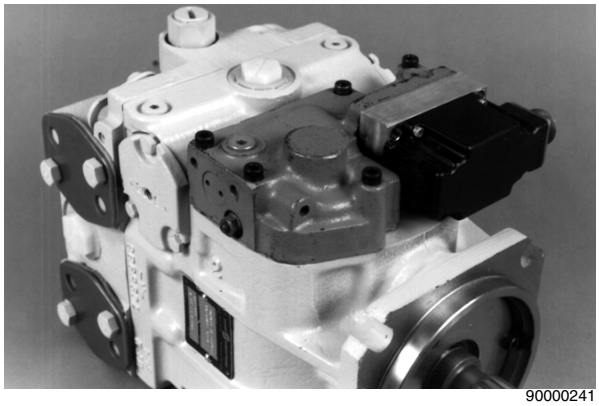
Checking Continuity of NSS
(Gauges installed in Servo Gauge Ports)

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90000240

PV with Hydraulic Displacement Control



90000241

PV with Electric Displacement Control

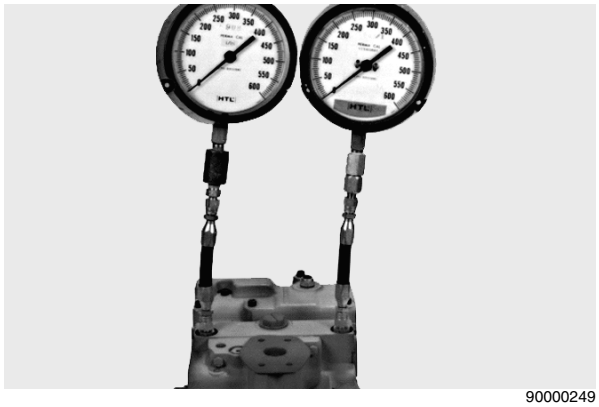
Hydraulic Displacement Control (HDC) and Electric Displacement Control (EDC) Adjustment

The “neutral” adjustment is the only adjustment that can be made on hydraulic and electric displacement controls. All other functions are preset at the factory.

This adjustment must be made on a test stand or on the vehicle/machine with the prime mover operating.

The neutral adjustment is performed by adjusting a neutral adjusting shaft (earlier production EDCs) or a neutral adjusting screw (HDCs and current production EDCs).

WARNING
The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.
S000007E



90000249

Install Gauges in Displacement Control Cylinder Gauge Ports

1. Install two 50 bar (or 1000 psi) gauges in each of the two displacement control cylinder gauge ports (M4 and M5). Disconnect the external control input (hydraulic or electronic) from the control. Start the prime mover and operate at normal speed.

2. Loosen the lock nut with a 17 mm hex wrench for the neutral adjusting shaft or with a 10 mm or 13 mm hex wrench for the neutral adjusting screw.

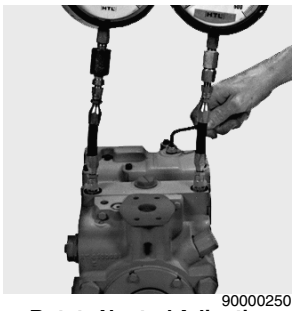
https://truckmanualshub.com/

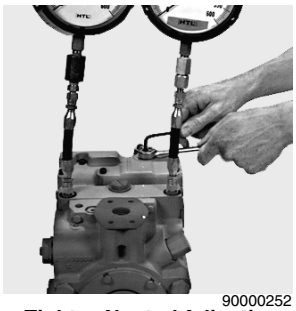
3. Using a 5 mm internal hex wrench for the neutral adjusting shaft or a 3 mm or 4 mm internal hex wrench for the neutral adjusting screw, rotate clockwise until the pressure increases in one of the pressure gauges. Note the angular position of the wrench. Then rotate the neutral adjusting shaft or screw counterclockwise until the pressure increases by an equal amount on the other gauge. Again note the angular position of the wrench.

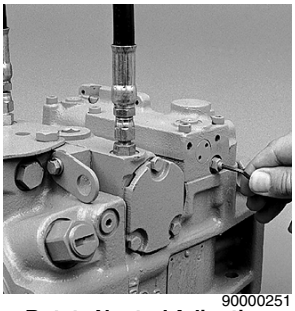
4. Rotate the neutral shaft or adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure (case pressure), indicating that the control is in its “neutral” position.

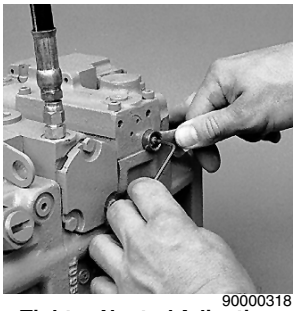
5. Hold the neutral adjusting shaft or screw stationary. Tighten the neutral shaft lock nut (early production controls) to 22 Nm (195 lbf in.). Tighten the neutral adjusting screw lock nut (later production controls) to 7 Nm (62 lbf in.) for the 6 mm screw or 13.5 Nm (120 lbf in.) for the 8 mm screw. **Do not overtorque the nut.**

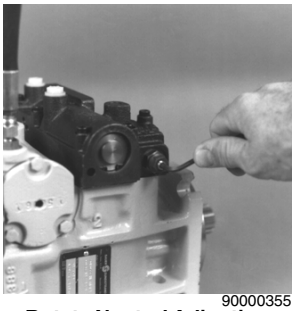
6. Once the neutral position is set, stop the prime mover, remove the gauges, and install the gauge port plugs. Reconnect the external control input.

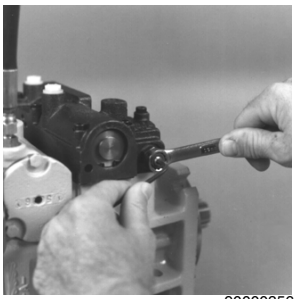

90000250
Rotate Neutral Adjusting Shaft (Early production)


90000252
Tighten Neutral Adjusting Shaft Lock Nut (Early production)


90000251
Rotate Neutral Adjusting Screw (Later production)

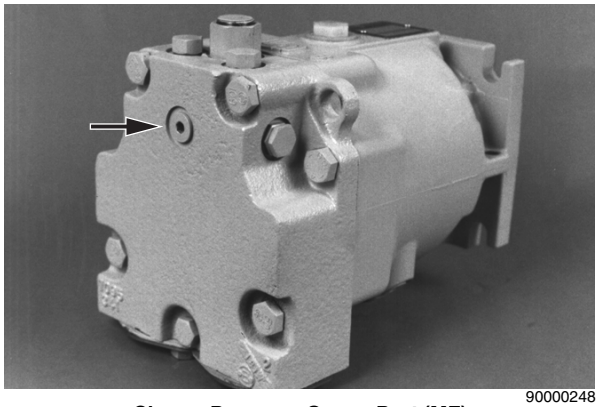

90000318
Tighten Neutral Adjusting Screw Lock Nut (Later production)


90000355
Rotate Neutral Adjusting Shaft (Current production HDC)


90000356
Tighten Neutral Adjusting Shaft Lock Nut (Current production HDC)

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Motor Adjustments



90000248

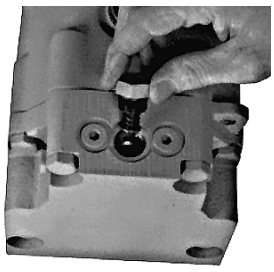
Charge Pressure Gauge Port (MF)

90M055 NC 0 N
8 N 0 C6 W 00
NNN 00 00 **24**

Nominal charge Pressure Setting

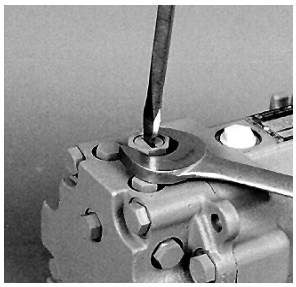
Model Code	Motor Charge Pressure (±1.4 bar [±20 psi])
10	8.1 bar (117 psi)
18	16.1 bar (233 psi)
20	18.1 bar (262 psi)
24	22.1 bar (320 psi)
28	26.1 bar (378 psi)
30	30.0 bar (435 psi)
	T002 279E

Model Code at the Name Plate (24 bar)



90000263

Shim Adjustable Charge Pressure Relief Valve (Motor)



90000343

Screw Adjustable Charge Pressure Relief Valve (Motor)

Charge Relief Valve Adjustment

1. To measure motor charge pressure, install a 50 bar (or 1000 psi) pressure gauge in the motor charge pressure gauge port (M3). Size 30 and 42 don't have the M3 gauge port. Install pressure gauge in the motor system pressure gauge port. For this kind of measurement add 1 bar (14.5 psi) to the nominal values shown in the table. Also install a gauge to measure case pressure. Operate the system with the pump in stroke (forward or reverse) when measuring motor charge pressure.

2. The following table shows acceptable motor charge pressures for some nominal charge relief valve settings (see model code at right). These pressures assume a reservoir temperature of 50°C (120°F). They are referenced to case pressure and assume a one pump/one motor system.

3. Earlier production Series 90 motors are equipped with a shim adjustable charge relief valve. Shim kits are available as service items. Adjustment of the charge pressure is accomplished by removing the plug (7/8 inch hex) and changing the shim thickness behind the spring. The plug for this type charge relief port should be torqued to 68 Nm (50 lbf ft).

   Later production Series 90 motors are equipped with an external screw adjustable charge relief valve. Adjustment of charge pressure is accomplished by loosening the lock nut,

Frame Size	Wrench Size
030 - 130	1-1/16 inch
	T002 293E

   and turning the adjustment plug with a large screwdriver or a 1/2 inch hex wrench. Clockwise rotation of the plug increases the setting, and counterclockwise rotation decreases the setting (at a rate of approximately 5.4 bar [78 psi] per turn). The lock nut for this type charge relief valve should be torqued to 52 Nm (38 lbf ft).

4. Once the desired charge pressure setting is achieved, remove the gauges.

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Displacement Limiter Adjustment (MV)

Both the maximum and minimum displacement may be limited.

1. Remove the tamper resistant cap from the displacement limiter screw. Loosen the seal lock nut retaining the displacement limiter adjusting screw with a 19 mm wrench.

Caution
The displacement limiters act as travel stops for the swashplate. Do not turn the limiter screws counterclockwise beyond the point of contact with the swashplate for either the maximum or minimum displacement position.

S000015E

2. All adjustments can only be done when the motor is running and the pump is in neutral position. Steer the respective displacement limiter by the control.

   Rotate the adjusting screw with a 6 mm internal hex wrench. Rotating the maximum displacement adjusting screw clockwise will decrease the maximum displacement of the motor. Rotating the minimum displacement adjusting screw clockwise will increase the minimum displacement of the motor.

Caution
Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. See corresponding section for speed and pressure limits.

The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

S000016E

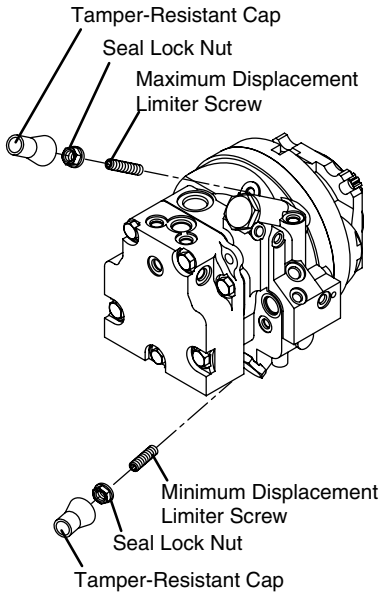
3. After establishing the desired displacement setting, tighten the lock nut on the adjusting screw to 54 Nm (40 lbf ft). Install a new tamper resistant cap.

4. One turn of the adjusting screw will change the maximum or minimum displacement according to the following chart.

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
055	5.6 cm^3 / Rev (0.34 in^3 / Rev)
075	7.1 cm^3 / Rev (0.43 in^3 / Rev)
	T002 280E

Displacement Control Adjustments

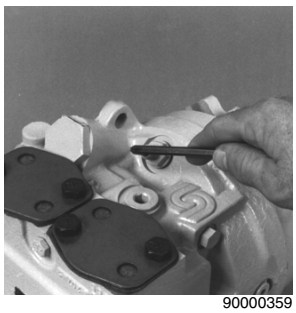
All variable motor displacement control settings do not require adjusting.



SAE Flange Version shown
(Cartridge Version similar)

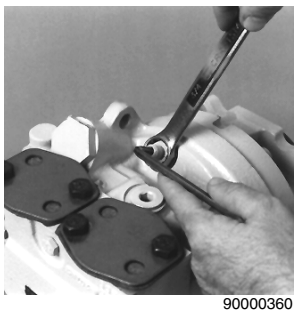
90000837E

MV Displacement Limiters



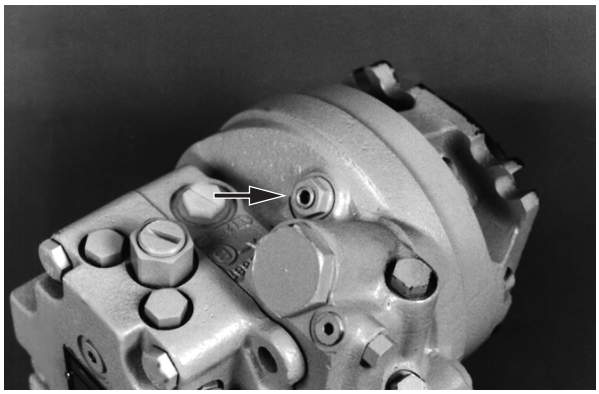
90000359

Rotate Adjusting Screw for Minimum Displacement Limiter



90000360

Tighten Lock Nut for Minimum Displacement Limiter

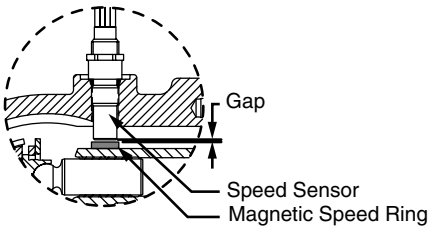


90000352

Maximum Displacement Limiter

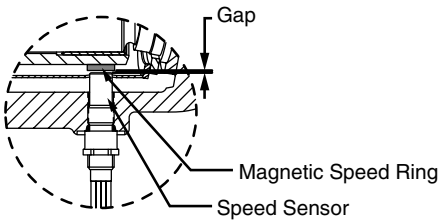
https://truckmanualshub.com/

Speed Sensor Adjustment



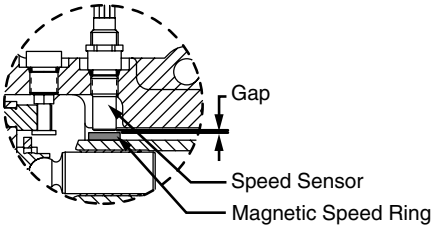
90000838E

Cross Section View of Speed Sensor in Variable Pump



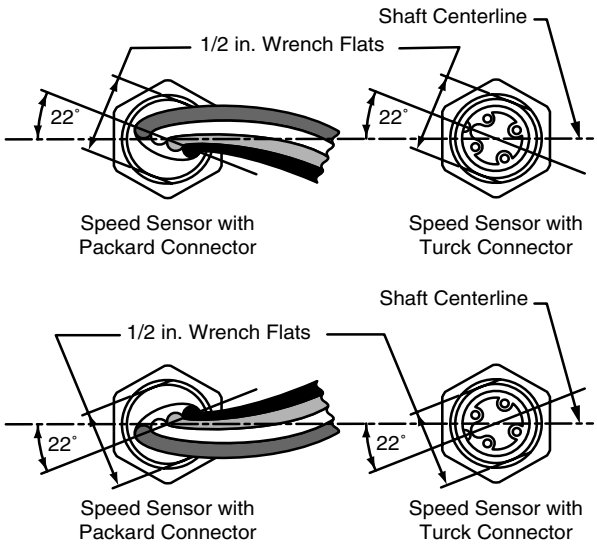
90000839E

Cross Section View of Speed Sensor in fixed Motor



90000840E

Cross Section View of Speed Sensor in Variable Motor



90000841E

Positioning Speed Sensor relative to Pump or Motor Shaft

When installing or adjusting the speed sensor on a pump or motor, it must be set at a specific distance from the speed ring on the unit's cylinder. To locate the position of the speed sensor on the unit or description see the corresponding section.

1. Loosen the sensor lock nut with an 1-1/16 inch hex wrench.
2. Turn the sensor clockwise (CW) by hand until it contacts the speed ring.
3. Turn the sensor counterclockwise (CCW) 1/2 turn (180°) to establish the nominal gap of 0.71 mm (0.028 inch).
4. Then turn the sensor clockwise (CW) until the wrench flats on sensor body are positioned at a 22° angle to the pump shaft center line.

Note: Many adjustable wrenches have a 22° handle offset.

5. The final sensor position should be between 1/2 (180°) and 1/4 turn (90°) counterclockwise (CCW) from the point where the sensor contacts the speed ring.
6. Hold sensor in position with a 1/2 inch hex wrench while tightening the lock nut to 13 Nm (10 lbf ft).

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Minor Repair Instructions

Minor repairs may be performed, following the procedures in this section, without voiding the unit warranty. Although specific models are shown, these procedures apply to all series and types of units in the Series 90 Family.

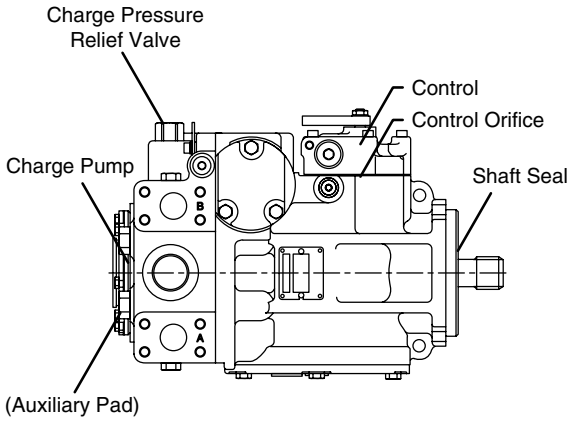
Cleanliness is a primary means of ensuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

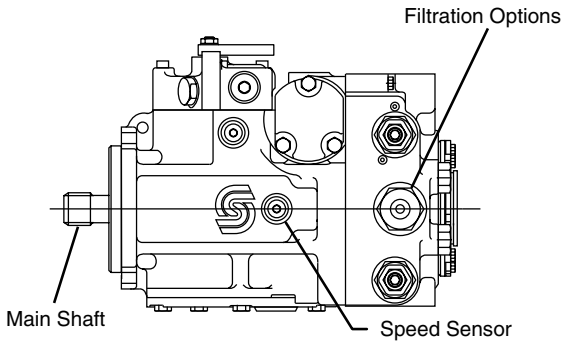
It is recommended that all gaskets and O-rings be replaced when servicing. All gasket sealing surfaces must be cleaned prior to installing new gaskets. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.

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Hydrostatic Unit Outlines for Minor Repair Reference



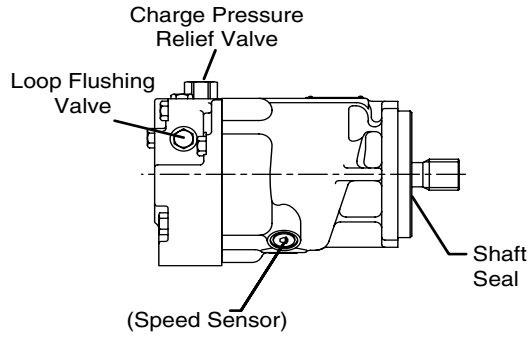
Left Side View



Right Side View

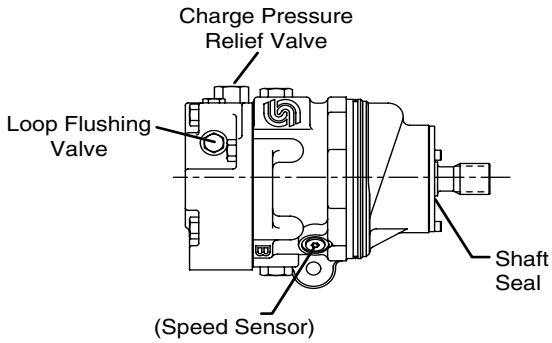
90000843E

SAE-Flange PV



Left Side View

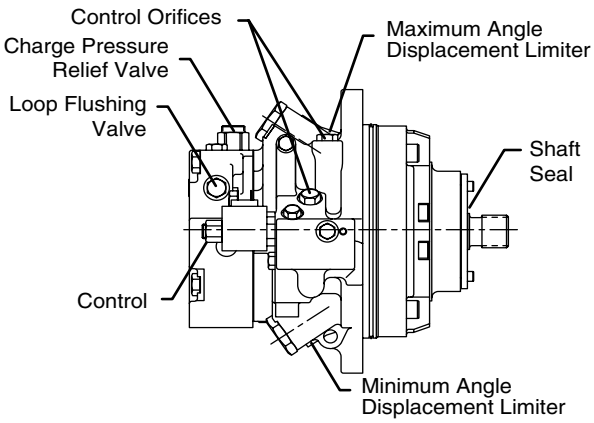
SAE Flange MF



Left Side View

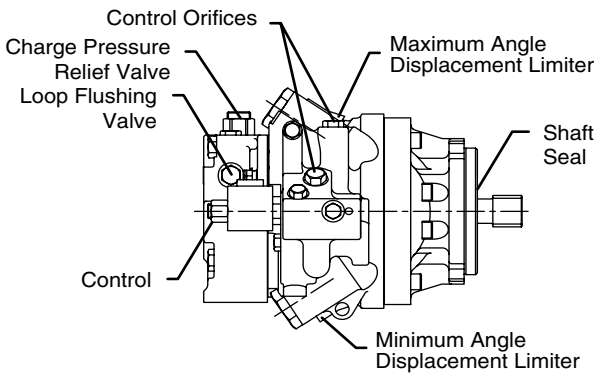
Cartridge Flange MF

90000844E



Left Side View

Cartridge Flange MV



Left Side View

SAE Flange MV

90000845E

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Pump and Motor Minor Repair

Pump / Fitting Torques

If any plugs or fittings are removed from the pump or motor during servicing, they should be torqued as indicated in the accompanying table.

Always install new O-rings before reinstalling the plugs or fittings.

Caution
Plugs or fittings installed into aluminum housings should always be torqued to the lower values specified for internal hex plugs of the same size.
S000017E

Description	Torque
7/16-20 O-ring 9/16 inch Hex Wrench	20 Nm (15 lbf ft)
7/16-20 O-ring 3/16 inch Internal Hex Wrench	12 Nm (9 lbf ft)
9/16-18 O-ring 11/16 inch Hex Wrench	37 Nm (27 lbf ft)
9/16-18 O-ring 1/4 inch Internal Hex Wrench	23 Nm (17 lbf ft)
3/4-16 O-ring 7/8 inch Hex Wrench	68 Nm (50 lbf ft)
3/4-16 O-ring 5/16 inch Internal Hex Wrench	68 Nm (50 lbf ft)
7/8-14 O-ring 1 inch Hex Wrench	95 Nm (70 lbf ft)
7/8-14 O-ring 3/8 inch Internal Hex Wrench	68 Nm (50 lbf ft)
1-1/16-12 O-ring 1 1/4 inch Hex Wrench	163 Nm (120 lbf ft)
1-1/16-12 O-ring 9/16 inch Internal Hex Wrench	115 Nm (85 lbf ft)
1-5/16-12 O-ring 1-1/2 inch Hex Wrench	190 Nm (140 lbf ft)
1-5/16-12 O-ring 5/8 inch Internal Hex Wrench	129 Nm (95 lbf ft)
1-5/8-12 O-ring 1-7/8 inch Hex Wrench	224 Nm (165 lbf ft)

T002 281E

https://truckmanualshub.com/

Shaft Seal and Shaft Replacement



90000270

Remove Screws Holding Retainer Plate and Seal Carrier



90000271

Remove Seal Carrier



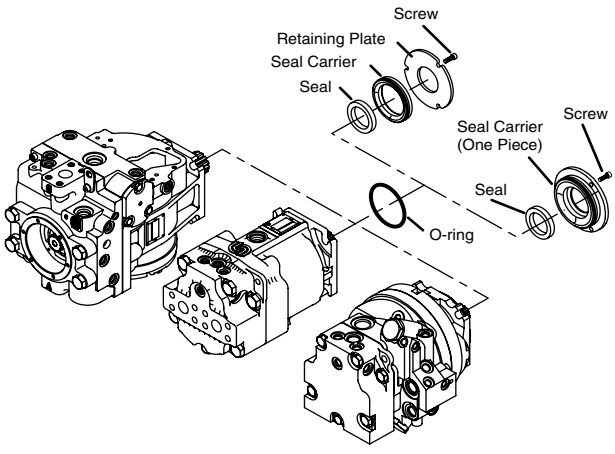
90000272

Press Out Old Seal



90000273

New Seal Installed in Carrier



90000846E

Series 90 Shaft Seal Components

Lip type shaft seals are used on Series 90 pumps and motors. These seals and/or the shafts can be replaced without major disassembly of the unit. However, replacement usually requires removal of the pump or motor from the machine.

1. Position the pump with the shaft facing up.

Note: If the unit is positioned horizontally when the shaft is removed, the cylinder block could move out of place, making shaft installation difficult.

2. Remove the three or four screws holding the retainer plate and seal carrier to the housing, using a 10 mm hex wrench (030 and 042 units), a 5 mm internal hex wrench (055 through 100 units), or a 6 mm internal hex wrench (130 through 250 units). Remove the retainer plate.

Note: Certain earlier production units use a one piece retainer plate and seal carrier.

3. After removing the screws, the spring force on the shaft may move the seal carrier out of its bore by approximately 5 mm (1/4 inch). If the seal carrier does not move from its bore after removing the screws, pry it from its bore as shown and/or lightly tap the end of the shaft with a soft mallet.

4. Remove the O-ring from the seal carrier.

5. Place seal carrier and seal in an arbor press and press out old seal.

6. Inspect the seal carrier, the new seal and the O-ring for any damage or nicks.

7. Using the arbor press, press the new seal into seal carrier. Be careful not to damage the seal.

Note: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This aids in preventing leaks caused by damage to the seal bore in the seal carrier.

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8. Inspect the sealing area on the shaft for rust, wear, or contamination.

   If the shaft is not being replaced proceed to step 12.

9. Remove shaft and roller bearing assembly from pump or motor. The bearing assembly can be transferred to the new shaft.

10. Remove the retaining ring that secures roller bearing assembly with a snap ring pliers. Remove the roller bearing assembly.

11. Place roller bearing assembly on new shaft and secure with the retaining ring.

12. Wrap spline or key end of shaft with plastic film to prevent damage to the sealing lip on the seal during installation.

13. Prior to assembly, lubricate the O-ring on the O.D. of the seal carrier and the I.D. of the seal with clean petroleum jelly.

14. Assemble the seal carrier and seal over the shaft and into the housing bore. Install the retainer plate (if used).

15. Install the screws and torque like the tables.

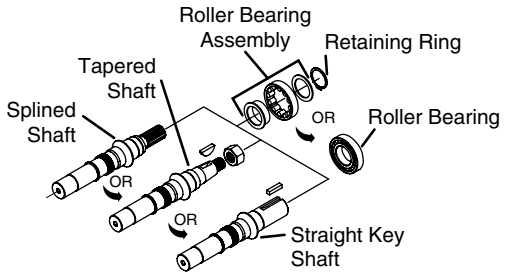
Pumps

Frame Size	Torque Pumps
030 - 042	12 Nm (9 lbf ft)
055 - 100	16 Nm (12 lbf ft)
130 - 250	32 Nm (24 lbf ft)
	T002 282E

Motors

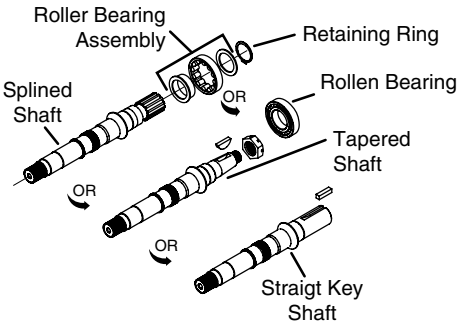
Frame Size	Torque Motors
030 - 100	9.5 Nm (7 lbf ft)
130	22.5 Nm (16.6 lbf ft)
	T002 283E

Note: Torque the screws in a sequenced pattern then recheck.



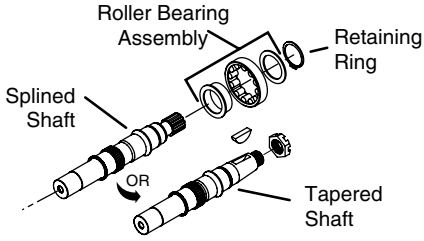
90000866E

Fixed Motor Shaft Configuration



90000867E

Variable Pump Shaft Configuration



90000868E

Variable Motor Shaft Configuration



90000274

Install Seal Carrier

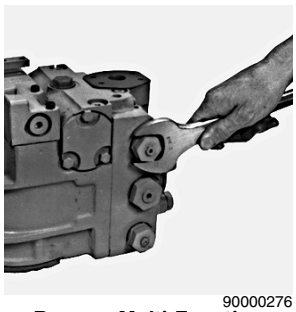


90000275

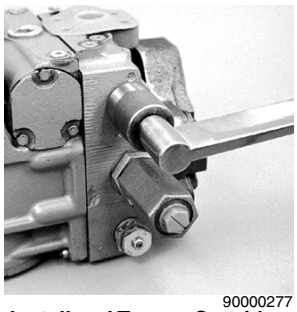
Torque Retainer Screw

https://truckmanualshub.com/

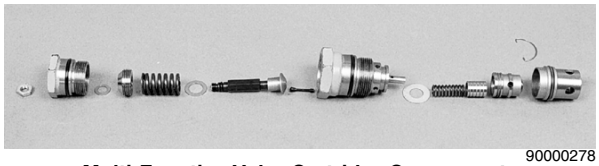
Pump Minor Repairs



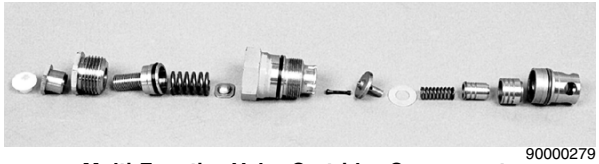
90000276
Remove Multi-Function Valve Cartridge



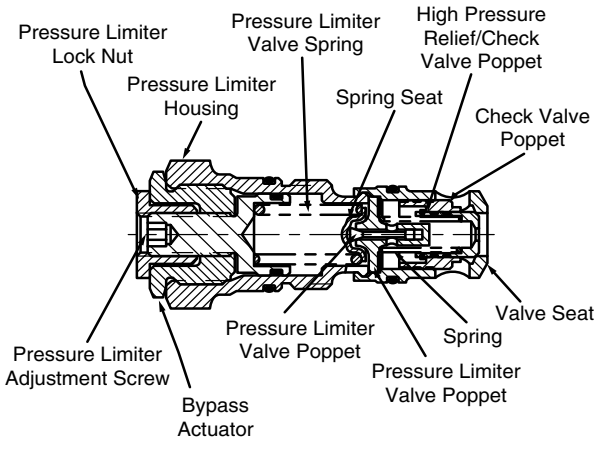
90000277
Install and Torque Cartridge



90000278
Multi-Function Valve Cartridge Components (Earlier production)



90000279
Multi-Function Valve Cartridge Components (Later production)



90000869E
Multi-Function Valve Cartridge Sectional View

Multi-Function Valve Cartridges

1. The multi-function valve cartridge is removed with a hex wrench on the largest hex on the cartridge.

Frame Size	Wrench Size
030 - 100	1-1/4 inch
130 - 250	1-5/8 inch
	T002 284E

2. Inspect cartridge for damage to parts and O-rings.

   The multi-function valve cartridge may be disassembled for cleaning. However, if the pressure limiter housing assembly is disassembled, the pressure settings must be readjusted. Usually, if there is contamination problem, it will be in the valve seat assembly. If it is not necessary to clean the interior of the cartridge, proceed to step 7.

Note: Multi-function valve components are not sold separately as service parts (except O-rings).

3. On early versions of the multi-function valves, the valve seat assembly is held by a retaining ring. Remove retaining ring with a snap ring pliers.

   On late versions, the valve seat section is pressed over a lip. Place the cartridge in a vise and pry the lower section off with an appropriate tool. Maintain sufficient control to prevent the contents from flying loose.

4. Remove pressure limiter lock nut and bypass actuator.

5. Unscrew the pressure limiter adjustment screw from the bypass actuator. Clean and inspect all disassembled parts.

6. Reassemble with new, lightly lubricated O-rings by reversing the above procedure. For early versions assemble with the retaining ring. For late versions, place the cartridge in a vise and press on lower assembly.

Caution
The pressure settings must be readjusted after disassembling the pressure limiter housing of the multi-function valve cartridge.
S000018E

7. Install cartridge in multi-function valve cavity and torque.

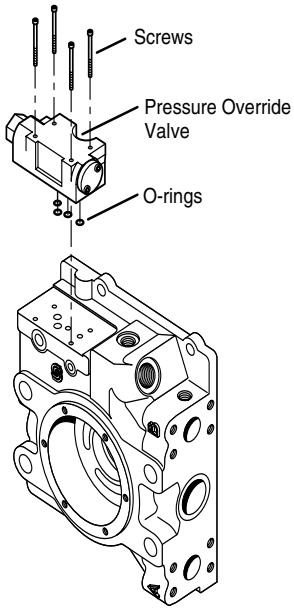
Frame Size	Torque
030 - 100	89 Nm (66 lbf ft)
130 - 250	210 Nm (155 lbf ft)
	T002 285E

Do not overtorque the multi-function valve cartridge.

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Pressure Override Valve (Option for 180 Frame Size)

1. Remove the four screws attaching the pressure override valve to the pump end cap with a 5 mm internal hex wrench. Remove the O-rings.
2. Inspect valve for damage to parts.
3. Install new O-rings. Install the valve onto the pump end cap and torque the screws to 16 Nm (12 lbf ft).



90000870E
Pressure Override Valve Components

Charge Relief Valve

The pump charge relief valve may be shim adjustable (early models) or screw adjustable (late models).

1. Remove the shim adjustable charge relief valve plug with a 1 inch hex wrench.

   Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to approximately maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut with a wrench.

Frame Size	Wrench Size
030 - 100	1-1/16 inch
130 - 250	1-5/8 inch
	T002 286E

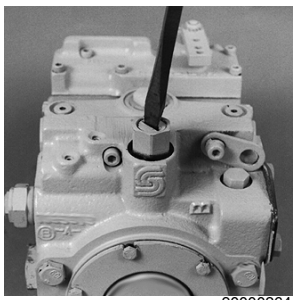
   Unscrew the plug with a large screwdriver or 1/2 inch hex wrench.
2. Remove the spring and relief valve poppet.
3. Inspect the poppet and mating seat in the end cap for damage or foreign material.

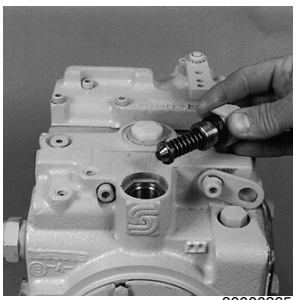
   When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.
4. Install the poppet and spring. For shim adjustable valves, install the plug and torque to 68 Nm (50 lbf ft). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 lbf ft).

   Check the charge pressure and adjust, if necessary.


90000280
Remove Charge Relief Valve (Shim adjustable)


90000262
Shim Adjustable Charge Relief Valve


90000264
Remove Charge Relief Valve (Screw adjustable)


90000265
Screw Adjustable Charge Relief Valve

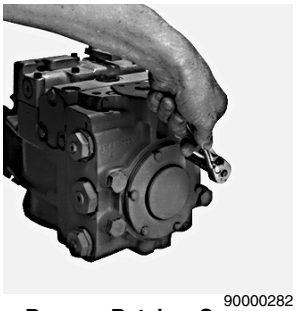
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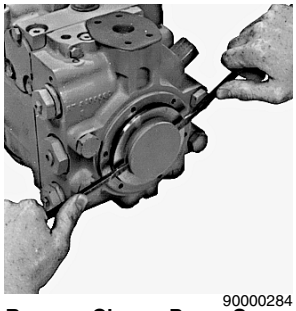
90000281
Remove Auxiliary Pad Adapter Screws



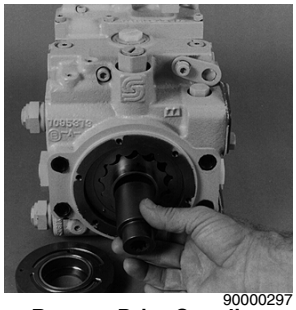
90000303
Remove Auxiliary Pad Adapter



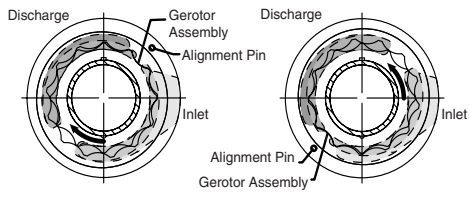
90000282
Remove Retainer Screws



90000284
Remove Charge Pump Cover



90000297
Remove Drive Coupling



Left Hand Rotation (Outside looking into pump)

Right Hand Rotation (Outside looking into pump)

90000871E
Orienting Alignment Pin

Charge Pump - Remove

The following procedure shows how to remove and install a charge pump.

1. For pumps with an auxiliary mounting pad, remove the four screws holding the pad to the end cap and remove the pad. Refer to the Auxiliary Mounting Pad Installation instructions (next section) for details.

Note: At earlier production frame size 75 pumps with twin ports secure the end cap to the pump housing with a clamp to avoid gasket damage.

Caution
Do not allow the force of the cylinder block spring and swashplate leveler springs to separate the end cap from the pump housing. Gasket damage and external leakage may result.

S000019E

2. Remove the six screws holding the charge pump cover retainer.

Frame Size	Wrench Size
030 - 100	10 mm
130 - 250	13 mm

T002 287E

3. Remove the retainer and the charge pump cover. For pumps with an auxiliary mounting pad, remove the auxiliary drive coupling. Note the orientation of the gerotor.

4. Remove the charge pump shaft and charge pump drive key.

5. Remove the spacer plate(s), if present (intermediate production pumps only).

   Remove the charge pump outer port plate, if present (early and intermediate production pumps).

   Remove the charge pump gerotor assembly.

6. Remove the outer eccentric ring and alignment pin.

7. Remove the inner port plate.

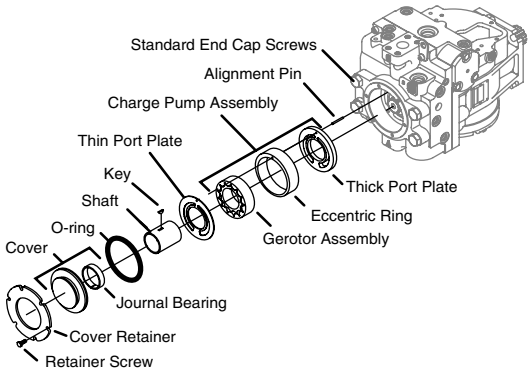
8. Inspect all parts for abnormal wear or damage.

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Note: If a different displacement charge pump is being installed, the gerotor assembly, gerotor outer eccentric ring, and inner port plate (early and late production pumps) or outer spacer plate(s) (intermediate production pumps) must be replaced together. If different thickness port plates are used in an early production charge pump assembly, the thicker plate is the inner port plate (installed next to the pump end cap).

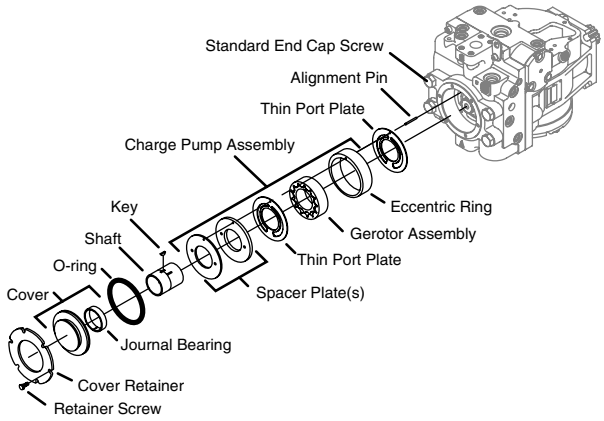
Each charge pump assembly includes a different quantity / types of port plates and spacer plates.

The charge pump kit "No Charge Pump" includes a spacer.



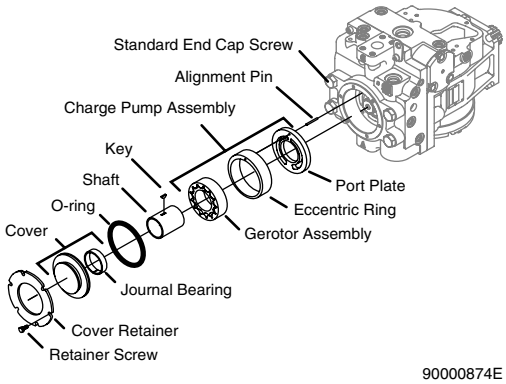
90000872E

Charge Pump Components (Early Production)



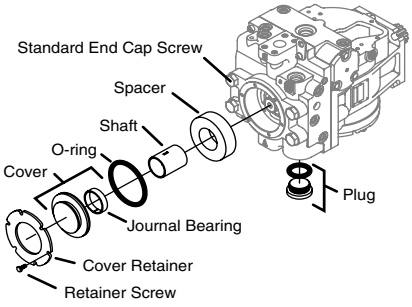
90000873E

Charge Pump Components (Intermediate Production)



90000874E

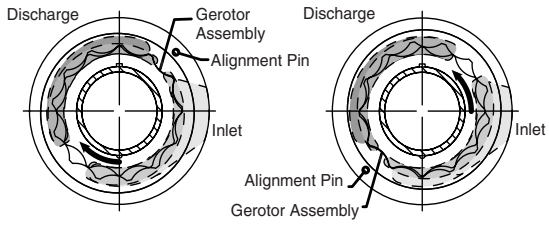
Charge Pump Components (Late Production)



90000875E

"No Charge Pump" Components

https://truckmanualshub.com/



Left Hand Rotation (Outside looking into pump)

Right Hand Rotation (Outside looking into pump)

90000871E

Orienting Alignment Pin



90000285

Install Inner Port Plate



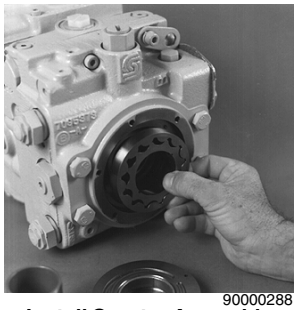
90000286

Install Gerotor Assembly Outer Ring



90000287

Install Alignment Pin



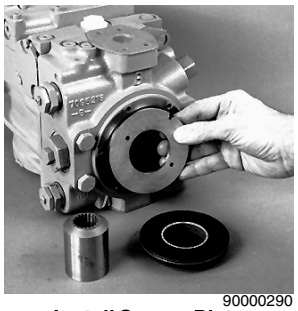
90000288

Install Gerotor Assembly



90000289

Install Outer Port Plate (Early and intermediate production only)



90000290

Install Spacer Plate (Intermediate production only)

Installing the Charge Pump

Be sure to install the charge pump in the proper orientation. If unsure of charge pump rotation, refer to the model code.

Note: The charge pump **rotation** is determined by the orientation of the gerotor assembly outer eccentric ring and the location of the alignment pin in the end cap.

Do not mix charge pump piece parts from different production periods. Always install as a complete assembly.

1. Install the inner port plate and the gerotor assembly outer ring.
2. Install the alignment pin to properly orient the port plates and outer eccentric ring for corresponding pump rotation.
3. Prior to installation, apply a small quantity of petroleum jelly to the I.D., O.D., and side faces of the gerotor assembly to provide initial lubrication.
4. Install the gerotor assembly.
5. Install the outer port plate (early production and intermediate production pumps only).
6. Install the spacer plate, if present (intermediate production pumps).
7. Install the charge pump drive key into the charge pump shaft and retain with petroleum jelly.

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Note: Intermediate production 75 cc and 100 cc pumps use the same charge pump drive shaft. Two keyways are provided in the drive shaft for the charge pumps used in these units. The rear keyway (with identifier groove) is used in 75 cc pumps. The front keyway (closest to the internally splined end of the shaft) is used in 100 cc pumps.

8. Install the charge pump shaft. The internally splined end of the shaft must engage the main pump shaft.

Note: The outside diameter of the internally splined end of some early production charge pump shafts was chamfered. Early production end caps may not be machined to accept a non-chamfered shaft. Always use a chamfered charge pump shaft in pumps with the early end cap.

9. For pumps with an auxiliary mounting pad, install the auxiliary drive coupling.

10. Install a new O-ring onto the non-auxiliary pad charge pump cover. (If an auxiliary pad is installed, an O-ring is not used on the cover.)

11. Carefully remove the alignment pin from the charge pump parts. Install the pin in its hole in the charge pump cover (see previous page for correct orientation) and retain with petroleum jelly. Install the cover (with alignment pin) into the end cap and aligned charge pump parts. (Take care not to damage the cover O-ring, if used.)

Caution
In order to avoid loss of charge pressure in pumps with an auxiliary mounting pad, always install the charge pump cover with the pad drain hole located on the same side of the end cap as the charge inlet port. Refer to the section Auxiliary Pad Installation" for details.

S000 020E

12. Install the charge pump cover retainer and the six hex screws and torque the screws.

Frame Size	Torque
030 - 100	13.5 Nm (10 lbf ft)
130 - 250	32 Nm (24 lbf ft)
	T002 288E

13. For pumps with auxiliary mounting pads, install the O-ring and auxiliary mounting pad adaptor onto the end cap. Refer to the corresponding section for instructions on auxiliary pad installation.

100 cc 75 cc



90000291
Keyways in Charge Pump Shaft (Intermediate Production 075 and 100)



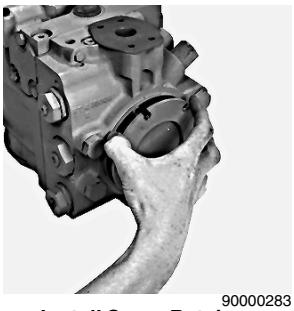
90000292
Install Charge Pump Shaft



90000293
Alignment Pin Installed in Cover



90000294
Install Charge Pump Cover

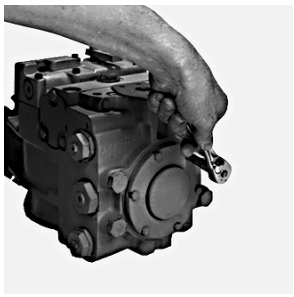


90000283
Install Cover Retainer

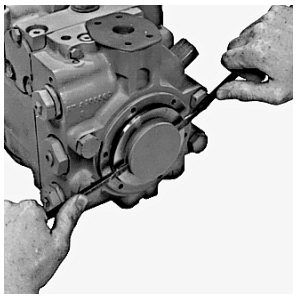


90000295
Torque Retainer Screws

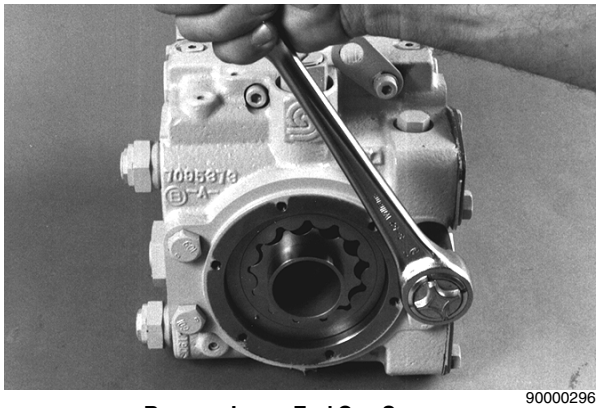
https://truckmanualshub.com/



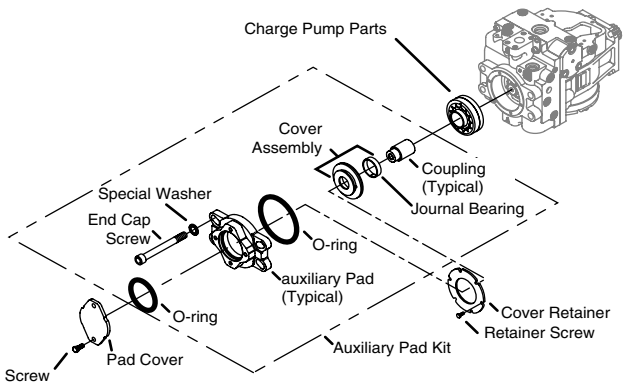
90000282
Remove Screws and Retainer



90000284
Remove Charge Pump Cover



90000296
Remove Large End Cap Screws



90000876E
Auxiliary Pad Components (Typical)

Auxiliary Pad Installation

1. Remove the six screws holding the charge pump cover retainer. Remove the retainer.

Frame Size	Wrench Size
030 - 100	10 mm
130 - 250	13 mm
	T002 287E

2. Remove the charge pump cover and its O-ring.

Note: The original charge pump cover will not be used when installing the auxiliary pad.

3. Remove the four large screws which fasten the end cap to the pump housing.

Frame Size	Wrench Sizes	
	Internal Hex	External Hex
030 - early 042	8 mm	
late 042	10 mm	
055		19 mm
075 - 100		24 mm
100 - 130	14 mm	
180 - 250	17 mm	
		T002 289E

Note: At earlier production frame size 75 pumps with twin ports secure the end cap to the pump housing with a clamp to avoid gasket damage.

Caution
Do not allow the force of the cylinder block spring and swashplate leveler springs to separate the end cap from the pump housing. Gasket damage and external leakage may result.

S000019E

4. Take care to assure the surfaces are clean and free of any foreign material or paint prior to installing the auxiliary pad.

5. Install the auxiliary drive coupling onto the pump drive shaft spline (auxiliary drive spline must be toward the rear of the pump).

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6. Carefully remove the alignment pin from the charge pump parts. Install the pin in its hole in the new charge pump cover (with hole for the auxiliary coupling) and retain with petroleum jelly. Install the new charge pump cover with alignment pin into the end cap and the aligned charge pump parts.

Caution
In order to avoid loss of charge pressure in pumps with an auxiliary mounting pad, always install the charge pump cover with the pad drain hole located on the same side of the end cap as the charge inlet port. Refer to the section "Auxiliary Pad Installation" for details.
S000 020E

7. Install the charge pump cover retainer and the six hex screws and torque the screws.

Frame Size	Torque
030 - 100	13.5 Nm (10 lbf ft)
130 - 250	32 Nm (24 lbf ft)
	T002 288E

8. Install O-ring on end cap pilot.

9. Install the auxiliary mounting pad adapter on external pilot on rear of end cap.

10. Install four new large screws and washers through the mounting pad and end cap into the housing. Torque per the accompanying table.

Frame Size	Torque
030 - early 042	58 Nm (43 lbf ft)
late 042	122 Nm (90 lbf ft)
055	122 Nm (90 lbf ft)
075 - 100	256 Nm (189 lbf ft)
100 - 130	298 Nm (220 lbf ft)
180 - 250	580 Nm (429 lbf ft)
	T002 290E

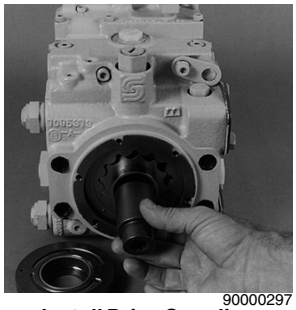
11. Install the O-ring and flange cover or auxiliary pump.

Auxiliary Pad Conversion

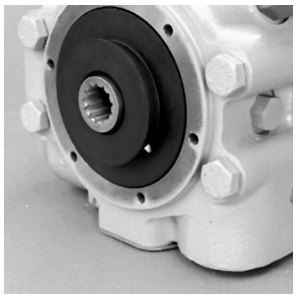
To convert an auxiliary mounting pad to a different size mounting pad, use the above procedure with the following additions:

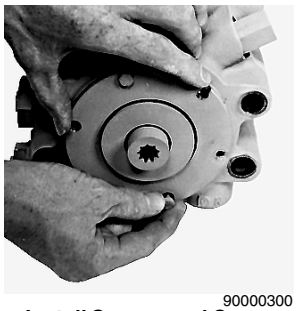
After removing the charge pump cover (step 2), remove the old auxiliary drive coupling.

After removing the four end cap retaining screws, remove the old auxiliary mounting pad adapter.


90000297
Install Drive Coupling

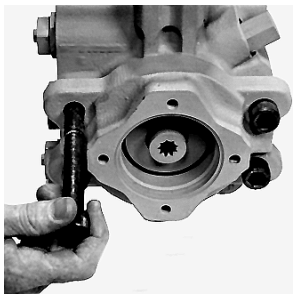

90000298
Install Alignment Pin in Cover (CCW rotation shown)


90000299
Install New Charge Pump Cover


90000300
Install Screws and Cover Retainer


90000302
Install O-ring on End Cap Pilot

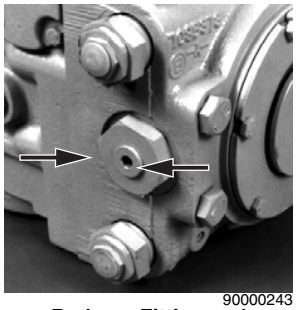

90000303
Install Auxiliary Pad Adapter

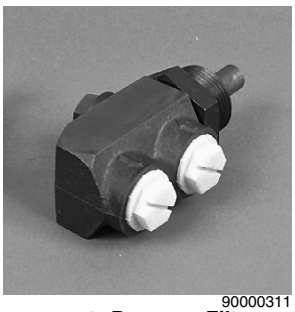

90000281
Install Auxiliary Pad Adapter Screws


90000305
Torque Pad Adapter Screws

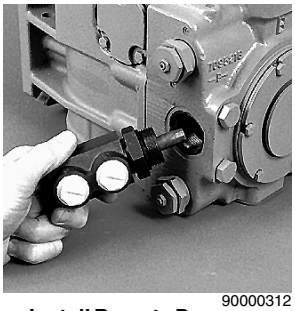
https://truckmanualshub.com/

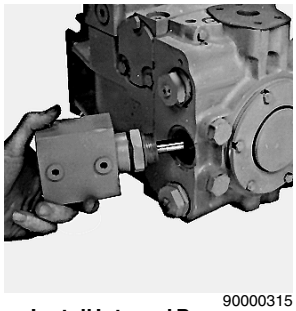

90000310
Charge Pump Inlet

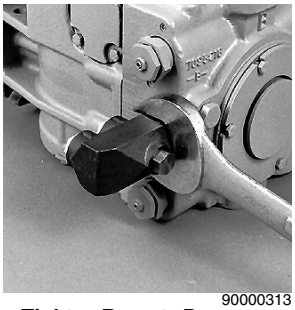

90000243
Reducer Fitting and Gauge Port Plug

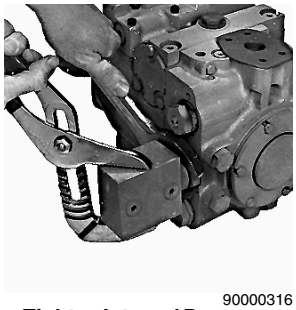

90000311
remote Pressure Filter Manifold


90000314
Integral Pressure Filter Head


90000312
Install Remote Pressure Filter Manifold


90000315
Install Integral Pressure Filter Head


90000313
Tighten Remote Pressure Filter Manifold Lock Nut


90000316
Tighten Integral Pressure Filter Head Lock Nut

Filtration Options

Suction Filtration Installation

1. Install the hydraulic fitting to connect the external suction filter to the charge pump inlet port.

2. The reducer fitting (placed on the charge pressure gauge port) is installed as follows.

Frame Size	Wrench Size	Torque
030 - 042	1-1/4 inch	70 Nm (52 lbf ft)
055 - 130	1-1/2 inch	122 Nm (90 lbf ft)
180 - 250	1-1/2 inch	156 Nm (115 lbf ft)
		T002 291E

The gauge port plug takes a 1/4 inch internal hex wrench and is torqued to 27 Nm (20 lbf ft).

Remote Charge Pressure Filtration or Integral Charge Pressure Filtration

Install either of these two filtration devices as follows.

1. Remove the reducer fitting, located at charge pressure gauge port, from pump end cap (this part will not be used).

2. Install the filter manifold or filter head into the port. The hydraulic tube should enter its mating bore in the pump end cap with a low force.

3. After rotating the filter manifold or filter head clockwise so that the threads engage with the threads in the end cap, continue to rotate it clockwise between 6 and 7 revolutions. Face manifold or head to the desired position.

Caution
Failure to install the filter manifold or filter head to a sufficient depth in the end cap will result in insufficient engagement of the tube in the end cap bore. This may allow unfiltered oil to bypass the filter and enter the charge system.
S000021E

4. While holding the filter manifold or filter head in the desired position, tighten the swivel lock nut.

Frame Size	Wrench Size	Torque
030 - 042	1-3/8 inch	70 Nm (52 lbf ft)
055 - 130	1-5/8 inch	122 Nm (90 lbf ft)
180 - 250	1-5/8 inch	156 Nm (115 lbf ft)
		T002 292E

5. After installing the integral pressure filter head assembly, install the filter canister per the instructions on the filter canister.

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Pump controls

Cover Plate

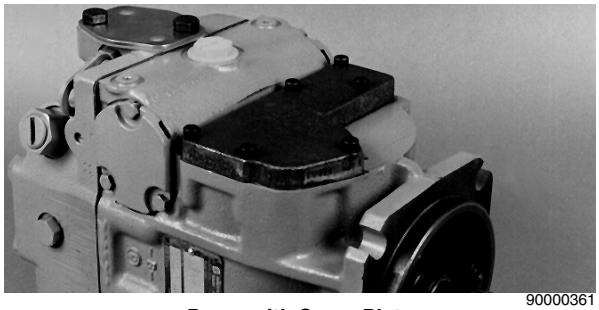
1. Thoroughly clean external surfaces prior to removal of cover plate.

2. Using a 5 mm internal hex wrench, remove the eight cover plate mounting screws. Remove the cover plate and gasket from housing.

Caution
Protect exposed surfaces and cavities from damage and foreign material.
S000022E

3. In preparation for installing the cover plate, place a new gasket on the housing. Place the cover plate into position and install the screws. Torque the screws to 16 Nm (12 lbf ft).

NOTE
A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.
S000023E

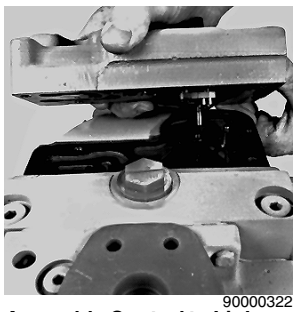

90000361
Pump with Cover Plate

https://truckmanualshub.com/


90000319
Remove Mounting Screws


90000320
Remove Control


90000321
Inner Face of Control


90000322
Assemble Control to Linkage


90000323
Assemble Control to Pump


90000324
Torque Mounting Screws

Manual Displacement Control (MDC)

1. Thoroughly clean external surfaces prior to removal of control.

2. Using a 5 mm internal hex wrench, remove the eight control mounting screws. Remove the control (with orifice check valve and spring) and control gasket from housing.

Caution
Protect exposed surfaces and cavities from damage and foreign material.
S000 022E

3. In preparation for installing the control, place a new gasket on the housing. Inspect to assure that the control orifice check valve and spring are in their proper position in the control.

4. While setting the control into position, engage the pin on the control linkage into the mating hole in the link attached to the swashplate.

5. With the control in position, move control lever both directions to check proper engagement of control linkage pin. Proper engagement will be indicated by centering torque as the lever is moved from center. Non-engagement of control linkage pin is indicated by lack of centering torque as the lever is moved. In case of non-engagement remove the control and repeat the above procedure.

6. Align the control gasket and install the screws. Torque the screws to 16 Nm (12 lbf ft).

NOTE
A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.
S000 023E

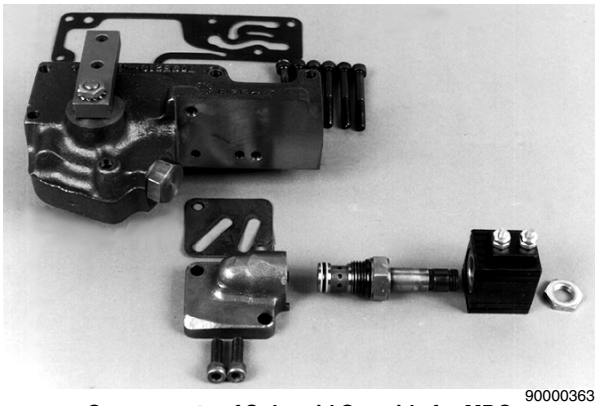
7. If the control is equipped with a neutral start switch, refer to the "MDC Neutral Start Switch Adjustment" instructions.

WARNING
The neutral start switch "neutral" must be readjusted after reassembling the MDC module.
S000 024E

https://truckmanualshub.com/

Solenoid Override Valve for MDC

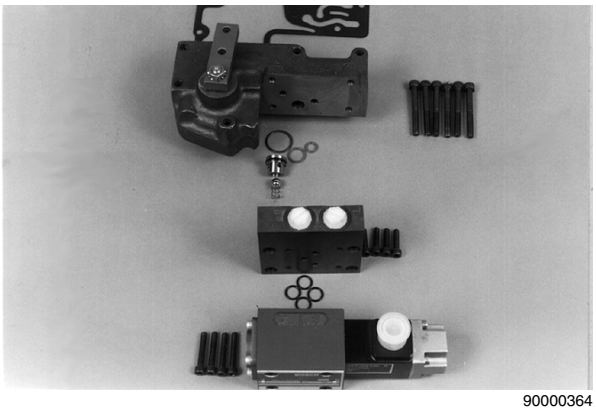
1. Thoroughly clean external surfaces prior to removal of valve.
2. Using a 5 mm internal hex wrench, remove the two screws and remove solenoid manifold from housing. Remove the old gasket.
3. The solenoid may be removed from the valve by removing the nut with a 3/4 inch hex wrench. The solenoid valve may be removed from the manifold with a 7/8 inch hex wrench.
4. When installing the solenoid valve into the manifold, the valve should be torqued to 24 ± 2.4 Nm (17.7 ± 1.8 lbf ft). When installing the solenoid onto the valve, torque the nut to 6 Nm (53 ± 12 lbf in).
5. In preparation for installing the solenoid manifold, place a new gasket on the control housing. Install the manifold onto the control housing, align the gasket, and install the screws. Torque the screws to 13.5 Nm (10 lbf ft).



90000363
Components of Solenoid Override for MDC

Solenoid Override Valve for MDC with Pressure Released Brake

1. Thoroughly clean external surfaces prior to removal of valve.
2. Using a 4 mm internal hex wrench, remove the four solenoid valve mounting screws. Remove the solenoid valve (with O-rings) from the adapter plate.
3. Using a 4 mm internal hex wrench, remove the four adapter plate mounting screws. Remove the adapter plate and O-rings from the control housing.
4. Remove the check valve seat and O-ring from the control side of the adapter plate. Remove the check ball and spring.
5. Install a new O-ring on the check valve seat and reassemble the check valve spring, ball, and seat into the adapter plate.
6. Install new O-rings on the adapter plate. Place the adapter plate into position and install the screws. Torque the screws to 5.4 Nm (48 lbf in).
7. Install new O-rings onto the solenoid valve assembly and install the solenoid valve onto the adapter plate. Install the screws and torque to 5.4 Nm (48 lbf in).



90000364
Components of Solenoid Override with Brake Pressure Defeat for MDC

https://truckmanualshub.com/


90000325
Remove Mounting Screws


90000326
Remove Control


90000327
Inner Face of Control


90000328
Assemble Control to Linkage


90000329
Install Mounting Screws


90000330
Torque Mounting Screws


90000332
PCP Components


90000334
Torque PCP Valve Screws

Hydraulic and Electric Displacement Controls

1. Thoroughly clean external surfaces prior to removal of control.

2. Using a 5 mm internal hex wrench, remove the eight control mounting screws. Remove the control (with orifice check valve and spring) and control gasket from housing.

Caution
Protect exposed surfaces and cavities from damage and foreign material.
S000 022E

3. In preparation for installing the control, place a new gasket on the housing. Inspect to ensure that the control orifice check valve and spring are in their proper position in the control.

4. While setting the control into position, engage the pin on the control linkage into the mating hole in the link attached to the swashplate.

5. With the control in position, move control assembly left and right to check engagement of pin in the link. Proper engagement will be indicated by an increasing resistance as the control is moved away from center position. Non-engagement of pin will be indicated by lack of spring force. In case of non-engagement, remove control and repeat the above procedure.

6. Align the control gasket and install the screws. Torque the screws to 16 Nm (12 lbf ft).

Caution
A sealing washer must be installed under the head of any mounting screws that are installed into "thru" holes in the housing.
S000 023E

Pressure Control Pilot (PCP) for Electric Displacement Control

1. Thoroughly clean external surfaces of control.

2. Using a 4 mm internal hex wrench, remove the four screws and remove the PCP.

3. Check surfaces for nicks or damage. Clean internal screens.

4. Install new O-rings in PCP Housing. Place PCP against EDC housing and install the screws. Torque to 5.4 Nm (48 lbf in).

Note: Do not remove black plastic cover from the aluminum plate. This is not a serviceable item and will void the product warranty.

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3-Position (FNR) Electric Control

1. Thoroughly clean external surfaces prior to removal of control.

2. Using a 4 mm internal hex wrench, remove the four solenoid valve mounting screws. Remove the solenoid valve (with O-rings and orifice) from the adapter plate.

3. Using a 5 mm internal hex wrench, remove the eight adapter plate mounting screws. Remove the adapter plate and gasket from housing.

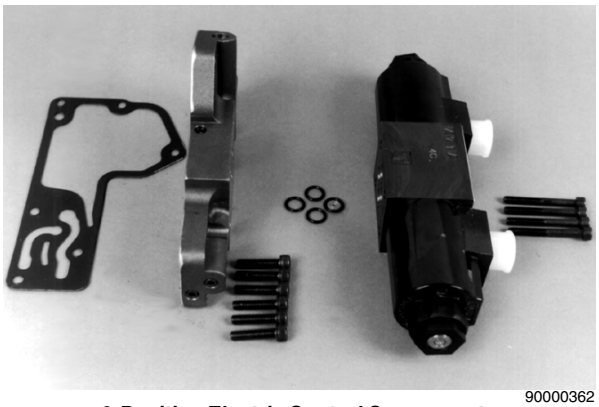
Caution
Protect exposed surfaces and cavities from damage and foreign material.
S000022E

4. Inspect the orifice installed between the valve and adapter plate. This orifice MUST be installed in the case drain passage for proper pressure limiter operation.

5. In preparation for installing the adapter plate, place a new gasket on the housing. Place the adapter plate into position and install the screws. Torque the screws to 16 Nm (12 lbf ft).

NOTE
A sealing washer must be installed under the head of any mounting screws that are installed into thru“ holes in the housing.
S000023E

6. Install new O-rings and the orifice onto the solenoid valve assembly and install the solenoid valve onto the adapter plate. Install the screws and torque to 5.4 Nm (48 lbf in).


90000362

3-Position Electric Control Components

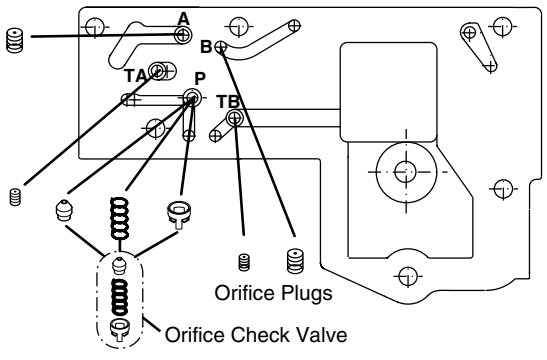
Displacement Control Components

Displacement Control Orifices

1. Remove the control assembly as described in the instructions for the specific displacement control.

2. Orifice plugs may be located in the control assembly, at the pump housing face surface. Remove the orifice plugs with a 4 mm internal hex wrench. Note the location of each plug, do not interchange plugs. Torque the orifice plugs to 3 Nm (26 lbf in).

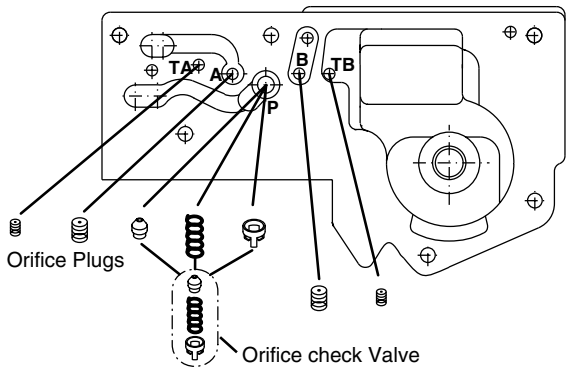
3. Assemble the control onto the pump. Refer to the instructions for the specific control.



90000849E

Underside of an HDC/EDC Module Showing Orifice Locations

https://truckmanualshub.com/



90000848E

Underside of an MDC Module Showing Orifice Locations

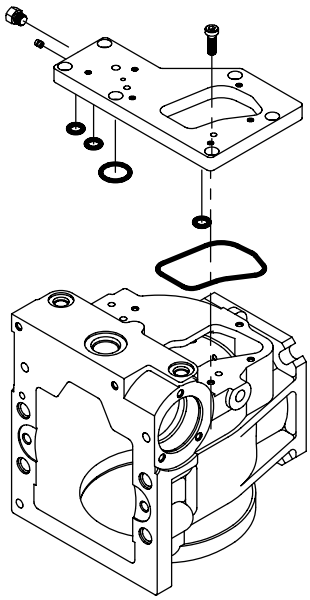
Displacement Control Orifice Check Valve

1. Remove the control assembly as described in the instructions for the specific displacement control.

2. The orifice check valve is located in the control assembly, at the surface of the pump housing face. Remove the spring retainer and spring from the orifice check valve cavity and then remove the orifice check valve.

3. Install the desired orifice check valve in the cavity and then install the spring and spring retainer to hold the orifice check valve in position.

4. Assemble the control onto the pump. Refer to the instructions for the specific control.



90000847

Displacement Control Adapter Plate (Early production 130cc Pumps only)

Displacement Control Adapter Plate (Early production 130 Pumps only)

The screws fastening the control adapter plate to the housing have retaining compound on the threads. They are removed with a 6 mm internal hex wrench.

When installing the adapter plate, ensure the O-rings are in the proper position and torque the screws to 32 Nm (24 lbf ft).

Displacement Control Filter Screens

If the pump is equipped with control filter screens in the pump housing (late production), they should be pressed into position (with the rounded edge of the filter screens facing the control until they are flush to 2.0 mm (0.08 inch) below the surface of the housing.

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Minor Repair - Motor

Loop Flushing and Charge Relief Valves

Loop Flushing Valve

1. Using an 1-1/16 inch wrench, remove the hex plugs and O-rings from both sides of the valve. Remove the springs, shoulder washers, and flushing valve shuttle spool. Note orientation of the washers. Remove the flushing valve spool.

2. Inspect parts for damage or foreign material.

Note: Early production motors used a small diameter shuttle valve spool. Late production motors use a larger diameter spool.

3. Install flushing valve spool in end cap, then install the shoulder washers (with shoulders facing “out”) and springs on each end of the spool. Install the hex plugs with O-rings, and torque to 41 Nm (30 lbf ft) on 030 through 100 motors or 68 Nm (50 lbf ft) on 130 motors.

Motor Charge Relief Valve

1. Remove the shim adjustable charge relief valve plug with a 7/8 inch hex wrench.

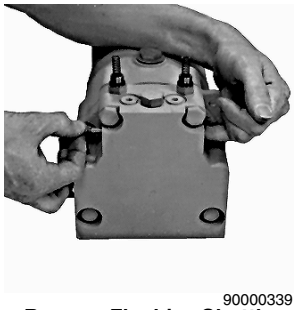
   Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and housing so as to be able to maintain the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut with a 1-1/16 inch hex wrench for 030 through 100 units, or a 1-5/8 inch hex wrench for 130 units, and unscrewing the plug with a large screwdriver or 1/2 inch hex wrench.

2. Remove the spring and valve poppet.

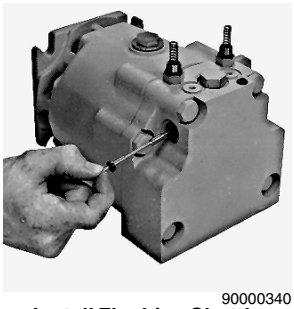
3. Inspect the poppet and mating seat in the end cap for damage or foreign material. When inspecting shim adjustable valves, do not alter the shims or interchange parts with another valve.



90000338
Remove Plugs Springs



90000339
Remove Flushing Shuttle Spool



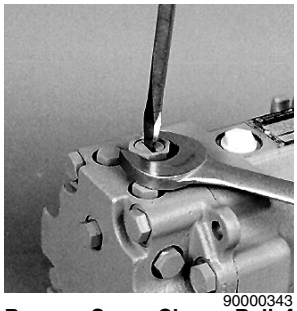
90000340
Install Flushing Shuttle Spool



90000341
Torque Plugs

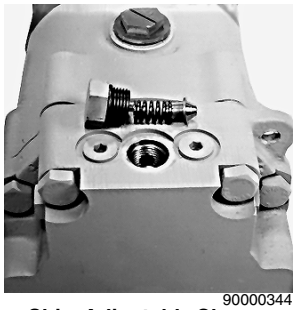


90000342
Remove Shim Charge Relief Valve

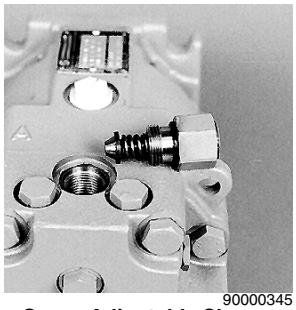


90000343
Remove Screw Charge Relief Valve

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90000344

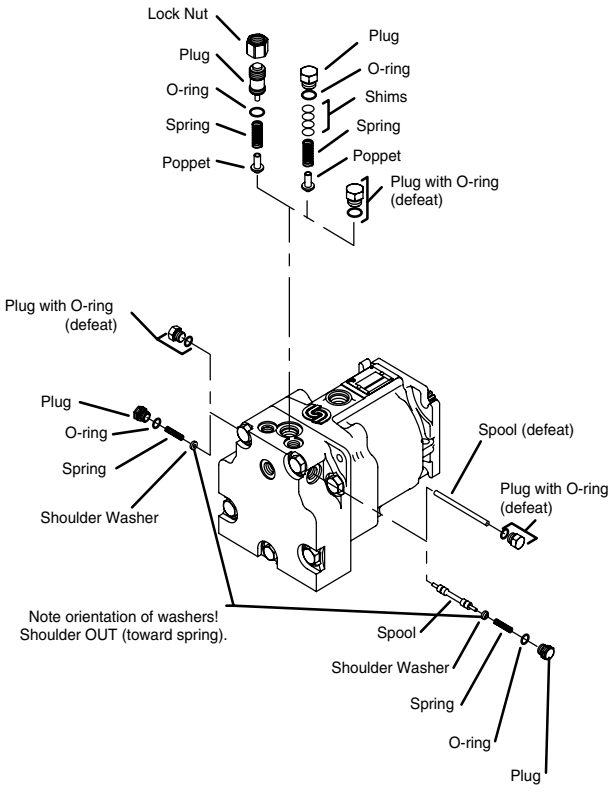
Shim Adjustable Charge Relief Valve


90000345

Screw Adjustable Charge Relief Valve

4. Install the poppet and spring. For shim adjustable valves, install the plug and torque to 68 Nm (50 lbf ft). For screw adjustable valves, install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 lbf ft).

5. Check and adjust the charge pressure.



90000850E

Motor charge Relief Valve and Loop Flushing Valve Parts

Defeating the Loop Flushing Valve

1. Remove loop flushing valve components (these parts will not be used).

2. Install defeating spool into spool bore in end cap.

3. Install hex plugs provided and torque to 41 Nm (30 lbf ft).

4. Remove charge relief valve components (these parts are not necessary).

5. Replace with the hex plug provided and torque to 41 Nm (30 lbf ft).

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Variable Motor Displacement Limiters

1. Remove the tamper-resistant cap from the displacement limiter. Measure and note the length of the adjustment screw up to the seal lock nut. Using a 19 mm hex wrench, loosen the seal lock nut and remove the nut. Remove the limiter screw from the motor housing with a 6 mm internal hex wrench.

2. Install the limiter screw with the noted length between adjustment screw and the seal lock nut. Do not install a new tamper-resistant cap until the limiter has been adjusted.

3. Final adjustment of the displacement limiters should be performed on a test stand.

   Do not turn the limiter screws counterclockwise beyond their initial adjustment positions.

Caution
Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The seal lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

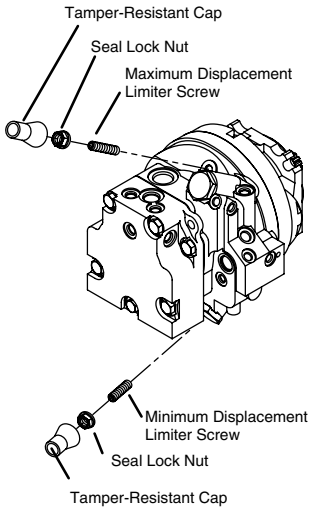
S000026E

One full turn of the displacement limiter adjustment screw will change the displacement as follows:

Frame Size	Approx Change in Disp per Rev of Adjusting Screw
055	5.6 cm^3 / Rev (0.34 in^3 / Rev)
075	7.1 cm^3 / Rev (0.43 in^3 / Rev)

T002 295E

4. Following the final adjustment, install new tamper resistant caps.

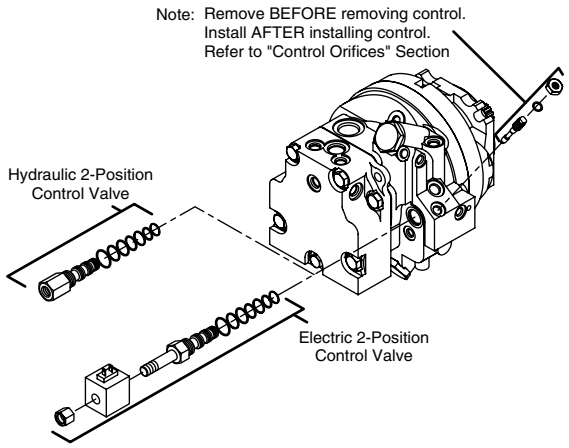


90000851E

MV Displacement Limiters

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Variable Motor Controls

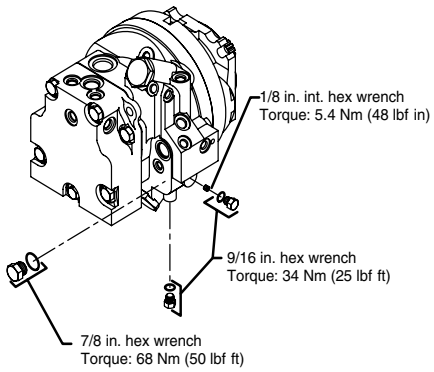


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MV Control components

Electrohydraulic 2-Position Control (Types NA, NB, NC, and ND)

1. Thoroughly clean external surfaces prior to removal of the control.
2. Disconnect the external electrical signal connection.
3. Remove the hex nut and solenoid from the control valve.
4. Remove the orifice check valve for the maximum angle control cylinder, if equipped.
5. Remove the control valve from the motor housing.
6. Remove O-rings from the valve.
7. Install new O-rings on the control valve.
8. Install the valve into the motor housing and torque to 47 Nm (35 lbf ft). **Do not overtorque the control valve.** Over-torquing may result in the valve spool sticking.
9. Install the solenoid onto the valve and torque the hex nut to 5 Nm (44 lbf in). **Do not overtorque the nut.**
10. If previously removed, reinstall the orifice check valve. Reconnect the external signal connection.



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MV Control Plugs

Hydraulic 2-Position Control (Type PT)

Follow the steps above, except that in step 2 a hydraulic signal line will be disconnected, and steps 3 and 9 are not applicable.

Control Plugs

Remove the control plugs from the housings of earlier production motors, if necessary. Install new O-rings, reinstall, and torque.

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Variable Motor Control Orifices

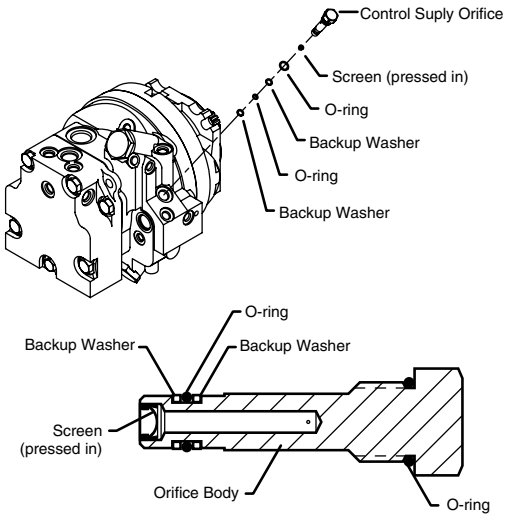
Control Supply Orifice

1. Remove the control supply orifice from the motor housing with an 1-1/16 inch hex wrench.

2. Remove the O-rings and the backup washers. Check that the filter screen is secure in the orifice body and that the screen and the orifice are not plugged.

3. Install new backup washers and O-rings onto the orifice body. Install the orifice into the motor housing and torque to 37 Nm (27 lbf ft).

Caution
Do not interchange the control supply orifice with the minimum displacement orifice (next section).
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Cross-section View of Control Supply Orifice Assembly

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MV Control Supply Orifice

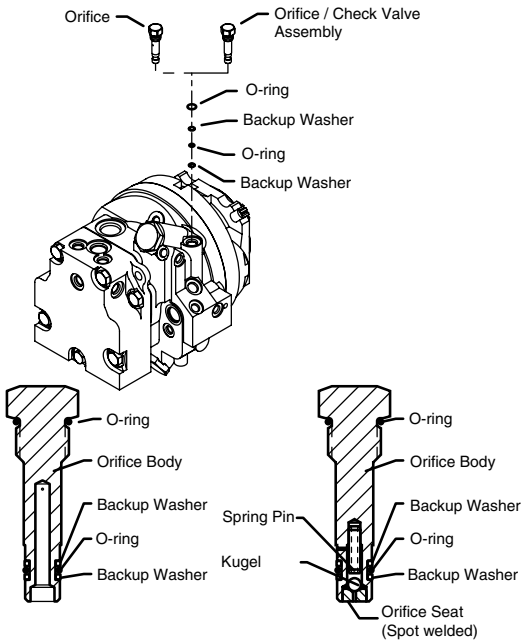
Minimum Displacement Cylinder Orifice or Orifice Check Valve

1. Remove the minimum displacement cylinder drain orifice or the orifice check valve from the motor housing with an 1-1/16 inch hex wrench.

2. Remove the O-rings and the backup washers. Check that the orifice is not plugged. Check that the check valve seat is secure in the body and that the check ball is free.

3. Install new backup washers and O-rings onto the orifice body. Install the orifice into the motor housing and torque to 37 Nm (27 lbf ft).

Caution
Do not interchange the control supply orifice (previous section) with the minimum displacement orifice.
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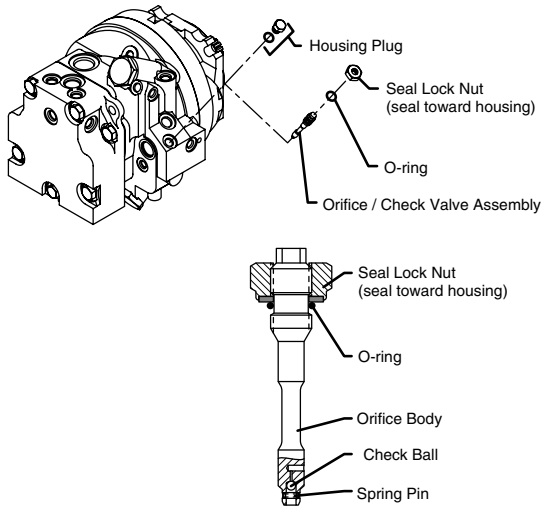
Cross-Section View of Orifice Assembly

Cross-Section View of Orifice / Check Valve Assembly

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MV Minimum Displacement Orifice

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Cross-Section View of Orifice / Check Valve Assembly

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MV Maximum Displacement Orifice

Maximum Displacement Cylinder Orifice Check Valve

1. Remove the seal lock nut with a 3/4 inch hex wrench. Remove the maximum displacement cylinder orifice check valve from the motor housing with a 1/4 inch end wrench. Remove the O-ring. The check ball in the valve must be free.

2. Reinstall the check valve and torque to 15 Nm (11 lbf ft). Install a new O-ring. Install the seal lock nut with the seal toward the motor housing.

   Hold the check valve from turning while torquing the seal lock nut to 34 Nm (25 lbf•ft).

3. If no orifice check valve is installed, the housing plug may be removed with a 9/16 inch hex wrench. Always install a new O-ring. Reinstall the plug and torque to 20 Nm (15 lbf ft).

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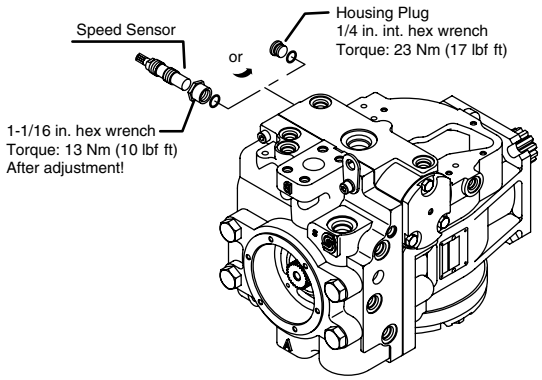
Speed Sensor

1. Remove the speed sensor by disconnecting the electrical connector, loosening the lock nut, and unscrewing the speed sensor from the pump or motor housing.

2. Always install a new O-ring before installing the sensor.

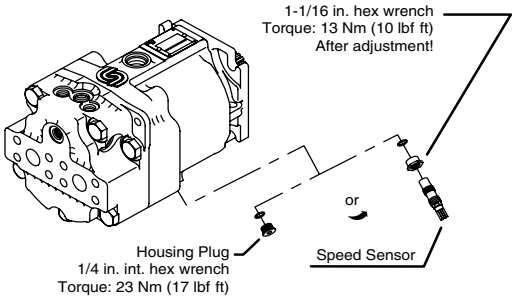
3. Reinstall the speed sensor (with lock nut and O-ring) into the housing. Adjust the gap between the sensor and the magnetic speed ring as instructed in Section "Speed Sensor Adjustment" and torque the sensor lock nut.

4. If a speed sensor is not installed, the housing plug should be torqued as indicated in the accompanying figure.



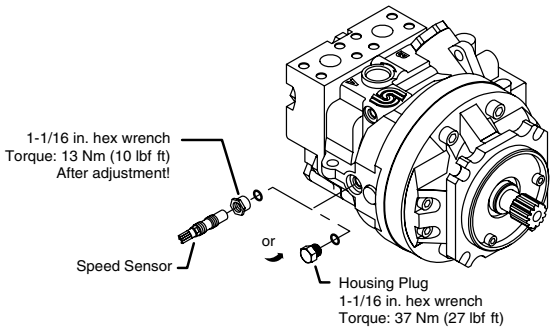
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Typical Location of Speed Sensor - PV



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Typical Location of Speed Sensor - MF



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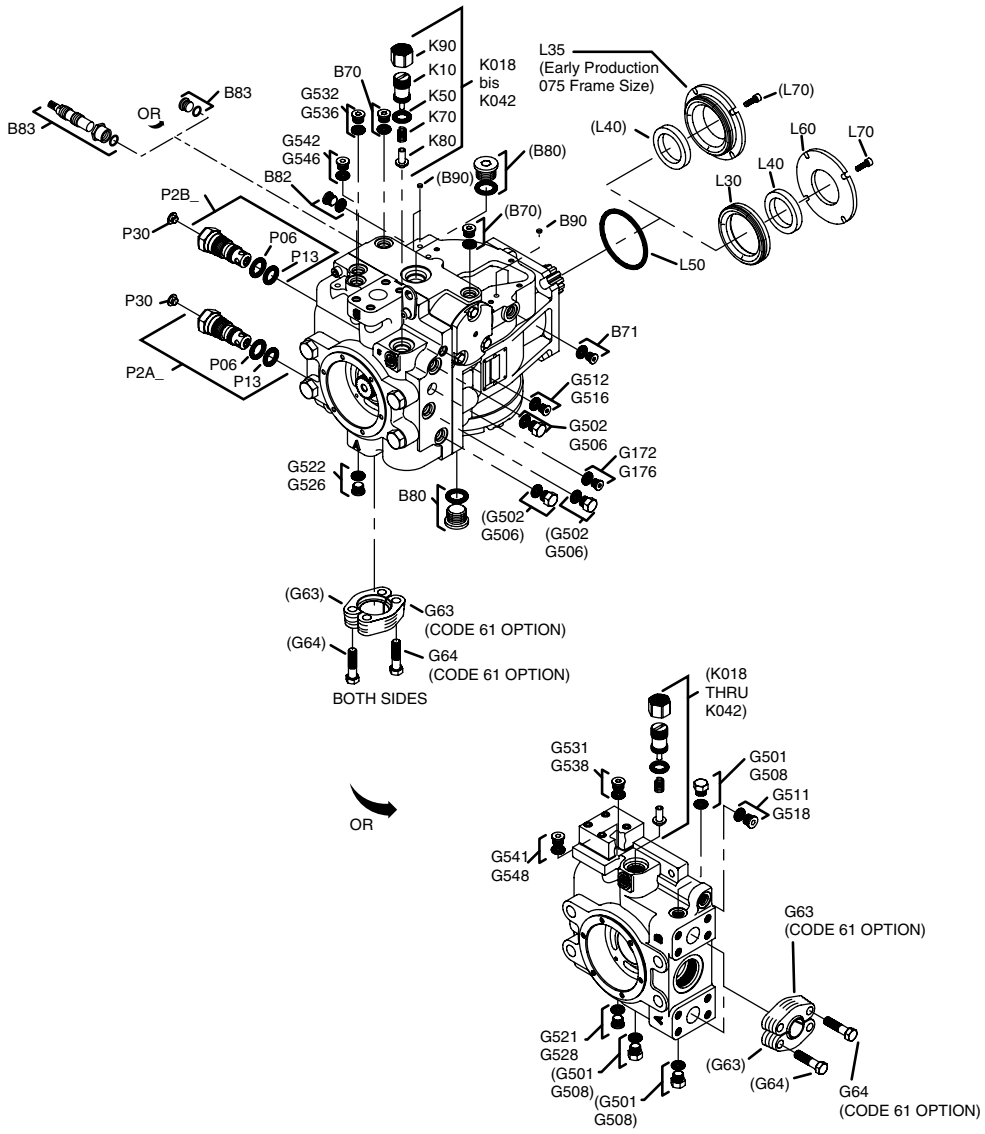
Typical Location of Speed Sensor - MV

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Exploded View Parts Drawings / Parts Lists

Variable Pumps

Minor Repair Parts



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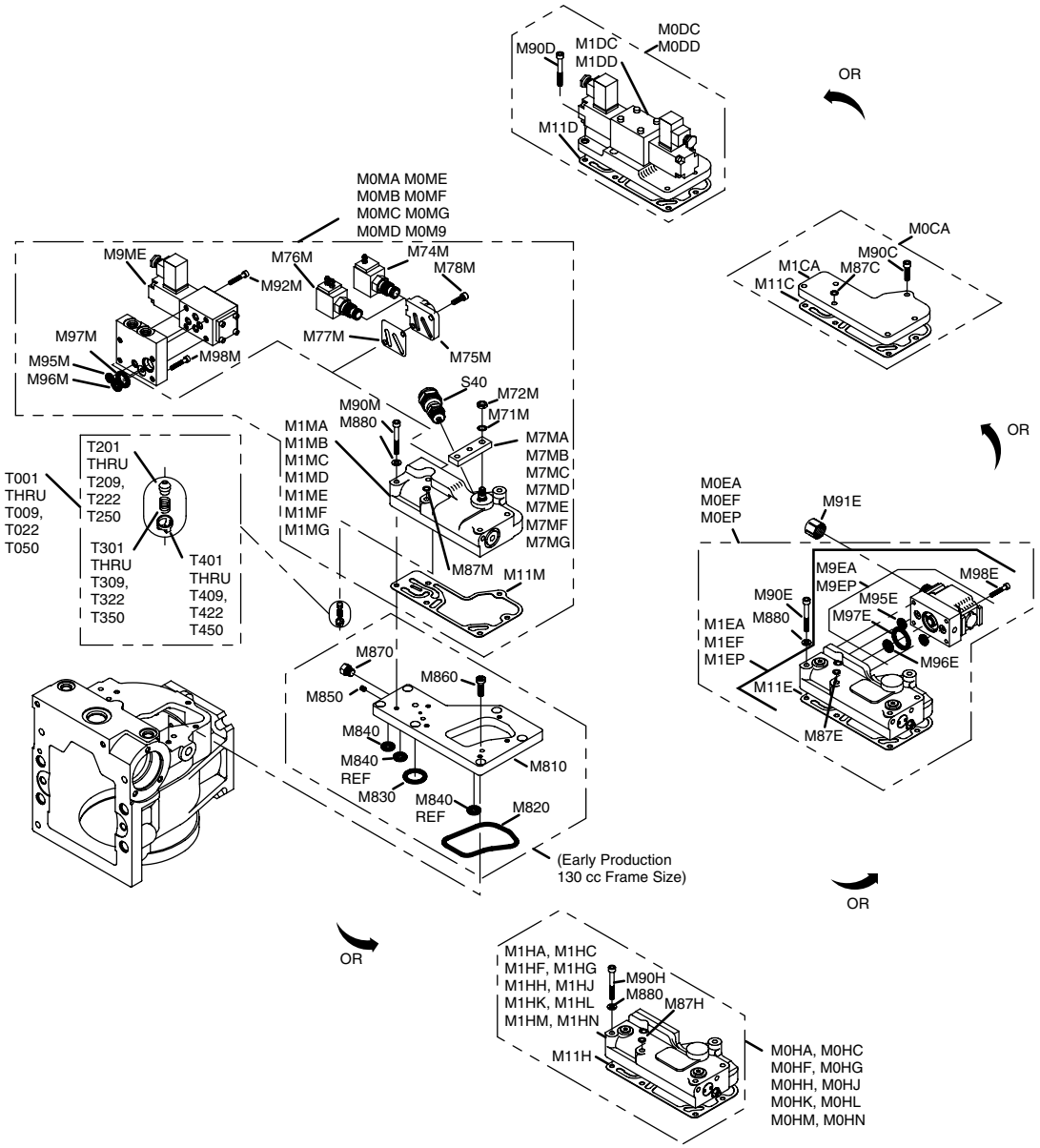
https://truckmanualshub.com/

Parts List

Item	Description	Qty
B70	Plug	2
B71	Plug	1
B80	Plug	1
B82	Plug	1
B90	Filter screen	3
G63	Split flange clamp	4
G64	Plug	4
G172	Plug	1
G176	O-ring	1
G501	Plug	3
G502	Plug	3
G506	O-ring	3
G508	O-ring	3
G511	Plug	1
G512	Plug	1
G516	O-ring	1
G518	O-ring	1
G521	Plug	1
G522	Plug	1
G526	O-ring	1
G528	O-ring	1
G531	Plug	1
G532	Plug	1
G536	O-ring	1
G538	O-ring	1
G541	Plug	1
G542	Plug	1
G546	O-ring	1
G548	O-ring	1
K10	Plug assembly	1
K50	O-ring	1
K70	Spring	1
K80	Poppet	1
K90	Nut	1
L30	Seal carrier	1
L35	Seal carrier	1
L40	Lip seal	1
L50	O-ring	1
L60	Retainer	1
L70	Screw	3
L8	Key	1
L9	Slotted nut	1

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Variable Pump Controls



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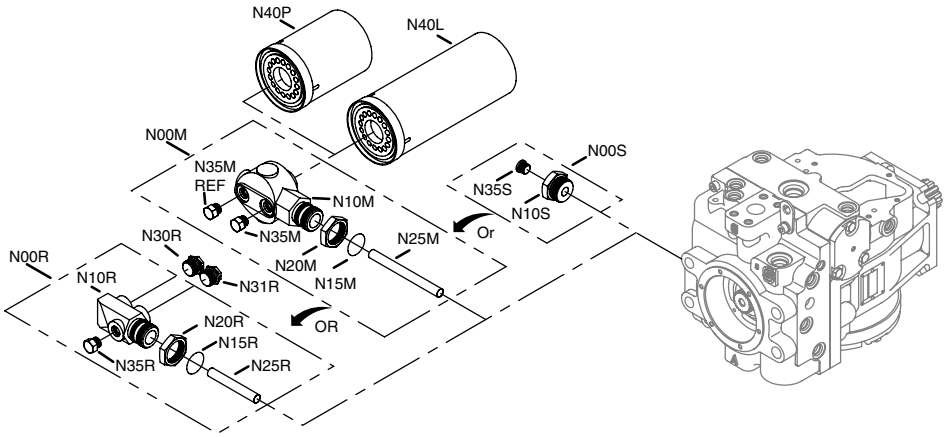
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Control Parts List

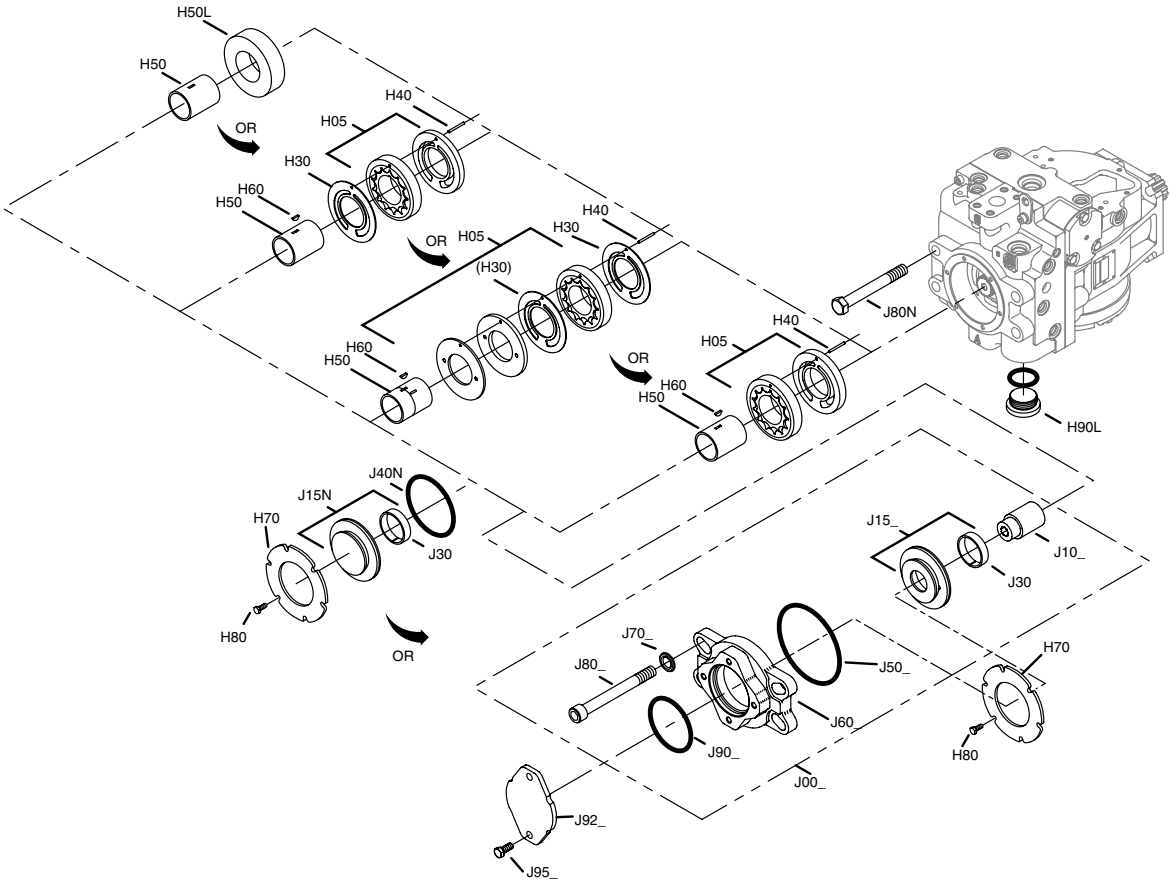
Item	Description	Qty
M0CA	Cover plate kit	1
M1CA	Cover plate	1
M11C	Control gasket	1
M11D	Control gasket	1
M87C	Washer, seal (042)	1
M90C	Screw	6
M0DC	Control kit, 3-position FNR 12V	1
M0DD	Control kit, 3-position FNR 24V	1
M1DC	Control, 3-position FNR 12V	1
M1DD	Control, 3-position FNR 24V	1
M80	Control gasket	1
M87D	Washer, seal (042)	1
M90D	Screw	6
M0EA	Control kit, EDC with MS connector	1
M0EP	Control kit, EDC with Packard connector	1
M1EA	Control, EDC with MS-connector	1
M1EP	Control, EDC with Packard-connector	1
M9EA	PCP type 3 oil filled (MS)	1
M9EA	PCP type 3 oil filled (Packard)	1
M80	Control gasket	1
M87E	Washer, seal (042)	1
M90E	Screw	6
M91E	Plastic cap (MS)	1
M95E	O-ring	2
M96E	O-ring	1
M97E	O-ring	1
M98E	Screw	4
M1MA	Servovalve kit	1
M0HA	Control kit, hydraulic, HDC	1
M0HC	Control kit, hydraulic, HDC	1
M1HA	Control, hydraulic, HDC	1
M1HC	Control, hydraulic, HDC	1
M11H	Control gasket	1
M80	Control gasket	1
M87H	Washer, seal (042)	1
M90H	Screw	6
M0MA	Control MDC w/o neutral start switch	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
M0MB	Control MDC w/ neutral start switch	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
S40	Neutral start switch kit	1
M0MC	Control MDC w/ sol. valve	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M74M	Solenoid valve	1
M75M	Control manifold	1
M77M	Manifold gasket	1
M78M	Screw	2
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
M0MD	Control MDC w/ sol. valve and neutral start switch	1
M7M	Control handle	1
M71M	Washer	1
M72M	Nut	1
M75M	Control manifold	1
M76M	Solenoid valve	1
M77M	Manifold gasket	1
M78M	Screw	2
M80	Control gasket	1
M87M	Washer, seal (042)	1
M90M	Screw	6
S40	Neutral start switch	1
M810	Adapter plate - Control (130 cc)	1
M820	O-ring (130 cc)	1
M830	O-ring (130 cc)	1
M840	O-ring (130 cc)	2
M850	Plug (130 cc)	1
M860	Screw (130 cc)	6
M870	Plug (130 cc)	1
M9ME	4/2 Way valve	1
M92M	Screw	4
M95M	O-ring	1
M96M	O-ring	1
M97M	O-ring	1
M98M	Screw	4
T001-9	Control orifice kit	1
T201-9	Orificed check valve	1
T301-9	Spring	1
T401-9	Spring retainer	1

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Filter and Options



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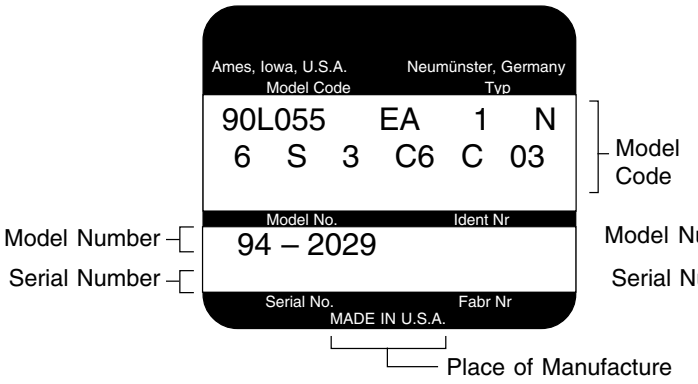
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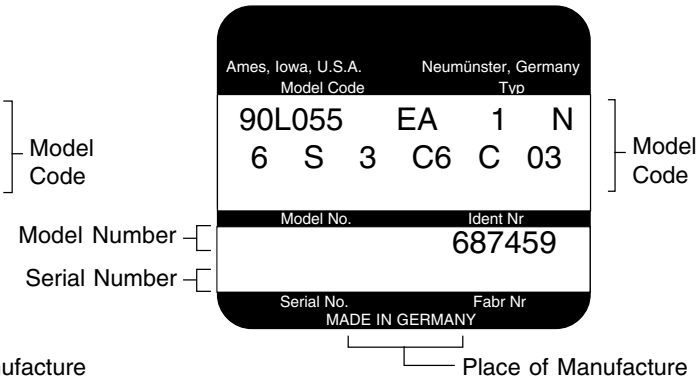
Parts List Filter and Options

Item	Description	Qty
H05B-H	Kit - Charge pump	1
H50L	Spacer (No charge pump)	1
H30	Port plate	2
H40	Pin	1
H50	Charge pump shaft	1
H60	Key	1
H70	Retaining plate	1
H80	Screw	6
H90L	Plug	1
J00A	Aux. mtg. SAE A flange	1
J00B	Aux. mtg. SAE B flange	1
J00C	Aux. mtg. SAE C flange	1
J00D	Aux. mtg. SAE D flange	1
J00T	Aux. mtg. SAE A flange (11 T)	1
J00V	Aux. mtg. SAE B-B flange	1
J00N	Aux. mtg. flange - none	1
J10A-V	Coupling	1
J15	Charge pump cover assembly	1
J15N	Charge pump cover assembly	1
J30	Bushing	1
J50A-V	O-ring	1
J60A/T	Flange adaptor SAE A	1
J60B/V	Flange adaptor SAE B	1
J60C	Flange adaptor SAE C	1
J60D	Flange adaptor SAE D	1
J70A-V	Washer	4
J80A-V	Screw	4
J80N	Screw	4
J90A-V	O-ring	1
J92A-V	Cover plate	1
J95A-V	Screw	2/4
N00M	Filtration manifold kit (Int)	1
N10M	Manifold	1
N15M	O-ring	2
N20M	Nut	1
N25M	Tube	1
N35M	Plug	2
N40L	Filter	1
N40P	Filter	1
N00R	Filtration manifold kit (Rmt)	1
N10R	Manifold	1
N15R	O-ring	1
N20R	Nut	1
N25R	Tube	1
N30R	Plastic plug	2
N35R	Plug	1
N00S	Filtration kit (Suction Flt)	1
N10S	Reducer fitting (Suction Flt)	1
N35S	Plug	1

Name Plates



Name Plate (U.S.A. Production)

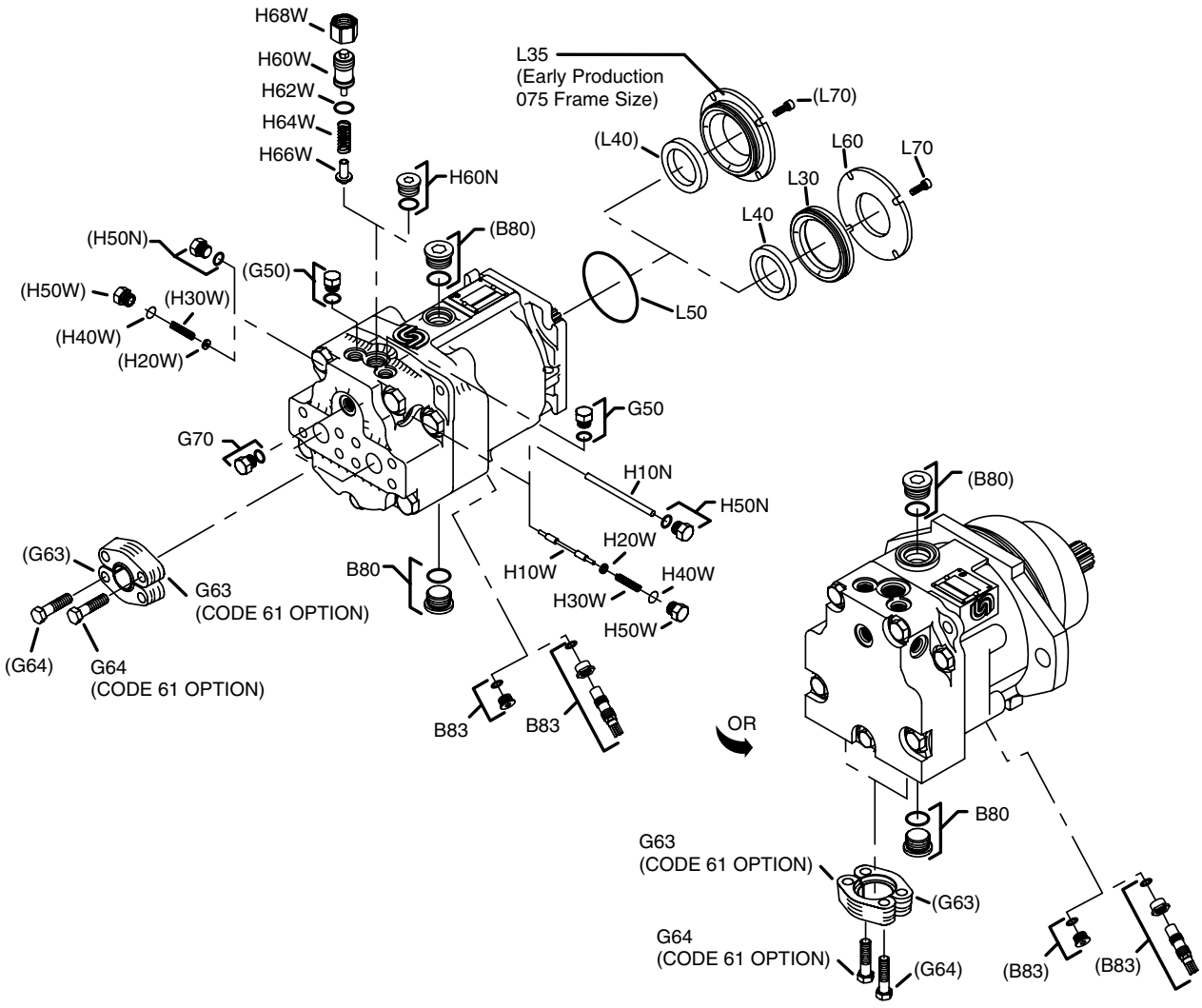


Name Plate (German Production)

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Fixed Motor

Minor Repair Parts



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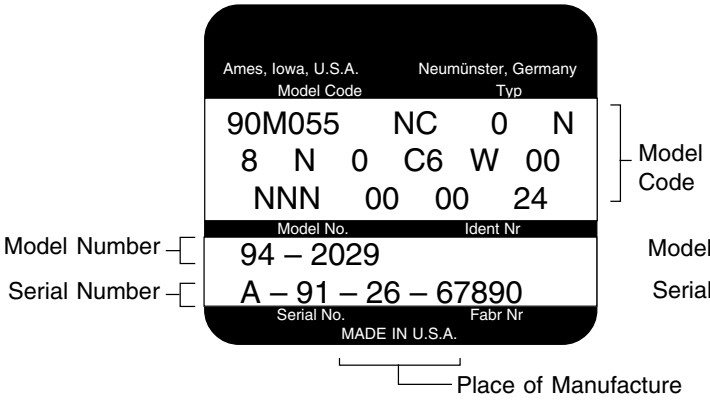
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Parts List

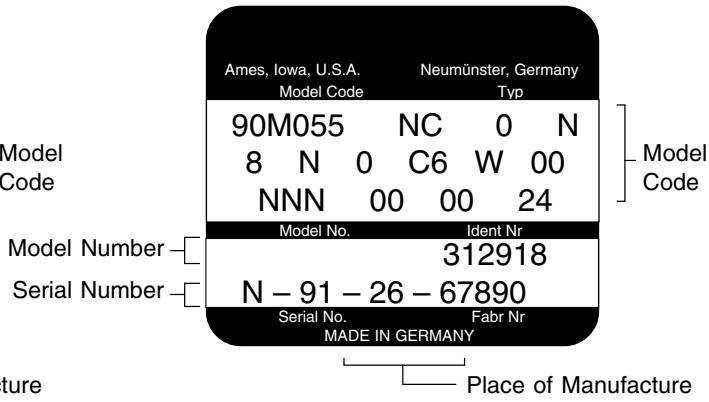
Item	Description	Qty
B80	Plug	2
B83	Plug	1
B83	Speed sensor	1
G50	Plug	2
G70	Plug	1
G63	Split flange screw	4
G64	Screw - Shipping Cover	4
H10N	Loop flushing spool - defeat	1
H50N	Plug	2
H10W	Shuttle valve spool	1
H20W	Spring guide	2
H30W	Spring	2
H40W	O-ring	2

Item	Description	Qty
H50W	Plug	2
H60W	Charge relief valve plug	1
H62W	O-ring	1
H64W	Spring	1
H66W	Charge relief poppet	1
H68W	Lock nut	1
L30	Seal carrier	1
L35	Seal carrier	1
L40	Lip seal	1
L50	O-ring	1
L60	Retainer	1
L70	Screw	3
L8	Key	1
L9	Slotted nut	1

Name Plates



Name Plate (U.S.A. Production)

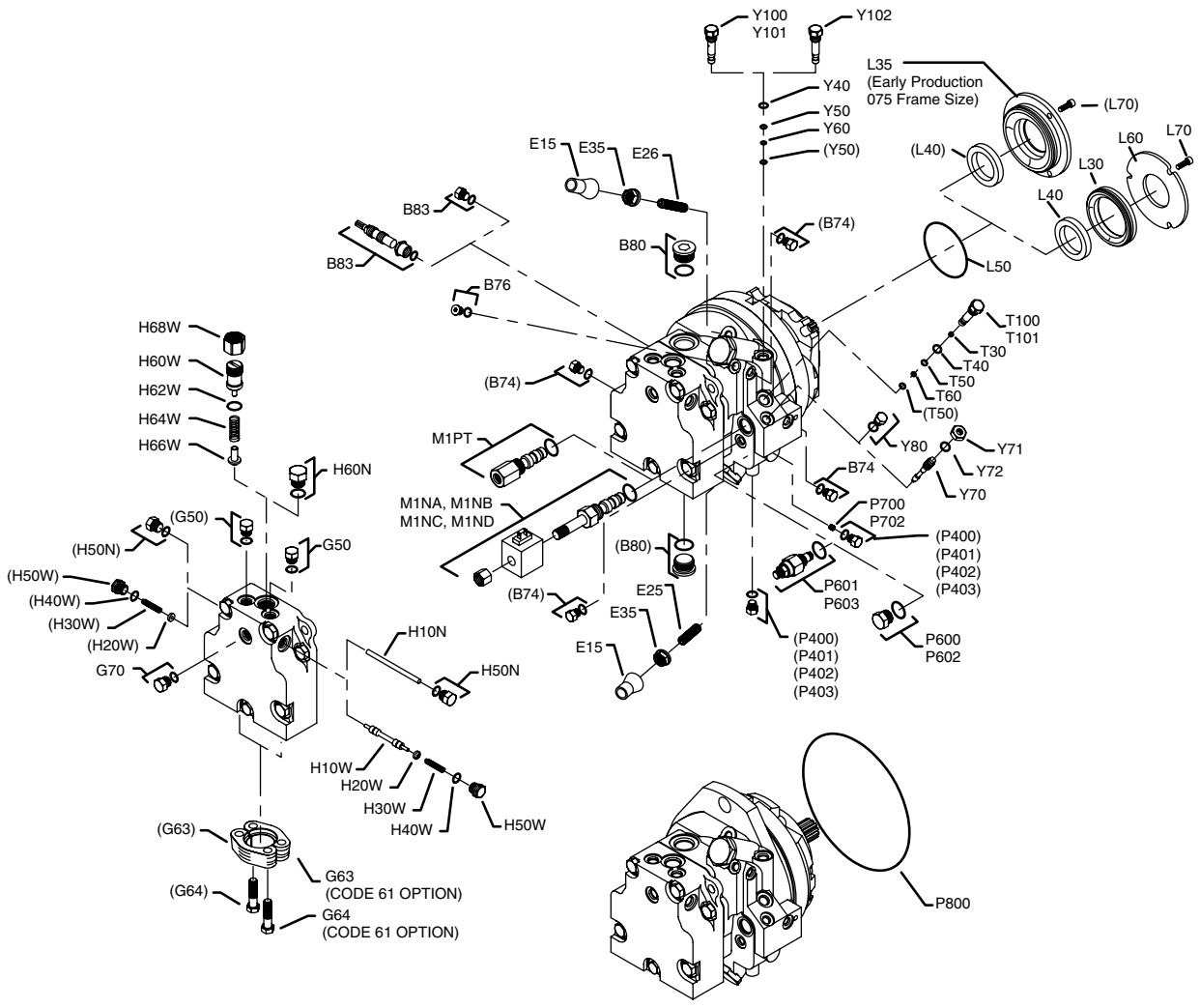


Name Plate (German Production)

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Variable Motor

Minor Repair Parts



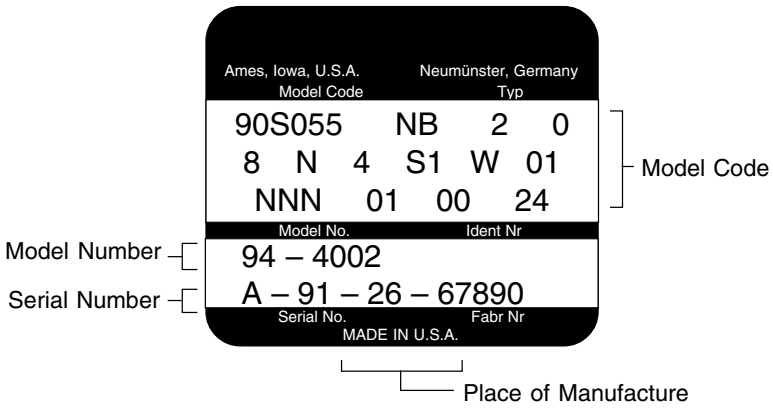
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Parts List

Item	Description	Qty
B74	Plug	4
B76	Plug	1
B80	Plug	2
B83	Plug	1
B83	Speed sensor	1
E15	Cap	1
E25	Set screw	1
E35	Nut - Seal Lock	1
G50	Plug	2
G63	Split flange clamp	4
G64	Shipping cover screw	4
G70	Plug	1
H10N	Loop flushing spool - defeat	1
H50N	Plug	2
H60N	Plug	1
H10W	Shuttle valve spool	1
H20W	Spring guide	2
H30W	Spring	2
H40W	O-ring	2
H50W	Plug	2
H60W	Charge relief valve plug	1
H62W	O-ring	1
H64W	Spring	1
H66W	Charge relief poppet	1
H68W	Lock nut	1
L8	Key	1
L9	Slotted nut	1
L30	Seal carrier	1
L35	Seal carrier	1
L40	Lip seal	1
L50	O-ring	1
L60	Retainer	1
L70	Screw	3
M1N	Control valve - electric	1
M1P	Control valve - hydraulic	1
P400	Plug	2
P600	Plug	1
P601	PCOR-Valve	1
P700	Special plug	1
P800	O-ring	1
T30	Filter screen	1
T40	O-ring	1
T50	Backup ring	2
T60	O-ring	1
T100	Orifice plug	1
Y40	O-ring	1
Y50	Backup ring	2
Y60	O-ring	1
Y70	Orifice check valve	1
Y71	Nut - Seal Lock	1
Y72	O-ring	1
Y80	Plug	1
Y100	Orifice plug	1
Y102	Orifice check valve	1

Name Plate



Name Plate (U.S.A. Production)

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SAUER DANFOSS

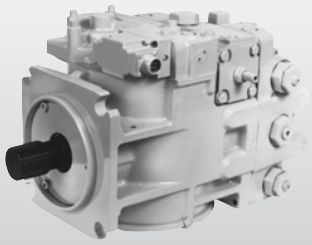
Hydraulic Power Systems

SAUER-SUNDSTRAND Hydraulic Power Systems - Market Leaders Worldwide

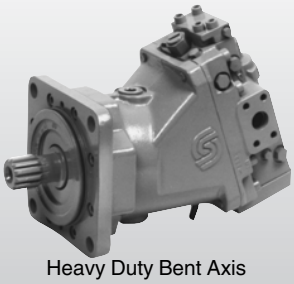
SAUER-SUNDSTRAND is a world leader in the design and manufacture of Hydraulic Power Systems. Research and development resources in both North America and Europe enable SAUER-SUNDSTRAND to offer a wide range of design solutions utilizing hydraulic power system technology.

SAUER-SUNDSTRAND specializes in integrating a full range of system components to provide vehicle designers with the most advanced total-design system.

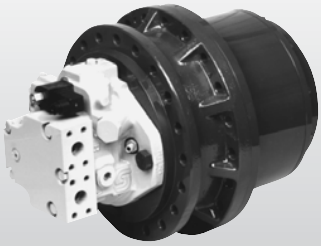
SAUER-SUNDSTRAND is Your World Source for Controlled Hydraulic Power Systems



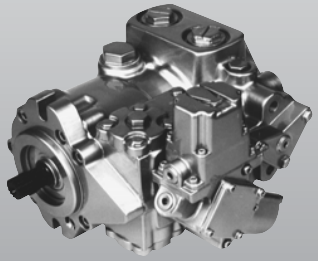
Heavy Duty Axial Piston Pumps and Motors



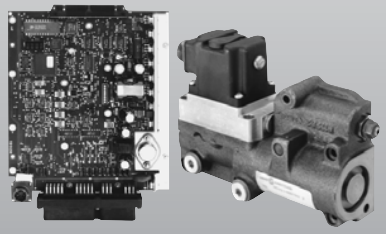
Heavy Duty Bent Axis Variable Motors



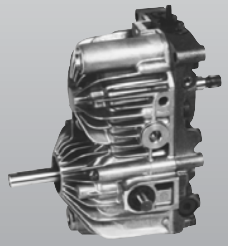
Cartridge Motors/ Compact Wheel Drives



Medium Duty Axial Piston Pumps and Motors



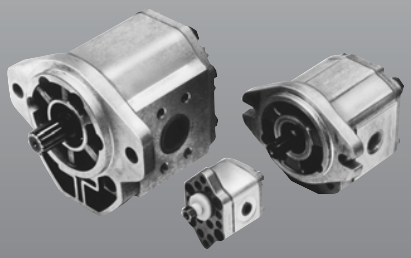
Microcontrollers and Electrohydraulic Controls



Hydrostatc Transmission Packages



Open Circuit Axial Piston Pumps



Gear Pumps and Motors



Genuine Service Parts

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SAUER SUNDSTRAND

Series 51





Bent Axis

Variable Motors

Service Manual

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Bent Axis Variable Displacement Motors Series 51

General Description

Series 51 Variable Displacement Motors are bent axis design units, incorporating spherical pistons.

These motors are designed primarily to be combined with other products in closed circuit systems to transfer and control hydraulic power.

Series 51 Motors have a large maximum / minimum displacement ratio (5 to 1) and high output speed capabilities. SAE flange and cartridge motor configurations are available.

A complete family of controls and regulators is available to fulfill the requirements of a wide range of applications.

Motors equipped with controls normally start at maximum displacement. This provides maximum starting torque (high acceleration).

The controls may utilize externally or internally supplied servo pressure. They may be overridden by a pressure compensator which functions when the motor is operating in motor and pump modes. A defeat option is available to disable the pressure compensator override when the motor is running in pump mode.

The pressure compensator option features a low pressure rise (short ramp) to provide optimal power utilization throughout the entire displacement range of the motor. The pressure compensator is also available as a stand-alone regulator.

- **The Series 51 - Advanced Technology Today**
- **The Most Technically Advanced Hydraulic Units in the Industry**
- **SAE Flange and Cartridge Motors**
- **Cartridge Motors designed for Direct Installation in Compact Planetary Drives**
- **Large Displacement Ratio (5:1)**
- **Complete Family of Control Systems**
- **Proven Reliability and Performance**
- **Optimum Product Configurations**
- **Compact, Lightweight**

Front page: Option - hydraulic two-position control

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Bent Axis Variable Displacement Motors Series 51

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Introduction

The purpose of this manual is to provide information necessary for the normal servicing of the Series 51 family of variable displacement hydrostatic motors.

This manual includes unit and component description, troubleshooting, adjustments, and minor repair procedures. By following the procedures in this manual, inspections and minor repairs may be performed without affecting the unit warranty.

A Series 51 motor does occasionally require servicing, and these units are designed to meet this requirement.

Many repairs or adjustments can be completed without removing the unit from the vehicle or machine, provided the unit is accessible and can be thoroughly cleaned before beginning any procedures.

Dirt or contamination is the greatest enemy of any type of hydraulic equipment. The greatest possible cleanliness is necessary when starting up the system, changing filters, or performing any other service procedure.

For Technical Information on Series 51 motors, refer to publication BLN-10042 or 368753.

For Fluid Quality Requirements, refer to publication BLN-9987 or 697581.

Sauer-Sundstrand provides a complete repair service for its products. Contact any Sauer-Sundstrand Authorized Service Center for details. Sauer-Sundstrand Authorized Service Center locations are listed in publication BLN-2-40527 or 698266.

Basic Hydraulic Circuits

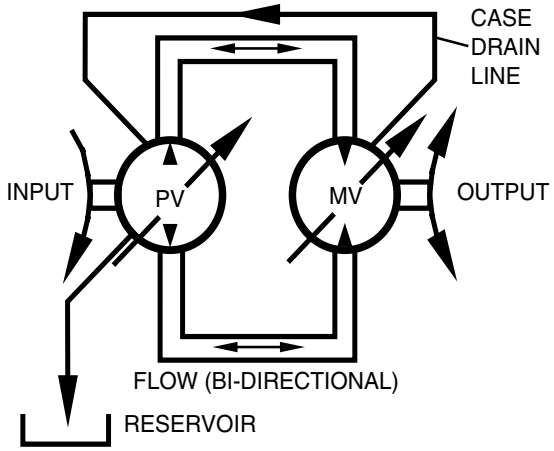


Fig. 0-1 - Basic Closed Circuit

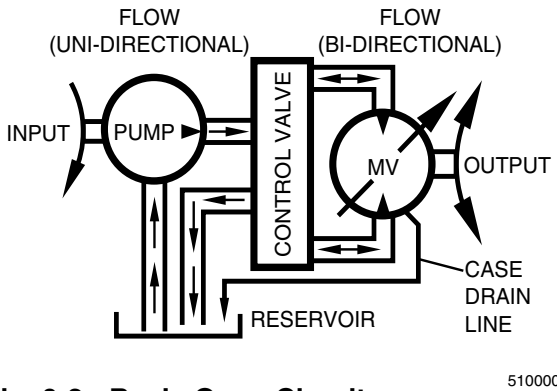


Fig. 0-2 - Basic Open Circuit

Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows in either direction from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. The direction and speed of fluid flow (and the motor output shaft rotation) depends on the position of the pump swashplate. The system pressure is determined by the machine load.

Open Circuit

The outlet port of the pump is connected by a hydraulic line to a directional control valve. The working ports of this valve are connected to the main ports of the motor. When the valve is actuated, fluid flows first from the pump to the valve. The valve then directs the fluid to the motor in either direction. The direction of fluid flow (and motor output shaft rotation) depends on the direction the control valve is shifted. The speed of fluid flow (and motor output shaft speed) depends on pump output volume and the distance the control valve is shifted. The system pressure is determined by the machine load.

Fluid returning from the motor is routed through the control valve to the reservoir. Additional components may be necessary to provide dynamic braking and to deal with over-running loads.

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General Description of the Series 51 Variable Displacement Motors

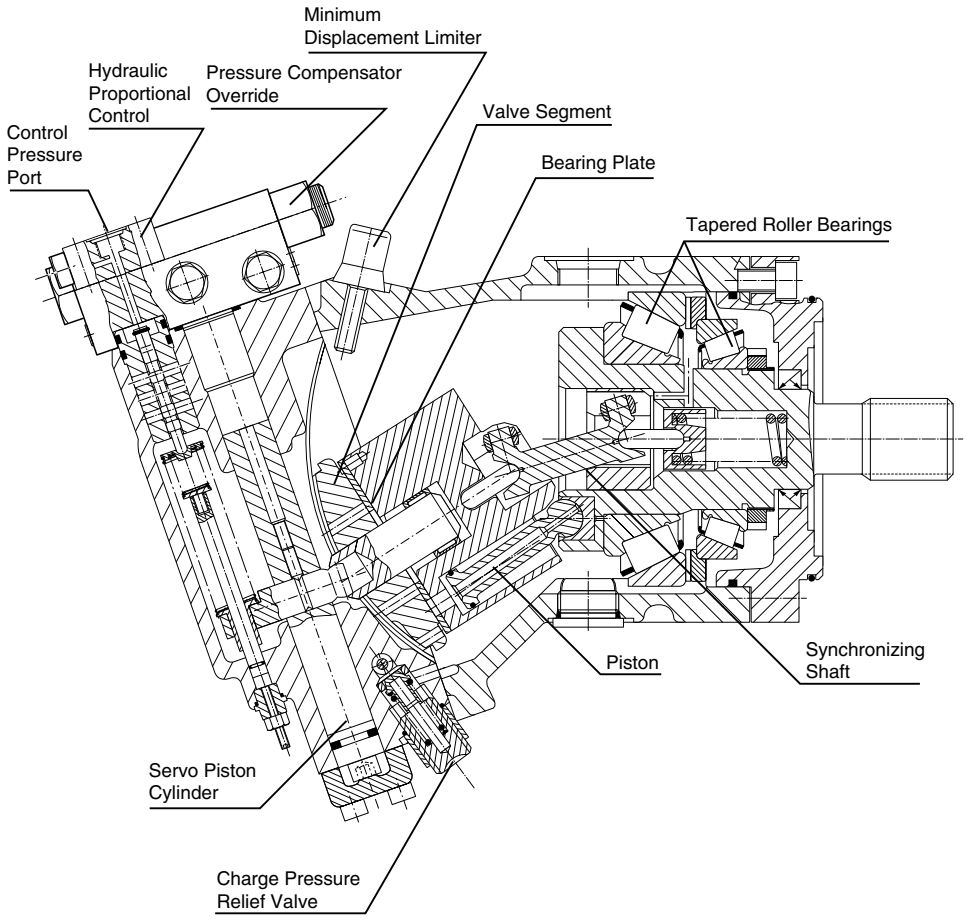
The Series 51 variable displacement hydraulic motors use spherical pistons and piston rings. The angle between the cylinder block and the output shaft can be set between 32° and 6°, providing a 5 to 1 maximum to minimum displacement ratio.

At maximum displacement, the motor will provide a certain maximum output shaft torque and minimum speed corresponding to the pressure and flow supplied to the motor. Under the same input conditions but at minimum displacement, the shaft speed will be approximately five (5) times faster while the available output torque will decrease to approximately one-fifth (1/5) the full displacement value. The displacement is changed by a servo piston which is connected to the valve segment.

Various hydraulic and electrohydraulic controls may be mounted on the motor end cap to control the servo piston and the motor displacement. Servo pressure oil may either be supplied internally from the motor, or externally.

For all controls except the N2 and PC, servo pressure oil is supplied to a four (4) way spool valve in the motor end cap. When a combination of pilot pressure (or force) from an external control assembly and internal spring force shifts this valve, servo pressure is routed to move the servo piston and change the motor's displacement.

A synchronizing shaft, with spherical rollers, synchronizes the rotation of the output shaft and the cylinder block. The ball end of each piston runs in a socket bushing, pressed into the output shaft. There are no other parts used to connect the pistons to the shaft. Two tapered roller bearings support the output shaft.



P001 196

Fig. 10-1 - Sectional view of Series 51 variable displacement motor (SAE Flange Configuration) with Hydraulic Proportional Control

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Functional Description



51000003

Fig. 10-2 - Loop Flushing Components



51000004

Fig. 10-3 - Loop Flushing Defeat Components

Loop Flushing

Series 51 motors used in closed circuit applications incorporate an integral loop flushing valve as standard equipment. Installations that require additional fluid to be removed from the main hydraulic circuit because of fluid cooling requirements, or circuits requiring the removal of excessive contamination from the high pressure circuit, can benefit from loop flushing. Series 51 motors used in open circuit applications may have the optional loop flushing defeat components installed.

Series 51 motors equipped with an integral loop flushing valve also include a charge pressure relief valve. The setting of the motor charge relief valve affects the function of the flushing circuit. Higher motor charge relief settings reduce the loop flushing flow and increase the flow over the pump charge pressure relief valve when the circuit is operating. Lower motor charge relief settings increase the loop flushing flow and may increase the motor case pressure when the circuit is operating.

An appropriate combination of pump and motor charge pressure settings should be maintained to insure the proper function of the loop flushing circuit. Correct charge pressure must be maintained under all conditions of operation to maintain pump control performance in closed loop systems.

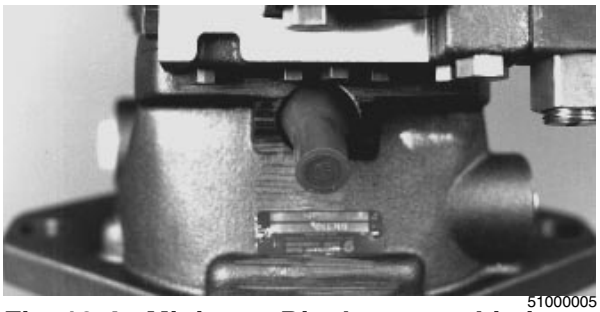
NOTE: An optional orifice may be installed between the motor charge relief and the motor case to limit the maximum flushing oil flow.

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Functional Description (Continued)

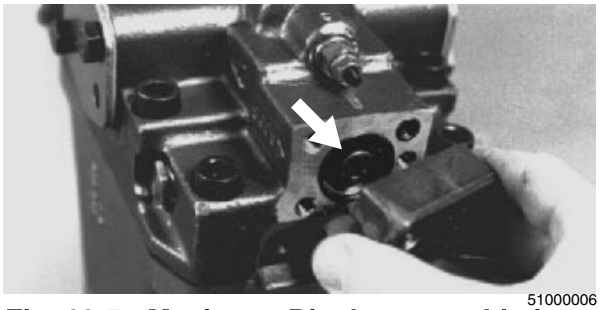
Displacement Limiters

All Series 51 motors incorporate mechanical displacement limiters. The minimum displacement of the motor can be limited within the standard range by a set screw in the motor housing. The maximum displacement can be limited with spacers installed on the servo piston.



51000005

Fig. 10-4 - Minimum Displacement Limiter with Tamper Resistant Cap (Cartridge Motor Configuration Shown)



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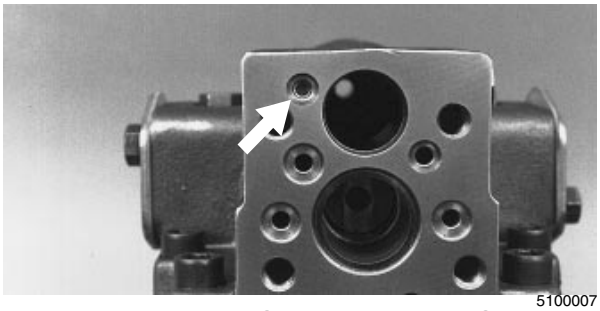
Fig. 10-5 - Maximum Displacement Limiter Screw

Controls - General

A wide range of control options is available for the Series 51 motors. These include pilot operated Electrohydraulic 2-Position Controls, Hydraulic Proportional Controls (single or two [2] connection), and Electrohydraulic Proportional Controls. A directly operated Hydraulic 2-Position Control and a Pressure Compensator regulator are also available.

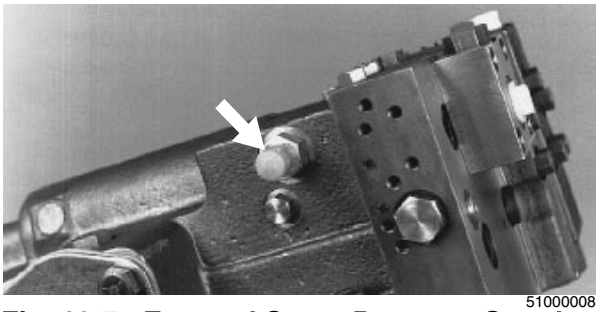
The Series 51 variable motor servo piston (except when equipped with N2 control or the PC regulator) may be operated either by servo pressure oil supplied internally from the main ports of the motor, or by servo pressure oil supplied from an external source. (The N2 control uses servo pressure supplied by an external control valve. The PC regulator obtains servo pressure from the main ports of the motor.)

Orifice plugs are installed in the control spool sleeve in the end cap to regulate the flow of oil from the servo piston to the motor housing. Orifice plugs may be installed in the end cap to regulate the flow of servo pressure supply oil to the control valve, and to regulate the flow of oil from the control valve to the servo piston.



5100007

Fig. 10-6 - Internal Servo Pressure Supply Screen with Multi-function Block and/or Control Removed (Plug for External Supply)

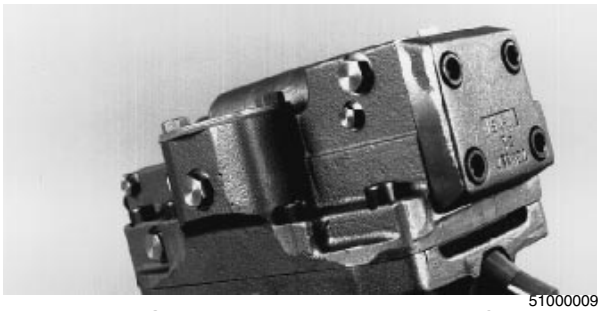


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Fig. 10-7 - External Servo Pressure Supply Fitting (Plug for Internal Supply)

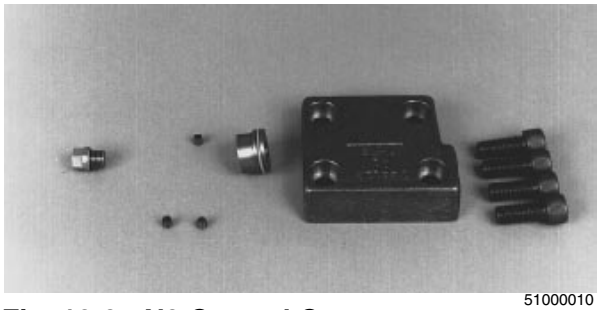
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Functional Description (Continued)



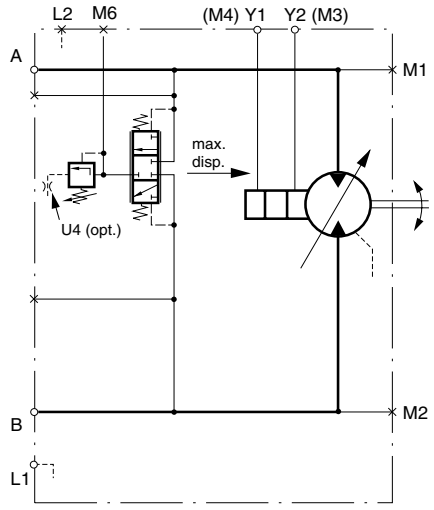
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Fig. 10-8 - Series 51 Motor with N2 Control



51000010

Fig. 10-9 - N2 Control Components



51000011

Fig. 10-10 - N2 Control Schematic

Hydraulic 2-Position Control (Type N2)

This is a two (2) position (maximum - minimum displacement) control, consisting of a cover plate mounted on the end cap. An external control valve supplies servo pressure from an external source directly to the servo piston. PCOR is not available with the N2 control.

When servo pressure is supplied to port “Y1,” the setting piston moves to the maximum motor displacement position. When servo pressure is supplied to port “Y2,” the setting piston moves to the minimum motor displacement position.

Orifices may be installed in the external control valve or its connections to regulate the speed of servo piston movement.

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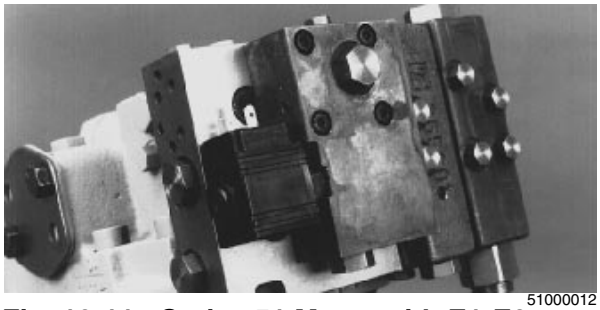
Functional Description (Continued)

Electrohydraulic 2-Position Control (Types E1•E2 and F1•F2)

A 12 or 24 VDC solenoid valve, mounted on the multi-function block, connects the end of the control valve spool in the end cap with pilot pressure (provided by the shuttle spool in the multi-function block) or with the motor case. The control valve in the end cap is biased by a threshold spring, and controls oil flow to the ends of the servo piston. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with these controls.

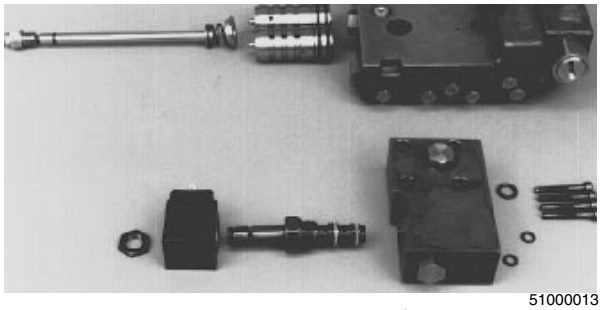
With the E1 and E2 controls, energizing the solenoid will cause the motor to shift to minimum displacement. When the solenoid is not energized, the motor is held at maximum displacement.

With the F1 and F2 controls, energizing the solenoid causes the motor to shift to maximum displacement. When the solenoid is not energized, the motor is held at minimum displacement.



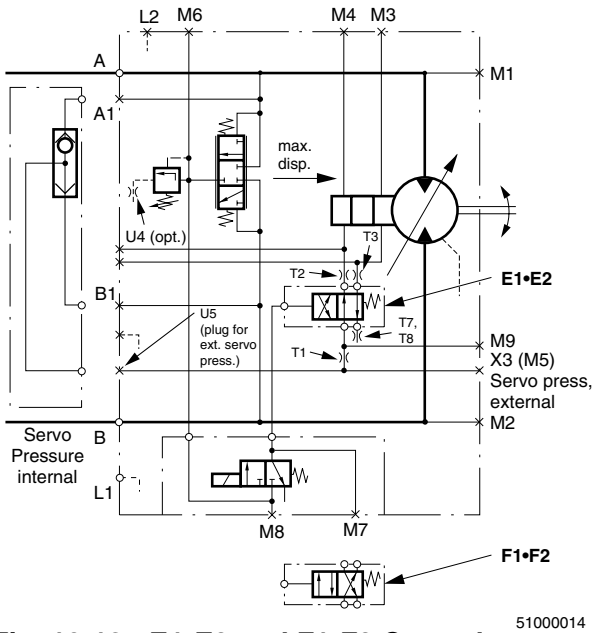
51000012

Fig. 10-11 - Series 51 Motor with E1•E2 or F1•F2 Control



51000013

Fig. 10-12 - E1•E2 and F1•F2 Control Components

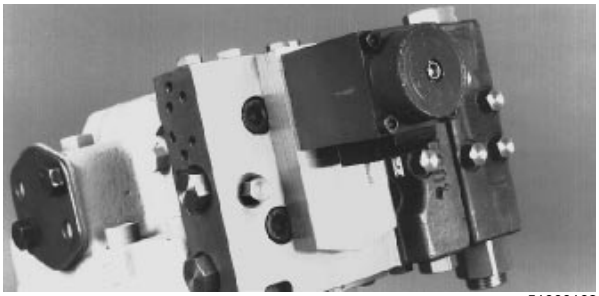


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Fig. 10-13 - E1•E2 and F1•F2 Control Schematic

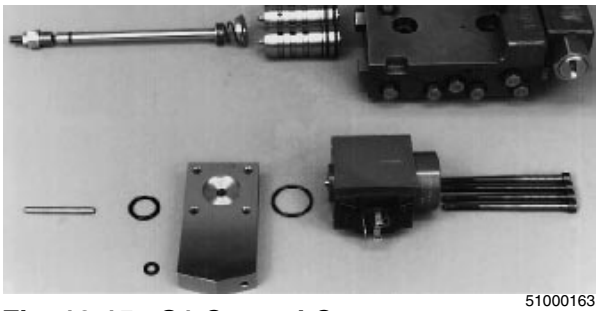
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Functional Description (Continued)



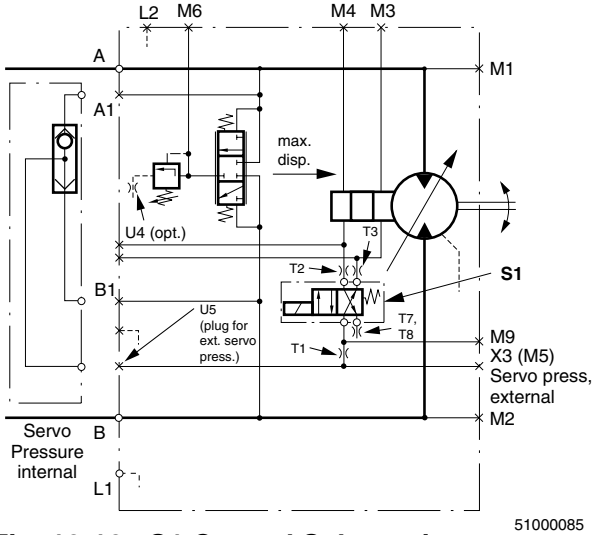
51000162

Fig. 10-14 - Series 51 Motor with S1 Control



51000163

Fig. 10-15 - S1 Control Components



51000085

Fig. 10-16 - S1 Control Schematic

Electric 2-Position Control (Type S1)

A 12 VDC solenoid valve, mounted on the multi-function block, directly operates the control valve spool in the end cap. The control valve in the end cap is biased by a threshold spring, and controls oil flow to the ends of the servo piston. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

With the S1 control, energizing the solenoid causes the motor to shift to maximum displacement. When the solenoid is not energized, the motor is held at minimum displacement.

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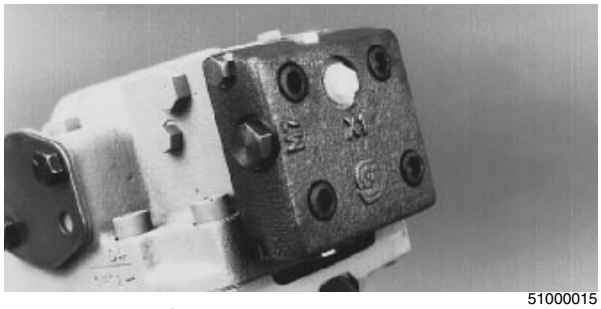
Functional Description (Continued)

Hydraulic Proportional Control (Type HZ)

The HZ control consists of a cover plate mounted directly on the end cap. A ball type shuttle valve provides internal servo pressure supply to the control valve in the end cap. PCOR is not available with the HZ control.

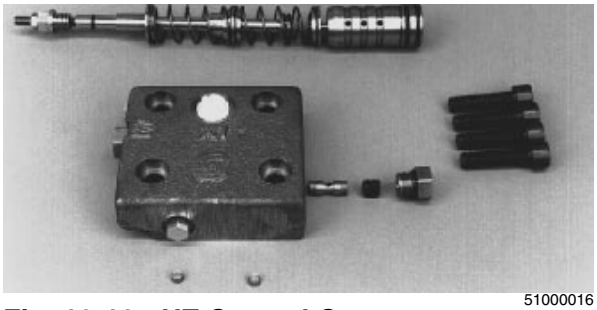
Feedback springs (single spring for 060, 080 and 110) and a threshold spring are installed in the end cap. The feedback springs and threshold spring provide a force on the end of the control spool. The force of the threshold spring is externally adjustable with an adjusting screw. The feedback spring is positioned between the control spool and a feedback lug attached to the servo piston. The force of the feedback spring increases as the motor's displacement decreases.

Pilot oil pressure from an external source is applied to the end of the control spool opposite the feedback and threshold springs. An increase in pilot pressure (above the threshold pressure and within the modulating pressure range) will result in a decrease in motor displacement, while a decrease in pilot pressure will result in an increase in motor displacement.



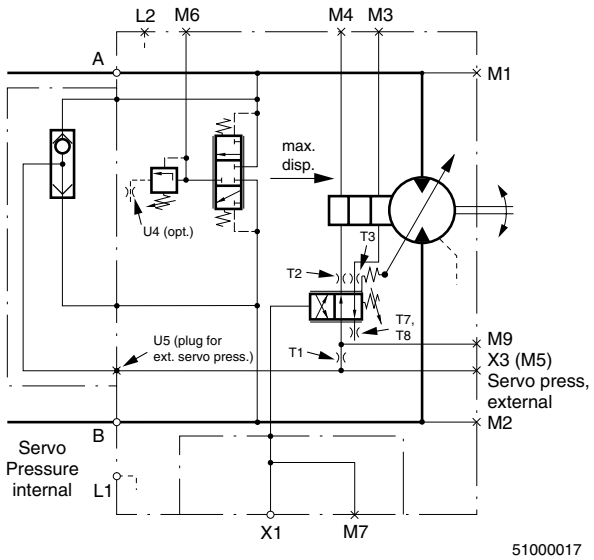
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Fig. 10-17 - Series 51 Motor with HZ Control



51000016

Fig. 10-18 - HZ Control Components

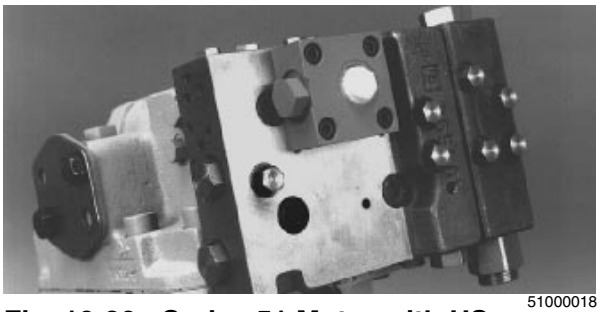


51000017

Fig. 10-19 - HZ Control Schematic

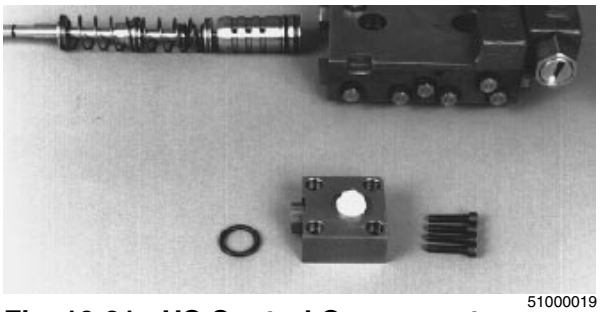
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Functional Description (Continued)



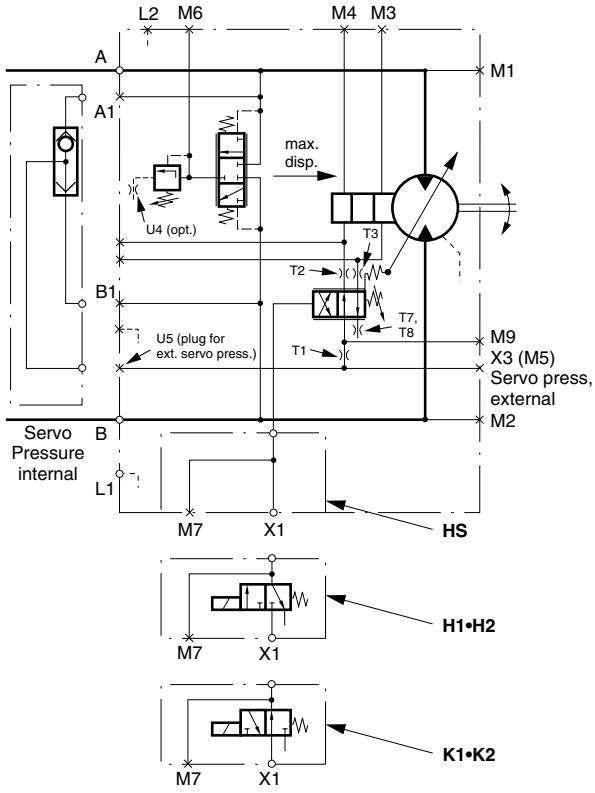
51000018

Fig. 10-20 - Series 51 Motor with HS Control



51000019

Fig. 10-21 - HS Control Components



51000022

Fig. 10-22 - HS, H1•H2, and K1•K2 Control Schematic

Hydraulic Proportional Control (Type HS)

The HS control consists of a cover plate (with a hydraulic port) mounted on the multi-function block. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

The function of the HS control is identical to the function of the HZ control.

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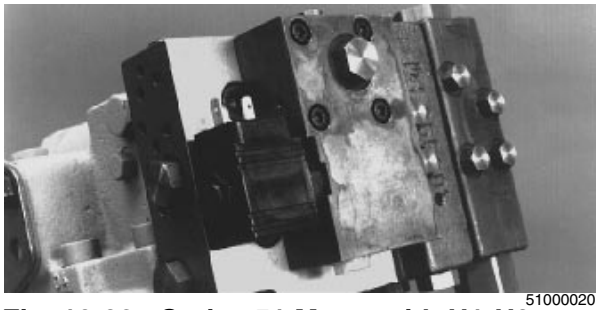
Functional Description (Continued)

Hydraulic Proportional Control with Electric Override (Types H1•H2 and K1•K2)

The function of the H1•H2 and K1•K2 controls is similar to the function of the HS control. A 12 or 24 VDC solenoid valve is installed between the external pilot pressure source and the control spool.

With the H1•H2 controls, energizing the solenoid allows the control to function as an HS control. When the solenoid is not energized, pilot pressure is blocked and the end of the control spool is drained to the motor case, causing the motor to shift to maximum displacement.

With the K1•K2 controls, energizing the solenoid blocks pilot pressure and drains the end of the control spool to the motor case, causing the motor to shift to maximum displacement. When the solenoid is not energized, the control functions as an HS control.



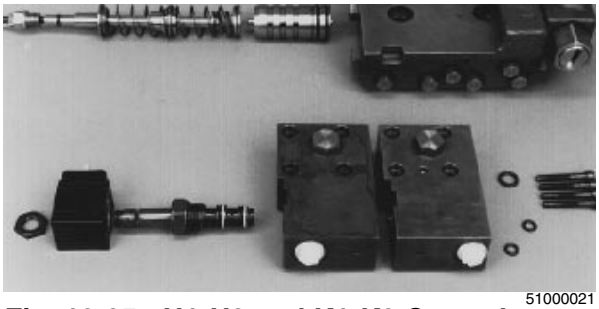
51000020

Fig. 10-23 - Series 51 Motor with H1•H2 Control



51000167

Fig. 10-24 - Series 51 Motor with K1•K2 Control

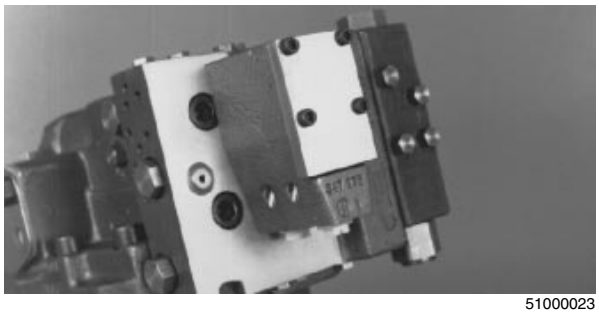


51000021

Fig. 10-25 - H1•H2 and K1•K2 Control Components

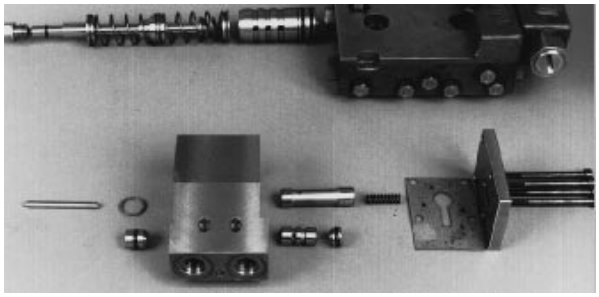
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Functional Description (Continued)



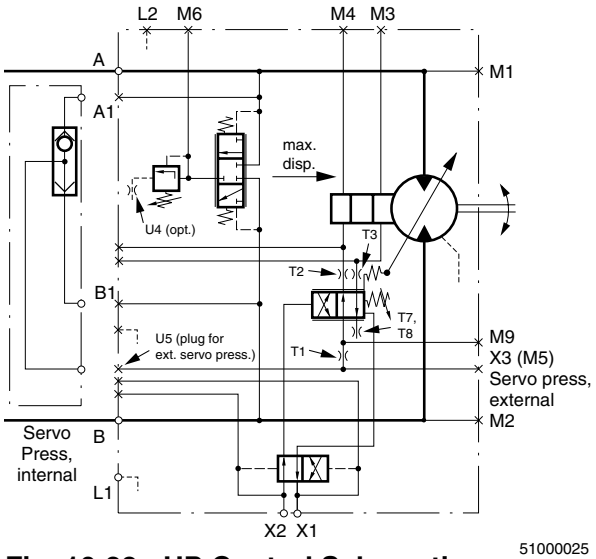
51000023

Fig. 10-26 - Series 51 Motor with HP Control



51000024

Fig. 10-27 - HP Control Components



51000025

Fig. 10-28 - HP Control Schematic

Two Line Hydraulic Proportional Control (Type HP)

This control consists of a valve block with two (2) hydraulic ports mounted on the multi-function block. The valve block incorporates a shuttle spool and a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap. Feedback springs (single spring for 060, 080, and 110) and a threshold spring are installed in the end cap. These springs function similar to the HS control. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

Two pilot pressures are provided to the control. The shuttle spool directs the higher pilot pressure to the end of the pilot piston opposite the feedback spring, and the lower pressure to the opposite side of the pilot piston. The rod transmits a force, proportional to the difference of the pilot pressures, to the control spool.

An increase in the difference between the pilot pressures will result in a decrease in motor displacement, while a decrease will result in an increase in displacement.

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Functional Description (Continued)

Two Line Hydraulic Proportional Control for "Dual-Path" Vehicles (Type HC)

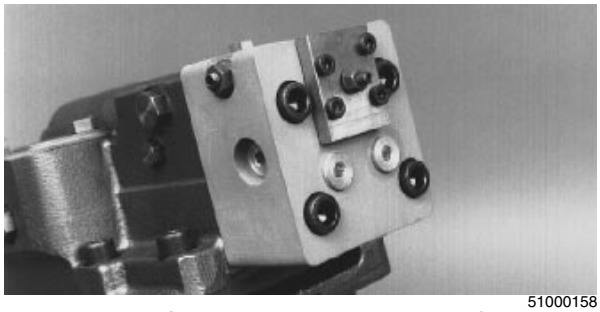
The HC control operates in a similar manner to the HP control, however the HC control is optimized for use in "dual-path" drive vehicles. This control consists of a valve block with two (2) hydraulic ports mounted on the end cap. The valve block incorporates a shuttle spool and a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap.

A bleed valve is provided to eliminate any air which might become trapped in the pilot piston oil passages.

Feedback springs are installed in the end cap. Servo pressure is supplied internally by a ball type shuttle valve in the control housing. PCOR is not available with this control.

Two pilot pressures are provided to the control. The shuttle spool directs the higher pilot pressure to the end of the pilot piston opposite the feedback springs, and the lower pressure to the opposite side of the pilot piston. The pin transmits a force, proportional to the difference of the pilot pressures, to the control spool.

An increase in the difference between the pilot pressures will result in a decrease in motor displacement, while a decrease will result in an increase in displacement. The feedback springs in the end cap have differing spring rates and operate in parallel (060, 080, and 110) or series (160 or 250) to provide a linear relationship between motor displacement and pilot pressure differential.



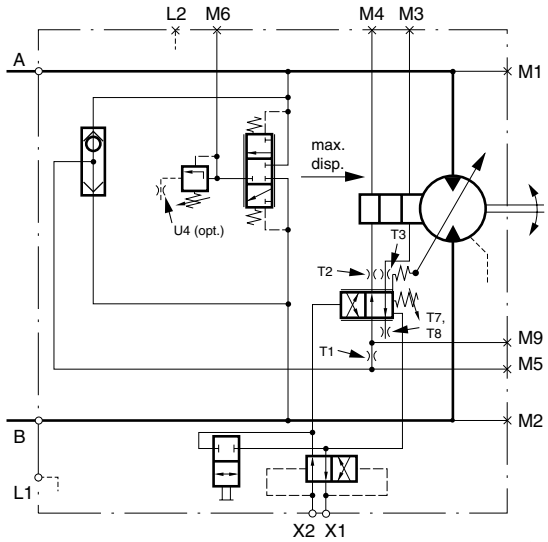
51000158

Fig. 10-29 - Series 51 Motor with HC Control



51000111

Fig. 10-30 - HC Control Components

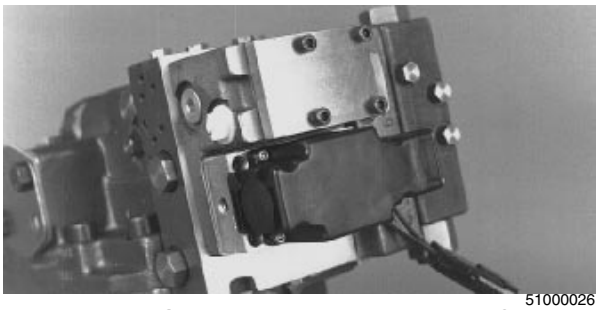


51000160

Fig. 10-31 - HC Control Schematic

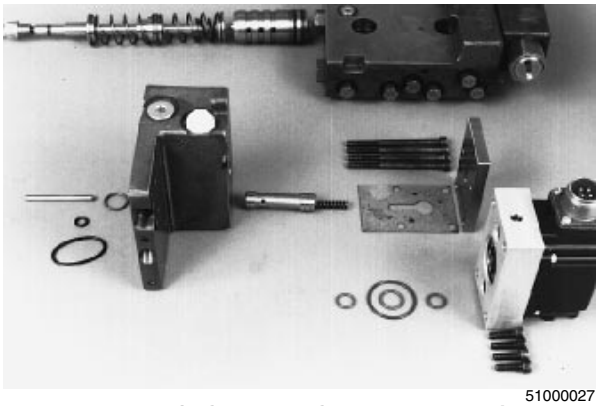
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Functional Description (Continued)



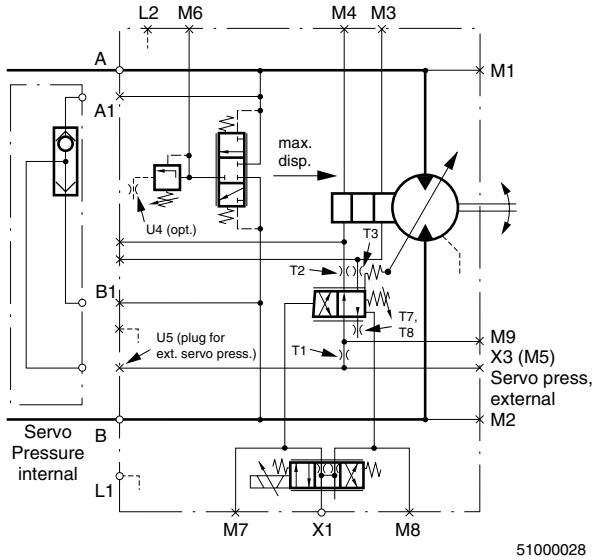
51000026

Fig. 10-32 - Series 51 Motor with EP Control (EQ Similar)



51000027

Fig. 10-33- EQ Control Components (EP Similar)



51000028

Fig. 10-34 - EP and EQ Control Schematic

Electrohydraulic Proportional Control (Types EP and EQ)

This control consists of a valve block and PCP (Pressure Control Pilot) valve mounted on the multi-function block. The valve block incorporates a pilot piston with centering springs. A pin transmits force from the pilot piston to the control spool in the end cap. Feedback springs (single spring for 060, 080, and 110) and a threshold spring are installed in the end cap. These springs function similar to the HS control. Servo pressure may be supplied from an external source or internally by the shuttle spool in the multi-function block. PCOR is available with this control.

An external pilot pressure source is connected to the inlet of the PCP valve, which produces differential pilot pressures proportional to the current through it. These pressures are applied to the pilot piston. The operation of this control is similar to that of the HP Control, with the motor displacement being proportional to the current through the PCP valve.

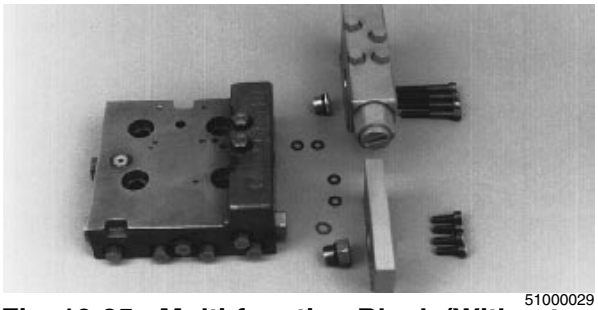
An increase in current (above the threshold current) will result in a decrease in motor displacement, while a decrease will result in an increase in displacement.

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Functional Description (Continued)

Multi-function Block Components

The Multi-function Valve Block includes a shuttle valve which provides internally supplied servo pressure, and an optional Pressure Compensator Over-Ride (PCOR) function with optional brake pressure defeat.



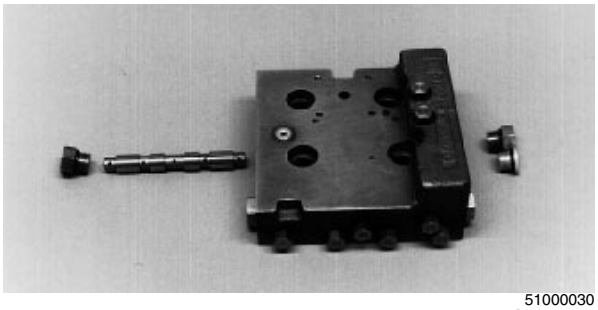
51000029

Fig. 10-35 - Multi-function Block (Without Control)

Servo Pressure Supply

For internal supply, the multi-function block incorporates a shuttle spool with internal check ball valve that routes oil from the main circuit ports of the motor to the control valve in the end cap. “High side” pressure is provided to the servo control valve in the end cap.

For external supply, the connection between the shuttle spool and the servo control valve is blocked in the end cap. The external pressure supply to the servo control valve connects to a port (“M5”) on the end cap.



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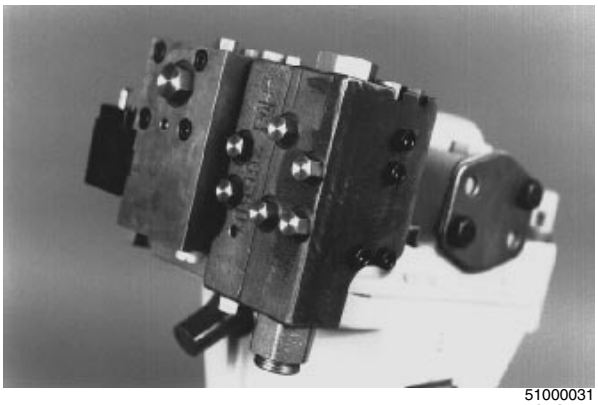
Fig. 10-36 - Multi-function Block with Servo Pressure Supply Shuttle Spool

Pressure Compensator Over-Ride (PCOR)

The Pressure Compensator Over-Ride (PCOR) system includes a spool valve located in the PCOR block which is attached to the multi-function block. This system increases the motor displacement at system pressures above the PCOR valve setting. (Pressure Compensator Over-Ride is not available with the N2 and HZ controls, or the PC regulator.)

For bi-directional PCOR operation, the shuttle valve in the multi-function block routes system high pressure to the PCOR spool valve. For single direction PCOR operation, the PCOR spool valve is connected to one (1) side of the closed loop through passages in the multi-function block

When system pressure exceeds the PCOR setting, the spool valve moves to connect the displacement reducing end of the servo piston to the motor case, and the displacement increasing end of the servo piston to system pressure. This increases the motor displacement, which reduces the motor output speed. When the PCOR valve closes, control of the servo piston returns to the control spool in the motor end cap.

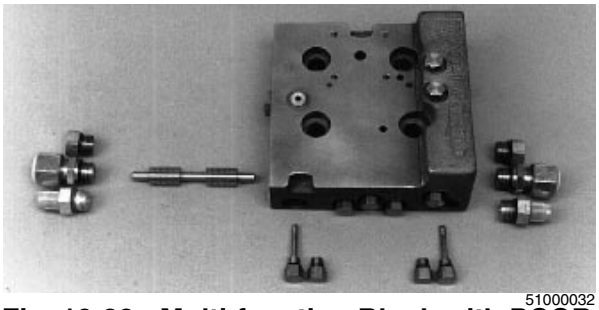


51000031

Fig. 10-37 - Multi-function Block with PCOR Block and Spool Valve (K1•K2 Control Shown)

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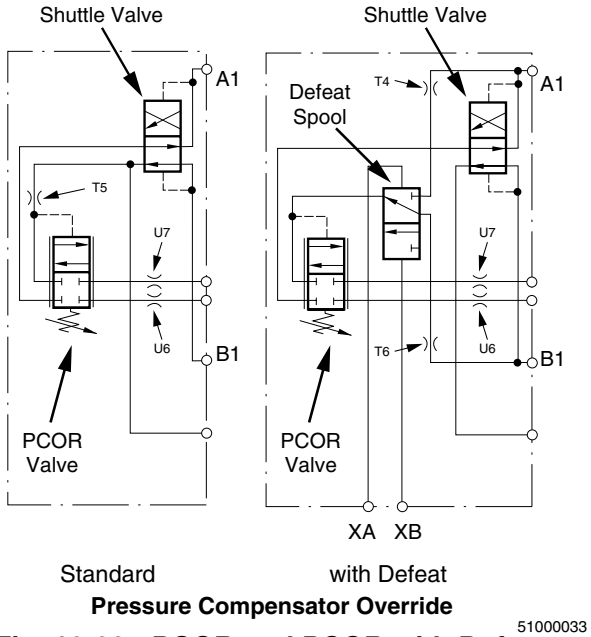
Functional Description (Continued)



51000032

Fig. 10-38 - Multi-function Block with PCOR Defeat Spool Components

An optional “brake pressure defeat” spool may be installed in the multi-function block. When used with the PCOR, this spool assures that the PCOR does not cause the motor displacement to increase during deceleration (which could cause pump overspeed). Pressure from a source such as the pump servos or an external valve, shifts the defeat spool to block the high pressure supply to the PCOR valve from the “deceleration” side of the closed loop. Either bi-directional or single direction PCOR operation can be specified when PCOR defeat is installed.



51000033

Fig. 10-39 - PCOR and PCOR with Defeat Schematic

PCOR Brake Pressure Defeat Operation

Rotation	High pressure port	Control pressure on port
CW	A	XB
CCW	B	XA

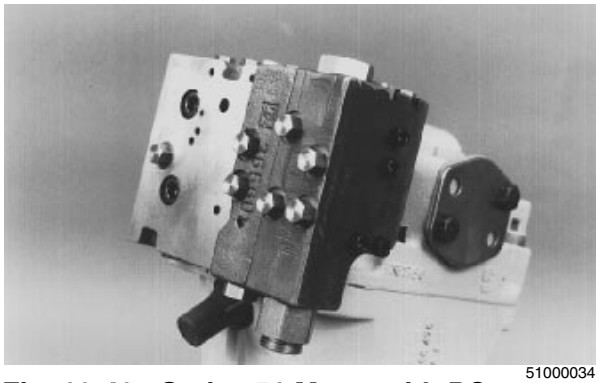
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Functional Description (Continued)

Pressure Compensator Regulator (Type PC)

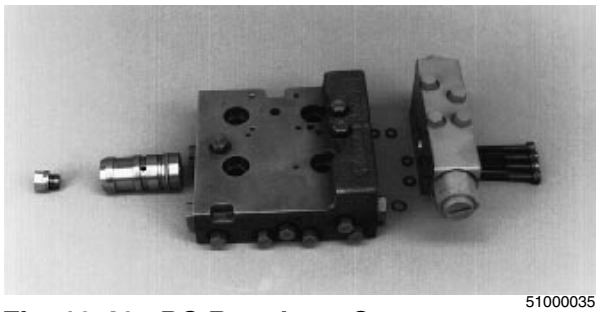
In this regulator, the Pressure Compensator system in the multi-function block assembly controls the motor displacement. At system pressures below the compensator setting, the servo piston is maintained in the minimum motor displacement position. When system pressure exceeds the POR setting, hydraulic pressure acts on the servo piston to increase the motor displacement.

With the Pressure Compensator regulator, an increase in system pressure (above the setting pressure) will result in an increase in motor displacement and output torque, and a decrease in motor shaft speed.



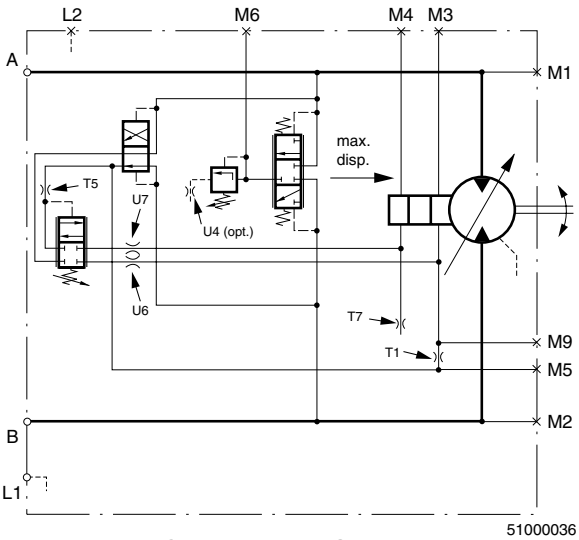
51000034

Fig. 10-40 - Series 51 Motor with PC Regulator



51000035

Fig. 10-41 - PC Regulator Components



51000036

Fig. 10-42 - PC Regulator Schematic

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Technical Specifications and Data - Variable Displacement Motors

Design

Piston motor with variable displacement, bent axis construction.

Type of Mounting

SAE four (4) bolt flange – SAE Flange Configuration.
Two (2) bolt flange – Cartridge Motor Configuration.

Pipe Connections

Main pressure ports: SAE flange
Remaining ports: SAE O-ring thread

Direction of Rotation

Clockwise and counter-clockwise.

Installation Position

Installation position discretionary. The housing must always be filled with hydraulic fluid.

System Pressure Range, Input

Max: 480 bar (6960 psi)
Min: 10 bar (145 psi)

Case Pressure

Max. Continuous: 3 bar (44 psi)
Intermittent (Cold start): 5 bar (73 psi)

Hydraulic Fluid

Refer to Sauer-Sundstrand publication BLN-9887 or 697581.

Temperature [1)]

ϑ min = -40°C (-40°F), intermittent, cold start
ϑ nominal = 104°C (220°F), continuous
ϑ max = 115°C (240°F), intermittent

[1)] at the hottest point, normally the case drain line. Hydraulic fluid viscosity must be as shown below.

Fluid Viscosity Limits

ν min =	5 mm²/s (42 SUS)	intermittent
ν min =	6.4 mm²/s (47 SUS)	min. continuous
ν min =	13 mm²/s (70 SUS)	optimum
ν max =	110 mm²/s (510 SUS)	max. continuous
ν max =	1600 mm²/s (7400 SUS)	intermittent, cold start

Filtration

Acceptable contamination level: ISO Code 18/13 or better. Refer to Sauer-Sundstrand publication BLN-9887 or 697581.

			Frame Size				
		Dimension	060	080	110	160	250
Displacement	maximum	cm^3 in^3	60.0 3.66	80.7 4.92	109.9 6.71	160.9 9.82	250.0 15.26
	minimum	cm^3 in^3	12.0 0.73	16.1 0.98	22.0 1.34	32.2 1.96	50.0 3.05
Continuous speed	at max disp at min disp	min^{-1} (rpm) min^{-1} (rpm)	3600 5600	3100 5000	2800 4500	2500 4000	2200 3400
Max. speed	at max disp at min disp	min^{-1} (rpm) min^{-1} (rpm)	4400 7000	4000 6250	3600 5600	3200 5000	2700 4250
Theoretical torque	at max disp	Nm / bar lbf•in / 1000 psi	0.95 583	1.28 784	1.75 1067	2.56 1563	3.98 2428
	at min disp	Nm / bar lbf•in / 1000 psi	0.19 117	0.26 156	0.35 214	0.51 313	0.80 486
Max. continuous flow	Q max	L / min gal / min	216 57	250 66	308 81	402 106	550 145
Max. corner power	Pcorner max	kW hp	336 450	403 540	492 660	644 864	850 1140
Mass moment of inertia	J	kg • m^2 lbf • ft^2	0.0046 0.1092	0.0071 0.1685	0.0128 0.3037	0.0234 0.5553	0.0480 1.1580
Weight (with control N2)	m	kg lb	28 62	32 71	44 97	56 123	86 190

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Safety Precautions

- **When Series 51 units are used in vehicular hydrostatic drive systems, the loss of hydrostatic drive line power in any mode of operation may cause a loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and hold the system should the condition develop.**
- **Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.**
- **Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.**
- **Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.**

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Notes

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Gauge Installation

Various pressure gauge readings can be a great asset in troubleshooting problems with the Series 51 motor or support system.

Snubbers are recommended to protect pressure gauges. Frequent gauge calibration is necessary to insure accuracy.

Fig. 30-1 - Gauge Ports, Motor with N2 Control

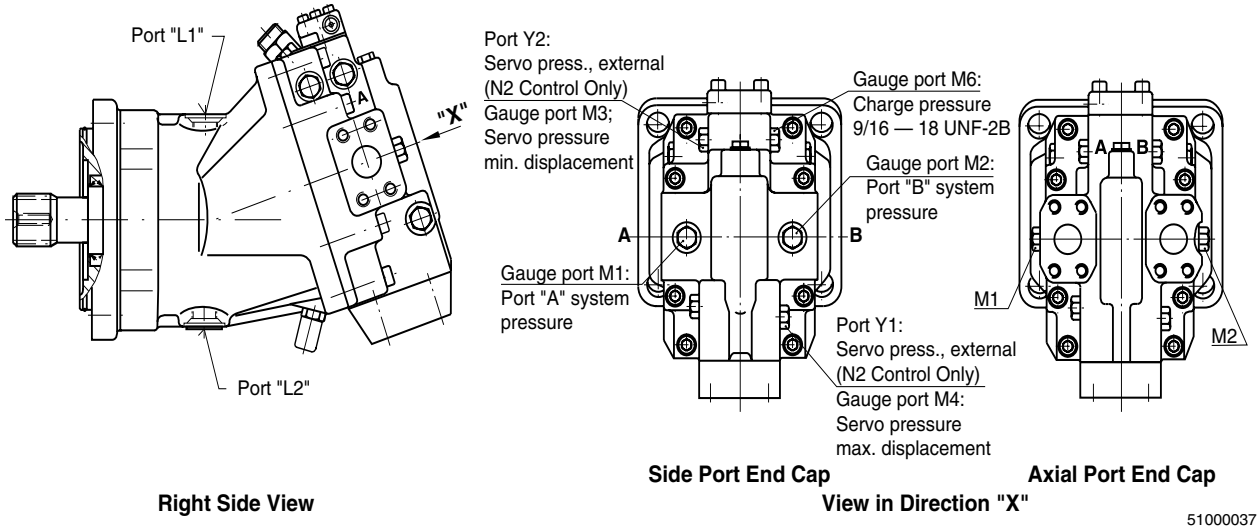


Fig. 30-2- Gauge Ports, Motor with E1•E2, F1•F2, H1•H2, and K1•K2 Controls

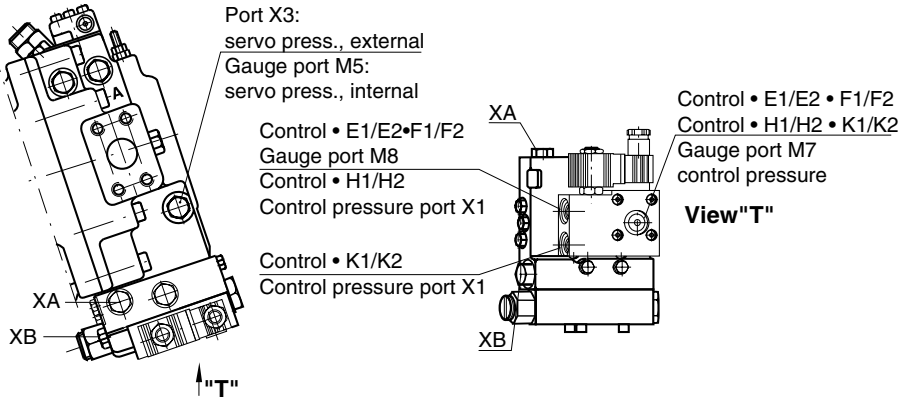
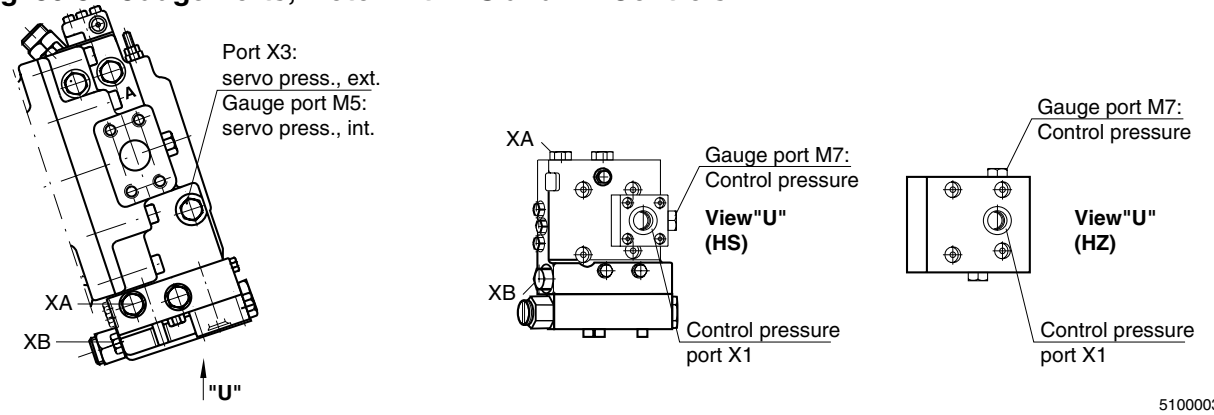


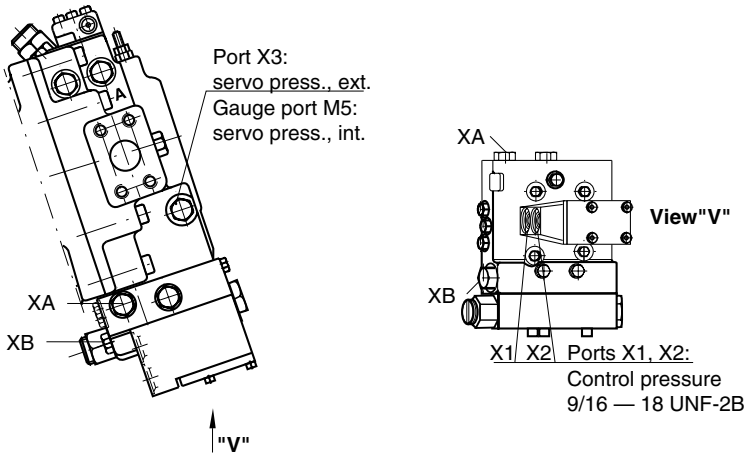
Fig. 30-3 - Gauge Ports, Motor with HS and HZ Controls



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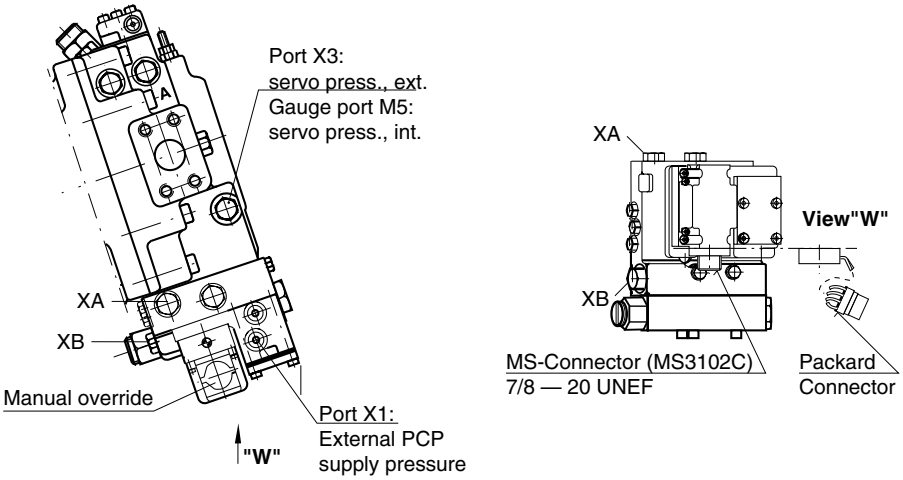
Gauge Installation (Continued)

Fig. 30-4 - Gauge Ports, Motor with HP Control



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Fig. 30-5 - Gauge Ports, Motor with EP•EQ Control



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Gauge Information

M1	System Pressure Port "A"	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting
M2	System Pressure Port "B"	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting
M3	Servo Pressure (Min. Angle)	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting
M4	Servo Pressure (Max. Angle)	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting
M5 (M9)	Servo Supply Pressure	600 bar or 10,000 psi Gauge 9/16 — 18 O-Ring Fitting or Tee into Control Pressure Line

M6	Motor Charge Pressure	60 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting
M7 M8	Control Test Port	60 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting
L1 L2	Case Pressure	60 bar or 1000 psi Gauge **060, 080, 110**: 1-1/16 — 12 O-Ring Fitting **160, 250**: 1-5/16 — 12 O-Ring Fitting
X1 X2 X3	Control Pressure	60 bar or 1000 psi Gauge 9/16 — 18 O-Ring Fitting
XA XB	Defeat Pressure	60 bar or 1000 psi Gauge Tee into Defeat Pressure Line(s)

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Start-Up Procedure and Maintenance

Start-Up Precautions

Cleanliness

Ensure that all system components, including fittings, pipes, and hoses, are completely clean. If cloths are used for cleaning components, they must be made of lint-free materials.

Follow the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581 for required fluid cleanliness levels at machine start-up.

Reservoir and Fluid Level

The reservoir should be designed to accommodate maximum volume changes during all system operating modes, and to promote de-aeration of the fluid as it passes through the tank. The reservoir outlet (charge pump inlet) and the reservoir inlet (fluid return) must always be below the normal fluid level. A sight glass is the preferred method for checking fluid level.

The reservoir inlet (fluid return) should be positioned so that flow to the reservoir is directed into the interior of the reservoir for maximum dwell and efficient de-aeration. A baffle (or baffles) between the reservoir inlet and outlet ports will promote de-aeration and reduce surging of the fluid.

No funnel-shaped eddying at the reservoir outlet (charge pump inlet) or formation of foam at the reservoir inlet (fluid return) is permitted.

Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 51 installation or when restarting an installation in which either the pump or motor has been removed from the system.

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before operating the vehicle/machine.

Prior to installing the motor, inspect the unit for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid, which should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

The inlet line leading from the reservoir to the pump must be filled prior to start up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

Install a 0 to 60 bar or 0 to 1000 psi pressure gauge in the charge pressure gauge port to monitor the charge pressure during start-up.

The external control input signal should be disconnected at the pump control during initial start-up. This will allow the pump to remain in its neutral position.

“Jog” or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure is established. Excess air may be bled from the high pressure lines through the high pressure gauge ports.

Once charge pressure is established, increase speed to normal operating RPM. Note the charge pressure. If charge pressure is incorrect, shut down and determine cause for improper pressure.

Shut down prime mover and connect external control input signal. Start prime mover, checking to be certain pump remains in neutral. With prime mover at normal operating speed, slowly check for forward and reverse machine operation.

Charge pressure should be maintained during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five (5) minutes.

Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add fluid if necessary.

The transmission is now ready for operation.

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Start-Up Procedure and Maintenance (Continued)

Maintenance

Cleanliness

The reservoir breather air filter (if equipped) must be kept clean. Clean the area around the filler cap before opening the reservoir. The hydraulic fluid should be filtered before it enters the reservoir.

Follow the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581 for required fluid cleanliness levels during machine operation.

Recommended Fluids

Hydraulic fluids used with Sauer-Sundstrand products should be carefully selected with assistance from a reputable supplier, following the guidelines presented in Sauer-Sundstrand publication BLN-9887 or 697581.

Checking for Leaks

Check the system components for leakage at regular intervals. Tighten any leaking connections while the system is not under pressure. Replace any defective seals and gaskets.

Check hydraulic hoses for damage or aging. When installing replacements, be certain that the hoses are clean and connected properly.

Checking the Fluid Level

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy or milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat).

Changing the Fluid and Filter

To insure optimum service life on Series 51 products, regular maintenance of the fluid and filter must be performed.

The fluid and filter must be changed per the vehicle/machine manufacturer's recommendations. In the absence of such recommendations, the following intervals may be used:

- System with a sealed type reservoir - 2000 hrs.
- System with a breathing type reservoir - 500 hrs.

It may be necessary to change the fluid more frequently if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been operating at temperature levels greater than the maximum recommended. Never reuse fluid.

The filter should be changed when changing the fluid, or whenever the filter indicator shows that it is necessary to change the filter.

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Component Inspection and Adjustment

WARNING

The following procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the adjustments to prevent injury to the technician and bystanders.

Charge Pressure Relief Valve Adjustment

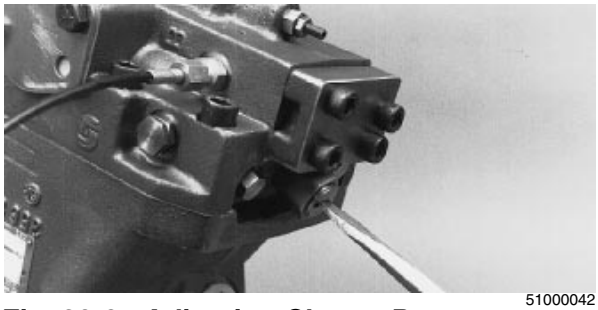
An appropriate combination of pump and motor charge pressure settings should be maintained to insure the proper function of the loop flushing circuit. **Correct charge pressure must be maintained under all conditions of operation to maintain pump control performance in closed loop systems.**

To measure motor charge pressure, install a 0 to 60 bar or 0 to 500 psi pressure gauge in the motor charge pressure gauge port. Install a gauge to measure case pressure. Operate the system with the prime mover at normal operating speed and the pump at half stroke (forward or reverse) when measuring motor charge pressure.

In most applications, the motor charge relief valve is set 2 to 4 bar (29 to 58 psi) below the setting of the pump charge relief valve (measured with the pump in its “neutral” or zero-angle position). This setting assumes a reservoir temperature of 50° C (122° F), and is referenced to case pressure.

Series 51 motors are equipped with an external screw adjustable charge pressure relief valve. To adjust the charge pressure, loosen the lock nut (with a 1-1/16" hex wrench) and turn the adjustment plug with a large screwdriver. Clockwise rotation of the plug increases the setting, and counter-clockwise rotation decreases the setting (at a rate of approximately 3.4 bar [50 psi] per turn). The lock nut should be torqued to 52 Nm (38 ft•lbsf).

Once the desired charge pressure setting is achieved, remove the gauges and reinstall the port plugs.



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Fig. 30-6 - Adjusting Charge Pressure Relief Valve

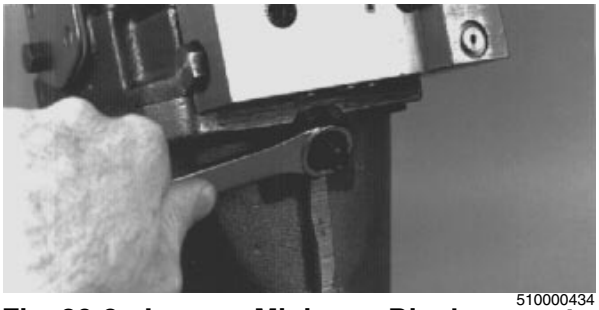


51000043

Fig. 30-7 - Tighten Charge Pressure Relief Valve Lock Nut

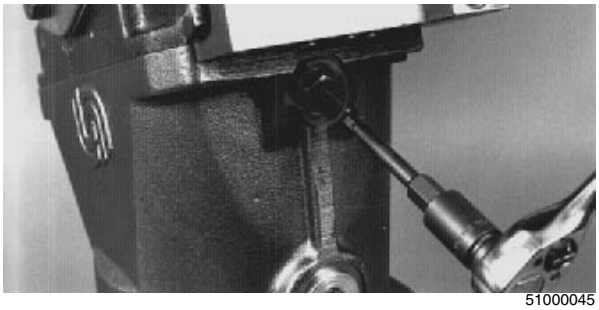
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Component Adjustment (Continued)



510000434

Fig. 30-8 - Loosen Minimum Displacement Limiter Lock Nut



51000045

Fig. 30-9 - Rotate Minimum Displacement Adjusting Screw

Frame Size	Approximate Change in Minimum Displacement Per Revolution of Adjusting Screw
060	1.5 cc/Rev (.09 in3/Rev)
080	2.1 cc/Rev (.13 in3/Rev)
110	3.1 cc/Rev (.19 in3/Rev)
180	4.0 cc/Rev (.24 in3/Rev)
250	6.2 cc/Rev (.38 in3/Rev)

Frame Size	Min. Displacement Range cc/Rev (in/Rev)	Screw Size and Length mm (in)
060	12 to 29 (.73 to 1.77) 30 to 40 (1.83 to 2.44)	M10x65 (2.56) M10x80 (3.15)
080	16 to 35 (.98 to 2.14) 36 to 54 (2.20 to 3.20)	M10x65 (2.56) M10x80 (3.15)
110	22 to 46 (1.34 to 2.81) 47 to 74 (2.87 to 4.52)	M12x70 (2.76) M12x80 (3.15)
160	32 to 72 (1.95 to 4.39) 73 to 107 (4.45 to 6.53)	M12x75 (2.95) M12x90 (3.54)
250	50 to 90 (3.05 to 5.49) 91 to 130 (5.55 to 7.93) 131 to 167 (7.99 to 10.19)	M12x75 (2.95) M12x90 (3.54) M12x100 (3.94)

Minimum Displacement Limiter Adjustment

The minimum displacement is set at the factory, and the adjustment screw is covered with a tamper-resistant cap

WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The sealing lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation.

NOTE: Changes in motor displacement can be detected by providing a constant flow of fluid to the motor, while maintaining the motor at minimum displacement and monitoring the motor output shaft speed. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.

To adjust the minimum displacement, first remove and discard the cap covering the adjusting screw. Using a 17 mm hex wrench for 060 and 080 frame size motors or a 19 mm hex wrench for 110 through 250 frame size motors, loosen the lock nut retaining the minimum displacement limiter adjusting screw.

Using a 5 mm internal hex wrench for 060 and 080 frame size motors or a 6 mm internal hex wrench for 110 through 250 frame size motors, rotate the adjusting screw to limit the minimum displacement of the motor.

Rotating the adjusting screw clockwise will increase the minimum displacement of the motor, while rotating the adjusting screw counter-clockwise will decrease the minimum displacement.

For each full revolution, of the adjusting screw, the displacement will change according to the accompanying chart.

Different minimum displacements may require different length adjusting screws. The various lengths are shown in the accompanying chart.

After establishing the desired minimum displacement setting, tighten the lock nut on the adjusting screw to 51 Nm (38 ft•lbsf) for 060 and 080 frame size motors or 86 Nm (63 ft•lbsf) for 110 through 250 frame size motors. Install a new tamper-resistant cap on the adjusting screw.

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Component Adjustment (Continued)

Maximum Displacement Limiter Adjustment

The maximum displacement of the Series 51 motors can be limited by limiting the stroke of the setting piston, and the resulting movement of the valve segment. A displacement stop screw is installed on the setting piston (under the minimum angle servo cover) to limit the stroke of the piston.

Spacers may be installed on the displacement stop screw to limit the stroke. A longer or shorter screw must be used to retain a thicker or thinner spacer.

WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable speed conditions. The stop screw must be retorqued after adjustment to prevent an unexpected change in operating conditions.

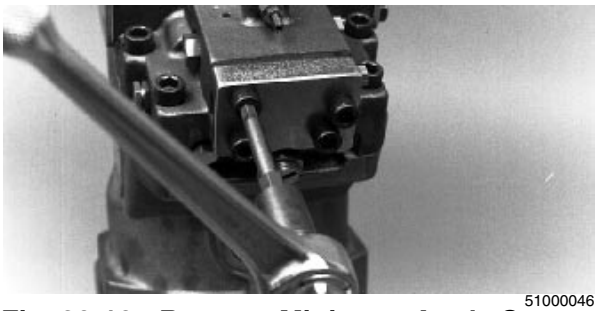
NOTE: Changes in motor displacement can be detected by providing a constant flow of fluid to the motor, while maintaining the motor at maximum displacement and monitoring the motor output shaft speed. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.

To adjust the maximum displacement, first remove the screws retaining the minimum angle servo cover to the end cap with an 8 mm internal hex wrench (060, 080, 110, and 160 units), or a 10 mm internal hex wrench (250 units). Remove the minimum angle servo cover and O-rings. Remove the displacement limiter screw with an 8 mm internal hex wrench.

Installing a thicker spacer on the end of the setting piston will reduce the maximum displacement of the motor. Installing a thinner spacer will increase the maximum displacement. The displacement will change according to the accompanying chart.

Torque the displacement limiter screw to 54 Nm (40 ft•lbsf).

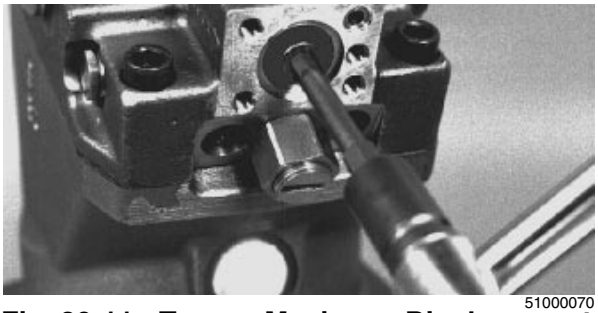
Install the minimum angle servo cover and its O-rings. Install the cover screws and torque to 78 Nm (58 ft•lbsf) for 060, 080, 110, and 160 motors, or 110 Nm (81 ft•lbsf) for 250 motors.



51000046

Fig. 30-10 - Remove Minimum Angle Servo Cover Screws

Frame Size	Approximate Change in Maximum Displacement with Change in Spacer Thickness cc/mm (in^3/.1 in)
060	0.98 (.15)
080	1.14 (.18)
110	1.48 (.23)
160	1.93 (.30)
250	2.63 (.41)



51000070

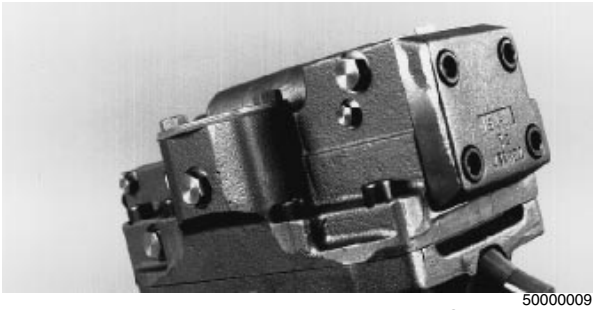
Fig. 30-11 - Torque Maximum Displacement Limiter Screw

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Component Adjustment (Continued)

Displacement Control Adjustments

NOTE: A change in motor displacement can be detected by providing a constant flow of fluid to the motor and monitoring the motor output shaft speed while adjusting the control. An increase in displacement will result in a decrease in shaft speed, while a decrease in displacement will result in an increase in shaft speed.



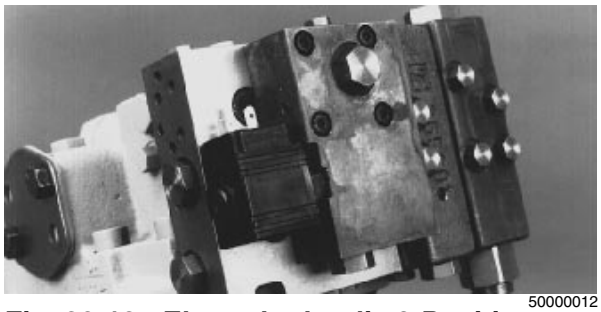
50000009

Fig. 30-12 - Hydraulic 2-Position Control, Type N2)

Hydraulic 2-Position Control (Type N2)

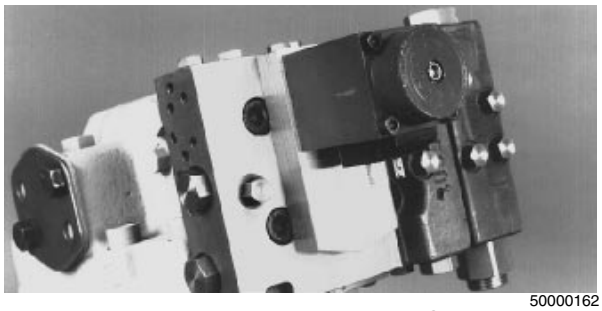
No adjustments are provided for the N2 control.

A minimum of 25 bar (360 psi) servo pressure is required to change the motor displacement with the motor shaft turning. A minimum of 70 bar (1015 psi) servo pressure is required to change the motor displacement with the motor shaft locked.



50000012

Fig. 30-13 - Electrohydraulic 2-Position Control, Types E1•E2 and F1•F2



50000162

Fig. 30-14 - Electric 2-Position Control, Type S1

Electrohydraulic 2-Position Control (Types E1•E2 and F1•F2) and Electric 2-Position Control (Type S1)

These controls do not require adjustment.

CAUTION

Do not tamper with the adjusting screw in the end cap (opposite the control).

Pilot pressure for the E1•E2 or F1•F2 electric solenoid valve is internally supplied. When the solenoid is energized, motor charge pressure should be present at test ports M7 and M8. When the solenoid is not energized, test port M8 should drop to case pressure.

The S1 control utilizes a direct acting solenoid to operate the control valve spool in the end cap.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

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Component Adjustment (Continued)

Hydraulic Proportional Control (Types HZ, HS, H1•H2, and K1•K2)

The control start pressure for these controls may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install a gauge to monitor the pilot pressure (connect to port M7 or tee into the pilot line connected to port X1), and the minimum angle servo pressure (port M3). If adjusting an H1 or H2 control, the override solenoid must be energized. If adjusting a K1 or K2 control, the solenoid must not be energized.

NOTE: The pilot signal may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

Increase the pilot signal to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

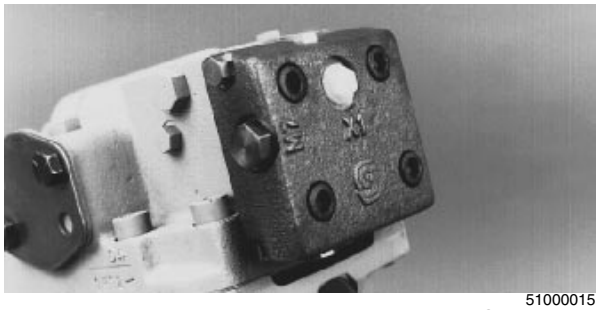
To adjust the control start pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

For the H1•H2 controls, the pilot signal pressure supplied to port X1 should also be present at test port M7 when the solenoid is energized. When the solenoid is not energized, test port M7 should drop to case pressure.

For the K1•K2 controls, the pilot signal pressure supplied to port X1 should also be present at test port M7 when the solenoid is not energized. When the solenoid is energized, test port M7 should drop to case pressure.

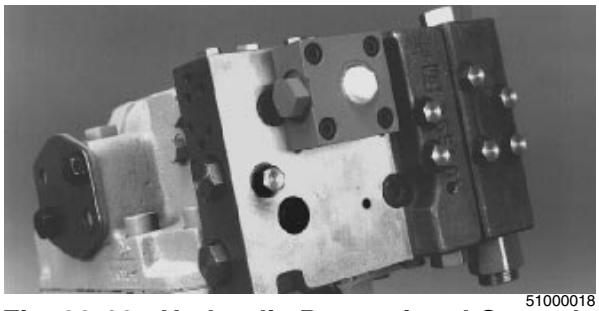
Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.



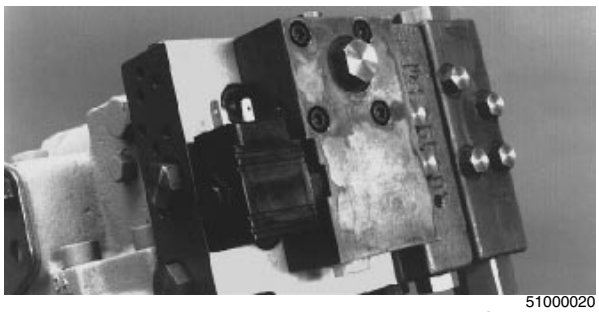
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Fig. 30-15 - Hydraulic Proportional Control, Type HZ



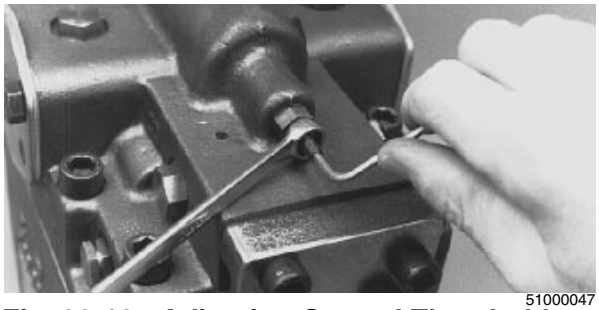
51000018

Fig. 30-16 - Hydraulic Proportional Control, Type HS



51000020

Fig. 30-17 - Hydraulic Proportional Control with Electric Override, Type H1•H2 (K1•K2 Similar)

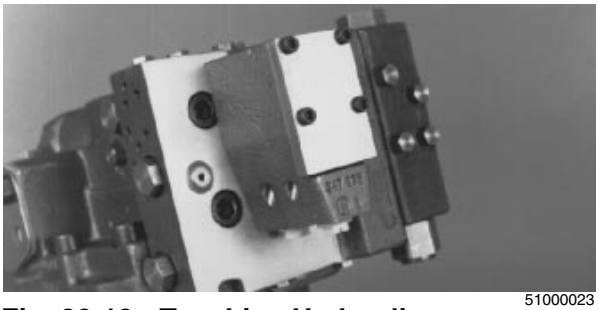


51000047

Fig. 30-18 - Adjusting Control Threshold, Types HS, HZ, H1•H2, and K1•K2

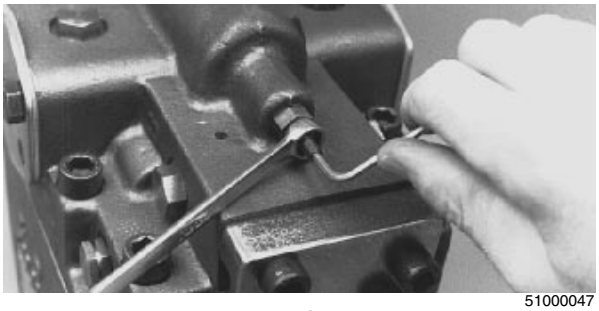
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Component Adjustment (Continued)



51000023

Fig. 30-19 - Two Line Hydraulic Proportional Control, Type HP



51000047

Fig. 30-20 - Adjusting Control Threshold (Type HP)

Two Line Hydraulic Proportional Control (Type HP)

The differential control start pressure for this control may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that differential pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install gauges to monitor the pilot pressures (tee into the pilot lines connected to ports X1 and X2), and the minimum angle servo pressure (port M3).

NOTE: The pilot signals may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

Increase the pilot signal differential to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

The differential control start pressure should be the same no matter which pilot pressure is higher. Differences in control operation when the pilot pressure differential is reversed indicate a problem with the shuttle spool in the control block.

To adjust the control start differential pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

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Component Adjustment (Continued)

Two Line Hydraulic Proportional Control for "Dual Path" Vehicles (Type HC)

The differential control start pressure for this control may be adjusted with the adjusting screw on the control housing. Control start is that differential pilot pressure at which the motor displacement starts to decrease.

To check the control start setting, install gauges to monitor the pilot pressures (tee into the pilot lines connected to ports X1 and X2), and the minimum angle servo pressure (port M3).

NOTE: The pilot signals may be determined by prime mover speed, other shaft speeds, or other control pressures, depending upon the design of the vehicle / machine control circuit.

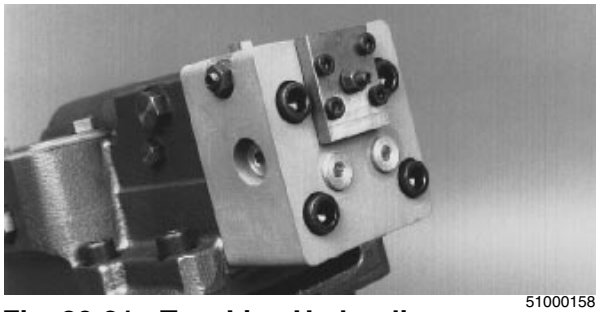
Increase the pilot signal differential to the required control start pressure. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

The differential control start pressure should be the same no matter which pilot pressure is higher. Differences in control operation when the pilot pressure differential is reversed indicate a problem with the shuttle spool in the control block.

To adjust the control start differential pressure, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw counter-clockwise (CCW) increases the control start pressure. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

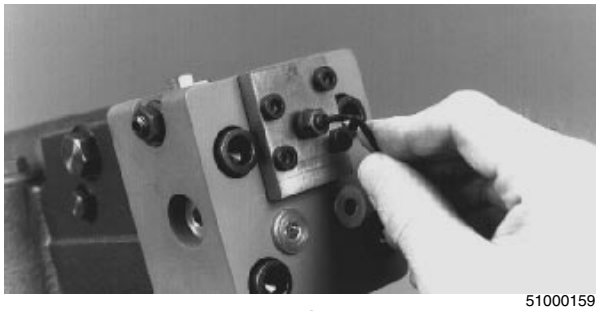
Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is provided internally from the main system ports of the motor.



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Fig. 30-21 - Two Line Hydraulic Proportional Control, Type HC

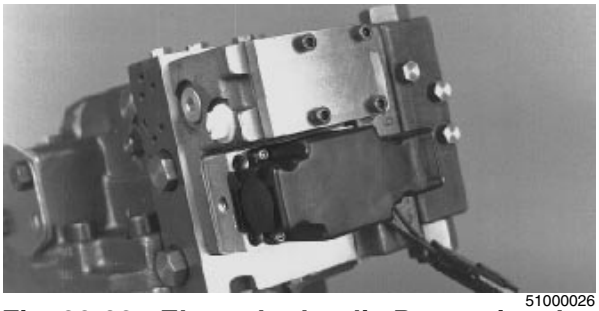


51000159

Fig. 30-22 - Adjusting Control Threshold (Type HC)

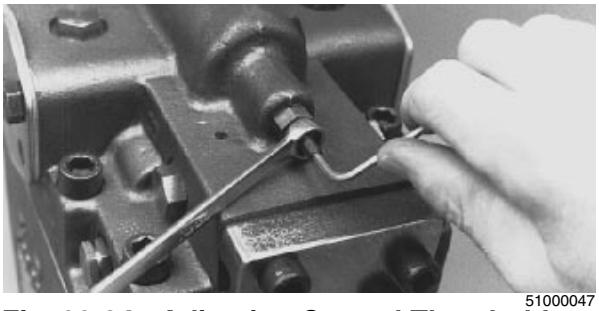
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Component Adjustment (Continued)



51000026

Fig. 30-23 - Electrohydraulic Proportional Control, Type EP (EQ Similar)



51000047

Fig. 30-24 - Adjusting Control Threshold (Type EP•EP)

Electrohydraulic Proportional Control (Types EP and EQ)

The control start current for the EP and EQ controls may be adjusted with the adjusting screw on the end cap (opposite the control block). Control start is that current supplied to the PCP (Pressure Control Pilot) valve at which the motor displacement starts to decrease.

To check the threshold setting, install instruments to monitor the PCP current, and the minimum angle servo pressure (port M3).

NOTE: The current supplied to the PCP may be determined by prime mover speed, other shaft speeds, control pressures, or other electrical signals, depending upon the design of the vehicle / machine control circuit.

Increase the PCP current to the required control start current. An increase in minimum angle servo pressure will be noted as the motor displacement starts to decrease.

To adjust the control start current, loosen the lock nut using a 10 mm hex wrench and turn the adjusting screw with a 4 mm internal hex wrench. Turning the screw clockwise increases the control start current. Torque the lock nut to 9 Nm (6.6 ft•lbsf) after adjusting.

PCP supply pressure oil is provided externally. PCP supply pressure must be a minimum of 20 bar (290 psi) and no more than 70 bar (1015 psi).

Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

Servo pressure supply oil is usually provided internally from the main system ports of the motor. If external servo pressure supply is utilized, a minimum of 25 bar (360 psi) is required to change the motor displacement with the motor shaft turning, and a minimum of 70 bar (1015 psi) is required with the motor shaft locked.

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Component Adjustment (Continued)

Pressure Compensator Over-Ride (PCOR) and Pressure Compensator Regulator (Type PC) Adjustment

The PCOR or PC regulator valve setting may be adjusted with the adjusting screw on the PCOR/PC valve block attached to the multi-function block. The regulator start pressure is that system pressure at which the PCOR or PC regulator starts to increase the motor displacement.

In order to measure the regulator start pressure setting of the PCOR or the PC regulator, the motor output shaft must be loaded to increase the system working pressure. This can accomplished by applying the vehicle's brakes or by loading the work function.

WARNING

The following procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the adjustment to prevent injury to the technician and bystanders.

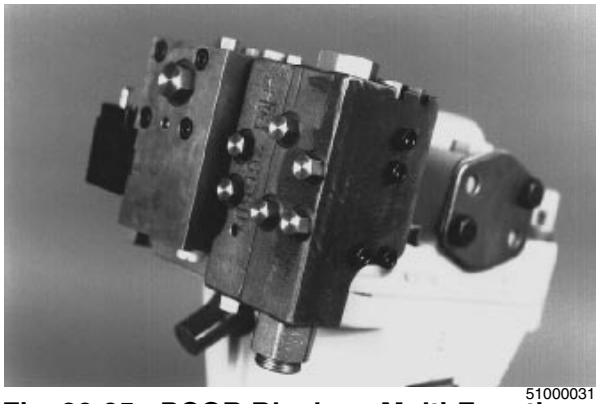
Install gauges to monitor system pressure (connect to ports M1 and M2), the minimum angle servo pressure (port M3), and the maximum angle servo pressure (port M4).

Start the prime mover and operate at normal speed. Provide a signal to the pump control to provide a constant flow of hydraulic fluid to the motor. Provide a signal to the motor control to maintain the motor at its minimum displacement.

Increase the load on the motor to increase the system pressure to the required regulator start pressure. The maximum angle servo pressure (M4) will increase and the minimum displacement servo pressure (M3) will decrease as the PCOR or PC regulator operates. The servo pressures will equalize, and the maximum angle servo pressure continue to increase, as the motor displacement starts to increase.

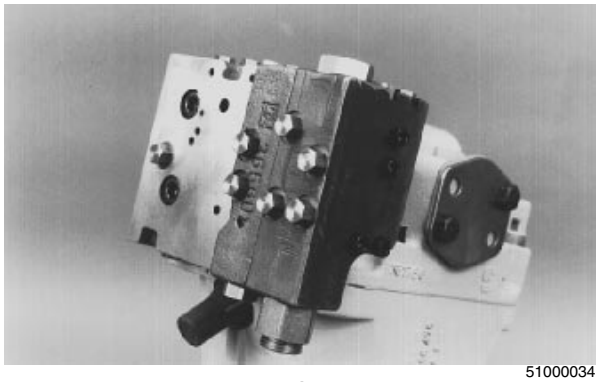
During the transition from minimum to maximum displacement, an additional 10 bar (145 psi) increase in system pressure may be noted.

Once the motor is at maximum displacement, further increases in load will result in increasing system pressure until the maximum system pressure (determined by the system relief valve or pump pressure limiter) is reached.



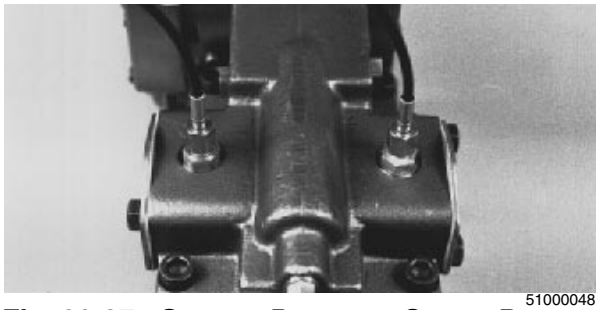
51000031

Fig. 30-25 - PCOR Block on Multi-Function Block (K1•K2 Control Shown)



51000034

Fig. 30-26 - Pressure Compensator Regulator (Type PC)

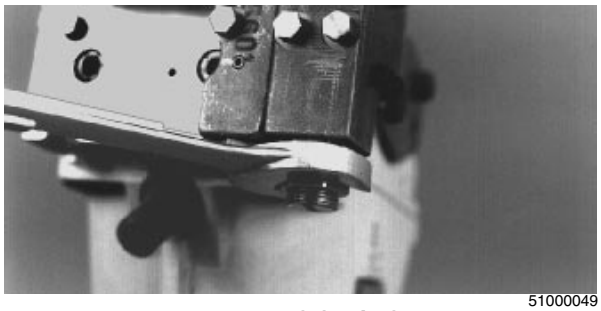


51000048

Fig. 30-27 - System Pressure Gauge Ports (Side Port End Cap)

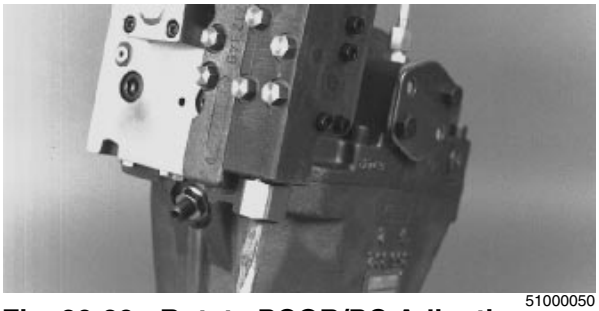
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Component Adjustment (Continued)



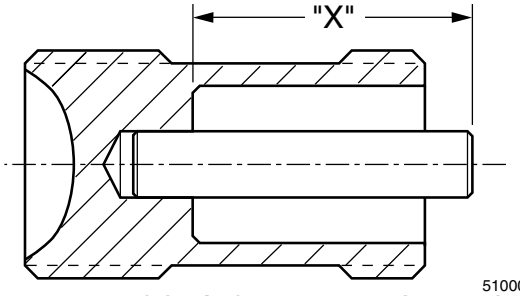
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Fig. 30-28 - Loosen PCOR/PC Lock Nut



51000050

Fig. 30-29 - Rotate PCOR/PC Adjusting Screw



51000051

Fig. 30-30 - PCOR/PC Adjusting Screw Stop Pin

Allow the pump to return to its neutral position. Repeat the procedure for the other side of the closed circuit if so configured. The PCOR or PC regulator must operate at the same start pressure as noted previously. Any noticeable difference in operation from side to side may indicate a problem with the pressure supply shuttle spool or brake pressure defeat spool in the multi-function block.

NOTE: Some motors may be configured for the PCOR or PC regulator to function on only one (1) side of the closed loop. Refer to the nomenclature on the motor nameplate.

In order for the PCOR or PC regulator to function properly on motors equipped with a brake pressure defeat spool, the defeat spool must be positioned correctly. The control pressure for the defeat spool should be applied to the appropriate port (XA or XB) as shown in the following table to shift the defeat spool and permit PCOR or PC regulator operation. Maximum pressure across the brake pressure defeat ports XA and XB is 50 bar (725 psi).

Pressure Compensator Override Defeat Operation

Rotation	High system pressure port	Control pressure on port
CW	A	XB
CCW	B	XA

The PCOR or PC regulator valve is screw adjustable. To adjust, loosen the locknut with a 1-1/16" hex wrench. Turn the adjusting screw with a large screwdriver until the desired pressure setting is established. Clockwise rotation of the adjustment screw will increase the pressure setting at a rate of approximately 70 bar (1000 psi) per turn.

CAUTION

A stop pin is installed in the adjusting screw to prevent "overtravel" of the PCOR/PC valve spool. The stop pin must protrude (distance "X") 19 mm (.75 in.) from the spring seat for settings of 270 to 370 bar (3900 to 5350 psi), or 24 mm (.94 in.) for settings of 110 to 260 bar (1600 to 3750 psi). Refer to the appropriate Service Parts Manual for further information.

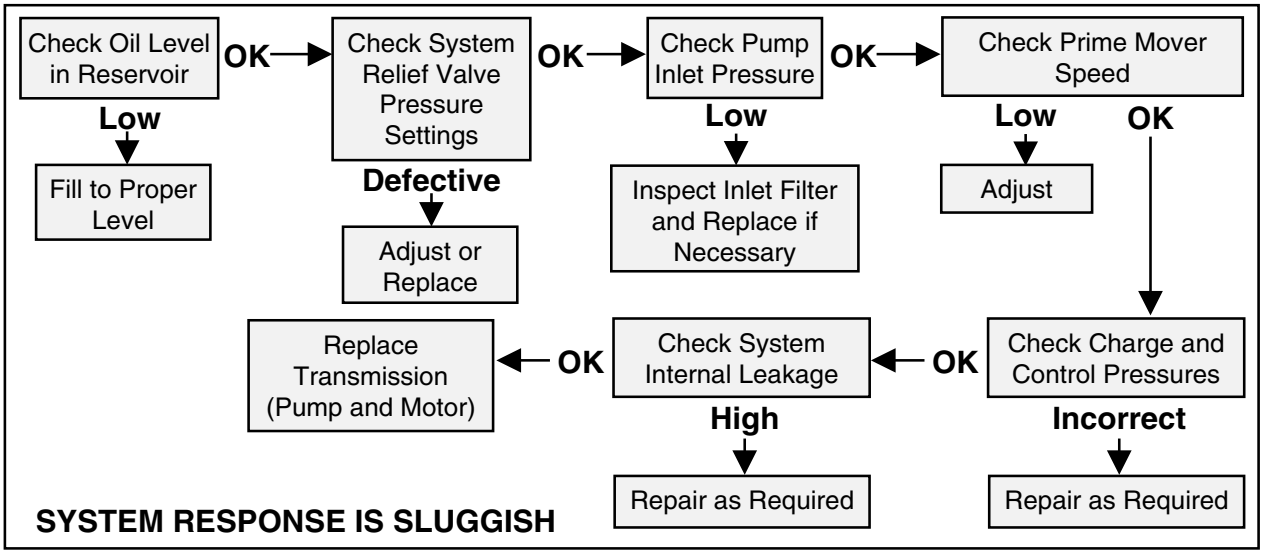
While holding the adjusting screw from turning, torque the lock nut to 52 Nm (38 ft•lbsf). Recheck the PCOR or PC regulator setting.

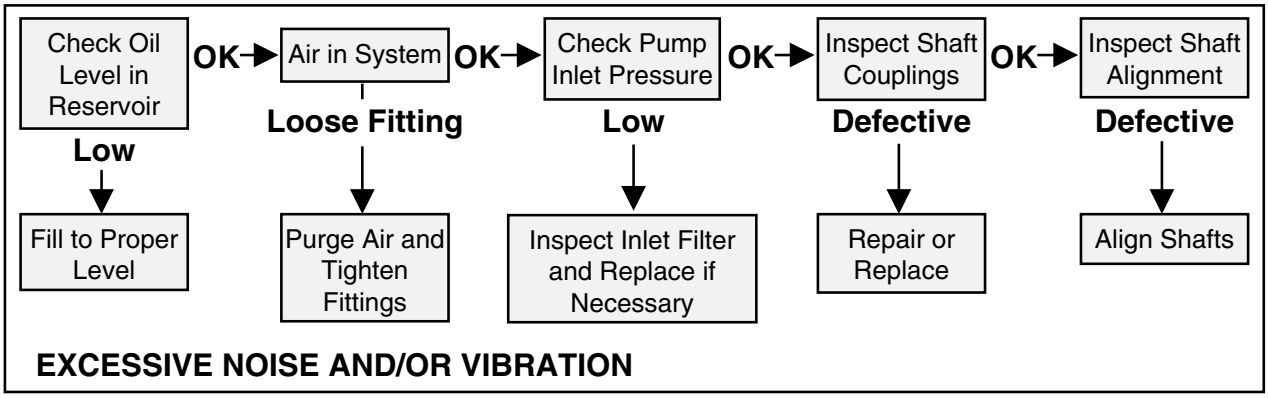
Shut down the prime mover. Remove the gauges and install the gauge port plugs. Return the pump and motor controls to their normal operation.

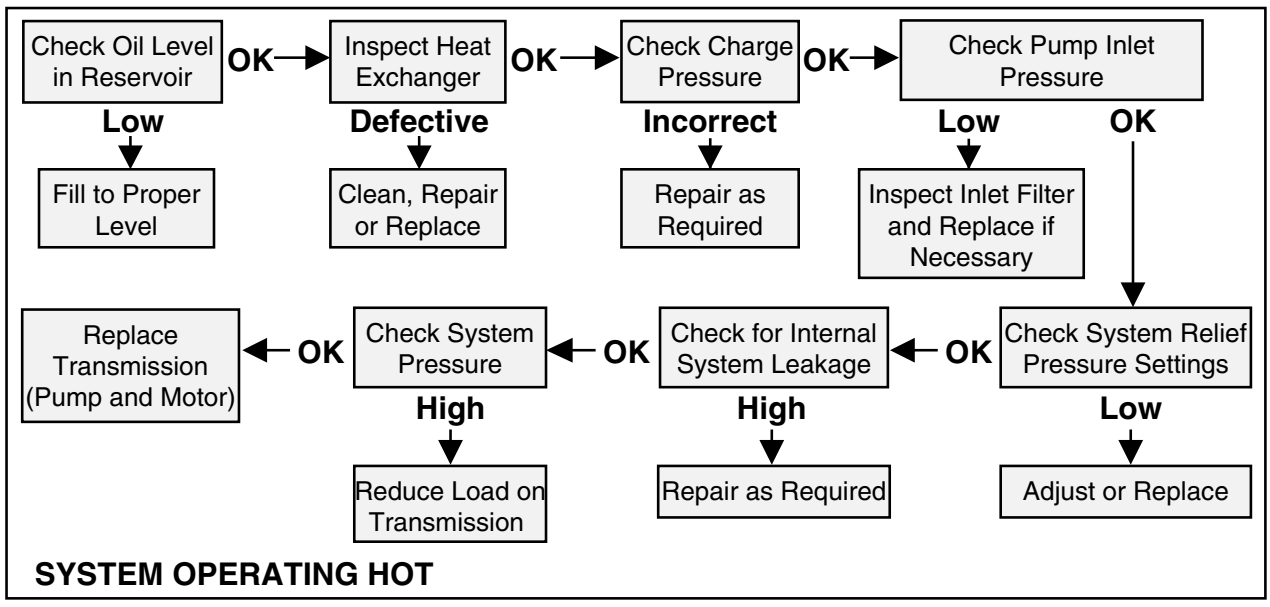
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Troubleshooting

Fault-Logic Diagrams • Closed Circuit



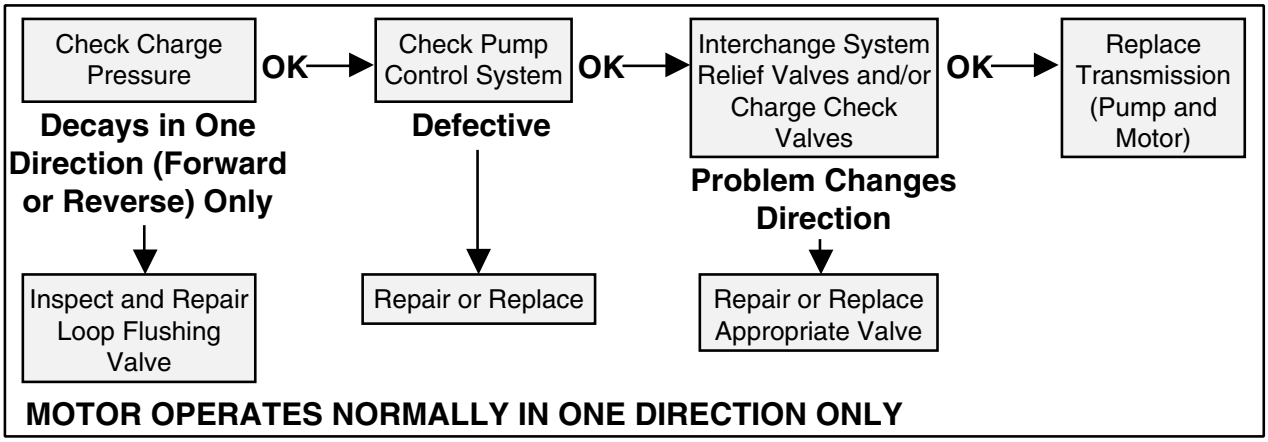


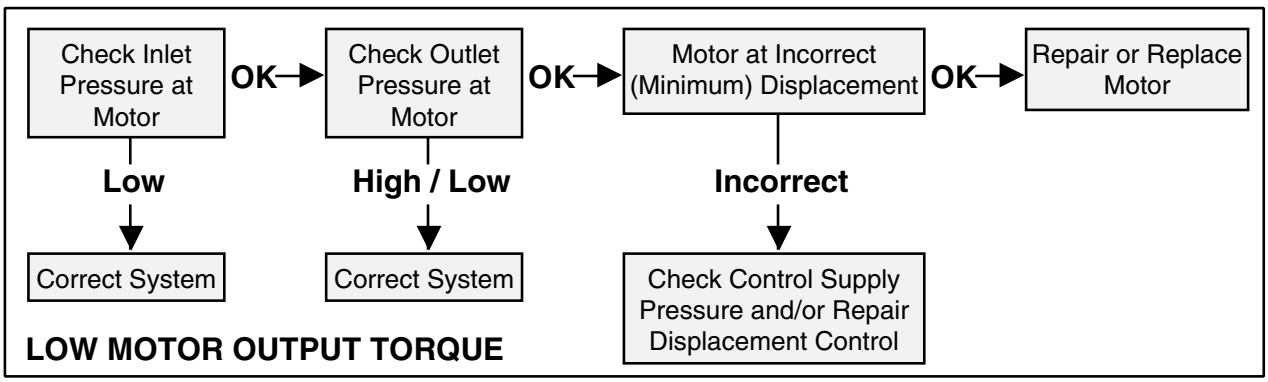


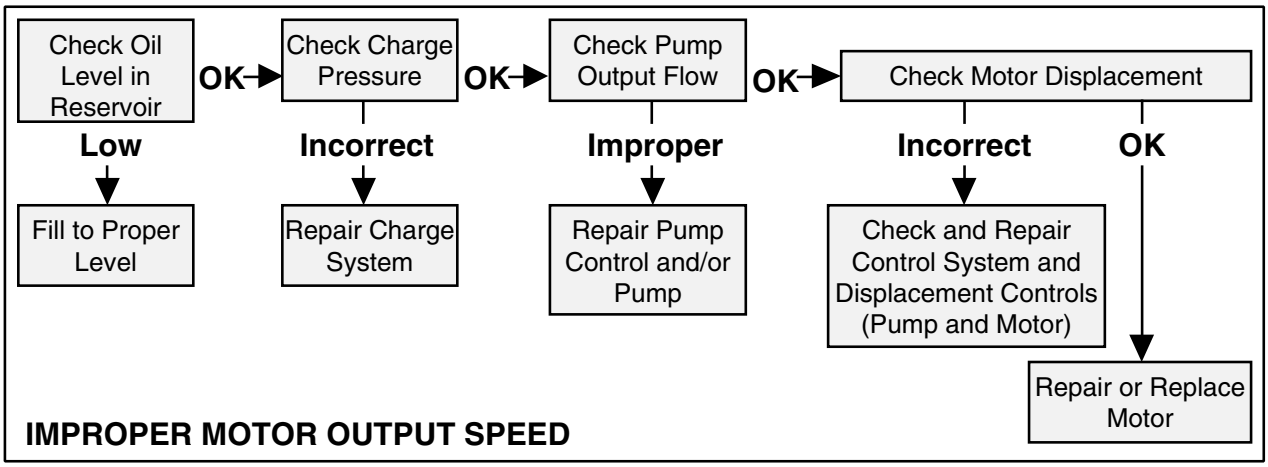
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Troubleshooting (Continued)

Fault-Logic Diagrams • Closed Circuit (Continued)







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Notes

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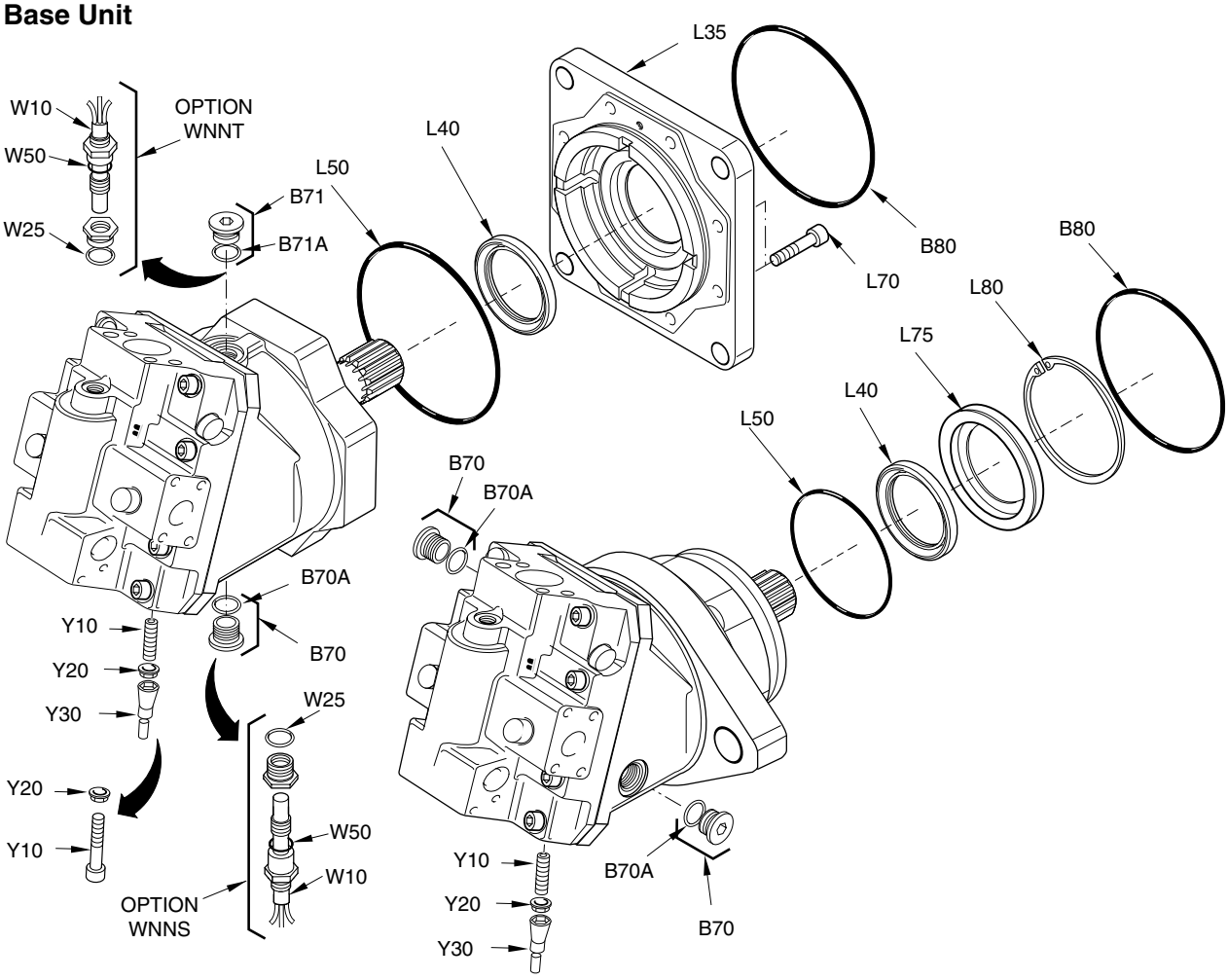
Notes

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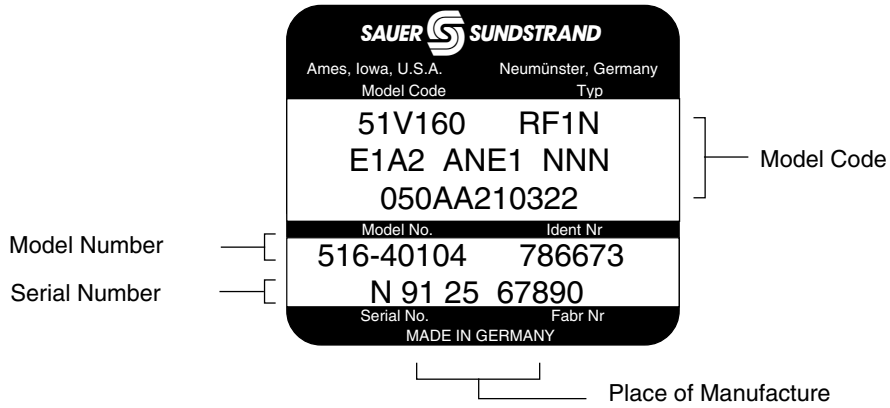
Exploded View of the Series 51 Variable Motor

The following information is for general parts identification ONLY. Refer to the applicable Service Parts List when ordering service parts.

Base Unit



Name Plate



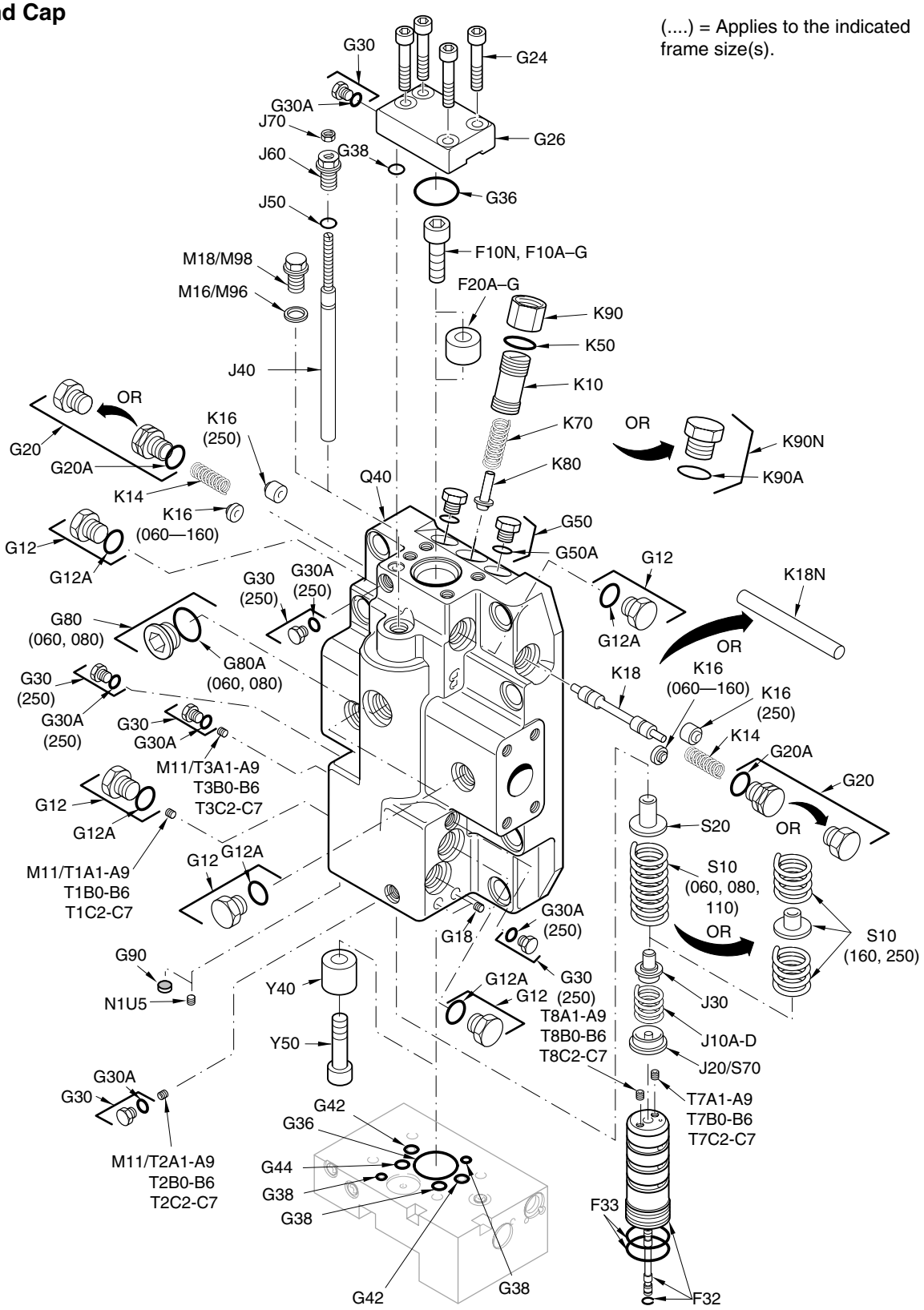
Name Plate (German Production)

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Exploded View of the Series 51 Variable Motor (Continued)

End Cap

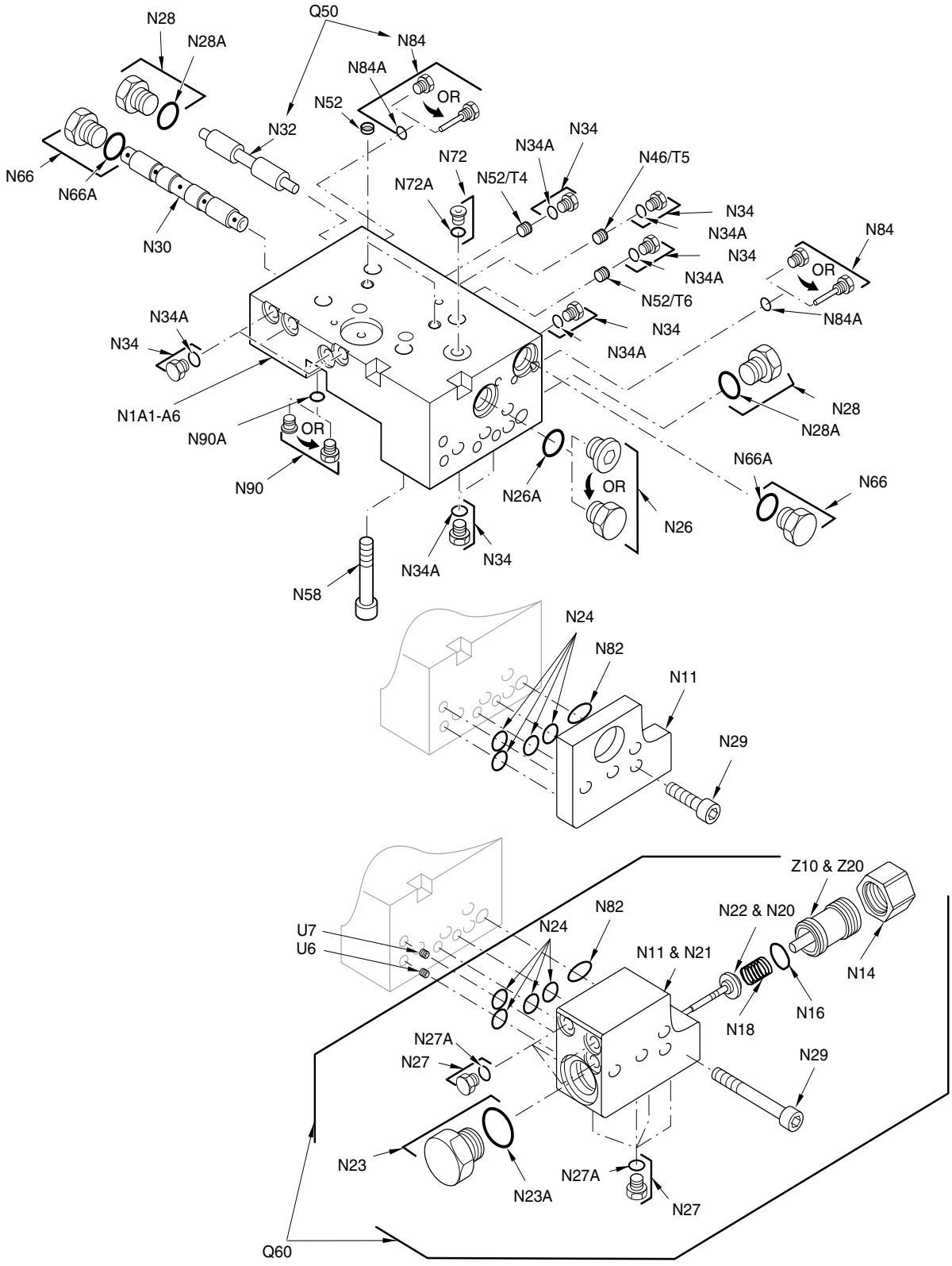
(....) = Applies to the indicated frame size(s).



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Exploded View of the Series 51 Variable Motor (Continued)

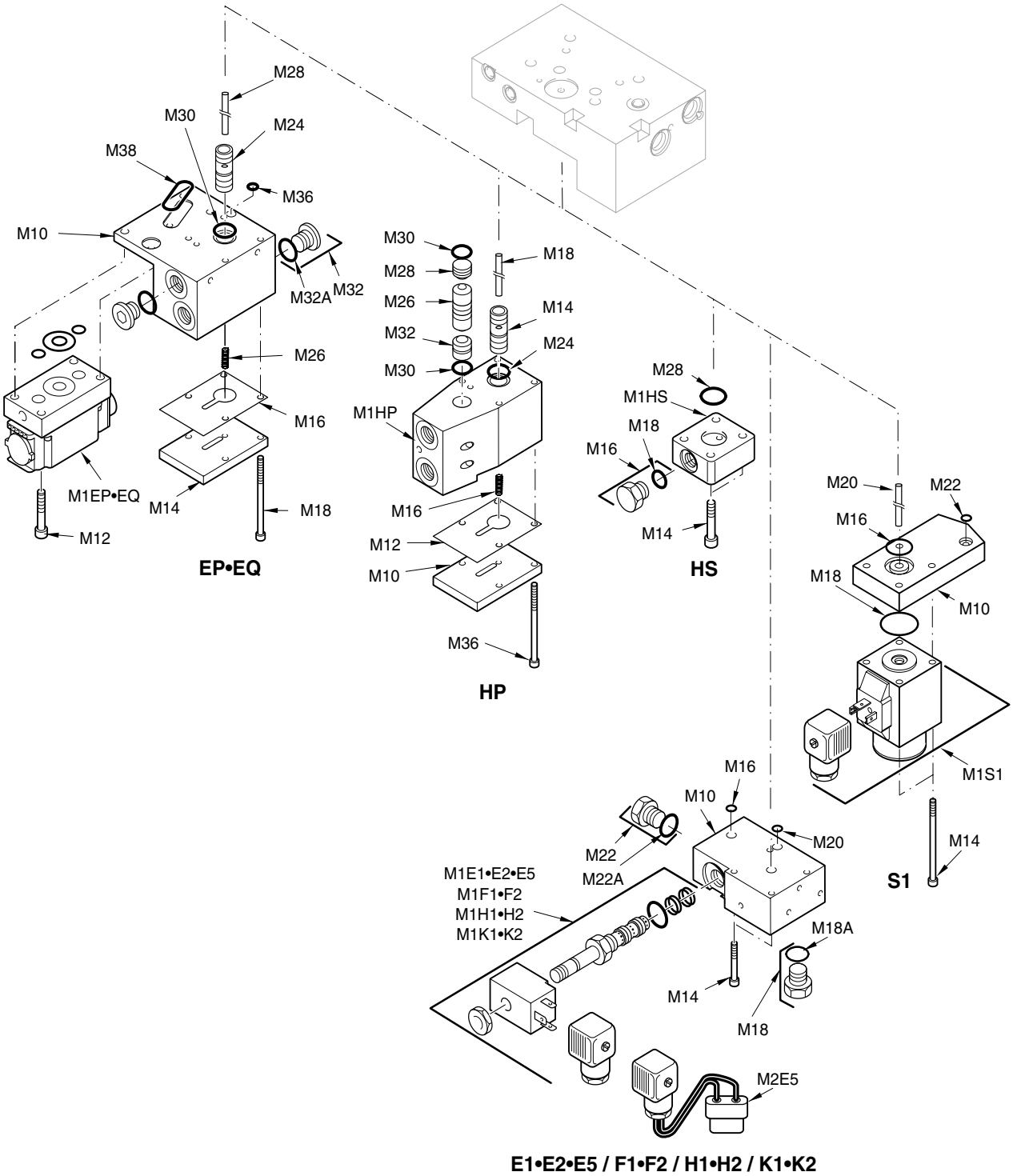
Multi-Function Valve



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Exploded View of the Series 51 Variable Motor (Continued)

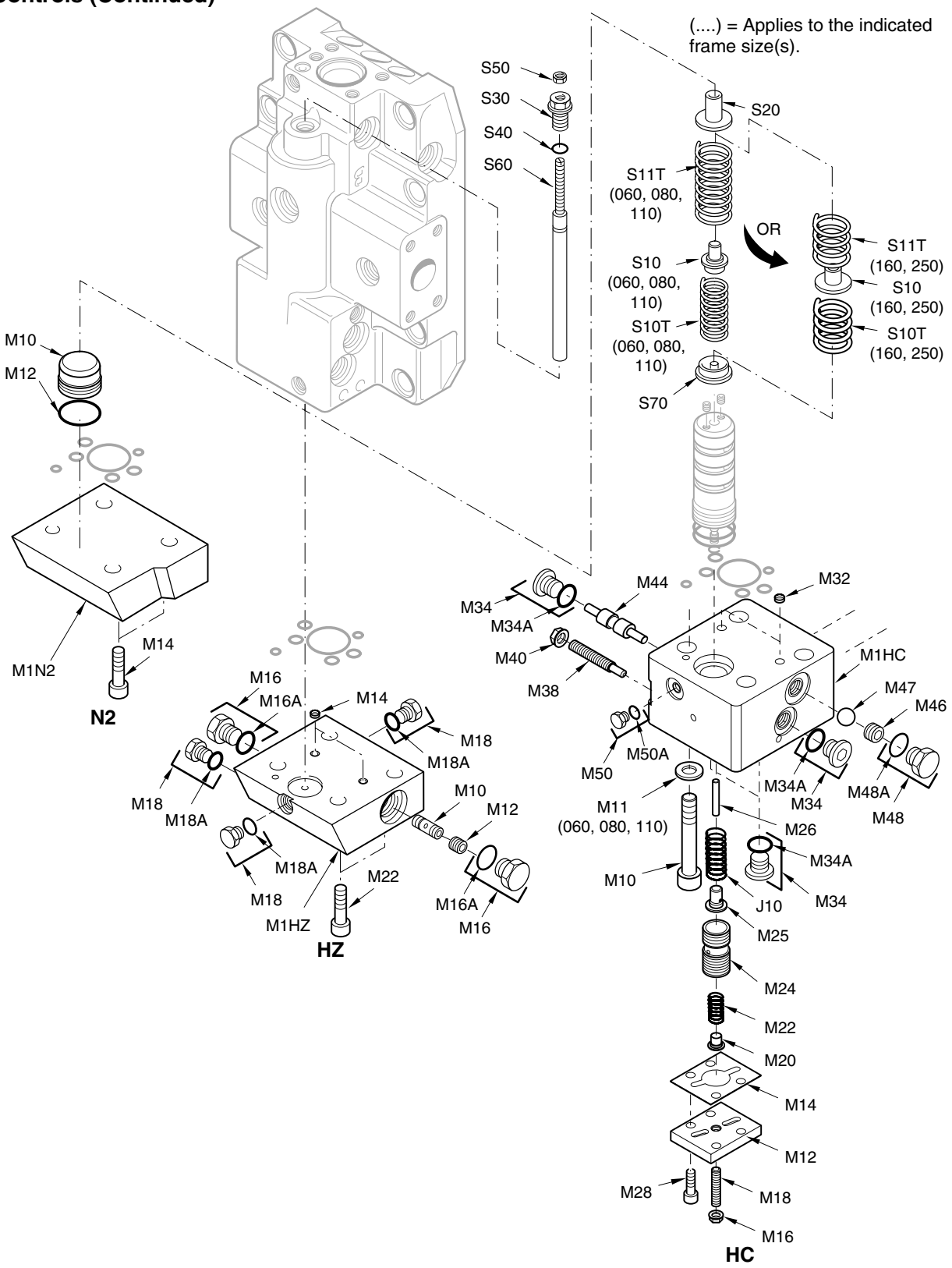
Controls



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Exploded View of the Series 51 Variable Motor (Continued)

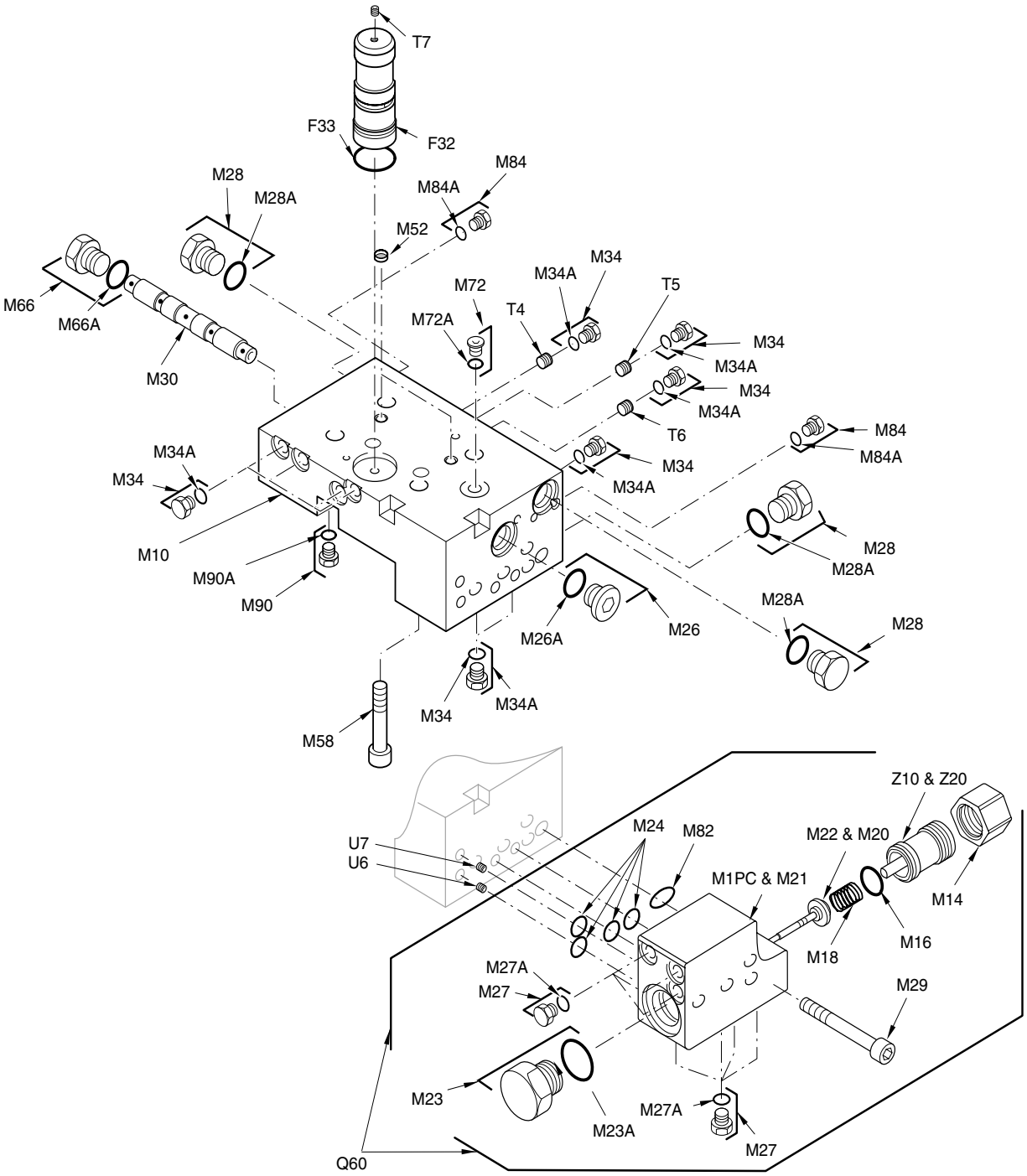
Controls (Continued)



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Exploded View of the Series 51 Variable Motor (Continued)

PC Regulator



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Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
B000	**COMMON PARTS GROUP (SAE FLNG)**	
B80	O-RING	1
L35	FLANGE- SAE	1
L40	SEAL- SHAFT	1
L50	O-RING	1
L70	SCREW- SOC HD	8
C000	**COMMON PARTS GROUP (CARTRIDGE)**	
L40	SEAL- SHAFT	1
L50	O-RING	1
L75	COVER- SEAL	1
L80	RING- RETAINING	1
F•••	**MAXIMUM DISPLACEMENT**	
F10	SPACER- MAX DISPL LMTR	1
F20	SCREW-SOC HD - MAX DISPL LMTR	1
G00A	**END CAP-AXIAL (160-250)**	
G00B	**END CAP-AXIAL, CODE 61 (160-250)**	
G00R	**END CAP-SIDE, LOOP FL**	
G00S	**END CAP-SIDE, LOOP FL, CODE 61**	
G12	PLUG-STR THD HEX	7
G14	PLUG-EXP	1
G16	PLUG-MANDREL	2
G18	SCREW-SET, FLAT PT	2
G20	PLUG- SPECIAL	2
G20N	PLUG- STR THD HEX	2
G24	SCREW-SOC HD	4
G26	COVER-SERVO PISTON	1
G30	PLUG-STR THD HEX	3
G36	O-RING	2
G38	O-RING	4
G42	O-RING	2
G44	O-RING	1
G50	PLUG-ST THD HEX	2
G70	COVER-PORT	2
G90	CONTROL SCREEN FILTER	1
K10	ADJ PLUG ASSY-CHG RLF	1
K14	SPRING-HELICAL COMP	2
K16	GUIDE-SPRING (060 — 160)	2
K16	GUIDE-SPRING (250)	2
K18	SHUTTLE VALVE SPOOL	1
K18N	LOOP FLUSH SPOOL- DEFEAT	1
K50	O-RING	1
K70	SPRING-HELICAL COMPRESSION	1
K80	POPPET-CHG RELIEF	1
K90	NUT-HEX LOCK	1
K90N	PLUG- ST THD HEX	1

Item	Description	Quantity
J00A-K	**CONTROL START SETTING**	
J10A-K	SPRING-HEL COMP- CONT START	1
J20	SEAT-SPRING	1
J30	SEAT-SPRING	1
J40	SCREW-ADJUSTING	1
J50	O-RING	1
J60	NUT-ADJUSTING SCREW	1
J70	NUT-LOCK	1
J00N	**CONT START N/A (FOR 2 POS CONT)**	
M0EP	**CONTROL- ELHYD PRP, PACKARD**	
M0EQ	**CONTROL- ELHYD PRP, MS**	
F32	BUSHING- VALVE ASSY	1
M1EP	PCP VALVE, PACKARD CONN	1
M1EQ	PCP VALVE, MS CONN	1
M10	HOUSING- CONTROL	1
M12	SCREW- SOC HD	4
M14	COVER	1
M16	GASKET	1
M18	SCREW- SOC HD	4
M24	PISTON- SHUTTLE, DELTA P	1
M26	SPRING- HEL COMPRESSION	1
M28	PIN	1
M30	O-RING	1
M32	PLUG-SOC HD	2
M34	PLUG-MANDREL	6
M36	O-RING	1
M38	O-RING	1
M40	CONTROL SCREEN FILTER	1
M42	PLUG-SOC HD	1
M44	PLUG-PLASTIC	1
N90	PLUG-STR THD HEX	1
M0E1/E2	**CONTROL- ELHYD 2 POS**	
M0F1/F2	**CONTROL- ELHYD 2 POS, MAX ANG**	
F32	BUSHING- VALVE ASSY	1
M1E1	VALVE ASSY- SOLENOID,12V	1
M1E2	VALVE ASSY- SOLENOID,24V	1
M10	HOUSING-CONT, ELHYD, 2 POS (E)	1
M10	HOUSING-CONT, ELHYD, 2 POS (F)	1
M12	PLUG-EXP	7
M14	SCREW-SOC HD	4
M16	O-RING	2
M18	PLUG-STR THD HEX	1
M20	O-RING	1
M22	PLUG-STR THD HEX	1
N90	PLUG-STR THD HEX	1

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Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
M0HC	**CONTROL- HYD PRPNL 2LN, DUAL PATH**	
F32	BUSHING- VALVE ASSY	1
M1HC	HOUSING- HYD PRPNL (2LN),DUAL	1
M10	SCREW-SOC HD	4
M11	WASHER, FLAT (060, 080, 110)	4
M12	COVER	1
M14	GASKET	1
M16	NUT-SEAL LOCK	1
M18	SCREW-SET, FL PT	1
M20	GUIDE- SPRING	1
M22	SPRING-HELICAL COMPRESSION	1
M24	PISTON- DELTA P	1
M25	SEAT- SPRING	1
M26	PIN	1
M28	SCREW-SOC HD	4
M32	CONTROL SCREEN FILTER	2
M34	PLUG-SOC HD	4
M38	VALVE- BLEED	1
M40	NUT- SEAL LOCK	1
M44	VALVE, SHUTTLE- DELTA P	1
M46	SEAT- BALL CHECK	1
M47	BALL- SHUTTLE	1
M48	PLUG-STR THD HEX	1
M50	PLUG-STR THD HEX	1
M0HP	**CONTROL- HYD PRPNL 2LN, W/BLD**	
F32	BUSHING- VALVE ASSY	1
M1HP	HOUSING- HYD PRPNL (2LN),W/BLD	1
M10	COVER	1
M12	GASKET	1
M14	PISTON-SHUTTLE, DELTA P	1
M16	SPRING-HELICAL COMPRESSION	1
M18	PIN	1
M24	O-RING	1
M26	VALVE SHUTTLE,DELTA P	1
M28	PLUG-SEALING	1
M30	O-RING	2
M32	PLUG-SEALING	1
M34	PLUG-EXP	6
M36	SCREW-SOC HD	4
N90	PLUG-STR THD HEX	1

Item	Description	Quantity
M0HS	**CONTROL- HYD PRP, 1 LN**	
F32	BUSHING-VALVE ASSY	1
M1HS	HOUSING- VALVE, HYD PRPRNL 1 LN	1
M10	SCREW-SOC HD	4
M12	O-RING	1
M14	PLUG-STR THD HEX	1
M16	PLUG-PLASTIC	1
N90	PLUG-STR THD HEX	1
M0HZ	**CONTROL- HYD PRP, 1 LN, CMPCT**	
F32	BUSHING- VALVE ASSY	1
M1HZ	HOUSING- VALVE, HYD PRP, 1 LN, CPT	1
M10	VALVE ASSY- DBL CHECK	1
M12	SCREW- SOC- DRILLED	1
M14	CONTROL SCREEN FILTER	2
M16	PLUG-STR THD HEX	2
M18	PLUG-STR THD HEX	3
M0H1/H2	**CONTROL- HYD PRP, 1 LN, MAX ANG**	
M0K1/K2	**CONTROL- HYD PRP, 1 LN, MIN ANG**	
F32	BUSHING-VALVE ASSY	1
M1H1	VALVE ASSY-SOLENOID,12V	1
M1H2	VALVE ASSY-SOLENOID,12V	1
M10	HSG-CONT,ELHYD, 2 POS	1
M12	PLUG-EXP	8
M14	SCREW-SOC HD	4
M16	O-RING	2
M18	PLUG-STR THD HEX	1
M20	O-RING	1
M22	PLUG-PLASTIC	1
N90	PLUG-STR THD,SOC HD	1
M0N2	**CON-HYD, 2 POS, DIRECT**	
M1N2	COVER	1
M10	PLUG	1
M11	SCREW- SET,FLT PT	3
M12	O-RING	1
M14	SCREW-SOC	4
M16	GASKET	1
M18	PLUG	1

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Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
M0PC	**REGULATOR- PRESS COMP**	
F32	PLUG- VALVE BUSHING BORE	1
F33	O-RING	1
M1PC	HOUSING- VALVE	1
M10	HOUSING- MULTI FUNCTION BLOCK	1
M14	NUT-HEX LOCK	1
M16	O-RING	1
M18	SPRING-HELICAL COMPRESSION	1
M20	SEAT-SPRING, PC	1
M21	BUSHING-VALVE	1
M22	SPOOL-PC VALVE	1
M23	PLUG-STR THD HEX	1
M26	PLUG-SOC HD	1
M27	PLUG-STR THD HEX	10
M28	PLUG-STR THD HEX	4
M29	SCREW-SOC	4
M30	SPOOL, BI-DIRECTIONAL CHECK	1
M34	PLUG-STR THD HEX	10
M36	SCREW-SET,FLT PT	5
M38	PLUG-EXP	11
M50	PLUG-EXP	8
M52	CONTROL SCREEN FILTER	2
M54	PLUG-EXP	1
M58	SCREW-SOC HD	4
M62	PLUG-EXP	1
M66	PLUG-STR THD HEX	2
M72	PLUG-STR THD,SOC HD	1
M82	O-RING	1
M84	PLUG-STR THD HEX	2
M86	SCREW-FL PT	1
M90	PLUG-STR THD HEX	1
M96	GASKET	1
M98	PLUG	1
N24	O-RING	5
M0S1	**CONTROL- ELECTRIC 2 POS, DIRECT**	
F32	BUSHING- VALVE ASSY	1
M1S1	SOLENOID,12V	1
M10	ADAPTER PLATE- SOLENOID	1
M14	SCREW-SOC HD	4
M16	O-RING	1
M18	O-RING	1
M20	PIN	1
M22	O-RING	1
N90	PLUG-STR THD HEX	1

Item	Description	Quantity
N0A1-6	**SVO PRS SPLY, PCOR, DFT**	
N1A1-6	HOUSING-MULTI FUNCTION BLOCK	1
N11	HOUSING-VALVE	1
N14	NUT-HEX LOCK	1
N16	O-RING	1
N18	SPRING-HELICAL COMPRESSION	1
N20	SEAT-SPRING, PCOR	1
N21	BUSHING-VALVE	1
N22	SPOOL-PCOR VALVE	1
N23	PLUG-STR THD HEX	1
N24	O-RING	5
N26	PLUG-SOC HD (W/PCOR)	1
N26	PLUG-STR THD HEX (WO/PCOR)	1
N27	PLUG-STR THD HEX	17
N28	PLUG-PLASTIC (W/DFT)	2
N28	PLUG-STR THD HEX (WO/DFT)	2
N29	SCREW-SOC	4
N30	SPOOL, BI-DIRECTIONAL CHECK	1
N32	PISTON	1
N34	PLUG-STR THD HEX	10
N36	SCREW-SET,FLT PT	5
N38	PLUG-EXP (060 - 110 ONLY)	11
N50	PLUG-EXP (060 - 110 ONLY)	6
N52	CONTROL SCREEN FILTER	2
N54	PLUG-EXP	1
N58	SCREW-SOC HD	4
N62	PLUG-EXP	1
N66	PLUG-STR THD HEX (060-110)	2
N66	PLUG-STR THD HEX (160-250)	1
N72	PLUG-STR THD,SOC HD	1
N74	SCREW-SET, FL PT	3
N82	O-RING	1
N84	PLUG, SPECIAL	2
N84	PLUG-STR THD HEX	2
N86	SCREW-SET	1
U5	PLUG- SOC (EXT SUPPLY)	1
U6	ORIFICE, PCOR DAMPING	1
U7	ORIFICE, PCOR DAMPING	1
N0NN	**SERVO PRESS SPLY- NONE**	
P0AA	**SYS PRESS PROTECT- NONE**	

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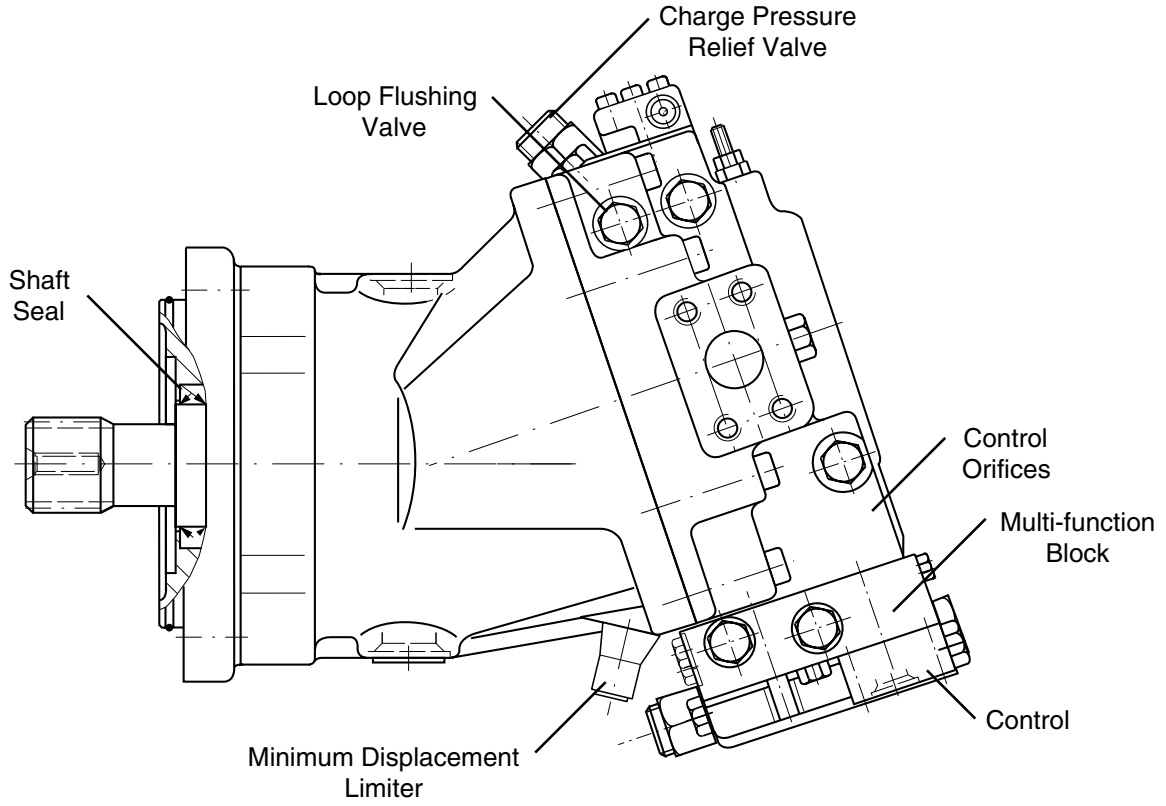
Exploded View of the Series 51 Variable Motor (Continued)

Item	Description	Quantity
S00D-G	**CONTROL RAMP- HP, HS, H1/H2, K1/K2**	
S10	GUIDE-SPRING (160-250)	1
S10D-G	CONT RAMP SPRING (060-110)	1
S10D-G	CONT RAMP SPRING ASSY (160-250)	2
S20	GUIDE-SPRING	1
S70	SEAT-SPRING	1
S00N	**CONTROL RAMP-NONE**	
S00T	**CONTROL RAMP- HC**	
S10	GUIDE-SPRING	1
S10T	CONT RAMP SPRING	1
S11T	CONT RAMP SPRING	1
S20	GUIDE-SPRING	1
S30	NUT- ADJUSTING SCREW	1
S40	O-RING	1
S50	NUT- LOCK	1
S60	SCREW- ADJUSTING	1
S70	SEAT-SPRING	1
S00U-Z	**CONTROL RAMP- EP/EQ**	
S10	GUIDE-SPRING (160-250)	1
S10U-Z	CONT RAMP SPRING (060-110)	1
S10U-Z	CONT RAMP SPRING ASSY (160-250)	1
T0A0	**CON ORIFICE (A0)- NONE**	
T0A1	**CON ORIFICE (A1)**	
T1	ORIFICE	1
T2	ORIFICE	2
T3	ORIFICE	1
T4	SCREW	2
T5	ORIFICE	1
T6	SCREW	1
T7	ORIFICE	2
T8	ORIFICE	1
U3	SCREW-FL PT	1
T0A2	**CON ORIFICE (A2)**	
T1	ORIFICE	1
T2	ORIFICE	2
T3	ORIFICE	1
T4	ORIFICE	2
T5	SCREW	1
T6	ORIFICE	1
T7	ORIFICE	2
T8	ORIFICE	1
WNNN	**SPCL HDW-NONE**	
A10	SPEED SENSOR 51V	0
B70	PLUG-SOC HD	1
B71	PLUG-PLASTIC	1

Item	Description	Quantity
Y•••	**MINIMUM DISPLACEMENT**	
Y10	SCREW- SET, FLT PT	1
Y20	NUT- HEX, SEAL LOCK	1
Y30	TAMPER RESISTANT CAP	1
Z000	**PRS COMP SET- NONE**	
Z0••	**PCOR / PRESS COMP SETTING**	
Z10	ADJUSTER- THREADED	1
Z20	PIN-STRAIGHT	1

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Minor Repair and Replacement - Variable Motor



51000052

Variable Displacement Motor (SAE Flange Configuration)

Fig. 50-1 - Minor Repairs

Minor Repairs may be performed, following the procedures in this section, without voiding the unit warranty. Although specific products are illustrated, these procedures apply to all units in the Series 51 family.

General

Cleanliness is a primary means of insuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

It is recommended that all gaskets and O-rings be replaced. All gasket sealing surfaces must be cleaned prior to installing new gasket. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly.

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Minor Repair and Replacement - Variable Motor (Continued)


51000178

Fig. 50-2 - Remove Screws Holding Flange to Housing (SAE)


51000179

Fig. 50-3 - Remove Flange (SAE)

Shaft Seal (SAE Flange Configuration)

Lip type shaft seals are used on the Series 51 motors.

Replacement of the shaft seal usually requires removal of the motor from the machine.

Remove the screws holding the flange to the housing, using a 6 mm internal hex wrench (060 and 080 units), an 8 mm internal hex wrench (110 units), a 10 mm internal hex wrench (160 units), or a 12 mm internal hex wrench (250 units).

Remove the flange from the housing using a suitable puller. Care must be taken so as to not damage the housing bore or shaft.

CAUTION

Do not allow the output shaft to move out of the housing while removing the flange. After the flange is removed, do not attempt to remove the shaft from the housing. If the output shaft moves out of the housing, the synchronizing shaft and rollers could fall out of position, requiring major disassembly of the unit.


51000053

Fig. 50-4 - Remove Old Seal from Flange (SAE)


51000054

Fig. 50-5 - New Seal Installed in Flange (SAE)

Remove the old seal from the flange. Once removed, the seal is not reusable.

Inspect the flange and the new seal for any damage or nicks.

Using an arbor press, press the new seal into the flange. Be careful not to damage seal.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the seal bore in the flange.

Inspect the sealing area on the shaft for rust, wear, or contamination.

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Minor Repair and Replacement - Variable Motor (Continued)

Install a new O-ring on the flange. Prior to assembly, lubricate the flange O-ring and the I.D. of the seal with petroleum jelly.

Protect the seal lip from damage during installation by wrapping the spline or key end of shaft with plastic film, or by using a seal installation tool.

Assemble the flange and seal over the shaft and into the housing bore. Install four (4) of the flange screws, and tighten them evenly to pull the flange into position. Take care to not damage the O-ring or seal lip during installation.

Install the flange screws and torque evenly to 32 Nm (24 ft•lbsf) for 060 and 080 motors, 63 Nm (46 ft•lbsf) for 110 motors, 110 Nm (81 ft•lbsf) for 160 motors, and 174 Nm (128 ft•lbsf) for 250 motors.



51000055

Fig. 50-6 - Install Flange onto Housing (SAE)



51000056

Fig. 50-7 - Torque Flange Screws (SAE)

Shaft Seal (Cartridge Configuration)

Lip type shaft seals are used on the Series 51 motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the motor from the wheel drive or track drive gearbox.

Remove the seal carrier retaining ring from the housing.

Carefully pull the seal cover out of the housing. Care must be taken so as not to damage the housing bore or shaft.

Remove the O-ring from the housing.

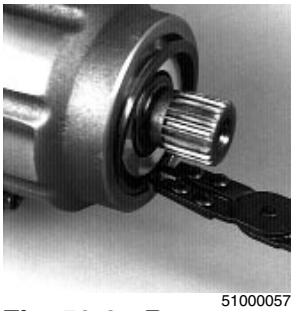
Remove the old seal from the carrier. Once removed, the seal is not reusable.

Inspect the carrier and the new seal for any damage or nicks.

Using an arbor press, press the new seal into the carrier. Be careful not to damage seal.

NOTE: The outside diameter of the seal may be lightly coated with a sealant (such as Loctite High Performance Sealant #59231) prior to installation. This will aid in preventing leaks caused by damage to the seal bore in the seal carrier.

Inspect the sealing area on the shaft for rust, wear, or contamination.



51000057

Fig. 50-8 - Remove Carrier Retaining Ring (Cartridge)



51000058

Fig. 50-9 - Remove Seal Carrier (Cartridge)



51000059

Fig. 50-10 - Seal Carrier Removed (Cartridge)



51000060

Fig. 50-11 - Seal Installed in Carrier (Cartridge)

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Minor Repair and Replacement - Variable Motor (Continued)


51000061

Fig. 50-12 - Install Seal Carrier (Cartridge)


51000057

Fig. 50-13 - Install Carrier Retaining Ring (Cartridge)

Install the carrier O-ring into the groove in the housing. Prior to assembly, lubricate the carrier O-ring and the I.D. of the seal with petroleum jelly.

Protect the seal lip from damage during installation by wrapping the spline or key end of shaft with plastic film, or by using a seal installation tool.

Assemble the carrier and seal over the shaft and into the housing bore. Take care to not damage the O-ring or seal lip during installation.

Install the seal carrier retaining ring.


51000062

Fig. 50-14 - Remove Shuttle Valve Plugs

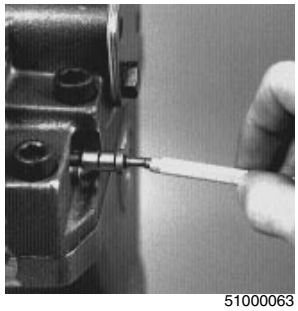

51000063

Fig. 50-15 - Remove Valve Spool

Loop Flushing Shuttle Valve (Option)

Using an 11/16" wrench, remove the hex plugs from both sides of end cap.

Remove springs and spring seat washers. Note the orientation of the washers.

NOTE The 250 frame size motors use thicker spring seat washers.

Remove flushing valve spool.

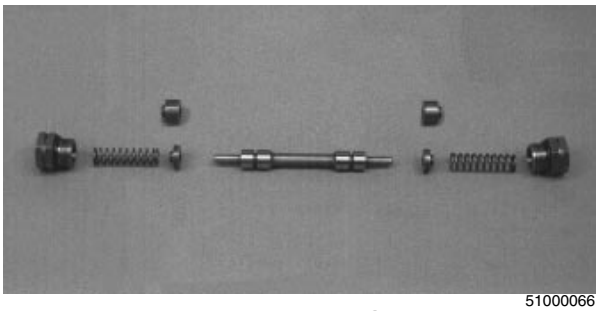

51000066

Fig. 50-16 - Loop Flushing Shuttle Valve Components

Inspect parts for damage or foreign material.


51000064

Fig. 50-17 - Install Valve Spool and Washers


51000065

Fig. 50-18 - Install Plugs and Springs

Install flushing valve spool in end cap, then install the spring seat washers (thick washers on 250 frame size motors) on each end of the spool. The step on the spring seat washers should face out, toward the springs.

Install the spool springs and hex plugs. Torque the plugs to 41 Nm (30 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Charge Pressure Relief Valve

Before removing the screw adjustable relief valve plug, mark the plug, lock nut, and end cap to allow maintaining the original adjustment when assembling. Remove the screw adjustable charge relief valve plug by loosening the lock nut (with a 1-1/16" hex wrench), and unscrewing the plug with a large screwdriver.

Remove the spring and relief valve poppet.

Inspect the poppet and mating seat in the end cap for damage or foreign material.

Install the poppet and spring. Install the plug with its lock nut, aligning the marks made at disassembly, and torque the lock nut to 52 Nm (38 ft•lbsf).

Check and adjust, if necessary, the charge pressure.



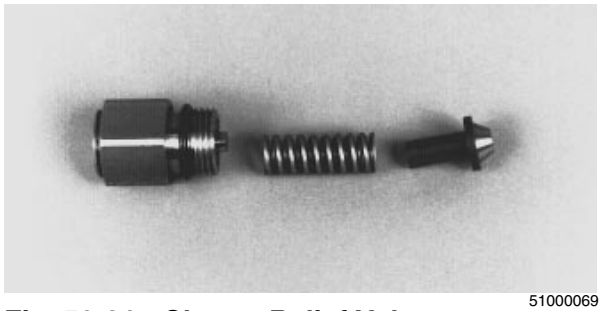
51000067

Fig. 50-19 - Remove Charge Relief Valve Plug



51000068

Fig. 50-20 - Remove Charge Relief Valve



51000069

Fig. 50-21 - Charge Relief Valve Components

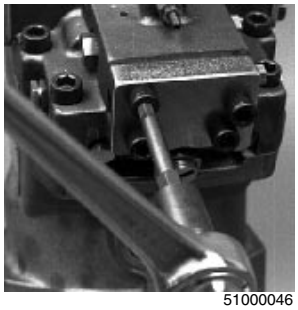
Minimum Angle Servo Cover

Thoroughly clean external surfaces prior to removal of cover.

Remove the four (4) screws retaining the cover to the end cap with an 8 mm internal hex wrench (060, 080, 110, and 160 units) or a 10 mm internal hex wrench (250 units). Remove the cover. Remove the O-rings between the cover and end cap.

Install new O-rings on the end cap and retain with petroleum jelly. Install the cover onto the end cap and install the screws. Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or 110 Nm (81 ft•lbsf) for 160 or 250 units.

The plug in the cover may be removed with a 7/16" hex wrench. Torque this plug to 9 Nm (7 ft•lbsf).



51000046

Fig. 50-22 - Remove Servo Cover Screws

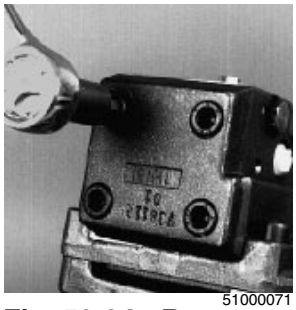


51000006

Fig. 50-23 - Install Servo Cover

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Minor Repair and Replacement - Variable Motor (Continued)



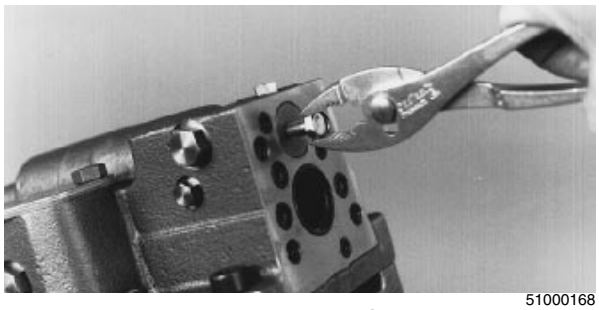
51000071

Fig. 50-24 - Remove Cover Plate Screws



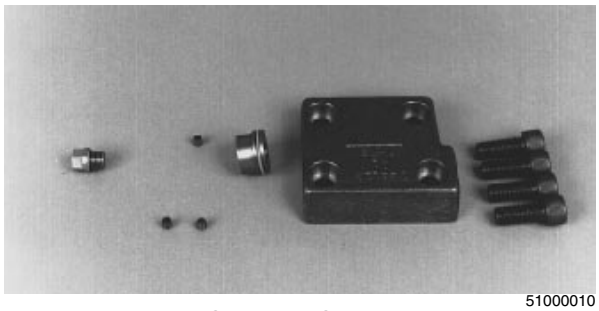
51000072

Fig. 50-25 - Remove Cover Plate



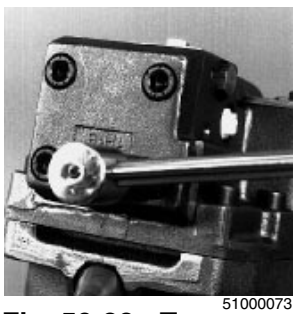
51000168

Fig. 50-26 - Remove Valve Sleeve Bore Plug



51000010

Fig. 50-27 - N2 Control Components



51000073

Fig. 50-28 - Torque Cover Plate Screws



51000074

Fig. 50-29 - Torque Plug in End Cap

Hydraulic 2-Position Control (Type N2)

Thoroughly clean external surfaces prior to removal of cover plate.

Remove the four (4) screws retaining the cover plate to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units). Remove the cover plate.

Remove the solid plug from the valve sleeve bore in the end cap. (An 8 mm threaded hole is provided in the plug for a puller screw.) Remove the O-ring from the plug.

Remove the O-rings from the end cap.

Install new O-rings on the end cap and retain with petroleum jelly.

Install a new O-ring on the solid plug and install the solid plug into the end cap.

Install the cover plate onto the end cap and install the screws. Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.

Set screws are installed in control orifice holes in the end cap to plug the valve sleeve bore passages. To gain access to the screw plugs, remove the outer plugs from the end cap with a 7/16" or 11/16" hex wrench. Remove the screw plugs with a 3 mm internal hex wrench. When installing, torque the screw plugs to 4 Nm (35 in•lbsf). Torque the 5/16" outer plugs to 9 Nm (7 ft•lbsf), and the 9/16" outer plugs to 37 Nm (27 ft•lbsf). Refer to the “Control Orifices” topic for additional information.

The special plug and seal washer on the end cap opposite the control may be removed with a 13 mm hex wrench. When installing, torque this plug to 20 Nm (15 ft•lbsf).

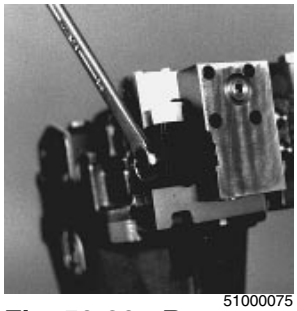
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Minor Repair and Replacement - Variable Motor (Continued)

Electrohydraulic 2-Position Controls (Types E1•E2 and F1•F2)

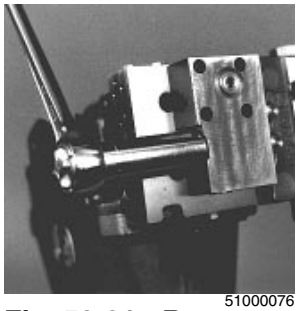
Thoroughly clean external surfaces prior to removing the control.

The solenoid may be removed from the valve by removing the nut with a 3/4" hex wrench. The solenoid valve may be removed from the control valve housing with a 7/8" hex wrench.



51000075

Fig. 50-30 - Remove E1•E2 or F1•F2 Control Solenoid

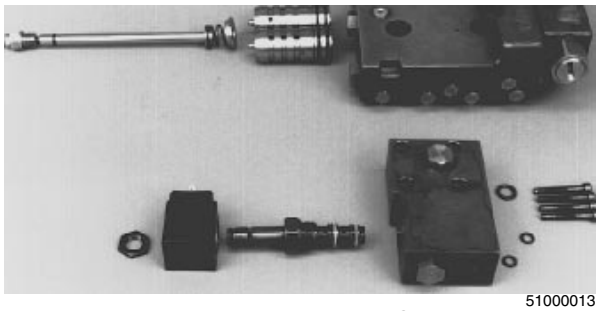


51000076

Fig. 50-31 - Remove Solenoid Valve

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

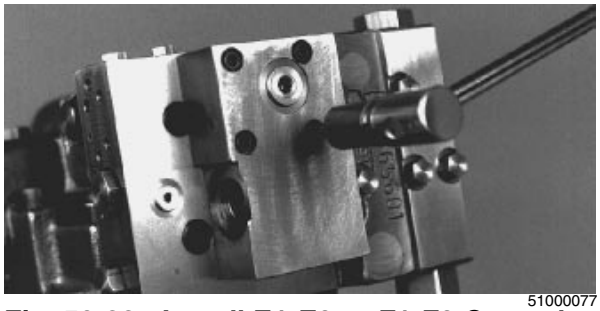
The plugs on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plugs to 37 Nm (27 ft•lbsf).



51000013

Fig. 50-32 - E1•E2 and F1•F2 Control Components

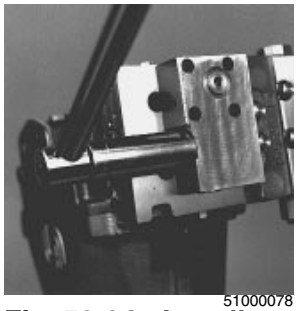
Install new O-rings onto the valve housing. Install the valve housing onto the multi-function block, and install the screws. Torque the screws to 6.4 Nm (4.7 ft•lbsf).



51000077

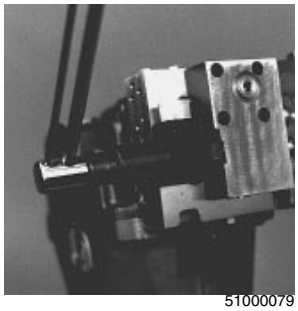
Fig. 50-33 - Install E1•E2 or F1•F2 Control Valve Housing

When installing the solenoid valve into the valve housing, the valve should be torqued to 20 Nm (15 ft•lbsf). When installing the solenoid onto the valve, torque the nut to 15 Nm (11 ft•lbsf.).



51000078

Fig. 50-34 - Install Solenoid Valve



51000079

Fig. 50-35 - Install Solenoid

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Minor Repair and Replacement - Variable Motor (Continued)

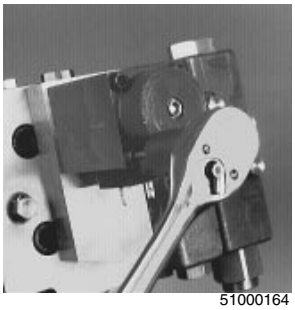

51000164

Fig. 50-36 - Remove S1 Control Screws


51000165

Fig. 50-37 - Remove Adapter Plate and Solenoid

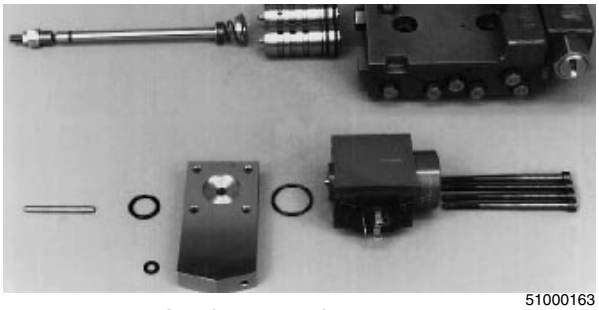

51000163

Fig. 50-38 - S1 Control Components

Electric 2-Position Controls (Type S1)

Thoroughly clean external surfaces prior to removing the control.

Remove the screws retaining the solenoid and solenoid adapter plate to the multi-function block with a 4 mm internal hex wrench. Remove the solenoid and the solenoid adapter plate from the multi-function block.

Remove the solenoid pin from the multi-function block.

Install new O-rings onto the adapter plate and the solenoid.

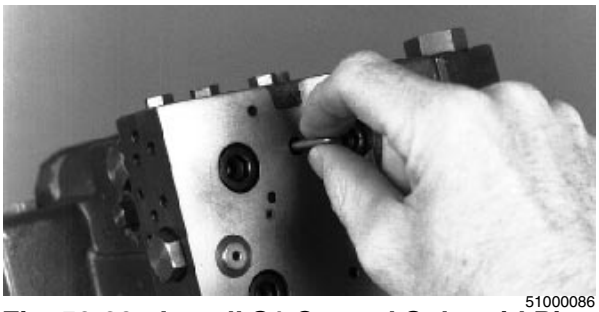

51000086

Fig. 50-39 - Install S1 Control Solenoid Pin

Install the solenoid pin into the hole in the multi-function block.

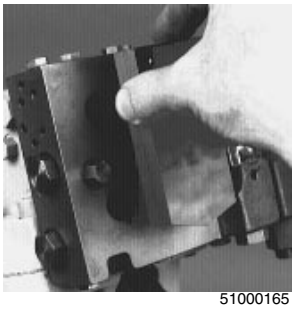

51000165

Fig. 50-40 - Install Adapter Plate and Solenoid

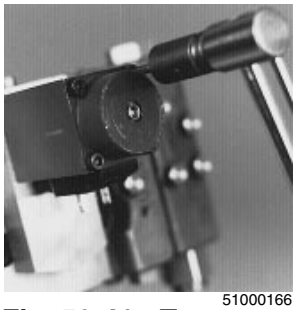

51000166

Fig. 50-41 - Torque Control Solenoid Screws

Install the adapter plate with O-rings onto the multi-function block.

Install the solenoid with O-ring onto the adapter plate.

Install the screws and torque to 6.4 Nm (4.7 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Hydraulic Proportional Control (Type HZ)

Thoroughly clean external surfaces prior to removal of control.

Remove the four (4) screws retaining the valve housing to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units). Remove the valve housing. Remove the O-rings between the valve housing and end cap, and the O-ring on the valve spool sleeve.

The plugs on the control housing may be removed with a 7/16" or 11/16" hex wrench. When reinstalling, torque the 5/16" plugs to 9 Nm (7 ft•lbsf), and the 9/16" plugs to 37 Nm (27 ft•lbsf)

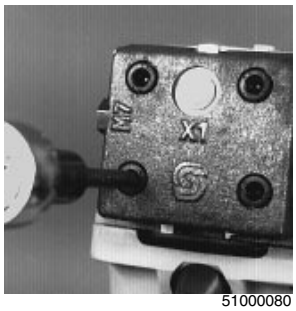
The valve housing is equipped with filter screens in the passages between the housing and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the valve housing or end cap.

Units with external servo pressure supply have a plug installed in the end cap passage leading to the valve spool sleeve. This plug may be removed with a 2.5 mm internal hex wrench. When installing this plug, torque to 2 Nm (18 in•lbsf).

Install a new O-ring onto the valve spool sleeve in the end cap. Install new O-rings onto the end cap.

Install the valve housing onto the multi-function block, and install the screws.

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.



51000080

Fig. 50-42 - Remove HZ Control Housing Screws


51000081

Fig. 50-43 - Remove HZ Control Housing

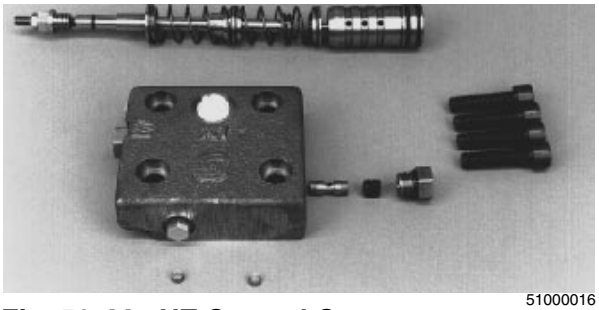

51000016

Fig. 50-44 - HZ Control Components

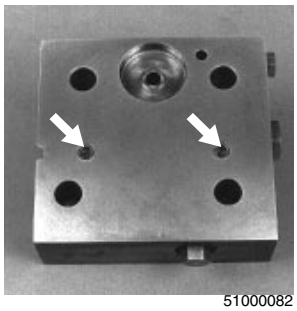

51000082

Fig. 50-45 - HZ Control Housing Screens

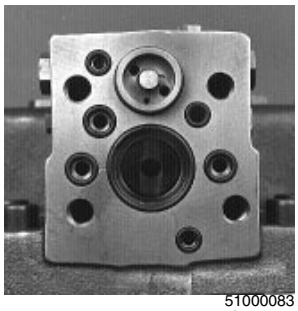
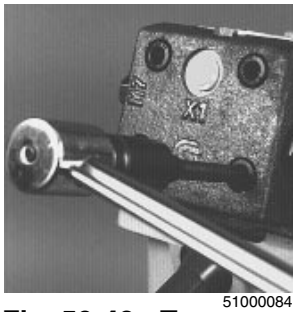

51000083

Fig. 50-46 - End Cap O-Rings Installed


51000081

Fig. 50-47 - Install HZ Control Housing

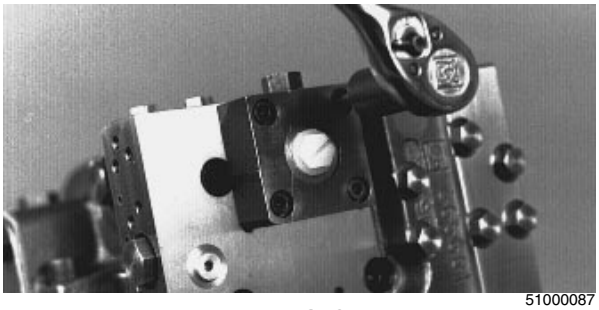


51000084

Fig. 50-48 - Torque HZ Control Valve Housing Screws

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Minor Repair and Replacement - Variable Motor (Continued)



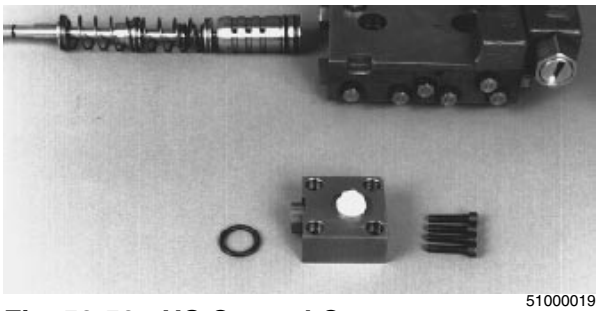
51000087

Fig. 50-49 - Remove HS Control Housing Screws

Hydraulic Proportional Control (Type HS)

Thoroughly clean external surfaces prior to removal of control.

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

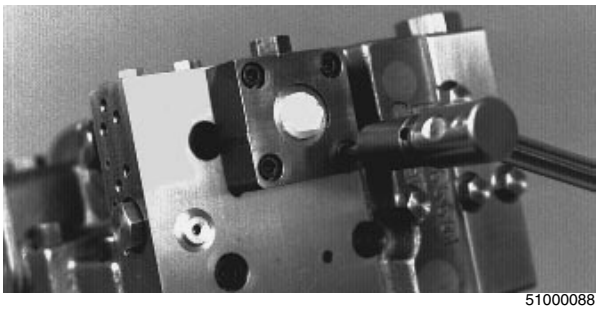


51000019

Fig. 50-50 - HS Control Components

The plug on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plug to 37 Nm (27 ft•lbsf).

Install a new O-ring onto the valve housing.



51000088

Fig. 50-51 - Torque HS Control Housing Screws

Install the valve housing onto the multi-function block, and install the screws.

Torque the screws to 6.4 Nm (4.7 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Hydraulic Proportional Control with Maximum Angle Over-ride (Types H1•H2 or K1•K2)

Thoroughly clean external surfaces prior to removing the control.

The solenoid may be removed from the valve by removing the nut with a 3/4" hex wrench.

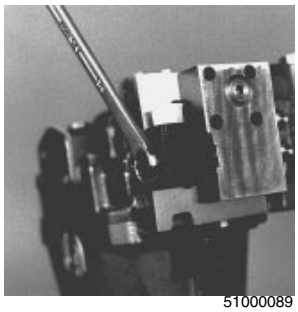

51000089

Fig. 50-52 - Remove H1•H2 or K1•K2 Control Solenoid

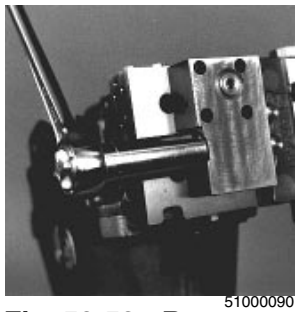

51000090

Fig. 50-53 - Remove Solenoid Valve

The solenoid valve may be removed from the control valve housing with a 7/8" hex wrench.

Remove the screws retaining the valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the valve housing.

The plugs on the control housing may be removed with an 11/16" hex wrench. When reinstalling, torque the plugs to 37 Nm (27 ft•lbsf).

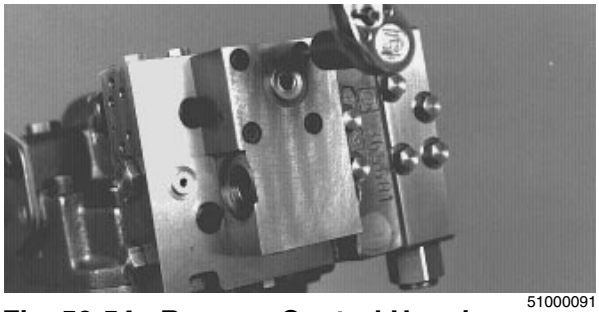

51000091

Fig. 50-54 - Remove Control Housing Screws

Install new O-rings onto the valve housing.

Install the valve housing onto the multi-function block, and install the screws. Torque the screws to 6.4 Nm (4.7 ft•lbsf).

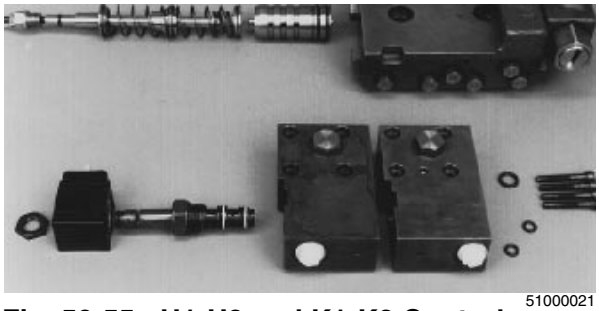

51000021

Fig. 50-55 - H1•H2 and K1•K2 Control Components

When installing the solenoid valve into the valve housing, the valve should be torqued to 20 Nm (15 ft•lbsf).

When installing the solenoid onto the valve, torque the nut to 15 Nm (11 ft•lbsf.).

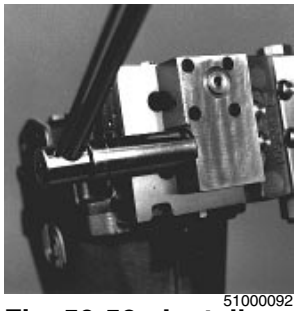

51000092

Fig. 50-56 - Install Solenoid Valve

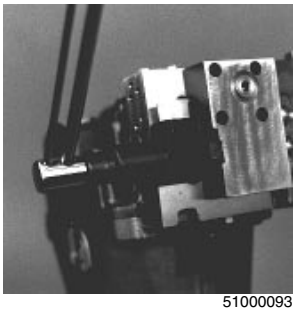

51000093

Fig. 50-57 - Install Solenoid

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Minor Repair and Replacement - Variable Motor (Continued)

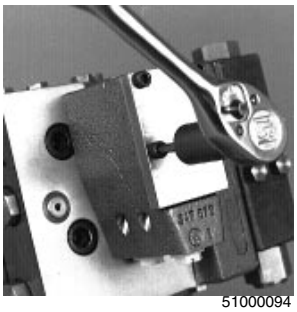

51000094

Fig. 50-58 - Remove HP Control Housing Screws

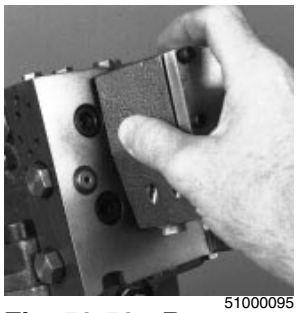

51000095

Fig. 50-59 - Remove Control Housing


51000096

Fig. 50-60 - Remove Shuttle Spool Plug

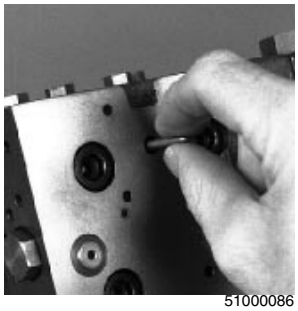

51000086

Fig. 50-61 - Remove Pilot Piston Pin

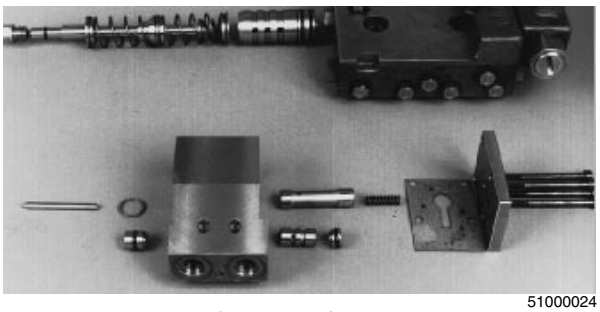

51000024

Fig. 50-62 - HP Control Components

Two Connection Hydraulic Proportional Control (Type HP)

Thoroughly clean external surfaces prior to removal of control.

Hold the control housing in position, and remove the screws retaining the cover and control housing to the multi-function block with a 4 mm internal hex wrench. Remove the housing cover and gasket. Remove the valve housing with shuttle valve assembly and pilot piston from the multi-function block.

Remove the O-rings from the valve housing. Remove the pilot piston and spring from the valve housing.

Remove the pilot piston pin from the multi-function block.

Remove the inner shuttle spool plug from the valve housing. (A 5 mm threaded hole is provided in the inner plug for a puller screw.) Remove the shuttle spool from the valve housing. Remove the outer shuttle spool plug. Remove the O-rings from the plugs.

Install new O-rings on the shuttle spool plugs.

Install new O-rings on the valve housing and retain with petroleum jelly.

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Minor Repair and Replacement - Variable Motor (Continued)

Install the pilot piston pin in the multi-function block.

Install the outer (thin) shuttle piston plug with the large chamfer toward the shuttle valve bore. Install the shuttle spool into its bore and install the inner (thick) plug with the large chamfer toward the shuttle valve bore.

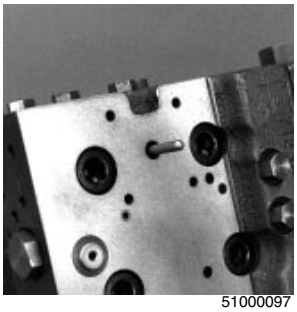

51000097

Fig. 50-63 - Pilot Piston Pin Installed

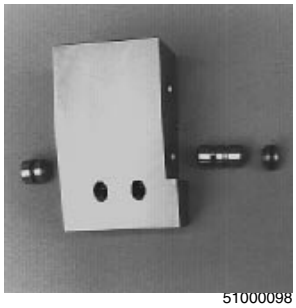

51000098

Fig. 50-64 - Install Shuttle Spool and Plugs

Position the valve housing (with O-ring) on the multi-function block.

Install the pilot piston into the housing and over the pin. The end of the piston with the cross drilled hole should engage the pin.

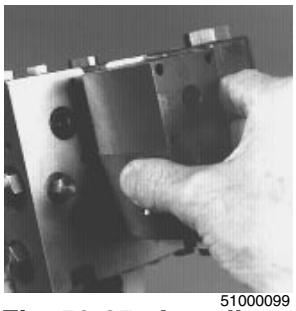

51000099

Fig. 50-65 - Install Control Housing

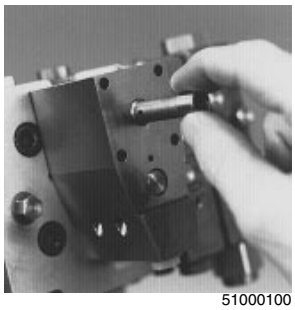

51000100

Fig. 50-66 - Install Pilot Piston

Install the small spring in the outer end of the pilot piston.

Install the control cover and gasket. Align the control assembly with the multi-function block and install the four (4) screws.

Torque the control screws to 6.4 Nm (4.7 ft•lbsf).

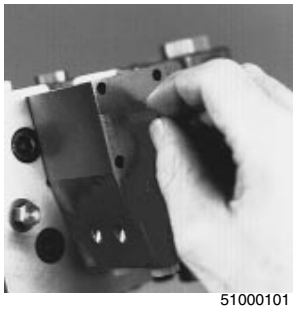

51000101

Fig. 50-67 - Install Spring

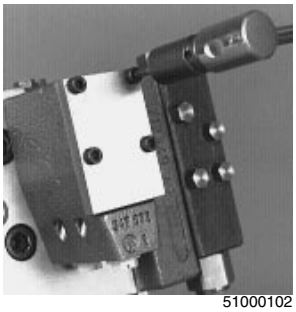

51000102

Fig. 50-68 - Install Cover, Gasket, and Screws

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Minor Repair and Replacement - Variable Motor (Continued)

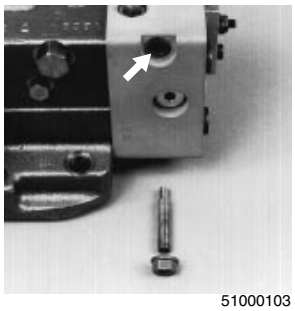

51000103

Fig. 50-69 - Remove HC Control Bleed Valve

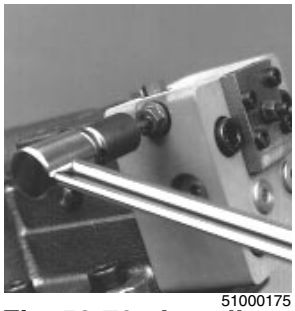

51000175

Fig. 50-70 - Install HC Control Bleed Valve

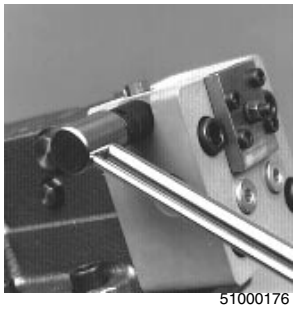

51000176

Fig. 50-71 - Install HC Control Bleed Valve Seal Nut

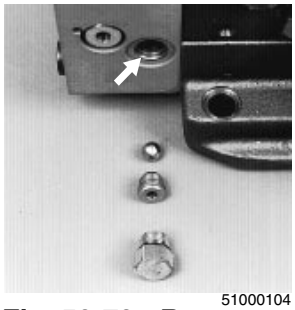

51000104

Fig. 50-72 - Remove Servo Pressure Ball Shuttle Valve

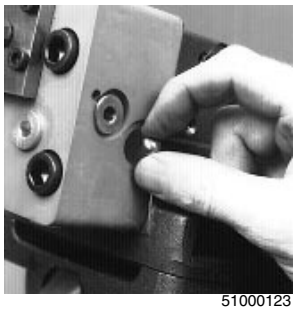

51000123

Fig. 50-73 - Install Servo Pressure Shuttle Ball Valve


51000174

Fig. 50-74 - Torque Servo Pressure Shuttle Ball Seat

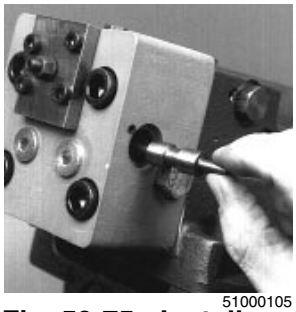

51000105

Fig. 50-75 - Install Control Pressure Shuttle Spool


51000122

Fig. 50-76 - Torque Shuttle Spool Plugs

Two Connection Hydraulic Proportional Control for "Dual Path" Vehicles (Type HC)

Bleed Valve

Loosen the seal lock nut on the bleed valve with a 10 mm hex wrench, and remove the valve with a 4 mm internal hex wrench.

Install the bleed valve and torque to 3 Nm (27 in•lbsf).

Install the seal lock nut and torque to 19 Nm (14 ft•lbsf).

Servo Pressure Shuttle Valve

Remove the servo pressure shuttle plug with an 11⁄16" hex wrench. Remove the shuttle ball seat with a 5 mm internal hex wrench and remove the ball.

Install the servo pressure shuttle ball.

Install the shuttle ball seat and torque to 11 Nm (8 ft•lbsf). Install the shuttle passage plug and torque to 37 Nm (27 ft•lbsf).

Control Pressure Shuttle Valve

Remove the shuttle spool plugs with a 1/4" internal hex wrench. Remove the control pressure shuttle spool.

Install the control pressure shuttle spool.

Install the shuttle spool plugs and torque to 20 Nm (15 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Pilot Piston and Control Housing

Thoroughly clean external surfaces prior to disassembly of control.

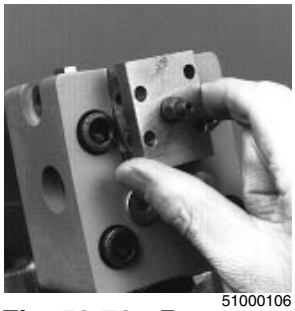
Remove the four (4) screws retaining the cover to the control housing with a 4 mm internal hex wrench.

Remove the housing cover and gasket (with the adjusting screw and seal lock nut).



51000177

Fig. 50-77 - Remove HC Control Housing Cover Screws



51000106

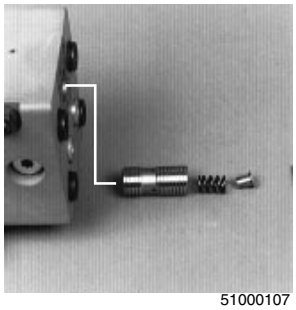
Fig. 50-78 - Remove HC Control Housing Cover

Remove the control start adjustor spring seat and spring from the pilot piston.

Remove the pilot piston from the control housing.

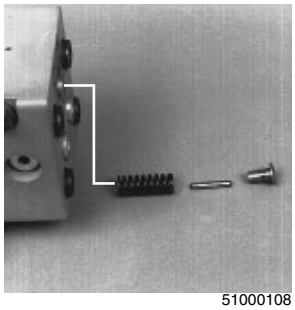
Remove the pilot piston pin seat and pin from the control housing (or pilot piston).

Remove the control start spring from the control housing.



51000107

Fig. 50-79 - Remove Adjustment Spring and Pilot Piston



51000108

Fig. 50-80 - Remove Pilot Piston Pin and Control Start Spring

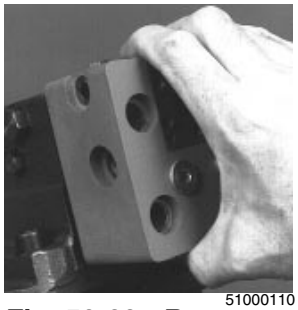
Remove the four (4) screws (and washers for 060, 080, and 110 units) retaining the control housing to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units).

Remove the control housing from the end cap. Remove the O-rings between the control housing and the end cap, and the O-ring on the valve spool sleeve.



51000109

Fig. 50-81 - Remove HC Control Housing Screws



51000110

Fig. 50-82 - Remove HC Control Housing

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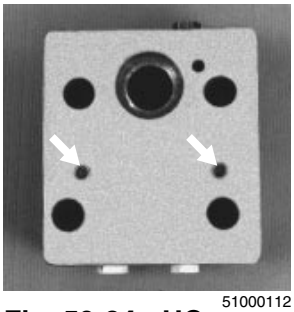
Minor Repair and Replacement - Variable Motor (Continued)



51000111

Fig. 50-83 - HC Control Components

The plugs on the control housing may be removed with a 7/16" hex wrench or a 1/4" internal hex wrench. When reinstalling, torque the 5/16" plugs to 9 Nm (7 ft•lbsf), and the 9/16" plugs to 20 Nm (15 ft•lbsf).



51000112

Fig. 50-84 - HC Control Housing Screens

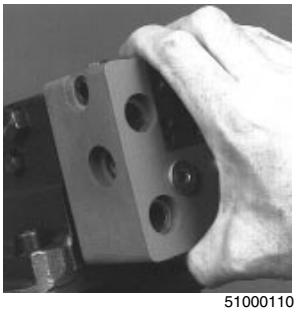


51000113

Fig. 50-85 - End Cap O-Rings Installed for HC Control

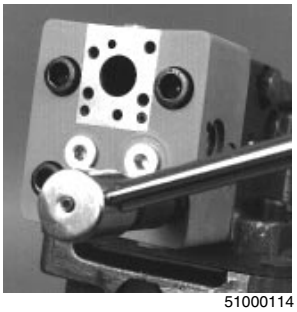
The control housing is equipped with filter screens in the passages between the housing and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the valve housing or end cap.

Install a new O-ring onto the valve spool sleeve in the end cap. Install new O-rings onto the end cap.



51000110

Fig. 50-86 - Install HC Control Housing



51000114

Fig. 50-87 - Torque HC Control Housing Screws

Install the valve housing onto the end cap, and install the screws (with flat washers on 060, 080, and 110 units).

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, and 110 units, or to 110 Nm (81 ft•lbsf) for 160 and 250 units.

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Minor Repair and Replacement - Variable Motor (Continued)

Install the control start spring into the control housing.

Install the pilot piston pin. The end of the pin must engage the recess in the end of the control valve spool.

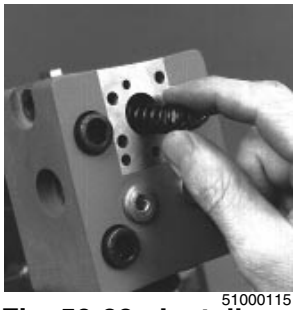

51000115

Fig. 50-88 - Install HC Control Start Spring

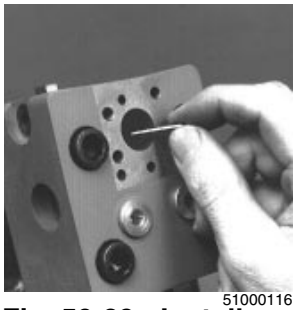

51000116

Fig. 50-89 - Install Pilot Piston Pin

Install the pilot piston pin seat.

Install the pilot piston into the housing and over the spring and spring seat. The end of the piston with the deeper bore and the cross drilled hole should engage the start spring and pin seat.


51000117

Fig. 50-90 - Install Pilot Piston Pin Seat

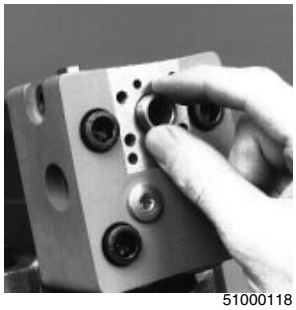

51000118

Fig. 50-91 - Install HC Control Pilot Piston

Install the adjustor spring in the outer end of the pilot piston.

Install the adjustor spring seat.

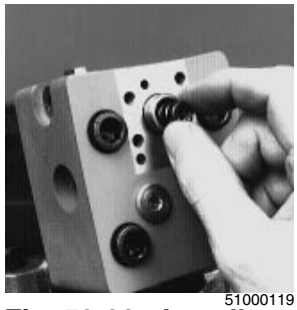

51000119

Fig. 50-92 - Install HC Control Start Adjuster Spring

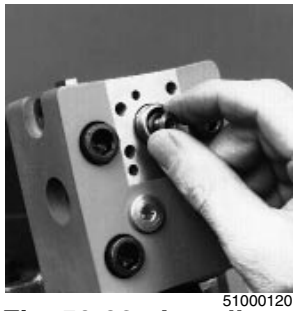

51000120

Fig. 50-93 - Install HC Control Start Adjuster Spring Seat

Install the control cover and gasket (with adjusting screw and seal lock nut).

Torque the control cover screws to 6.4 Nm (4.7 ft•lbsf).

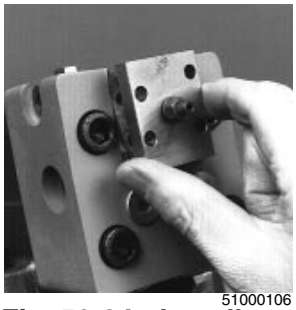

51000106

Fig. 50-94 - Install HC Control Cover and Gasket


51000121

Fig. 50-95 - Torque Control Cover Screws

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Minor Repair and Replacement - Variable Motor (Continued)

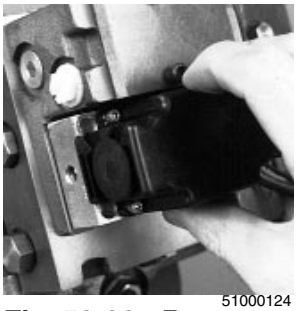

51000124

Fig. 50-96 - Remove PCP Valve

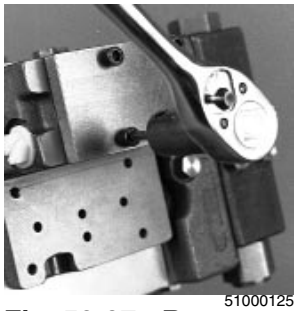

51000125

Fig. 50-97 - Remove EP•EQ Control Housing Screws


51000126

Fig. 50-98 - Remove EP•EQ Control Housing

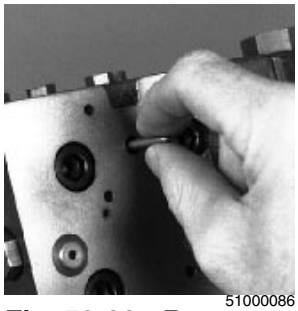

51000086

Fig. 50-99 - Remove Pilot Piston Pin

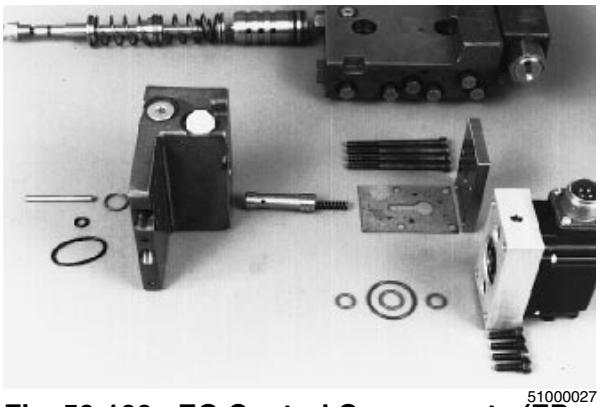

51000027

Fig. 50-100 - EQ Control Components (EP Similar)

Electrohydraulic Proportional Control (Types EP and EQ)

Thoroughly clean external surfaces prior to removal of control.

The Pressure Control Pilot (PCP) valve may be removed from the control valve housing, as described under the following heading.

Remove the screws retaining the control housing cover and control valve housing to the multi-function block with a 4 mm internal hex wrench. Remove the housing cover and gasket.

Remove the valve housing with the pilot piston from the multi-function block.

Remove the O-rings from the valve housing. Remove the pilot piston and spring from the valve housing.

Remove the pilot piston pin from the multi-function block.

Install new O-rings on the valve housing and retain with petroleum jelly.

The plugs on the control housing may be removed with a 1/4" internal hex wrench. When reinstalling, torque the 9/16" plugs to 20 Nm (15 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Install the pilot piston pin in the multi-function block.

Position the valve housing (with O-rings) on the multi-function block.

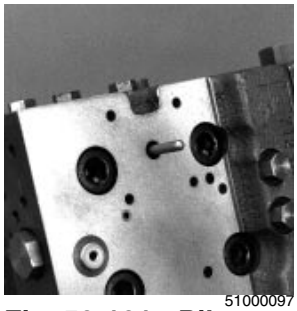

51000097

Fig. 50-101 - Pilot Piston Pin Installed


51000127

Fig. 50-102 - Install Control Housing

Install the pilot piston into the housing and over the pin. The end of the piston with the cross drilled hole should engage the pin.

Install the small spring in the outer end of the pilot piston.


51000128

Fig. 50-103 - Install Pilot Piston

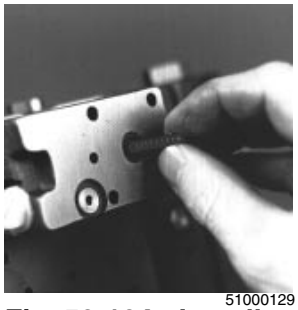

51000129

Fig. 50-104 - Install Spring

Install the control cover and gasket. Align the control assembly with the multi-function block and install the four (4) screws.

Torque the control screws to 6.4 Nm (4.7 ft•lbsf).

Reinstall the PCP valve, if removed.

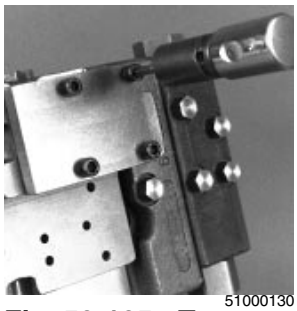

51000130

Fig. 50-105 - Torque Cover, Gasket, and Screws

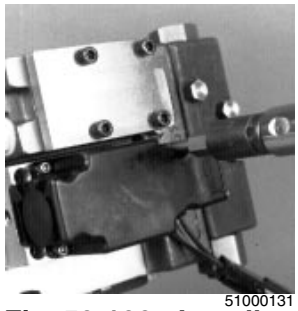

51000131

Fig. 50-106 - Install PCP Valve

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Minor Repair and Replacement - Variable Motor (Continued)

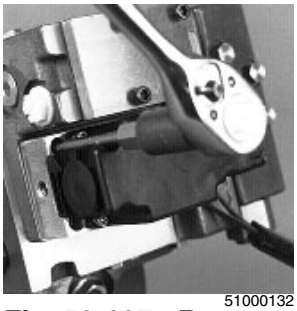

51000132

Fig. 50-107 - Remove PCP Valve Screws

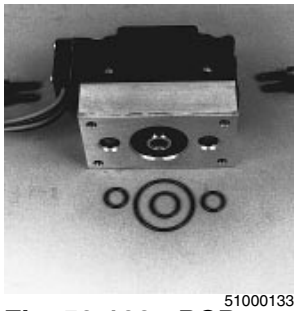

51000133

Fig. 50-108 - PCP Valve Components

Pressure Control Pilot (PCP) Valve for Electrohydraulic Proportional Control (Types EP and EQ)

Thoroughly clean external surfaces of control.

Using a 4 mm internal hex wrench, remove the four (4) screws and remove the PCP valve.

Check surfaces for nicks or damage. Clean internal screens.

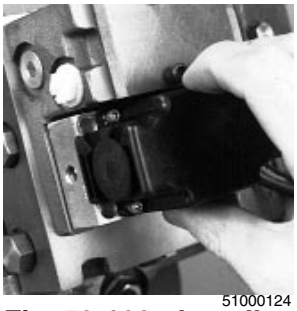

51000124

Fig. 50-109 - Install PCP onto Control

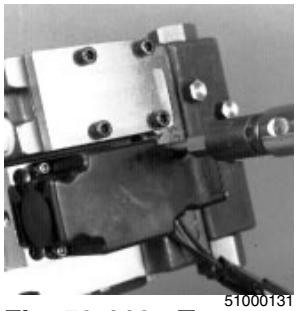

51000131

Fig. 50-110 - Torque PCP Valve Screws

Install new O-rings on the PCP housing and retain with petroleum jelly. Position the PCP on the control valve housing and install the screws.

Torque the screws to 5.4 Nm (48 in•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Multi-function Block

Removal and Installation

Remove the external control assembly as described in the instructions for the specific control.

Remove the four (4) screws (and washers for 060, 080, and 110 units) retaining the multi-function block to the end cap with an 8 mm internal hex wrench (060, 080, and 110 units) or a 10 mm internal hex wrench (160 and 250 units).

Remove the multi-function block from the end cap. Remove the O-rings between the multi-function block and the end cap, and the O-ring on the valve spool sleeve.

The multi-function block is equipped with filter screens in the passages between the block and the end cap. Units with internal servo pressure supply have a filter screen installed in the end cap passage leading to the valve spool sleeve. These screens should be pressed into position (with the rounded edge of the filter screens facing “out”) until they are flush to 2.0 mm (0.08 in.) below the machined surface of the multi-function block or end cap.

Units with external servo pressure supply have a plug installed in the end cap passage leading to the valve spool sleeve. This plug may be removed with a 2.5 mm internal hex wrench. When installing this plug, torque to 2 Nm (18 in•lbsf).

Install a new O-ring onto the valve spool sleeve in the end cap.

Install new O-rings onto the end cap.

Install the multi-function block onto the end cap, and install the screws.

Torque the screws to 78 Nm (58 ft•lbsf) for 060, 080, or 110 units, or to 110 Nm (81 ft•lbsf) for 160 or 250 units.

Reinstall the external control assembly as described in the instructions for the specific control.

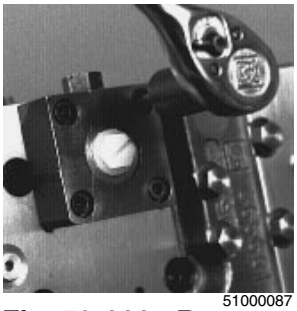

51000087

Fig. 50-111 - Remove External Control (HS Shown)

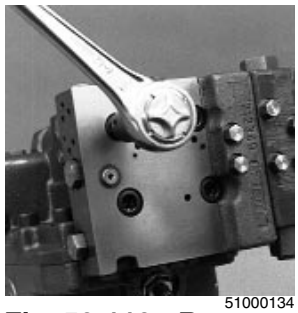

51000134

Fig. 50-112 - Remove Multi-function Block Screws


51000135

Fig. 50-113 - Remove Multi-function Block

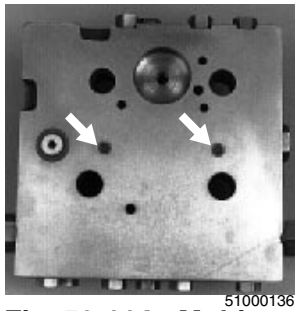

51000136

Fig. 50-114 - Multi-function Block Screens

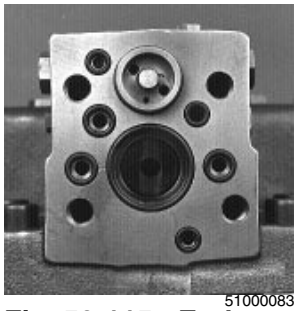

51000083

Fig. 50-115 - End Cap O-Rings Installed


51000135

Fig. 50-116 - Install Multi-function Block

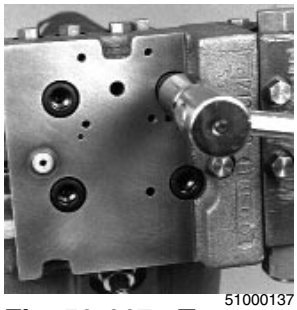

51000137

Fig. 50-117 - Torque Multi-function Block Screws

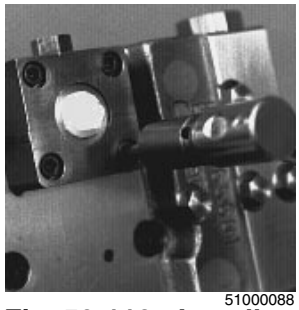

51000088

Fig. 50-118 - Install External Control (HS Shown)

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Minor Repair and Replacement - Variable Motor (Continued)

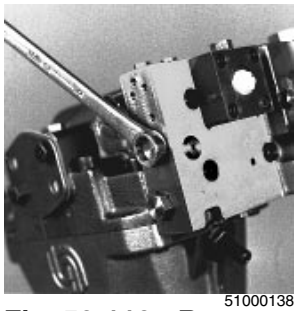

51000138

Fig. 50-119 - Remove Servo Pressure Supply Spool Plug

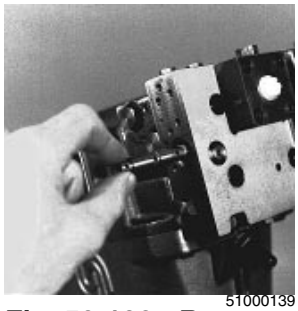

51000139

Fig. 50-120 - Remove Servo Pressure Supply Shuttle Spool

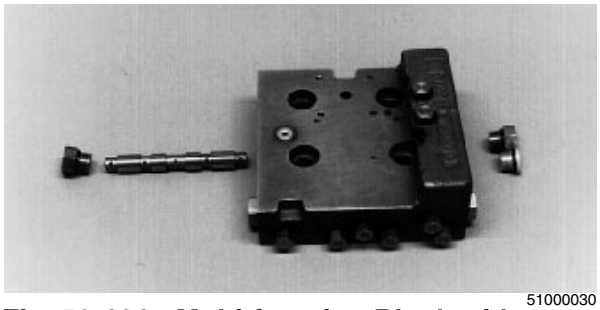

51000030

Fig. 50-121 - Multi-function Block with Servo Pressure Supply Shuttle Spool

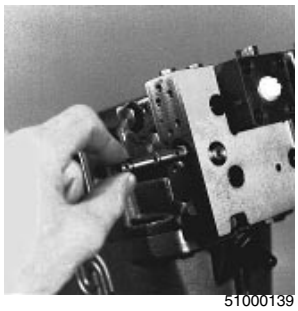

51000139

Fig. 50-122 - Install Servo Pressure Supply Shuttle Spool


51000140

Fig. 50-123 - Torque Servo Pressure Supply Spool Plug

Servo Pressure Supply Shuttle Spool

Remove the servo pressure supply shuttle spool plug from the multi-function valve with a 9/16" hex wrench.

NOTE: If a pressure compensator valve block is installed, the opposite end of the shuttle spool bore in the multi-function valve is plugged with an internal hex head plug located under the valve block. If a pressure compensator valve block is not installed, the opposite end of the shuttle spool bore is plugged with a hex head plug.

Remove the servo pressure supply shuttle spool from the multi-function valve block.

Inspect the shuttle spool for burrs or scoring. The spool must slide free in its bore. The shuttle ball in the spool must be free to move.

Install the shuttle spool into the multi-function block.

Install the hex head plug into the multi-function valve and torque to 37 Nm (27 ft•lbsf).

NOTE: If an internal hex head plug was removed from the opposite end of the shuttle spool bore, torque it to 20 Nm (15 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Blocking Plate for Multi-function Block Without PCOR

The blocking plate may be removed by removing the four (4) screws with a 5 mm internal hex wrench. Remove the O-rings from the plate.

Install new O-rings on the blocking plate and retain with petroleum jelly. Install the plate on the multi-function block and install the screws. Torque the screws to 11 Nm (8 ft•lbsf).


51000170

Fig. 50-124 - Remove Blocking Plate (Less PCOR)

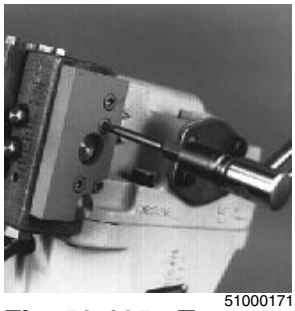

51000171

Fig. 50-125 - Torque Blocking Plate Screws (Less PCOR)

Pressure Compensator Valve for Pressure Compensator Over-Ride (PCOR) and Pressure Compensator Regulator (Type PC)

Loosen the adjusting screw lock nut with a 1-1/16" hex wrench. Remove the adjusting screw from the valve block with a large screwdriver.

Remove the pressure compensator valve spring and the spool assembly from the block.

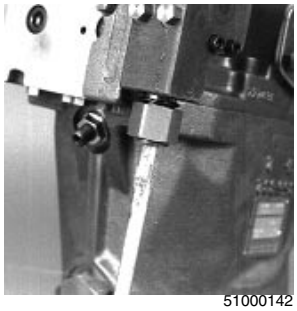

51000142

Fig. 50-126 - Remove PCOR•PC Adjustor

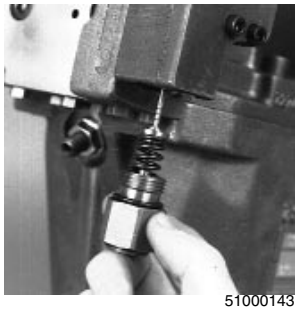

51000143

Fig. 50-127 - Remove PCOR•PC Spring and Spool Valve

Remove the valve block plug with a 1" hex wrench.

Remove the four (4) screws retaining the valve block to the multi-function block with a 5 mm internal hex wrench. Remove the valve block and O-rings.


51000144

Fig. 50-128 - Remove PCOR•PC Plug

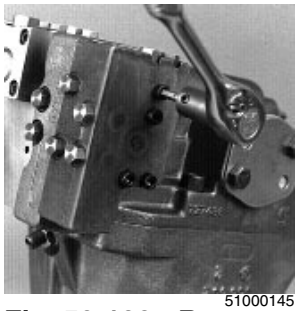

51000145

Fig. 50-129 - Remove PCOR•PC Valve Block

Install new O-rings on the pressure compensator valve block and retain with petroleum jelly. Install a new O-ring on the adjusting screw.

The plugs on the valve block may be removed with a 7⁄16" hex wrench. When reinstalling, torque the 5⁄16" plugs to 9 Nm (7 ft•lbsf).

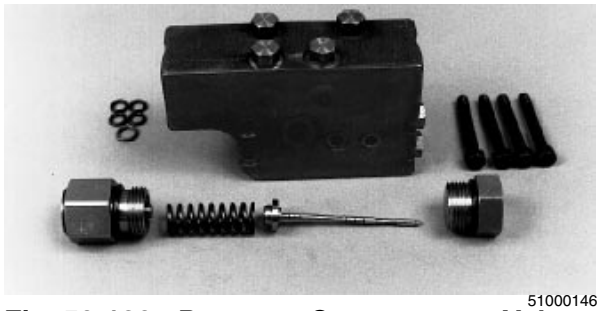

51000146

Fig. 50-130 - Pressure Compensator Valve Block Components

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Minor Repair and Replacement - Variable Motor (Continued)

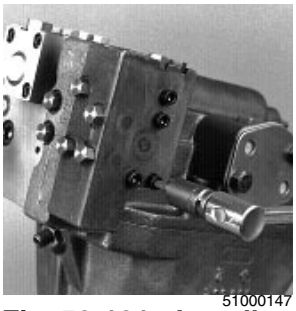

51000147

Fig. 50-131 - Install PCOR•PC Valve Block

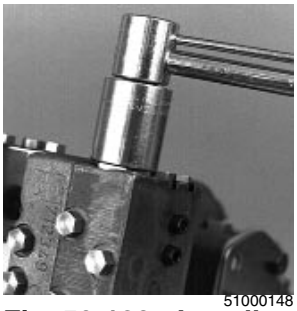

51000148

Fig. 50-132 - Install PCOR•PC Valve Plug

Install the valve block on the multi-function block and install the screws. Torque the screws to 11 Nm (8 ft•lbsf).

Install the valve block plug and torque to 54 Nm (40 ft•lbsf).

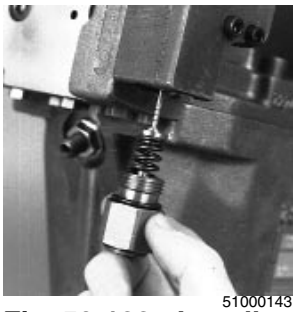

51000143

Fig. 50-133 - Install PCOR•PC Spring and Spool Valve

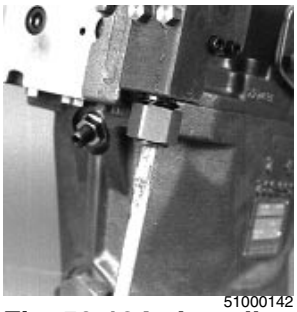

51000142

Fig. 50-134 - Install PCOR•PC Adjusting Screw

Install the pressure compensator spool assembly and the valve spring.

Install the adjusting screw and lock nut. Perform the PCOR or PC regulator pressure adjustment as described under “Component Adjustment."

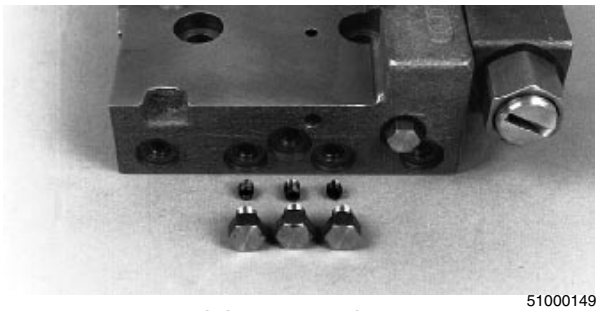

51000149

Fig. 50-135 - PCOR and PC Regulator Orifices

PCOR and PC Regulator Orifices

To gain access to the PCOR or PC regulator orifices, remove the three (3) plugs located between the defeat spool stop plugs on the multi-function block, using a 7/16" hex wrench. Remove the PCOR brake pressure defeat spool (if installed). Remove the orifice plug(s) and plain plug(s) with a 2.5 mm internal hex wrench.

Refer to the appropriate Service Parts Manual for information on orifice locations and sizes.

Install the orifice plug(s) and plain plug(s), and torque to 4 Nm (35 in•lbsf). Install the outer plugs and torque to 6 Nm (4 ft•lbsf). Reinstall the PCOR defeat spool (if removed).

Additional orifices are installed in the passages under the pressure compensator valve block.

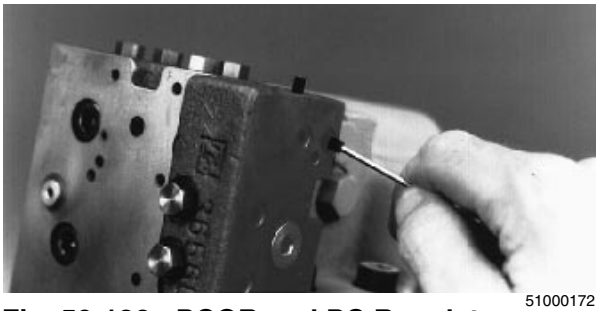

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Fig. 50-136 - PCOR and PC Regulator Orifices

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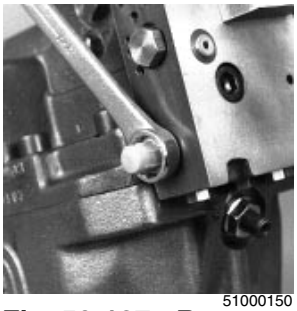
Minor Repair and Replacement - Variable Motor (Continued)

PCOR Brake Pressure Defeat Spool

Remove the PCOR defeat spool bore plugs or fittings with a hex wrench.

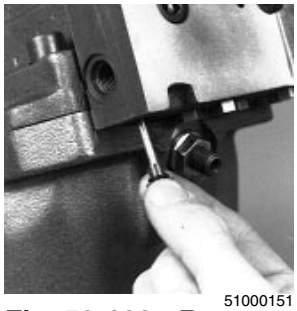
Remove the PCOR defeat spool stop plugs with a 7/16" hex wrench. Remove the defeat spool.

NOTE: The defeat spool may be removed from either end of its bore in the multi-function block.



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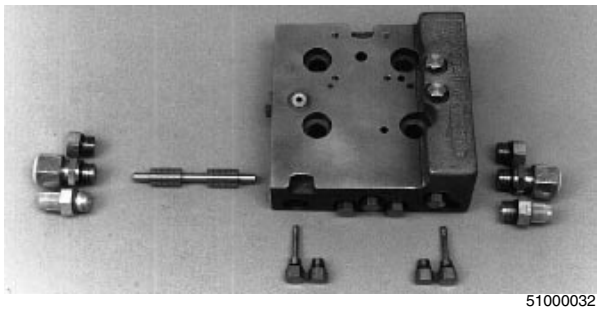
Fig. 50-137 - Remove PCOR Defeat Spool Plug or Fitting



51000151

Fig. 50-138 - Remove PCOR Defeat Spool Stop Plug

Inspect the defeat spool for burrs or roughness. The spool must slide freely in its bore. Inspect the pins in the stop plugs for damage.



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Fig. 50-139 - Multi-function Block With PCOR Defeat Spool Components

Install the PCOR defeat spool into its bore in the multi-function block.

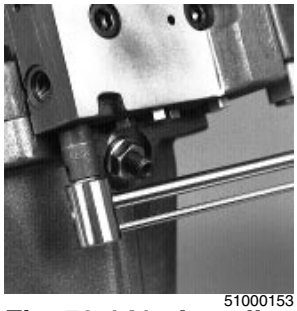
Install the spool stop plugs into the multi-function block. Torque the stop plugs to 6 Nm (4 ft•lbsf).

Install the defeat spool bore plugs or fittings and torque to 27 Nm (20 ft•lbsf).



51000152

Fig. 50-140 - Install PCOR Defeat Spool

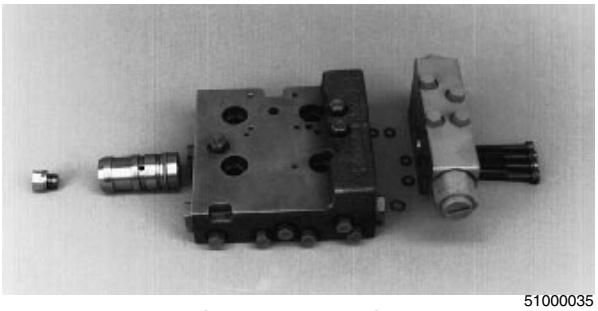


51000153

Fig. 50-141 - Install PCOR Defeat Spool Stop Plug

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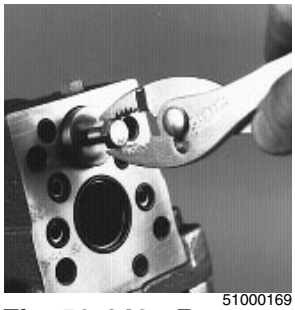
51000035

Fig. 50-142 - PC Regulator Components

Pressure Compensator Regulator (Type PC)

The PC regulator utilizes the multi-function block and pressure compensator valve to control the motor displacement.

Service procedures for these components are included in the “Multi-function Block” section of this manual.



51000169

Fig. 50-143 - Remove Valve Sleeve Bore Plug



51000173

Fig. 50-144 - Servo Drain Orifice (T7)

A valve sleeve bore plug is installed in the motor end cap in place of the valve spool sleeve. Remove the plug from the valve sleeve bore in the end cap. (An 8 mm threaded hole is provided in the plug for a puller screw.) Remove the O-ring from the plug.

A single servo drain orifice is installed in the valve sleeve bore plug. This orifice limits oil flow from the maximum displacement end of the servo piston to the motor case.

Install a new O-ring on the valve sleeve bore plug. Install the bore plug into the end cap.

The special plug and seal washer on the end cap opposite the multi-function block may be removed with a 13 mm hex wrench. When installing, torque this plug to 20 Nm (15 ft•lbsf).

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Minor Repair and Replacement - Variable Motor (Continued)

Control Orifices

Orifices are installed in the motor end cap to regulate oil flow to the servo control valve and the servo piston.

To gain access to these orifice plugs, remove the three (3) plugs located on the motor end cap nearest the multi-function block or control, using a 7⁄16" or 9⁄16" hex wrench. Remove the orifice plugs (plain plugs for N2 control) with a 3 mm internal hex wrench.

Install the orifice plugs, and torque to 4 Nm (35 in•lbsf). Torque the 5⁄16" outer plugs to 9 Nm (7 ft•lbsf), and the 9⁄16" outer plug to 37 Nm (27 ft•lbsf).

Orifices are also installed in the servo control valve sleeve to control oil flow from the servo piston to the motor case.



Fig. 50-145 - Servo Pressure Supply Orifice (T1)

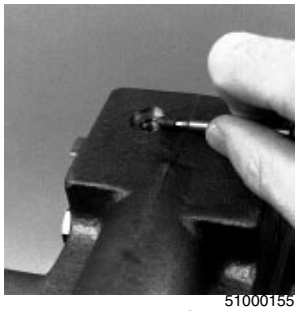


Fig. 50-146 - Servo Orifice for Maximum Displacement (T2)



Fig. 50-147 - Servo Orifice for Minimum Displacement (T3)



Fig. 50-148 - Servo Drain Orifices (T7 and T8)

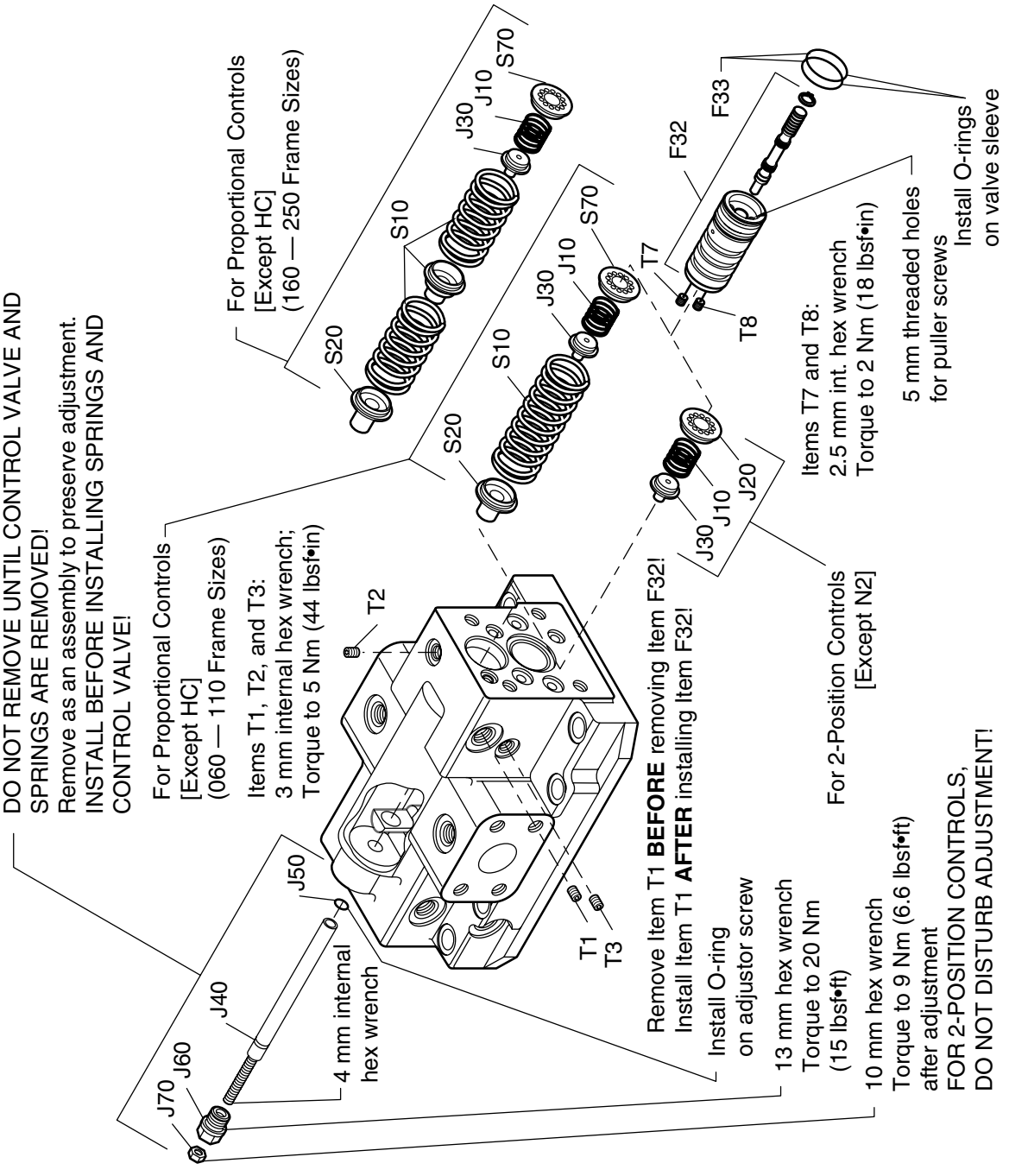
Plug / Fitting Torques

If any plugs or fittings are removed from the unit during servicing, they should be torqued as indicated in the accompanying table.

Item	Torque
Pressure Gauge Ports (9/16—18 O-Ring Hex)	37 Nm (27 ft•lbsf)
Construction Plugs (9/16—18 O-Ring Int. Hex)	20 Nm (15 ft•lbsf)
Construction Plugs (5/16—24 O-Ring)	9 Nm (7 ft•lbsf)
Screw Plugs (M6 Int. Hex)	4 Nm (35 in•lbsf)

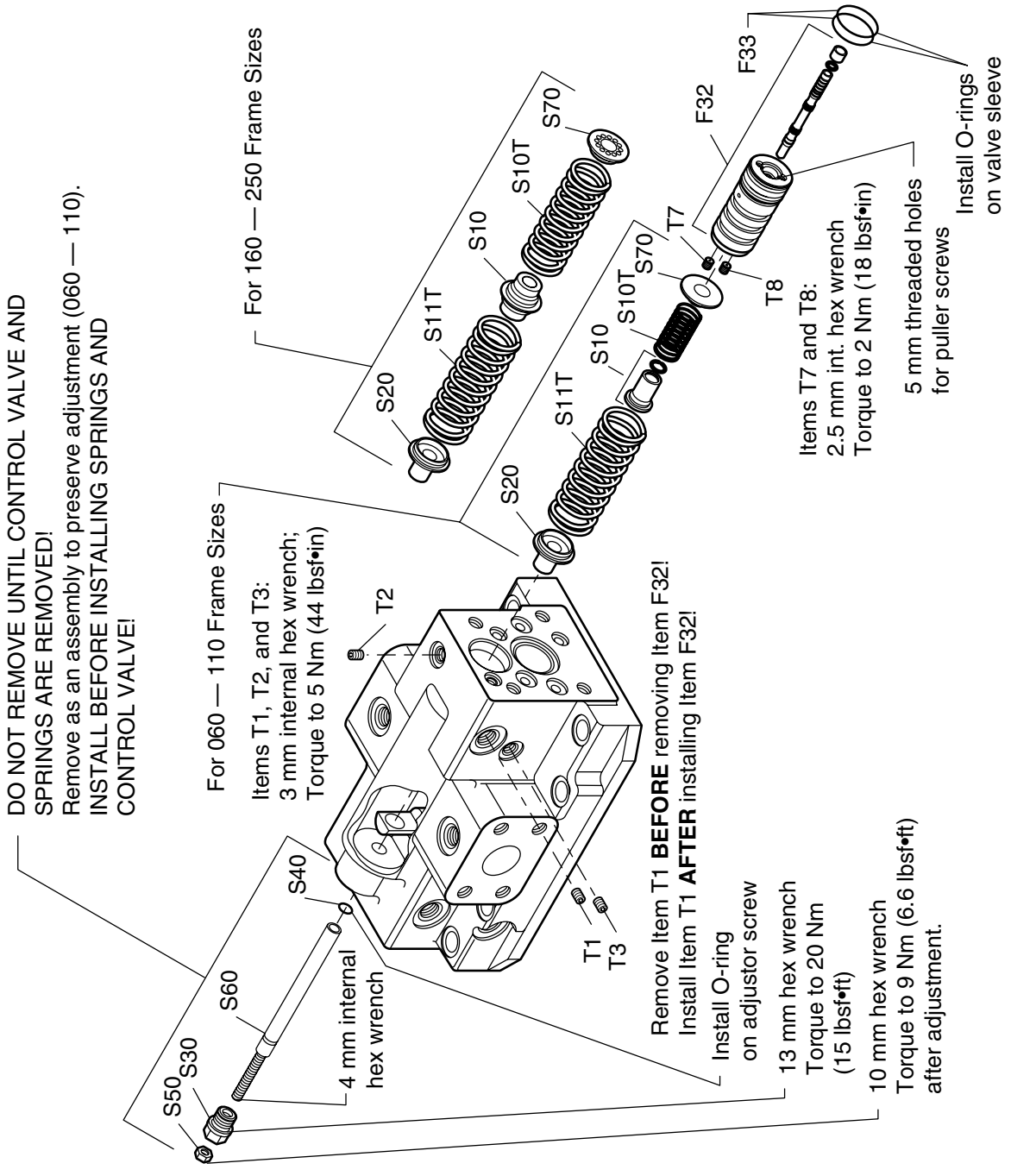
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Minor Repair Instructions
4-Way Valve and Feedback Springs



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Minor Repair Instructions
4-Way Valve and Feedback Springs - HC Control



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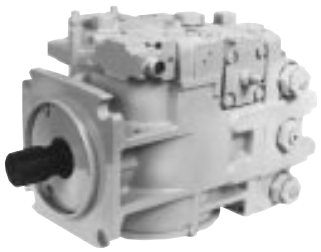
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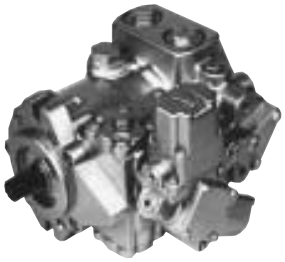
Heavy Duty Axial Piston Pumps and Motors



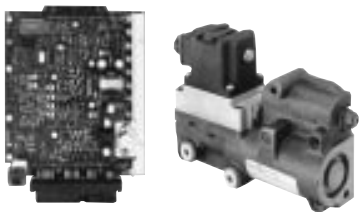
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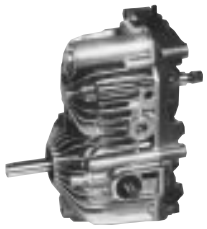
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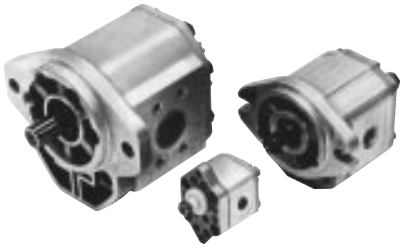
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16.3 Transmission CR

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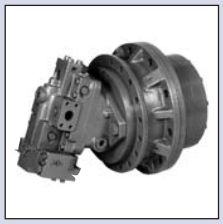
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Series CR Compact Roller Drive

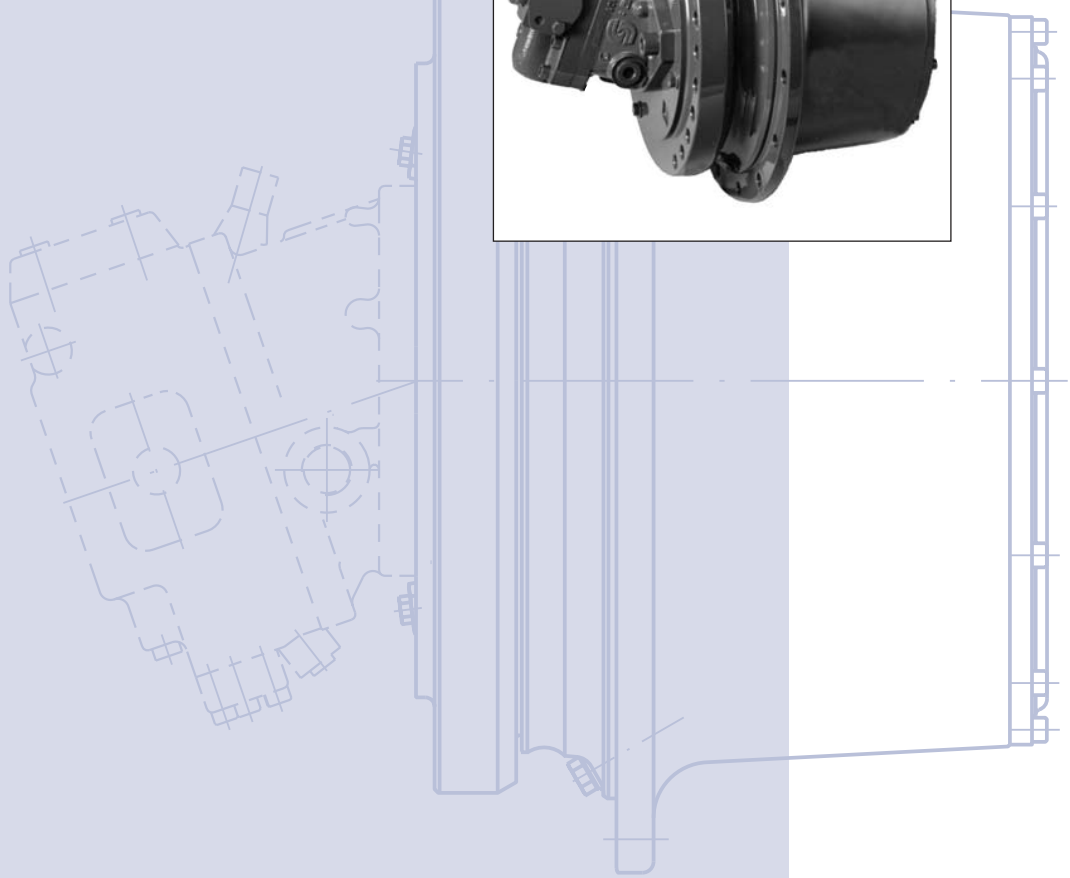
Service Manual and Repair Instruction











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Series CR – Compact Roller Drive
Service Manual and Repair Instruction
Introduction

INTRODUCTION

This brochure represents information for normal service as well as an instruction for minor repairs of Sauer-Danfoss planetary designed compact gears Series CR.

Minor repairs includes replacement of brake, gears, carriers and bearings of the CR gear drive.

The assembling of the spindle group (B010) requires a special tool in order to handle the torque of 6000 Nm [53 100 lbf•in] for CR 31 and 8000 Nm [70 8000 lbf•in] for the CR 51.

In any case of an economically repairable failure at this group the whole gearbox should be returned to Sauer-Danfoss Neumünster.

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Series CR – Compact Roller Drive
Service Manual and Repair Instruction
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TYPE DESIGNATION AND ORDER CODE



Series or Product	
CR	= Series CR Compact Roller Drives

Output torque	
31 (A1)	= 31 000 Nm [274 370 lbf•in]
31 (A2)	= 23 250 Nm [205 780 lbf•in]
51	= 51 000 Nm [451 380 lbf•in]

Spindle and motor configuration		31	51
A150	with mech. brake release 51C110	❍	❍
A210	with special brake release 90K055	❍	-
A220	with special brake release 90K075	❍	-
A240	with special brake release 51C080	❍	-

Shaft spline motor		Ratio	31	51
C046	W40x2x30x18 DIN 5480	45.57 : 1	❍	-
C074		73.50 : 1	-	❍
4046	14 teeth 12/24 pitch ANSI	45.57 : 1	❍	-

Special hardware features	
00	without special hardware
TB	special nametag customer
TD	

Brake	
O	not available brake
K	with brake, static brake torque input shaft 725 Nm [6420 lbf•in]

Revision status of unit

- = Not available
❍ = Optional

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DESCRIPTION

Roller Drives consist of two (2) or three (3) simple planetary stages connected in series. Each planetary stage consists of a sun pinion (input) gear, an internal tooth ring gear and a set of planet or satellite gears mounted to a planet carrier. The sun gear "floats" within the planet gears to allow uniform load distribution at the multiple gear mesh points.

A hydrostatic cartridge motor drives the sun pinion which in turn drives the planet gears within the ring gear causing rotation of the planet carrier. The planet carrier is coupled directly to the sun gear of the next stage.

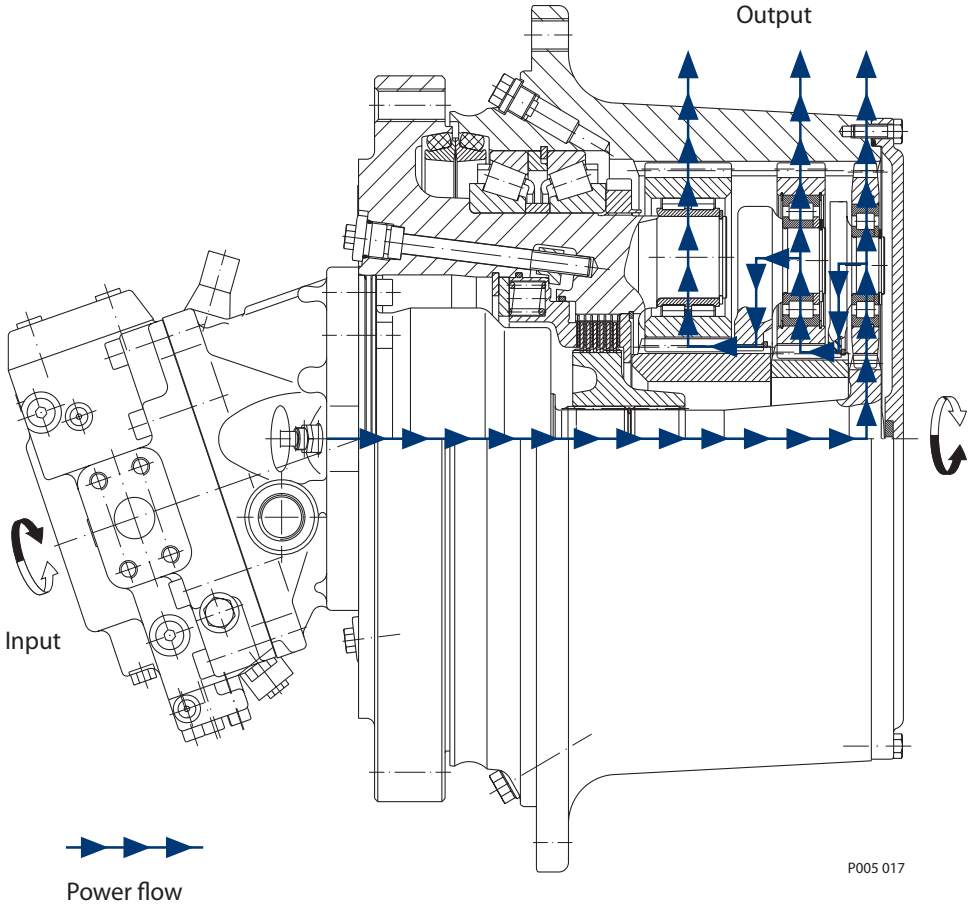
The output planet carrier is fixed (non-rotating) and the ring gear transmits main torque to the output. Output hub rotation is opposite to the input rotation.

The planet gears are supported on full complement roller bearings. The output hub is supported on tapered roller bearings to provide large external load carrying capability.

All gears and shafts are machined from case hardened steel or high tensile alloy steel and all housings are cast iron or nodular iron or steel according to load requirements.

POWER FLOW DIAGRAM

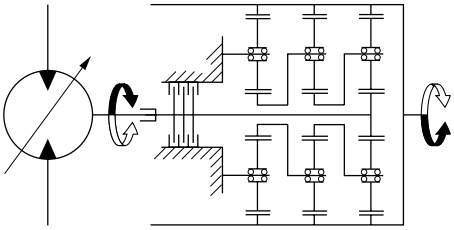
Compact Roller Drive – CR51



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Series CR – Compact Roller Drive
Service Manual and Repair Instruction
Technical Features

SCHEMATIC



P001 237

DESIGN

Two (2) or three (3) stage series planetary gearing combined with optional fixed displacement axial piston and variable displacement bent axis hydrostatic motors.

TYPE OF MOUNTING

Frame mounting and drum mounting, piloted and internally threaded holes on a bolt circle diameter.

DIRECTION OF ROTATION

Clockwise and counterclockwise, output rotation opposite to the input rotation.

INSTALLATION POSITION

Normal installation is horizontal, contact manufacturer for other positions.

LUBRICANTS

Gear lubricants, see *520L0463 Hydraulic Fluids and Lubricants*.

TEMPERATURE RANGE

ϑ_{min} = - 30 °C [-22 °F]
ϑ_{max} = 100 °C [212 °F]

LUBRICANT VISCOSITY LIMITS

ν_{min} = 25 mm²/s [119 SUS*]
ν_{max} = 20 000 mm²/s [92 600 SUS*]

* SUS (Saybolt Universal Second)

TECHNICAL DATA

Technical data					
		Dimension	**CR31 A1**	**CR31 A2**	**CR51**
Maximum output torque	Intermittent	Nm [lbf•in]	31 000 [274 370]	23 250 [205 780]	51 000 [451 380]
	Continuous	Nm [lbf•in]	23 000 [203 560]	17 435 [154 300]	38 000 [336 330]
Dyn. load capacity maximum		kN [lbf]	65 [14 610]	65 [14 610]	90 [20 230]
Output speed, maximum		min^{-1} (rpm)	50	50	50
Brake torque, maximum (static)		Nm [lbf•in]	725 [6416]	725 [6416]	725 [6416]
Ratio		i	45.57 : 1	45.57 : 1	73.50 : 1
Lubricant capacity (approx.)		l [US gal]	2.7 [0.71]	2.7 [0.71]	3.0 [0.79]
Weight without lubricant		kg [lb]	220 [485]	220 [485]	250 [551]

Note: For further details see *Outline drawings on pages 10-11.*

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BRAKE

Input brakes have been designed to be used as static holding or parking brakes. These brakes are mechanically spring applied and hydraulic pressure is required to release them.

In addition, the units are equipped with an easy mechanical brake release for towing conditions. There is no special tooling required for applying the mechanical brake release. Care must be taken, when sizing an application, to ensure that the brake torque and gear ratio selected match the capacity of the hydrostatic motor and gearbox.

The table below shows brake options:

Input brakes			
	Dimension	Frame size	
		CR31	**CR51**
		Option **K**	
Static torque	Nm [lbf•in]	725 [6416]	
Release pressure, Minimum	bar [psi]	14 [203]	
Release pressure, Maximum	bar [psi]	40 [580]	

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START-UP AND MAINTENANCE

The gearbox is shipped **without** oil.

Before start-up fill gear with EP-gear lubricant SAE 90, API-Classification GL5; FZG power stage >12 according DIN 51354. At higher temperatures we recommend gear lubricants with SAE-Viscosity grade 140.

Fill with lubricant to level of control bore L4 (approx. 2,7 l [0.71 US gal] for CR 31; 3,0 l [0.79 US gal] for CR 51) and check oil level regularly. First oil change after 200 working hours, then after every 2000 hours, but at least once a year.

Periodically clean the gear housing and inspect for loosened screws and bolts.
It is recommended to check the oil level every 250 working hours and add it if necessary.

SERVICING THE COMPACT GEARS

While the brake is mechanically released, the piston motor loses its mechanical braking capability. The mechanical braking capability of the vehicle must be maintained by means of a vehicle brake, or for stationary equipment, must be maintained by means of an equipment brake in order to avert any danger to life and limb.

Mechanical releasing of the brake

In case of lacking brake bleeding pressure it may be necessary to move a stationary machine. For this purpose it is possible to release the brake mechanically.

For mechanical releasing, two socket head screws are located at the spindle-front side (see chapter *Outline drawings on pages 10-11*). For brake releasing the two socket head screws must be turned uniformly in a clockwise direction (alternately 1/2 rotation) in order to avoid cocking of the piston.

Turning the screws inward pushes the piston against the effect of the cup spring and thus the braking effect is neutralized.

Turn the screws inward until they come into a contact with the piston and continue until the piston comes against the stop. The brake has been released.

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SERVICING THE COMPACT GEARS (continued)

If the screws for mechanical releasing of the brake are not adjusted in the way described, in case of wear of the brake disks, the piston may come to rest prematurely on the screws. In that case the braking effect will be considerably reduced or completely neutralized.

Reestablish braking capability

Reestablish braking capability by unscrewing the screws for the loosening of the brake to the point where contact with the piston is just lost. After this, the screws must be turned outward counter-clockwise against stop.

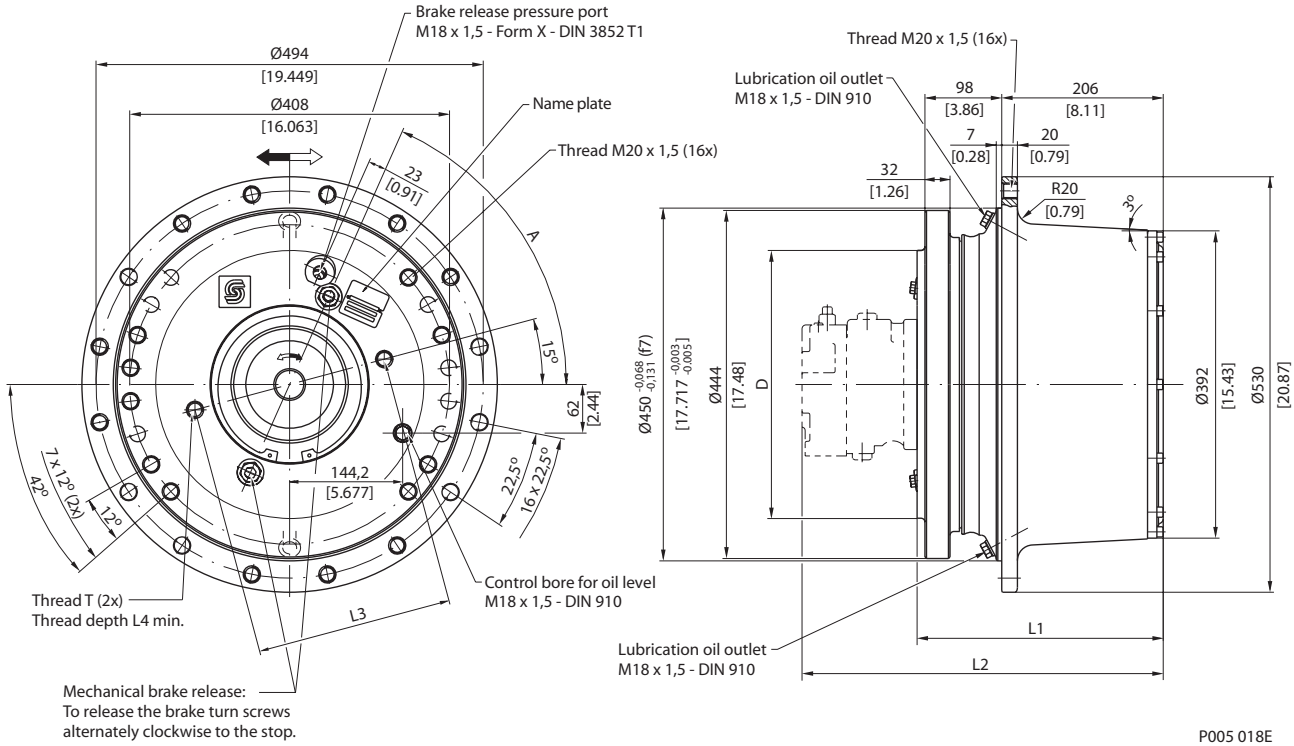
Check braking effect according the instructions of the manufacturer of the machine or vehicle.

The compact gear CR31 A2 is equipped with an adapter flange for the smaller size of hydromotor. For mechanical brake releasing at this compact gear remove the (4) screws (Item B260) that fix the adapter flange and move motor adapter (with motor) 5 mm out against the stop which is given by the (2) screws (Item B250).

After reestablish of braking capability the (4) screws (B260) have to be torqued to 100 $^{+20}$ Nm [885 $^{+177}$ lbf•in].

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ROLLER DRIVE GEARBOX WITH CARTRIDGE MOTOR – CR31

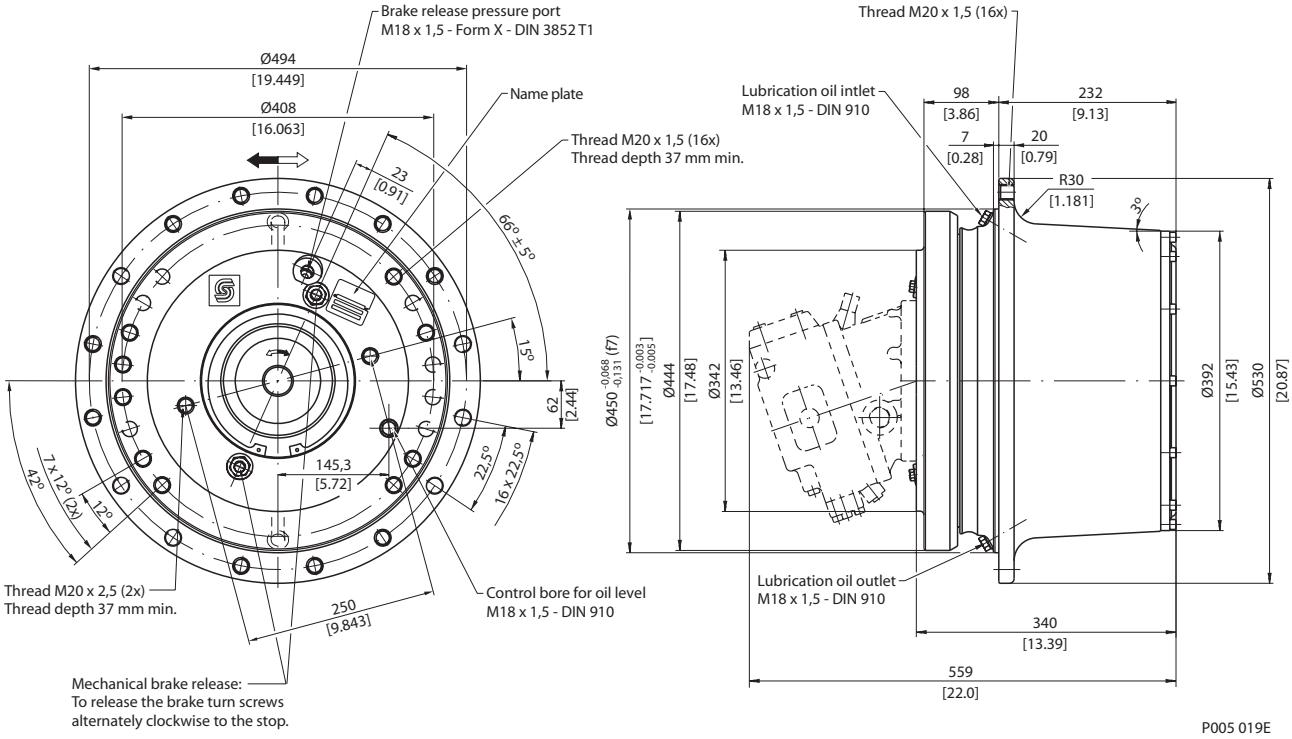


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CR31									
Series	Frame size	Design	L1 mm [in]	L2 mm [in]	L3 mm [in]	L4 mm [in]	T	D mm [in]	A °
90	055	**K**	296 [11.65]	443 [17.44]	200 [7.874]	19 [0.748]	M16 x 2	-	78
	075	**K**	305 [12.01]	460 [18.11]	224 [8.819]	28 [1.102]	M20 x 2,5	264 [10.39]	78
51	080	**C**	305 [12.01]	517 [20.35]	224 [8.819]	28 [1.102]	M20 x 2,5	264 [10.39]	78
	110	**C**	314 [12.36]	533 [20.98]	250 [9.843]	37 [1.45]	M20 x 2,5	342 [13.46]	66

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ROLLER DRIVE GEARBOX WITH CARTRIDGE MOTOR – CR51



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GENERAL

Repair of spindle-group (B010) requires special assembly tools (to tighten the nut), hence we recommend that any repairs of this group should be performed by Sauer-Danfoss, Neumünster. Sauer-Danfoss expressly disclaims any liability for workmanship related failures resulting from repairs performed by any person.

This instruction describes procedures for replacement of brake, gears, carriers and bearings of planet gearboxes for CR-series Compact Gear drives.

The gearbox must be removed from the vehicle, oil drained and the exterior cleaned before performing this service procedure.

Disassembly and assembly of gearbox must be done in clean and dustless places.
Item numbers of the parts used in this instruction are related to drawings - see *chapter Exploded views on pages 16-18.*

DISASSEMBLY

Gears and planet carriers disassembly

CR31

1. Remove screws (D180) from back cover (D170).
2. Remove back cover (D170).
3. Remove sun pinion gear (D020).
4. Remove spacer ring (D030).
5. Remove 1st stage carrier (D040) with planet gears (D060) and 2nd stage sun gear (D080).
6. Remove retaining rings (D070) and pull out the planet gears (D060) with bearings using suitable tool.
7. Remove retaining rings (D115) from planet gears (D060) and push out the bearing (D050) using suitable tool.
8. Remove retaining ring (D090) and pull out the 2nd stage sun gear (D080) from the carrier (D040).
9. Remove retaining rings (B050) and pull out the planet gears (B040) from the spindle group (B010) using suitable tool.

CR51

1. Remove screws (D180) from back cover (D170).
2. Remove back cover (D170).
3. Remove sun pinion gear (D020).
4. Remove 1st stage planet carrier (D040) with planet gears (D060) and 2nd stage sun gear (D080).
5. Remove retaining rings (D070) and press out the 2nd stage planet gear (D060) from planet carrier using a suitable tool.
6. Remove retaining ring (D090) and pull out the 2nd stage sun gear (D080) from carrier (D040).
7. Pull out 2nd stage carrier (D100) with planet gears (D120) and 3rd stage sun gear (D140).
8. Remove retaining rings (D130) and pull out planet gears (D120) with bearings from carrier using a suitable tool.
9. Remove the retaining rings (D115) from planet gears (D120) and push out the bearing (D110) using a suitable tool.
10. Remove the retaining ring (D150) and pull out the 3rd stage sun gear (D140) from the carrier (D100).
11. Remove the retaining rings (B050) and pull out the planet gears (B040) from the spindle group (B010) using a suitable tool.

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DISASSEMBLY (continued)

Brake disassembly

CR31 A1, CR51

1. Push spacer ring (B130) using a suitable tool to release retaining ring (B140).
2. Remove retaining ring (B140).
3. Using a suitable tool remove spacer ring (B130) and springs (C080).
4. Remove brake piston (C070) and O-rings (C050, C060).
5. Remove brake plates (C025).
6. Remove clutch (D010).

CR31 A2

1. Remove screws (B250).
2. Remove bushing (B230).
3. Remove screws (B260).
4. Pull out adapter (B200) with brake piston (C070).
5. Remove O-rings (C050, C060).
6. Remove screws (B240) and remove bushings (B230).
7. Remove springs (C080).
8. Remove brake plates (C025).
9. Remove clutch (D010).

ASSEMBLY

Every O-ring and seal has to be replaced.

Every part must be clean, especially must be rustless on the bearing seating and sliding surfaces. Parts must be fitted to unit easy, when they are oiled by transmission oil.

It is necessary to easy coat the O-rings with grease (e.g. Shell ALVANIA G3).

Following parts are orderable only as subassemblies:

Subassemblies		
	CR31	**CR51**
Spindle - group	B010	B010
Planet gear assembly 1st stage	-	D060
Planet gear assembly 2nd stage	B040	-
Planet gear assembly 3rd stage	--	B040

Rolling bearings must be unpacked from original package only directly to installation. It must be installed only using the suitable installing tools.
Screw torque - see *chapter Screw torque on page 15*.

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ASSEMBLY (continued)

Gear and planet carriers assembly

CR31

1. Heat the planet gears (B040) to temperature 90 - 100 °C [194 - 212 °F], press planet gears on pins of spindle group (B010) using press and insure it using retaining-ring (B050).
2. Clean up inner surface of the gear (D060) and gently oil it. Install retaining ring (D115) from one side. Unpack bearing (D050) and insert it into gear until retaining ring using a tool. Install second retaining ring (D115).
3. Install 2nd stage sun gear (D080) to 1st stage carrier (D040) and insure it using retaining ring (D090).
4. Install planet gear (D060) according to step 2 on carrier (D040) using inner ring of the bearing and press. Insure it using retaining ring (D070). Planet carrier must be supported on the pitch circle zone during press of planet gear.
5. Install carrier (D040) according to step 4 to spindle group (B010). Turn hub to check smooth turn.
6. Install spacer ring (D030) between planet gear (D060) and carrier (D040) so that the spacer inside diameter is located opposite the inside diameter of 2nd stage sun gear.
7. Install sun gear (D020).
8. Install cover with O-ring on hub and install screws (D180) retaining cover to the hub.

Never install bearing with the gear using strike.

Use always new screws (D180) for cover assembly.

CR51

1. Heat the planet gears (B040) to temperature 90 - 100 °C [194 - 212 °F], press planet gears on pins of spindle group (B010) using press and insure it using retaining ring (B050).
2. Clean up inner surface of the gear (D120) and gently oil it. Install retaining ring (D115) from one side. Unpack bearing (D110) and insert it into the gear until retaining ring using suitable tool. Install second retaining ring (D115).
3. Install 3rd stage sun gear (D140) to 2nd stage carrier (D100) and insure it using retaining ring (D150).
4. Install planet gear (D120) according to step 2 on 2nd stage planet carrier (D100) using inner ring of the bearing and press. Insure it using retaining ring (D130). Planet carrier must be supported on the pitch circle zone during press of planet gear.
5. Install carrier (D100) according to step 4 into spindle-group (B010). Turn hub to check smooth turn.
6. Install 2nd stage sun gear (D080) to 1st stage carrier (D040) and insure it using retaining ring (D090).
7. Install planet gear (D060) on carrier (D040) using inner ring of the bearing and press. Insure it using retaining ring (D070). Planet carrier must be supported on the pitch circle zone during press of planet gear.
8. Install carrier (D040) according to step 7 to spindle group (B010). Turn hub to check smooth turn.
9. Install sun gear (D020).
10. Install cover with O-ring on hub and install screws (D180) retaining cover to the hub.

Never install bearing with the gear using strike.

Use always new screws (D180) for cover assembly.

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DISASSEMBLY (continued)

Brake assembly

CR31 A1, CR51

1. Install O-rings (C050, C060) into spindle group (B010).
2. Install clutch (D010) into spindle group (B010).
3. Install outer and inner brake plates (C025), start with outer plate. Install inner plates on the clutch (D010).
4. Lightly oil brake piston (C070) on the outer surface. Carefully push it until the plates (C025).
5. Install springs (C080) into brake piston (C070).
6. Install spacer ring (B130) and retaining ring (B140).
7. Press spacer ring (B130) using tool as retaining ring expose the groove in spindle group (B010). Inspect that retaining ring seats properly in the groove.

CR31 A2

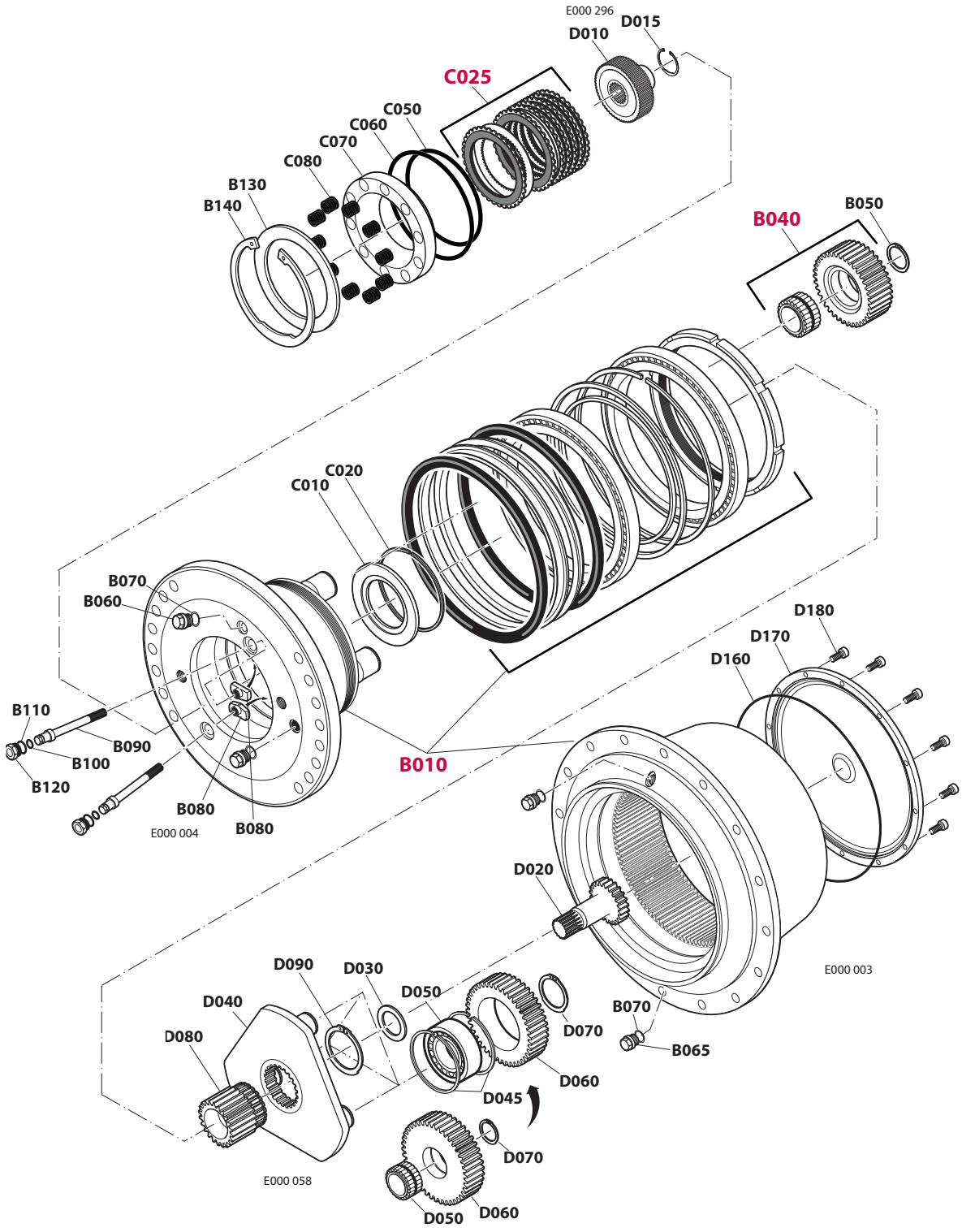
1. Install O-rings (C050, C060) into spindle group (B010).
2. Install clutch (D010) into spindle group (B010).
3. Install outer and inner brake plates (C025), start with outer plate. Install inner plates on the clutch (D010).
4. Install springs (C080) into brake piston (C070).
5. Install O-rings (B210 and B220) on adapter (B200). Put adapter (B200) on springs (C080) so that screw holes in adapter are located opposite the piston one's.
6. Install screws (B240) with bushings (B230) through adapter (B200) into piston (C070). Push springs (C080) using consecutive round tightening of screws.
7. Lightly oil brake piston (C070) on the outer surface and carefully push it together with screwed adapter (B200) until plates (C025).
8. Install screws (B260).
9. Install screws (B250) with bushings (B230) through adapter (B200) into the spindle group (B010).

Screw torque

Screw Torque			
Gearbox	**Name**		**Torque** Nm [lbf•in]
Number	Screw	Thread	
CR			
B060 B065	Plug	M18 x 1.5	45^{+10} [$398^{+88.5}$]
D180	Screw	M8	20^{+3} [$177^{+26.6}$]
CR51, CR31 A1			
B120	Plug	0.875 - 14 UNF-2B	45^{+10} [$398^{+88.5}$]
CR31 A2			
B240 B250	Screw - socket	M6	10^{+2} [$88.5^{+17.7}$]
B260	Screw - socket	M12	100^{+20} [885^{+177}]

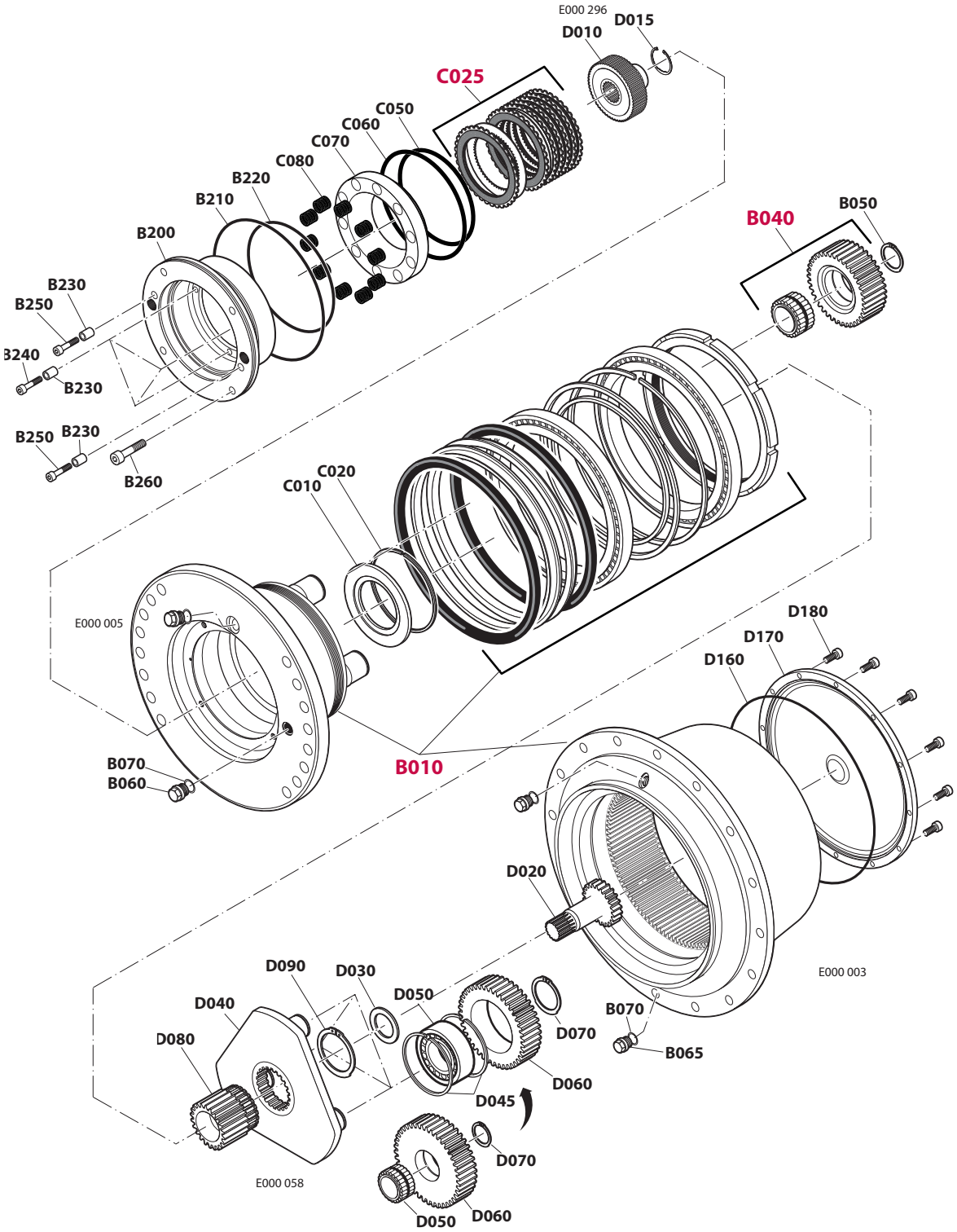
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EXPLODED VIEW – CR 31 A1



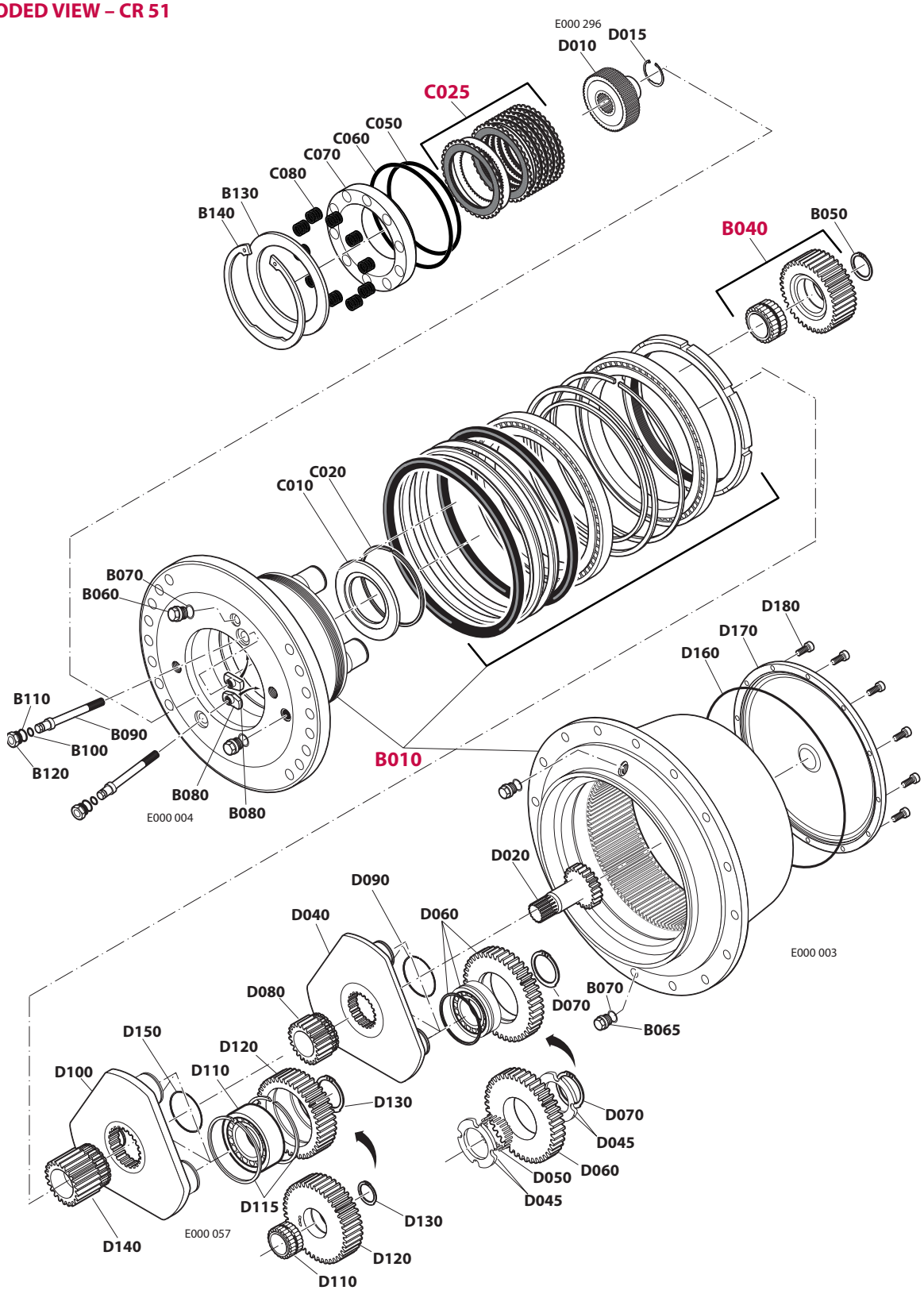
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EXPLODED VIEW – CR 31 A2



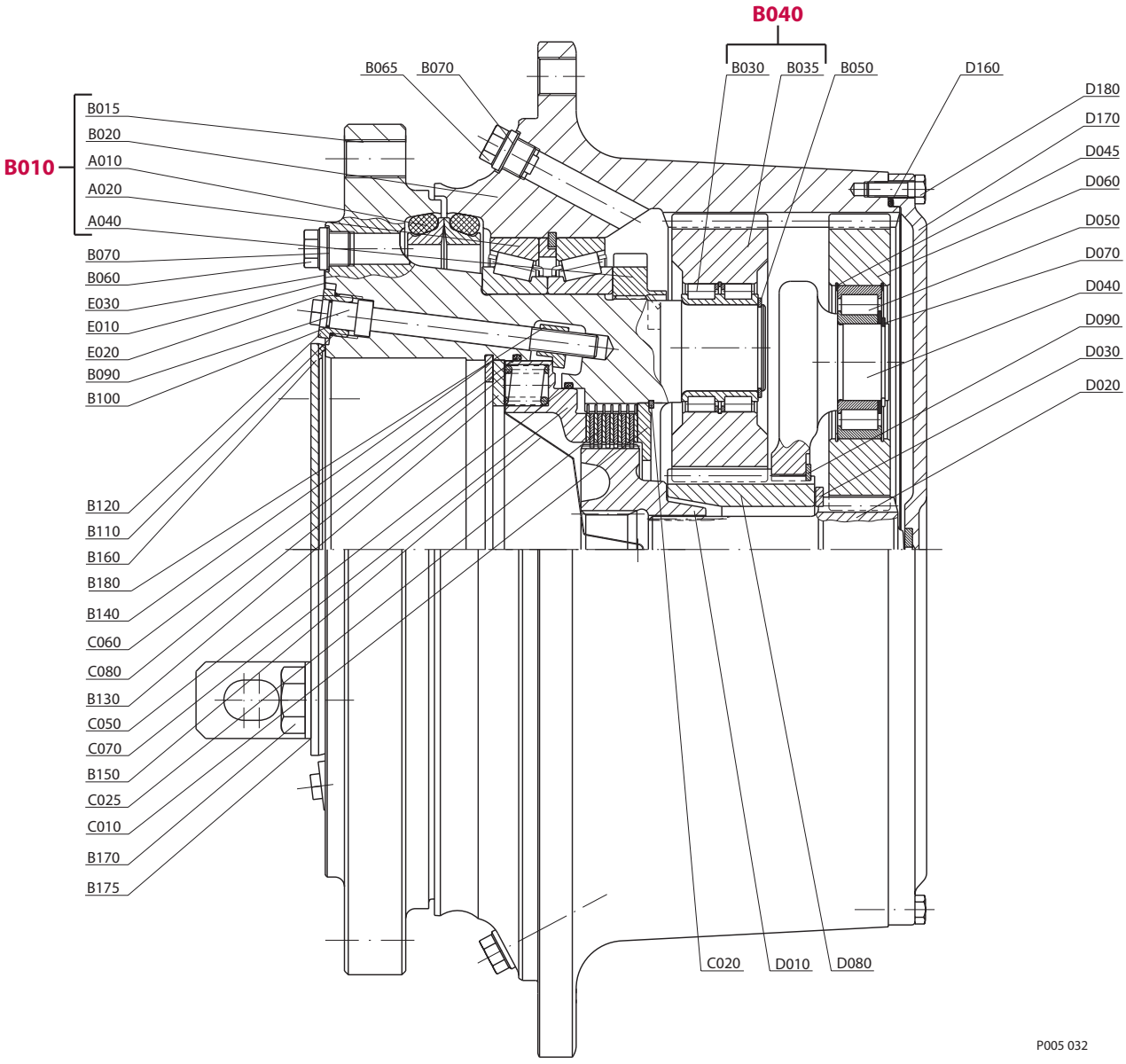
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EXPLODED VIEW – CR 51



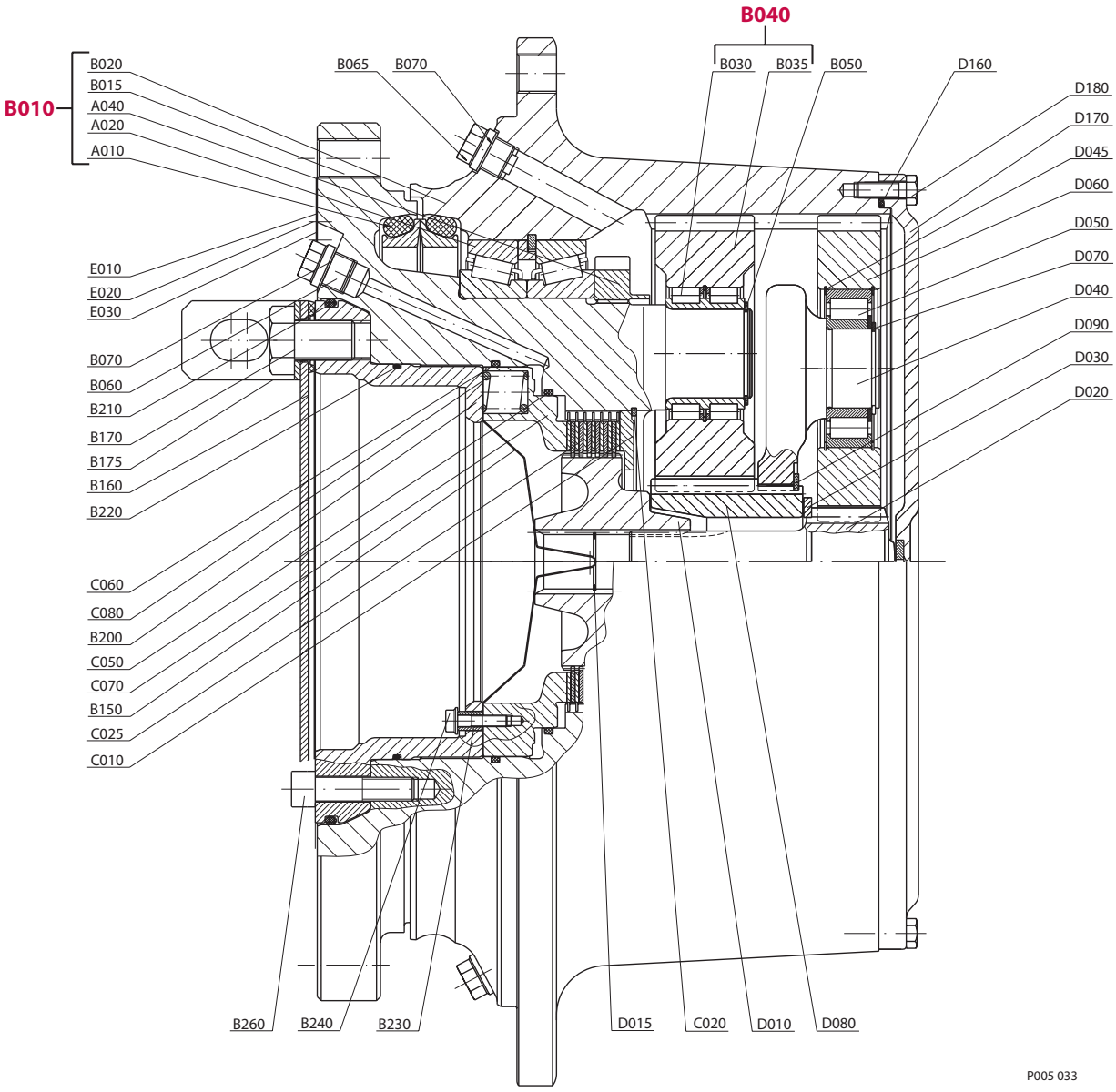
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CROSS SECTION VIEW – CR 31 A1



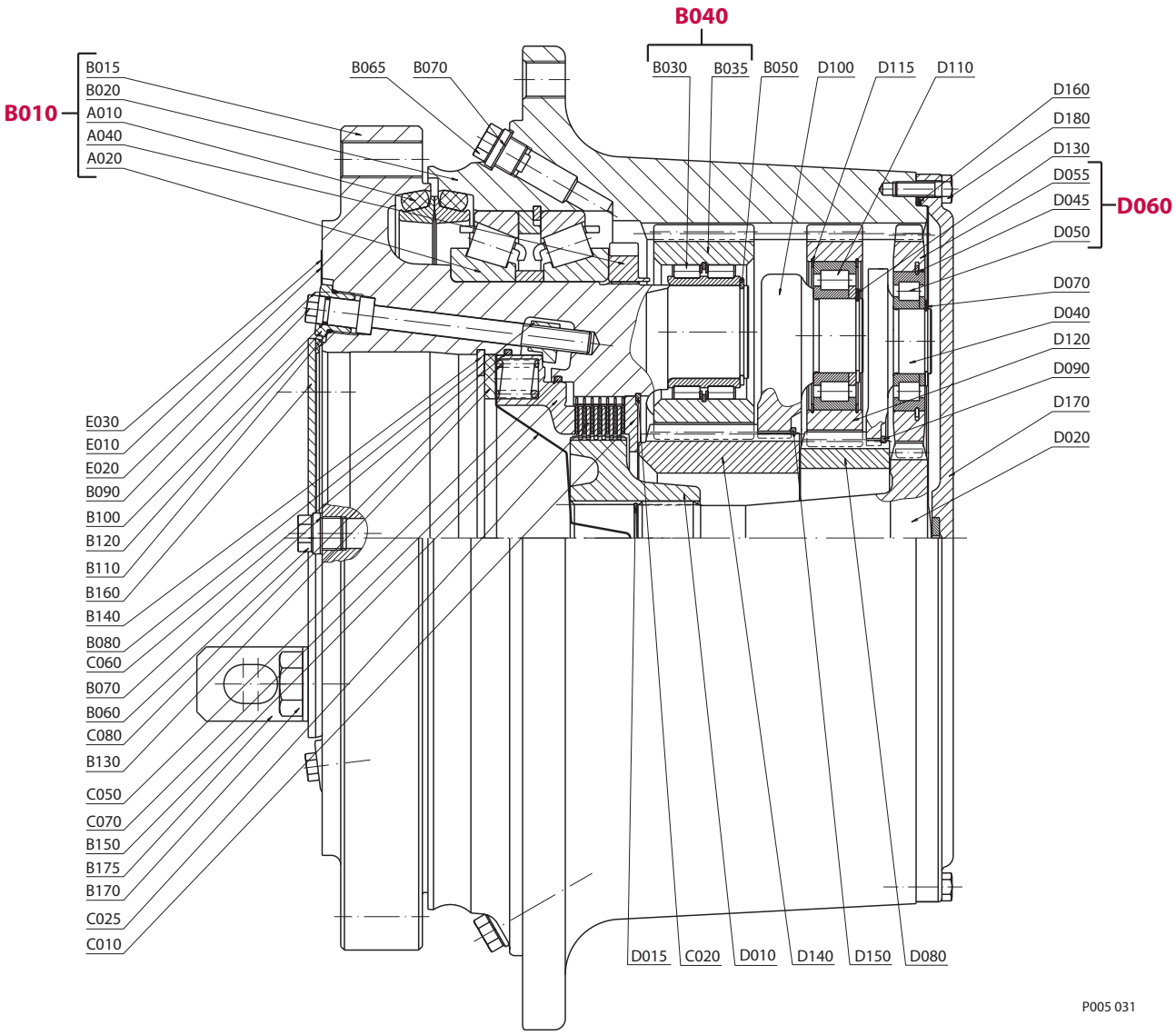
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CROSS SECTION VIEW – CR 31 A2



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CROSS SECTION VIEW – CR 51



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PARTS LIST

Item	Description	Quantity		
		CR31 A1	CR31 A2	CR51
A010	Rotating mechanical seal	1	1	1
A020	Tapered roller bearing	1	1	1
A040	Nut	1	1	1
B010	Spindle group	1	1	1
B015	Spindle	1	1	1
B020	Hub	1	1	1
B030	Roller bearing	4	3, 4*	5
B035	Planet gear	4	3, 4*	5
B040	Planet gear subassembly	4	3, 4*	5
B050	Retaining ring	4	3, 4*	5
B060	Plug	2	2	2
B065	Plug	2	2	2
B070	Sealing ring	4	4	4
B080	Cam	2	-	2
B090	Spindle	2	-	2
B100	O-ring	2	-	2
B110	O-ring	2	-	2
B120	Plug	2	-	2
B130	Spacer ring	1	-	1
B140	Retaining ring	1	-	1
B200	Adapter	-	1	-
B210	O-ring	-	1	-
B220	O-ring	-	1	-
B230	Bushing	-	5	-
B240	Screw	-	3	-
B250	Screw	-	2	-
B260	Screw	-	4	-
C010	Spacer ring	1	1	1
C020	Retaining ring	1	1	1
C025	Brake plates subassembly	1	1	1
C050	O-ring	1	1	1
C060	O-ring	1	1	1
C070	Brake piston	1	1	1
C080	Spring	10	10	10
D010	Clutch	1	1	1
D015	Retaining ring	1	(1)	1
D020	Sun gear	1	1	1
D030	Spacer ring	1	1	-
D040	Carrier	1	1	1
D045	Retaining ring	-	-	3
D050	Roller bearing	3	3	3
D055	Planet gear	-	-	3
D060	Planet gear	3	3	-
D060	Planet gear subassembly	-	-	3
D070	Retaining ring	3	3	3
D080	Sun gear	1	1	1

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PARTS LIST (continued)

Item	Description	Quantity		
		CR31 A1	CR31 A2	CR51
D090	Retaining ring	1	1	1
D100	Carrier	-	-	1
D110	Roller bearing	-	-	4
D115	Retaining ring	6	6	8
D120	Planet gear	-	-	4
D130	Retaining ring	-	-	4
D140	Sun gear	-	-	1
D150	Retaining ring	-	-	1
D160	O-ring	1	1	1
D170	Cover	1	1	1
D180	Screw	12	12	12

* = valid from January 2, 2002

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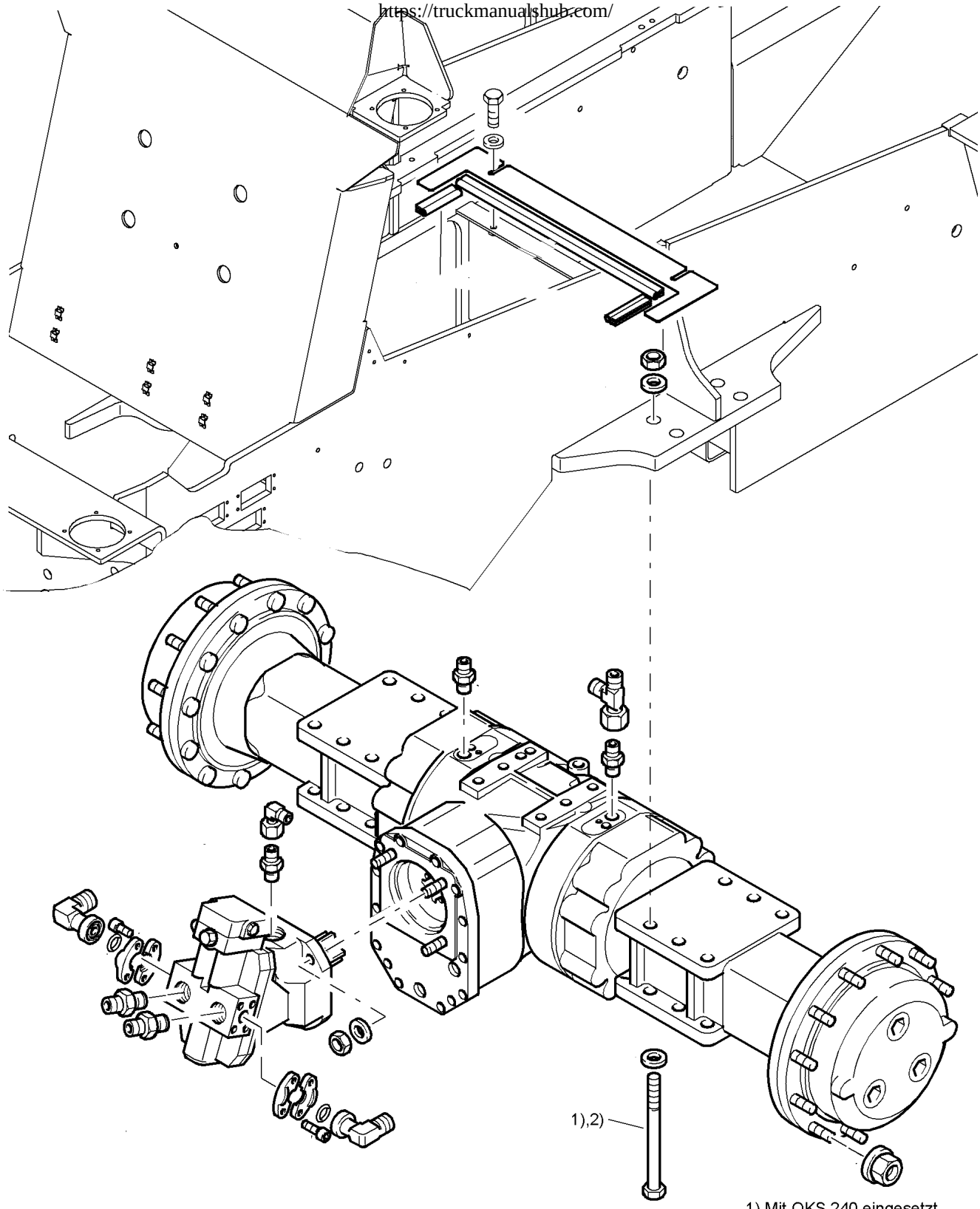
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16.4 Axle DANA 193

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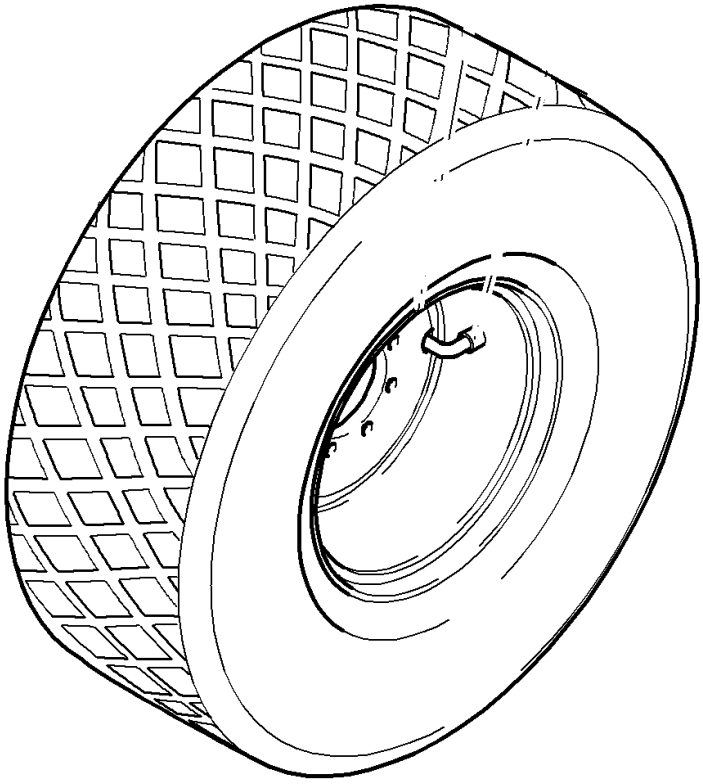


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1) Mit OKS 240 eingesetzt
With OKS 240 inserted
2) Anziehdrehmoment 710 Nm
Tightening torque 710 Nm

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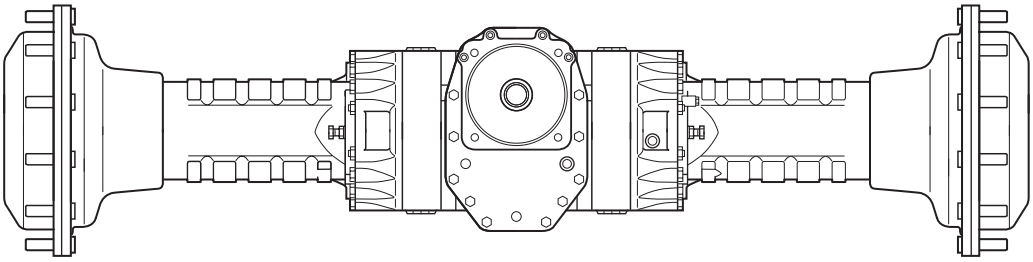
Anziehdrehmoment der Radmuttern 550 Nm
Tightening torque of the wheelnuts 550 Nm



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MO193F10



DANA

maintenance and repair INSTRUCTION MANUAL

MANUALE D'ISTRUZIONE E RIPARAZIONE
WARTUNG UND REPARATURANLEITUNG
MANUAL DE MANUTENCION Y REPARACION
MANUAL ENTRETIEN ET REPARATION

DRIVE AXLE TYPE 193

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Realizzazione a cura dell'Ufficio Post Vendita della DANA ITALIA S.p.A.
Impaginazione: TEMAS s.r.l. - Gallarate (Va)
Stampa: Agosto 1999 (N.L. 7416)

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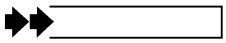
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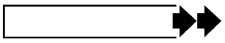
The efficiency and continued operation of mechanical units depend on constant, correct maintenance and also on efficient repair work, should there be a break-down or malfunction. The instructions contained in this manual have been based on a complete overhaul of the unit. However, it is up to the mechanic to decide whether or not it is necessary to assemble only individual components, when partial repair work is needed. The manual provides a quick and sure guide which, with the use of photographs and diagrams illustrating the various phases of the operations, allows accurate work to be performed.
All the information needed for correct disassembly, checks and assembly of each individual component is set out below. In order to remove the differential unit from the vehicle, the manuals provided by the vehicle manufacturer should be consulted. In describing the following operations it is presumed that the unit has already been removed from the vehicle.

IMPORTANT: In order to facilitate work and protect both working surfaces and operators, it is advisable to use proper equipment such as: trestles or supporting benches, plastic or copper hammers, appropriate levers, pullers and specific spanners or wrenches.
Before going on to disassemble the parts and drain the oil, it is best to thoroughly clean the unit, removing any encrusted or accumulated grease.

INTRODUCTORY REMARKS: All the disassembled mechanical units should be thoroughly cleaned with appropriate products and restored or replaced if damage, wear, cracking or seizing have occurred.
In particular, thoroughly check the condition of all moving parts (bearings, gears, crown wheel and pinion, shafts) and sealing parts (O-rings, oil shields) which are subject to major stress and wear. In any case, it is advisable to replace the seals every time a component is overhauled or repaired. During assembly, the sealing rings must be lubricated on the sealing edge. In the case of the crown wheel and pinion, replacement of one component requires the replacement of the other one. During assembly, the prescribed pre-loading, backlash and torque of parts must be maintained.

CLASSIFICATION: This manual classifies units according to part numbers. For a correct interpretation, classification is indicated as follows:


= up to the part number


= from the part number on

When no classification is given, disassembly and assembly operations are the same for all versions.

SPECIFIC EQUIPMENT AND SPARE PARTS: The drawings of all specific tools required for maintenance and repair work can be found at the end of this manual ; spare parts may be ordered either from the vehicle manufacturer or directly from the Service Centers or Authorised Distributors of DANA ITALIA S.p.A..

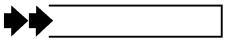
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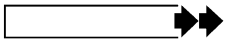
Il rendimento e la continuità degli organi meccanici dipendono oltre che da una costante e corretta manutenzione, anche dal tempestivo intervento, nell'eventualità di guasti o anomalie.
Nel proporre questo manuale si è considerata l'ipotesi di una revisione generale del gruppo ma è il meccanico a valutare la necessità di montare solo i singoli componenti nel caso di riparazione. Il manuale è una guida rapida e sicura che consente interventi precisi, tramite le fotografie ed i disegni prospettici che illustrano le varie fasi delle operazioni. Di seguito sono riportate tutte quelle informazioni ed avvertenze necessarie al corretto disassemblaggio, alle relative verifiche ed all'assemblaggio dei singoli componenti. Per la rimozione del ponte differenziale dal veicolo, è necessario consultare i manuali forniti dal costruttore del veicolo. Nel descrivere le operazioni seguenti, si presuppone che il ponte sia già stato rimosso dal veicolo.

IMPORTANTE: In tutte le operazioni, è consigliabile usare attrezzature idonee quali cavalletti o banchi di sostegno, martelli in plastica o rame, leve appropriate estrattori e chiavi specifiche, al fine di facilitare il lavoro salvaguardando nel contempo le superfici lavorate e la sicurezza degli operatori.
Prima di procedere al disassemblaggio delle parti e scaricare l'olio, è opportuno eseguire un'accurata pulizia del ponte, asportando incrostazioni ed accumuli di grasso.

PREMESSA: Tutti gli organi meccanici smontati, devono essere accuratamente puliti con prodotti appropriati, quindi ripristinati o sostituiti nel caso presentino danni, usura, incrinature, grippaggi, ecc. In particolare, verificare l'integrità di tutte quelle parti in movimento (cuscinetti, ingranaggi, coppia conica, alberi) e di tenuta (anelli OR, paraolio), soggette a maggiori sollecitazioni ed usura. È consigliabile, comunque, la sostituzione degli organi di tenuta ogni qualvolta si proceda alla revisione o riparazione dei componenti. Al momento del montaggio, gli anelli di tenuta devono essere lubrificati sui bordi di tenuta. Nel caso della coppia conica, la sostituzione di uno dei suoi ingranaggi comporta anche la sostituzione dell'altro. In fase di montaggio sono da rispettare scrupolosamente i giochi, i precarichi e le coppie prescritte.

VALIDITÀ: Il manuale fornisce le validità dei gruppi sotto forma di matricola. Al fine di una corretta interpretazione, le validità sono indicate come:


= fino alla matricola


= dalla matricola

Se non sono indicate validità, le operazioni di smontaggio ed assemblaggio sono comuni a tutte le versioni.

MANUTENZIONE E RIPARAZIONE: Al fine di facilitare interventi sui gruppi ponte differenziali e cambi di velocità la SPICER CLARK-HURTH, ha ritenuto opportuno compilare queste istruzioni di manutenzione e riparazione. I disegni delle attrezzature specifiche eventualmente necessarie per l'esecuzione di interventi di manutenzione e riparazione possono essere acquistati direttamente presso il costruttore; i ricambi possono essere ordinati tramite il costruttore della macchina o direttamente presso la DANA ITALIA S.p.A..

D

Die Leistung und Lebensdauer der mechanischen Teile hängt nicht nur von einer ständigen und richtig durchgeführten Wartung sondern auch von einem sofortigen Eingriff im Störungsfall ab. Um dieses Handbuch zu erstellen sind wir von einer allgemeinen Überprüfung der Einheit ausgegangen, doch entscheidet der Mechaniker ob die einzelnen Teile bei Reparaturen montiert werden müssen oder nicht. Das Handbuch ist schnell und einfach nachzuschlagen und ermöglicht es anhand der Abbildungen und der Zeichnungen, die die verschiedenen Vorgänge darstellen, gezielt einzugreifen. Nachstehend sind alle Informationen und Hinweise aufgeführt, die zur Zerlegung, Prüfung und Montage der Einzelteile nötig sind. Um die Differentialachse des Fahrzeugs abzumontieren, lesen Sie bitte die Anweisungen in den Handbüchern des Fahrzeugherstellers. Die nachstehenden Beschreibungen gehen davon aus, daß die Fahrzeugachse schon abmontiert worden ist.

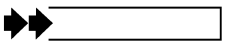
WICHTIG: Um die Arbeit zu erleichtern und gleichzeitig die verarbeiteten Flächen zu schützen und die Sicherheit der Arbeiter zu gewährleisten, empfehlen wir geeignete Werkzeuge wie Böcke, Tisch, Gummi- oder Kupferhammer, geeignete Abzieher und Schlüssel zu verwenden.
Bevor mit der Zerlegung der Teile begonnen und das Öl abgelassen wird, muß die Achse sorgfältig gereinigt und Verkrustungen und Fettablagen abgetragen werden.

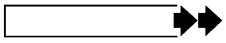
VORAUSSETZUNG: Alle abmontierten mechanischen Teile müssen sorgfältig mit geeigneten Reinigungsmitteln gereinigt oder, wenn beschädigt, verschleißt, gerissen, festgefressen usw. ausgewechselt werden. Insbesondere muß der einwandfreie Zustand aller beweglichen Teile (Lager, Zahnräder, Kegelradpaare, Wellen) und der Dichtungen (O-Ringe, Ölabdichtungen), die am meisten beansprucht werden und verschleißen, kontrolliert werden. Wir empfehlen auf jeden Fall die Abdichtungselemente immer auszuwechseln, wenn eine Überholung oder eine Reparatur der Teile vorgenommen wird. Bei

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der Montage müssen die Ränder der Dichtringe geschmiert werden. Wenn beim Kegelradpaar ein Zahnrad ausgewechselt werden muß, muß auch das andere Zahnrad ausgewechselt werden. Bei der Montage müssen die vorgeschriebenen Spiele, Vorspannungen und Drehmomente strengstens eingehalten werden.

GÜLTIGKEIT: Das Handbuch gibt an zu welchen Kennummern die Einheiten gehören. Der Einfachheit halber sind die Angehörigkeiten folgendermaßen aufgeführt:

 = bis Kennummer

 = ab Kennummer

Wenn keine Angehörigkeit angegeben ist, verstehen sich die Arbeiten zur Zerlegung und Montage für alle Ausführungen gültig.

SPEZIFISCHE WERKZEUGE UND ERSATZTEILE: die Zeichnungen der für Wartungsarbeiten erforderlichen spezifischen Werkzeuge, sind am Ende des Handbuchs aufgeführt; Ersatzteile können beim Fahrzeughersteller oder direkt bei der Kundendienststelle oder bei einem zugelassenen Händler der DANA ITALIA S.p.A. bezogen werden.

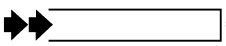
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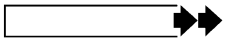
El rendimiento y la duración de los órganos mecánicos depende, además que del constante y correcto mantenimiento, también de la intervención inmediata en caso de averías o anomalías.
Al proponer este manual, ha sido considerada la suposición de una revisión general del grupo, pero es el mecánico quien tiene que valorar la necesidad de montar cada uno de los componentes en caso de reparación. El manual es una guía rápida y segura que permite intervenciones precisas por medio de fotografías y de planos que muestran las distintas fases de las operaciones. A continuación figuran todas las informaciones y advertencias necesarias para ejecutar un montaje correcto, para las comprobaciones y el montaje de cada uno de los componentes. Para remover el puente diferencial del vehículo hay que consultar los manuales de los fabricantes del vehículo. En la descripción de las operaciones siguientes se supone que el puente ya ha sido sacado del vahículo.

IMPORTANTE: Para facilitar el trabajo salvaguardando al mismo tiempo las superficies mecanizadas y la seguridad de los operadores, se aconseja que se usen equipos y herramientas adecuados como caballetes y bancos de soporte, martillos de plástico o de cobre, palancas adecuadas, extractores y llaves específicas.
Antes de desmontar las partes y descargar el aceite, es conveniente que se haga una limpieza minuciosa del puente sacando las incrustaciones y acumulaciones de grasa.

INTRODUCCION: Todos los órganos mecánicos desmontados tienen que ser limpiados minuciosamente con productos adecuados y restaurados o sustituidos en el caso de que presenten daños, desgaste, rajaduras, agarrotamientos, etc. En particular, comprobar la integridad de todas las partes en movimiento (cojinetes, engranajes, par cónico, ejes) y de estanqueidad (anillos OR, detenedor de aceite) sujetas a mayores solicitaciones y desgaste. Se aconseja, de todas formas, que se sustituyan los órganos de estanqueidad cada vez que se ejecute la revisión o reparación de los componentes.
Al volver a montar, los segmentos de compresión tienen que estar lubricados en los bordes de estanqueidad. En el caso del par cónico, la sustitución de uno de sus engranajes comporta también la sustitución del otro. Al montar hay que tener en cuenta escrupulosamente los juegos, las precargas y los pares descriptos.

VALIDEZ: El manual suministra la validez de los grupos en forma de matrícula. Para poder tener una interpretación correcta, la validez está indicada:

 = hasta la matrícula

 = desde la matrícula en adelante

Si no ha sido indicada validez, las operación de desmontaje y montaje son comunes a todas las versiones.

HERRAMIENTAS ESPECIFICAS Y RECAMBIOS: Los planos de las herramientas especificas necesarias para la ejecución de las intervenciones de mantenimiento figuran al final del manual; los recambios se pueden pedir al fabricante de la máquina o directamente al Service Center o a Distribuidores autorizados de DANA ITALIA S.p.A..

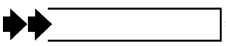
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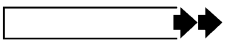
Le rendement et la continuité des organes mécaniques dépendent, non seulement d'une maintenance correcte et constante, mais également de la rapidité d'intervention en cas de pannes ou d'anomalies. En vous proposant ce manuel, on envisage l'hypothèse d'une révision générale du groupe, mais c'est au mécanicien d'évaluer la nécessité de monter ou non chacun des composants en cas de réparation. Le manuel est un guide rapide et sûr consentant des interventions précises, au travers de photographies et de dessins prospectifs qui illustrent les différentes phases des opérations. Ensuite, sont reportées toutes les informations et précautions nécessaires pour un démontage correct et les vérifications et assemblage de chaque composant. En ce qui concerne le déplacement du pont d'étai du véhicule, il est nécessaire consulter les manuels fournis par le constructeur du véhicule. En décrivant les opérations suivantes, on présume que le pont ait déjà été enlevé du véhicule.

IMPORTANT: Pour faciliter le travail en sauvegardant en même temps les surfaces usinées et la sécurité des opérateurs, il est préconisé d'utiliser des installations appropriées telles que des étais ou banc de support, maillets en plastique ou cuivre, leviers appropriés, extracteurs et clés spécifiques.
Avant de procéder au démontage des parties et vidanger l'huile, il vaut mieux nettoyer soigneusement le pont, en enlevant incrustations et blocs de gras.

PRELIMINAIRE: Tous les organes mécaniques démontés doivent être soigneusement nettoyés à l'aide de produits appropriés et réparés ou remplacés dans le cas où ils seraient abîmés, usés, fêlés, grippés, etc. Vérifier, l'intégrité, en particulier, de toutes les parties en mouvement (paliers, engrenages, couple conique, arbres) et l'étanchéité des bagues (bagues OR, parahuile), qui sont sujettes à plus de sollicitations et à l'usure. Il est préconisé, de toute façon, de substituer les organes d'étanchéité, chaque fois que l'on effectue une révision ou une réparation des composants. Au moment du montage, les bagues d'étanchéité doivent être lubrifiées sur les bords étanches. Dans le cas du couple conique, la substitution de l'un de ses engrenages comporte également la substitution de l'autre. En phase de montage, il faut respecter scrupuleusement les jeux, les précharges et les couples prescrits.

VALIDITE: Le manuel fournit la validité des groupes sous forme de matricule. Pour une meilleure interprétation, les validités sont indiquées comme:

 = jusqu'à l'immatriculation

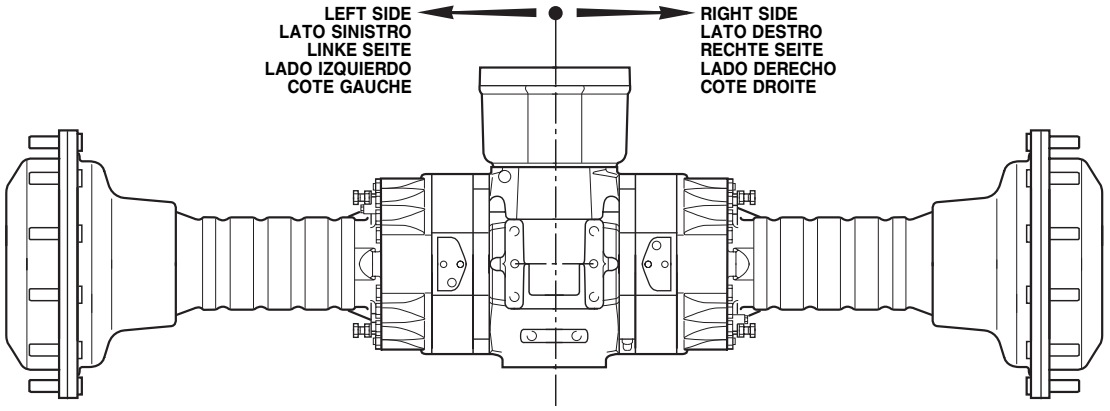
 = à partir de l'immatriculation et après

Si les validités ne sont pas indiquées, les opérations de démontage et d'assemblage sont pareilles dans toutes les versions.

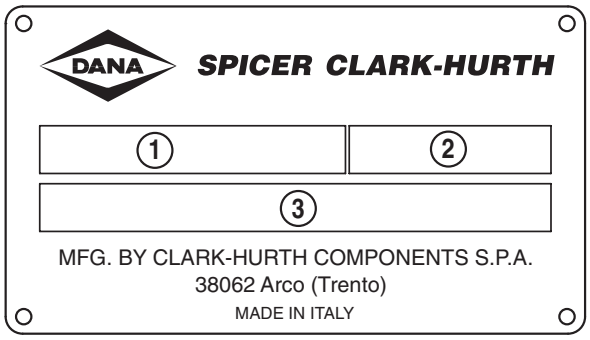
INSTALLATIONS SPECIFIQUES ET PIECES DETACHEES: Les dessins des installations spécifiques nécessaires pour effectuer des interventions d'entretien sont reportées à la fin du manuel, les pièces détachées peuvent être commandées au constructeur de la machine ou directement aux Centres de Services, ou Distributeurs agréés de la Société DANA ITALIA S.p.A..

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DEFINITION OF VIEWPOINTS - DEFINIZIONE VISTE - DEFINITION DER ANSICHTEN - DEFINICION VISTAS - DÉFINITION VUES

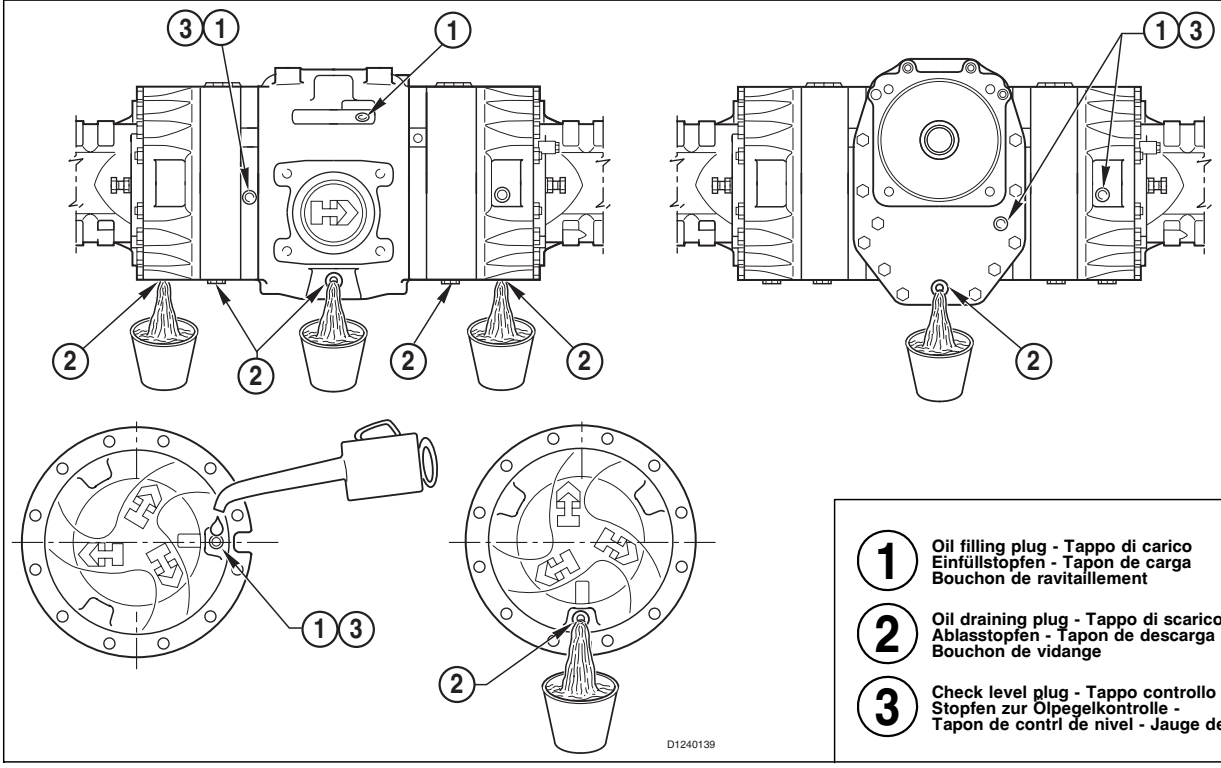


DATA PLATE - TARGA MATRICOLA - KENNUMMERNSCHILD - MATRICULA - PLAQUE D'IMMATRICULATION



1. Type and model unit - modification index
   Tipo e modello gruppo - indice di modifica
   Typ und Modelleles Antriebes - Änderungsverzeichnis
   Tipo y modelo grupo - indice de modificacion
   Type et modéle de ensemble - tableau des modifications
2. Serial number
   Numero di serie
   Seriennummer
   Número de serie
   Numero de serie
3. Lubricant
   Lubrificante
   Schmieroel
   Lubricante
   Lubrificant

MAINTENANCE POINTS - PUNTI DI MANUTENZIONE - WARTUNGSSTELLEN - PUNTOS DE MANUTENCION - POINTS D'ENTRETIEN



1. Oil filling plug - Tappo di carico
   Einfüllstopfen - Tapon de carga
   Bouchon de ravitaillement
2. Oil draining plug - Tappo di scarico
   Ablasstopfen - Tapon de descarga
   Bouchon de vidange
3. Check level plug - Tappo controllo livello
   Stopfen zur Ölpegelkontrolle -
   Tapon de contrl de nivel - Jauge de niveau

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MAINTENANCE INTERVALS - INTERVALLI DI MANUTENZIONE - WARTUNGSINTERVALLE - INTERVALOS DE MANUTENCIÒN - INTERVALLE DE SERVICE

OPERATION - OPERAZIONE - ARBEITSVORGANG - OPERACION - OPERATION		FREQUENCY - PERIODICITÀ - ZEITABSTAND - FRECUENCIA - PERIODICITE	LUBRICANTS - LUBRIFICANTI - SCHMIERSTOFFE - LUBRICANTES - LUBRIFIANTS
• Check levels: • Controllo livelli: • Ölstandkontrolle: • Control niveles: • Contrôle niveaux:	Differential Differenziale Im differential Diferencial Differentiel	monthly mensile monatlich cada mes mensuel	• SAE85W90 (API GL4 - MIL L-2105) With additives for oil-bath brakes Con additivi per freni a bagno d'olio Mit Zusatzmittel für Bremsen in Ölbad Con aditivos para frenos de baño de aceite Avec adjuvants pour freins en bain d'huile • SAE85W90 (API GL5 - MIL 2105-B) With additives for oil-bath brakes, for units presenting hypoid crown wheel and pinion and /or self-locking differential gear Per esecuzioni con coppia conica ipoide e/o con differenziale autobloccante, con additivi per freni a bagno d'olio Bei Ausführungen mit Kegel- und Telleradpaar und/oder Selbstsperrdifferential, mit Zusatzmitteln für Bremsen in Ölbad Para ejecuciones con par cónico hipoide y/o con diferencial autobloqueante con aditivos para frenos de baño de aceite. Pour exécutions avec couple conique hypoïde et/ou différentiel autobloquant, avec adjuvants pour freins en bain d'huile
	Planetary reduction Riduzione epicicloidale Planetengetrieb Reducción epicicloidal Reduction epicycloidale	every 200 hours ogni 200 ore alle 200 Std. cada 200 horas toutes les 200 heures	
• Oil change: • Cambio olio: • Ölwechsel: • Cambio aceite: • Vidange huile:	Differential Differenziale Im differential Diferencial Differentiel	every 800 hours ✻ ogni 800 ore alle 800 Std. cada 800 horas toutes les 800 heures	
	Planetary reduction Riduzione epicicloidale Planetengetrieb Reducción epicicloidal Reduction epicycloidale	every 1000 hours ✻ ogni 1000 ore alle 1000 Std. cada 1000 horas toutes les 1000 heures	
	Self-locking differential gear Differenziale autobloccante Selbstsperrdifferential Diferencial autobloqueante Differentiel autobloquant	every 700 hours ✻ ❒ ogni 700 ore alle 700 Std. cada 700 horas toutes les 700 heures	

✻ Initially after 100 working hours - Inizialmente dopo 100 ore di lavoro - Erstmals nach 100 Betriebstunden - Al principio, después de 100 horas de trabajo - Initialement après 100 heures de travail

❒ When it starts sounding noisy - Anche ai primi cenni di rumorosità - Auch falls ungewöhnliche Geräusche zu bemerken sind - También al primer indicio de ruido - Même aux premiers signaux de bruit

OPERATION - OPERAZIONE - ARBEITSVORGANG - OPERACION - OPERATION	MEMBER - ORGANO - ELEMENT - ORGANO - ORGANE	CONDITIONS - CONDIZIONI - BEDINGUNG - CONDICIONES - CONDITIONS	FREQUENCY - PERIODICITÀ - ZEITABSTAND - FRECUENCIA - PERIODICITE	LUBRICANTS - LUBRIFICANTI - SCHMIERSTOFFE - LUBRICANTES - LUBRIFIANTS
Greasing Ingrassaggio Schmieren Engrase Graissage	Articulations Snodi Gelenk Rótula Articulations	Normal work Lavori normali Normale Arbeit Trabajos normales Tâches ordinaires	monthly mensile monatlich cada mes mensuel	MOLIKOTE
		Awkward work Lavori gravosi Schwere Arbeit Trabajos pesados Tâches extraordinaires	Weekly Settimanale Wöchentlich Semanal Hebdomadaire	

ADJUSTMENT AND CHECKS - REGISTRAZIONE E CONTROLLI - EINSTELLUNGEN UND KONTROLLEN - AJUSTE Y CONTROLES - REGLAGES ET CONTROLES

UNIT - GRUPPO - AGGREGAT - GRUPO - GROUPE	OPERATION - OPERAZIONE ARBEITSVORGANG - OPERACION - OPERATION	FREQUENCY - PERIODICITÀ - ZEITABSTAND - FRECUENCIA - PERIODICITE	SERVICE BRAKE CIRCUIT - CIRCUITO COMANDO FRENI - BREMSKREISLAUF - CIRCUITO MANDOS FRENOS - CIRCUIT DE COMMANDE DES FREINS
Negative brake Freno negativo Federspeicherbremse Freno negativo Frein négatif	Adjustment Registrazione Einstellen Ajuste Réglage	every 1000 hours ✻ ogni 1000 ore alle 1000 Std. cada 1000 horas toutes les 1000 hours	Only for mineral oil use e.g. ATF Dexron II. Make sure that master cylinder seals are suitable for mineral oil. Usare esclusivamente olio minerale ATF Dexron II. Accertarsi che le guarnizioni del cilindro master siano adatte a questo olio. Nur mineralisches Öl verwenden, z.B.: ATF Dexron II. Achtung: Dichtringe des Hauptbremszylinders müssen für dieses Öl geeignet sein. Usar exclusivamente aceite mineral ATF Dexron II. Asegurarse de que las juntas del cilindro principal son adecuadas para este aceite. Utiliser exclusivement huile minérale ATF Dexron II. Vérifier que les joints du maître-cylindre, soien compatibles avec cette huile.
Service brake Freni di servizio Hilfsbremse Frenos de ejercicio Freins de service	Adjustment Registrazione Einstellen Ajuste Réglage	every 500 hours ogni 500 ore alle 500 Std. cada 500 horas toutes les 500 hours	
Wheel nuts Dadi ruota Radmuttern Tuercas rueda Ecrous de roue	Tightening Serraggio - Festziehen Apriete Serrage	every 200 hours ogni 200 ore alle 200 Std. cada 200 horas toutes les 200 hours	

✻ Initially after 100 working hours - Inizialmente dopo 100 ore di lavoro - Erstmals nach 100 Betriebstunden - Al principio, después de 100 horas de trabajo - Initialement après 100 heures de travail

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CONVERSION TABLES - TABELLE DI CONVERSIONE - UMRECHNUNGSTABELLEN
TABLAS DE CONVERSION - TABLEAUX DE CONVERSION

Units of pressure - Unità di pressione - Druckeinheiten
Unidad de presión - Unités de pression: $1\ Atm \cong 1\ bar \cong 10^5\ P_A \cong 14.4\ P_{Si}$

Units of weight - Unità di peso - Gewichtseinheiten
Unidad de peso - Unités de poids

	N	daN	kN	kg	lbs
1N	1	0,1	0,001	0,102	0,225
1daN	10	1	0,01	1,02	2,25
1kN	1000	100	1	102	225
1kg	9,81	0,981	0,00981	1	2,205

Units of torque - Unità di coppia - Drehmomenteinheiten
Unidad de par - Unités de couple

	Nm	daNm	kNm	kgm	lb-in
1Nm	1	0,1	0,001	0,102	8,854
1daNm	10	1	0,01	1,02	88,54
1kNm	1000	100	1	102	8854
1kgm	9,81	0,981	0,00981	1	86,8
1lb-in	0,1129	0,01129	0,0001129	0,01152	1

TIGHTENING TORQUES - COPPIE DI SERRAGGIO - ANZIEHDREHMOMENTE
PARES DE TORSION - COUPLES DE SERRAGE

Unit - Unità di misura - Meßeinheiten - Unidad de medida - Unités de mesure: Nm

SIZE OF BOLT MISURA VITE SCHRAUBENMASS TAMAÑO TORNILLO MESURE VIS		TYPE OF BOLT - TIPO VITE - GEWINDE - TIPO DE TORNILLO - TYPE DE VIS					
		8.8		10.9		12.9	
		Normali + Loctite 242	Normali + Loctite 270	Normali + Loctite 242	Normali + Loctite 270	Normali + Loctite 242	Normali + Loctite 270
COARSE PITCH - PASSO GROSSO - GROßER SCHRITT - PASO GRUESO - GROS PAS	M6 x 1	9,5-10,5	10,5-11,5	14,3-15,7	15,2-16,8	16,2-17,8	18,1-20,0
	M8 x 1,25	23,8-26,2	25,6-28,4	34,2-37,8	36,7-40,5	39,0-43,0	43,7-48,3
	M10 x 1,5	48-53	52-58	68-75	73-81	80-88	88-97
	M12 x 1,75	82-91	90-100	116-128	126-139	139-153	152-168
	M14 x 2	129-143	143-158	182-202	200-221	221-244	238-263
	M16 x 2	200-221	219-242	283-312	309-341	337-373	371-410
	M18 x 2,5	276-305	299-331	390-431	428-473	466-515	509-562
	M20 x 2,5	390-431	428-473	553-611	603-667	660-730	722-798
	M22 x 2,5	523-578	575-635	746-824	817-903	893-987	974-1076
	M24 x 3	675-746	732-809	950-1050	1040-1150	1140-1260	1240-1370
	M27 x 3	998-1103	1088-1202	1411-1559	1539-1701	1710-1890	1838-2032
	M30 x 3,5	1378-1523	1473-1628	1914-2115	2085-2305	2280-2520	2494-2757
FINE PITCH - PASSO FINE - KLEINER SCHRITT - PASO FINO - PAS FIN	M8 x 1	25,7-28,3	27,5-30,5	36,2-39,8	40,0-44,0	42,8-47,2	47,5-52,5
	M10 x 1,25	49,4-54,6	55,2-61,0	71,5-78,5	78,0-86,0	86,0-94,0	93,0-103,0
	M12 x 1,25	90-100	98-109	128-142	139-154	152-168	166-184
	M12 x 1,5	86-95	94-104	120-132	133-147	143-158	159-175
	M14 x 1,5	143-158	157-173	200-222	219-242	238-263	261-289
	M16 x 1,5	214-236	233-257	302-334	333-368	361-399	394-436
	M18 x 1,5	312-345	342-378	442-489	485-536	527-583	580-641
	M20 x 1,5	437-483	475-525	613-677	674-745	736-814	808-893
	M22 x 1,5	581-642	637-704	822-908	903-998	998-1103	1078-1191
	M24 x 2	741-819	808-893	1045-1155	1140-1260	1235-1365	1363-1507
	M27 x 2	1083-1197	1178-1302	1520-1680	1672-1848	1834-2027	2000-2210
	M30 x 2	1511-1670	1648-1822	2138-2363	2332-2577	2565-2835	2788-3082

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SCREW-LOCKING, SEALING AND LUBRICATING MATERIALS - MATERIALI PER BLOCCAGGIO VITI, TENUTA E LUBRIFICAZIONE - MATERIAL ZUR BLOCKIERUNG VON SCHRAUBEN UND FÜR DICHTUNGEN UND SCHMIERMITTEL - MATERIALES PARA EL BLOQUEO, ESTANQUEIDAD Y LUBRICACION - MATÉRIAUX POUR LE BLOCAGE VIS, ÉTANCHÉITÉ ET LUBRIFICATION

⚠ 1 - Locking, sealing and lubricating materials referred to in this manual are the same used in the shop-floor.
I materiali per il bloccaggio, tenuta e lubrificazione specifica indicati nel manuale, sono quelli usati in fabbrica.
Die Materialien zur Blockierung von Schrauben, für Dichtungen und Schmiermittel, die im Handbuch aufgeführt sind, sind dieselben die auch vom Hersteller verwendet werden.
Los materiales para el bloqueo, estanqueidad y lubricación específica indicados en el manual, son los que se usan en la fábrica
Les matériaux de blocage, d'étanchéité et de lubrification spécifiés indiqués dans ce manuel sont ceux employés à l'usine.

2 - The table below gives an account of the typical applications of each single material, in order to facilitate replacement with similar products marketed by different brand names with different trade marks.
Di questi materiali, vengono riportate le applicazioni tipiche che li distinguono, in modo da poterli sostituire con prodotti similari commercializzati da altre marche e quindi con altre sigle.
Von diesen Materialien werden die typischen Anwendungen genannt, um sie mit ähnlichen Materialien zu ersetzen, die unter anderen Namen und Kennzeichnungen im Handel erhältlich sind.
De estos materiales damos las aplicaciones típicas que los distinguen, de manera que se puedan sustituir con productos similares comercializados por otras marcas y por tanto con otras siglas.
De ces matériaux ne sont reportées que les applications typiques qui les distinguent de telle sorte qu'ils puissent être substitués par des produits semblables se trouvant dans le commerce sous d'autres marques et par conséquent sous d'autres sigles.

DENOMINATION **DENOMINAZIONE** **BEZEICHNUNG** **DENOMINACION** **DENOMINATION**	**APPLICATION - APPLICAZIONE - ANWENDUNG - APLICACION - APPLICATION**
Loctite 242	• Anaerobic product apt to prevent the loosening of screws, nuts and plugs. Used for medium-strength locking. Before using it, completely remove any lubricant by using the specific activator. • *Prodotto anaerobico adatto a prevenire l'allentamento di viti, dadi e tappi. Usato per la frenatura a media resistenza. Deve essere usato dopo aver asportato ogni traccia di lubrificante con l'attivatore specifico.* • Anaerobes Produkt, um das Lockern von Schrauben, Muttern und Stopfen zu verhindern. Für mittlere Widerstandskräfte geeignet. Darf erst aufgetragen werden, wenn die Flächen von Schmiermittel richtig sauber sind. Dazu das entsprechende Produkt verwenden. • *Producto anaeróbico apto para prevenir el aflojamiento de tornillos, tuerca y tapones. Usado para el frenado de media resistencia. Tiene que ser usado sólo después de haber quitado todo residuo de lubricante con el activador especifico.* • Produit anaréobic servant à prévenir le relâchement des vis, écrous et bouchons. Utilisé pour le freinage demi résistant. Il doit être utilisé après avoir enlevé toute trace de lubrifiant à l'aide d'un activeur spécial.
Loctite 243	• The oleocompatible alternative to 242. Does not require the activation of lubricated surfaces. • *Prodotto alternativo al 242 che, essendo oleocompatibile, non richiede l'attivazione di superfici lubrificate.* • Alternatives Produkt zu Loctite 242. Da es ölkompatibel ist müssen die geschmierten Flächen nicht aktiviert werden. • *Producto alternativo al 242 que, siendo oleocompatible, no requiere la activación de superficies lubricadas.* • Produit en alternance avec le 242 lequel étant oléocompatible ne requiert aucune activation des surfaces lubrifiées.
Loctite 270	• Anaerobic product for very-high strength locking of screws and nuts. Before using it, completely remove any lubricant by using the specific activator. To remove parts, it may be necessary to heat them at 80°C approx. • *Prodotto anaerobico adatto per la frenatura ad altissima resistenza di viti e dadi. Deve essere usato dopo aver asportato ogni traccia di lubrificante con l'attivatore specifico.* *La rimozione delle parti, può richiedere un riscaldamento a circa 80°C.* • Anaerobes Produkt für hohe Widerstandskräfte für Schrauben und Muttern geeignet. Zuerst die Fläche sorgfältig aktivieren. Um die Flächen zu säubern, diese auf ca. 80°C erwärmen. • *Producto anaeróbico apto para el frenado de alta resistencia de tornillos y tuercas. tiene que ser usado después de haber quitado todo residuo de lubricante con el activador específico.* *La remoción de las partes, puede requerir un calentamiento a unos 80°C.* • Produit anaréobic apte au freinage à très haute résistance des vis et des écrous. Il doit être utilisé après avoir enlevé toute trace de lubrifiant à l'aide d'un activeur spécial.
Loctite 275	• Anaerobic product suitable for high-strength locking and sealing of large threaded parts, bolts and stud bolts, for pipe sealing and for protecting parts against tampering; suitable for sealing coupling surfaces with a max. diametrical clearance of 0.25 mm. • *Prodotto anaerobico adatto per la frenatura e sigillatura ad alta resistenza di parti filettate, bulloni e prigionieri di grandi dimensioni, protezione antimanomissione e sigillatura di tubazioni; può sigillare accoppiamenti con gioco diametrale massimo di 0,25 mm.* • Anaerobes Produkt zum Bremsen und Siegeln von großen Gewinden, Muttern und Stiftschrauben , sehr widerstandsfähig, verschleierungsbeständig, und zum Siegeln von Rohrleitungen geeignet; kann Kupplungen mit einer maximalen Lagerluft von 0,25 mm siegeln. • *Producto anaerobico apto para el frenado y selladura a alta resistencia de tornillos, tuercas y prisioneros de grandes dimensiones, protecion anti manomision y selladura de tubaciones ; puede sellar encolcados con juego diametral.* • Produit anaérobie adapté au freinage et au scellage à haute résistance des parties filetées, boulons et prisonniers de grandes dimensions, protection anti-altération et scellage de tuyauteries; il peut sceller des accouplements ayant un jeu diamétral maximal de 0,25 mm.

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SCREW-LOCKING, SEALING AND LUBRICATING MATERIALS - MATERIALI PER BLOCCAGGIO VITI, TENUTA E LUBRIFICAZIONE - MATERIAL ZUR BLOCKIERUNG VON SCHRAUBEN UND FÜR DICHTUNGEN UND SCHMIERMITTEL - MATERIALES PARA EL BLOQUEO, ESTANQUEIDAD Y LUBRICACION - MATÉRIAUX POUR LE BLOCAGE VIS, ÉTANCHÉITÉ ET LUBRIFICATION

DENOMINATION DENOMINAZIONE BEZEICHNUNG DENOMINACION DENOMINATION	APPLICATION - APPLICAZIONE - ANWENDUNG - APLICACION - APPLICATION
Loctite 510	• Anaerobic product for the hermetic sealing of flanged units and screw holes communicating with fluids. Can seal clearances between flanges up to 0.2 mm. • *Prodotto anaerobico adatto alla tenuta ermetica di fluidi tra assiemi flangiati e di viti a foro comunicante con i fluidi. Può sigillare giochi tra le flange fino a 0,2 mm.* • Anaerobes Produkt zur Abdichtung von Flüssigkeiten an Flanschen und Schrauben mit Löcher, die mit Flüssigkeiten in Kontakt stehen. Kann ein Spiel zwischen Flanschen bis 0,2 mm abdichten. • *Producto anaeróbico apto para le estanqueidad de fluidos entre grupos bridados y de tornillos de orificio comunicante con los fluidos. Puede sellar juegos entre las bridas hasta 0,2 mm.* • Produit anaréobic apte à la tenue étanche des fluides entre les pièces à brides et des vis à trou en contact avec les fluides. Il peut sceller un jeu parmi les flasques jusqu'à 0,2 mm.
Loctite 577	• Quick anaerobic sealant for sealing threaded portions of conical or cylindrical unions up to M80. Before using it, remove any lubricant with the specific activator. After polymerisation, disassembly may result rather difficult, so heating may be necessary for larger diameters. • *Prodotto anaerobico sigillante rapido per la tenuta di filettature di raccordi conici o cilindrici fino a M80. Deve essere usato dopo aver asportato ogni traccia di lubrificante con l'attivatore specifico. Dopo la polimerizzazione presenta una moderata difficoltà di smontaggio per cui può richiedere, per i diametri maggiori, un riscaldamento.* • Anaerobes Produkt zum schnellen Siegeln und Abdichten von Kegel- oder Zylinderkupplungen bis M80. Darf erst aufgetragen werden, nachdem mit einem spezifischen Wirkstoff jede Spur von Schmiermittel abgetragen worden ist. Nach der Polymerisation könnte das Abmontieren etwas schwierig sein weshalb größere Durchmesser zuerst erhitzt werden müssen. • *Producto anaerobico sellante rapido para el estanqueido de tornillos de empalme conico o cilindrico hasta M80. Debe de ser utilisado despues de haber quitado cada mancha de lubrificante con activador especifico. Despues de la polimeracion presenta una moderada dificultà de desmontaje por lo tanto puede necesitar, para los diametros majores, un calientamiento.* • Produit anaérobie collage rapide assurant l'étanchéité des filetages des raccords coniques ou cylindriques jusqu'à M80. Il doit être utilisé après qu'on ait enlevé toute trace de lubrifiant à l'aide d'un activeur spécial. Une certaine difficulté de démontage se présente après la polymérisation, on peut donc avoir la nécessité de devoir chauffer préalablement pour de plus amples diamètres.
Loctite 638	• Anaerobic adhesive for fast and high-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with clearance ranging between 0.1 and 0.25 mm. • *Adesivo anaerobico per l'incollaggio rapido ad alta resistenza di giunti cilindrici in metallo (mozzo su albero). Può incollare particolari con gioco tra 0,1 e 0, 25 mm.* • Anaerober Klebstoff für große Widerstandskräfte für Zylinderkupplungen aus Metall geeignet (Wellennaben). Kann Einzelteil mit einem Radialspiel zwischen 0,1 mm und 0,25 mm zusammenkleben. • *Adhesivo anaeróbico para el encolado rápido de alta resistencia de juntas cilíndricas de metal (cubo en el eje). Puede encolar piezas con juego entre 0,1 mm y 0,25 mm.* • Adhésif anaérobic servant à un collage rapide et hautement résistant des joints cylindriques en métal (moyeu sur l'arbre). Il peut servir à coller des pièces avec un jeu allant de 0,1 à 0,25 mm.
Loctite 648	• Anaerobic adhesive for fast and medium-strength gluing of cylindrical metal joints (hub on shaft). Can glue together parts with radial clearance below 0.1 mm. • *Adesivo anaerobico per l'incollaggio rapido a media resistenza di giunti cilindrici in metallo (mozzo su albero). Può incollare particolari con gioco radiale inferiore a 0,1 mm.* • Anaerober Klebstoff für mittlere Widerstandskräfte für Zylinderkupplungen aus Metall geeignet (Wellennaben). Kann Einzelteil mit einem Radialspiel von weniger als 0,1 mm zusammenkleben. • *Adhesivo anaeróbico para encolado rápido de media resistencia juntas cilíndricas de metal (cubo en el eje). Puede encolar piezas con juego radial inferior a 0,1 mm.* • Adhésif anaérobic servant à un collage rapide moyennement résistant des joints cylindriques en métal (moyeu sur l'arbre). Il peut servir à coller des pièces avec un jeu radial inférieur à 0,1 mm.
(AREXONS) Repositionable jointing compound for seals *Mastice per guarnizioni riposizionabile* Klebstoff für verstellbare Dichtungen *Pasta para juntas reposicionable* Mastic pour garnitures à remettre en place	• Solvent-based sealing compound for elastic seals, drying through evaporation. Used for sealing the outer diameter of sealing rings for rotating shafts with outer metal reinforcement. • *Mastice sigillante per guarnizioni elastiche a base di solvente, essicante per evaporazione. Viene utilizzato per la tenuta sul diamentro esterno di anelli di tenuta per alberi rotanti con armatura metallica esterna.* • Klebstoff für Gummidichtung auf Lösemittelbasis, trocknet durch Verdampfung. Wird am äußeren Durchmesser von Dichtungsringe bei rotierenden Wellen mit Metallmantel verwendet. • *Pasta para juntas de sellado para juntas elásticas a base de disolvente, deshidratante por evaporación. Se utiliza para la estanqueidad en el diámetro externo de segmentos de compresión, para ejes giratorios con armadura metálica exterior.* • Mastic adhésif à base de solvants pour garnitures élastiques, séchant par évaporation. Il sert garder étanche le diamètre extérieur des bagues d'étanchéité des arbres rotatifs ayant une armature métallique externe.

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SCREW-LOCKING, SEALING AND LUBRICATING MATERIALS - MATERIALI PER BLOCCAGGIO VITI, TENUTA E LUBRIFICAZIONE - MATERIAL ZUR BLOCKIERUNG VON SCHRAUBEN UND FÜR DICHTUNGEN UND SCHMIERMITTEL - MATERIALES PARA EL BLOQUEO, ESTANQUEIDAD Y LUBRICACION - MATÉRIAUX POUR LE BLOCAGE VIS, ÉTANCHÉITÉ ET LUBRIFICATION

DENOMINATION **DENOMINAZIONE** **BEZEICHNUNG** **DENOMINACION** **DENOMINATION**	**APPLICATION - APPLICAZIONE - ANWENDUNG - APLICACION - APPLICATION**
Silicone ***Silicone*** **Silikon** ***Silicona*** **Silicone**	• Semi-fluid adhesive material used for sealing and filling and to protect components from environmental and physical elements. Polymerises with non-corrosive dampness. • *Materiale adesivo semifluido usato per sigillatura, riempimenti e per la protezione di componenti dagli elementi ambientali e fisici. Polimerizza con umidità non corrosiva.* • Halbflüssiger Klebstoff zum Befestigen, Füllen und zum Schutz von Bestandteilen vor äußeren Einwirkungen. Polymerisiert durch nicht korrosive Feuchtigkeit • *Material adhesivo semifluido usado para el sellado, llenado y para la protección de componentes de elementos ambientales y físicos. Polimeriza con humedad no corrosiva.* • Produit adhésif semi-fluide utilisé pour le scellage, remplissage et protection des éléments ambiants et physiques. Polymérise à une humidité non corrosive.
(TECNO LUPE/101) Silicone-based grease *Grasso al silicone* Silikonfett *Grasa a la silicona* Graisse au silicone	• Highly adhesive synthetic grease, with silicone compounds added. Applied to adjustment screws with hole communicating with oil-type fluids. Used when frequent adjusting is required. • *Grasso sintetico con elevato grado di adesività, additivato con composti siliconici.* *Applicato su viti di registrazione a foro comunicante con fluidi di tipo oleoso.* *Usato quando si richiedono frequenti interventi di registrazione.* • Synthetisches Fett mit hoher Haftfestigkeit, mit silikonhaltigen Stoffen legiert. Wird auf Stellschrauben mit Loch, die mit ölhaltigen Flüssigkeiten in Kontakt stehen, angebracht. Wird verwendet, wenn die Schraub öfters eingestellt werden muß. • *Grasa sintética con elevado grado de adhesión, aditivada con componentes silicónicos.* *Aplicada en tornillos de ajuste de orificio comunicante con fluidos de tipo oleoso.* *Se usa cuando se requieren frecuentes intervenciones de ajuste.* • Graisse synthétique ayant un degré d'adhésivité élevé, adjuvé de composés au silicone. Appliqué sur les vis de réglage à trou communiquant avec des fluides du type huileux. Utilisé quand il y a besoin de réglages fréquents.
Molikote (DOW CORNING)	• Lubricating compound containing molybdenum disulphide, used to lubricate articulation pins and to prevent sticking and oxidation of parts that are not lubricated on a regular basis. • *Composto lubrificante contenente bisolfuro di molibdeno, usato per la lubrificazione di perni snodo e per prevenire incollamenti ed ossidazioni di particolari non lubrificati in modo continuo.* • Schmierstoff mit Molybidändisulfid; wird zum Schmieren von Gelenkstiften und gegen Ankleben und Oxydation von nicht dauergeschmierten Einzelteilen verwendet. • *Compuesto lubricante que contiene bisulfuro de molibdeno, usado para la lubricación de rótulas y para prevenir encoladuras y oxidaciones de piezas no lubricadas de manera continua.* • Composé lubrifiant contenant du bisulfure de molybdène, utilisé pour lubrifier les axes d'articulation et prévenir collages et oxydations des pièces qui ne sont pas continuellement lubrifiées.
(Lithium-based) Grease ***Grasso (al Litio)*** **(Lithium) Fett** ***Grasa (al Litio)*** **Graisse (au Lithium)**	• Applied to bearings, sliding parts and used to lubricate seals or parts during assembly • *Applicato a cuscinetti, parti scorrevoli e per lubrificare guarnizioni o pezzi in fase di montaggio.* • Wird auf Lager, Gleitteilen aufgetragen und zum Schmieren von Dichtungen oder von Teilen bei der Montage verwendet. • *Aplicada a cojinetes, partes deslizables o para lubricar juntas o piezas en fase de montaje.* • Appliqué sur les paliers, parties coulissantes et pour lubrifier les garnitures ou pièces pendant la phase de montage.

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NOTES ON SAFETY PRECAUTIONS - NOTE RIGUARDANTI LA SICUREZZA - BEMERKUNGEN ZUR SICHERHEIT - NORMAS CONCERNIENTES A LA SEGURIDAD - NOTES EN MATIERE DE SECURITE

GB

1 - During all operations described in this manual, the axle should be fastened onto a trestle, while the other parts mentioned should rest on supporting benches.
2 - When removing one of the arms, an anti-tilting safety trestle should be placed under the other arm.
3 - When working on an arm that is fitted on the machine, make sure that the supporting trestles are correctly positioned and that the machine is locked lengthways.
4 - Do not admit any other person inside the work area; mark off the area, hang warning signs and remove the ignition key from the machine.
5 - Use only clean, quality tools; discard all worn, damaged, low-quality or improvised wrenches and tools. Ensure that all dynamometric wrenches have been checked and calibrated.
6 - Always wear gloves and non-slip rubber shoes when performing repair work.
7 - Should you stain a surface with oil, remove marks straight away.
8 - Dispose of all lubricants, seals, rags and solvents once work has been completed. Treat them as special waste and dispose of them according to the relative law provisions obtaining in the country where the axles are being overhauled.
9 - Make sure that only weak solvents are used for cleaning purposes; avoid using turpentine, dilutants and toluol-, xylol-based or similar solvents; use light solvents such as Kerosene, mineral spirits or water-based, environment friendly solvents.
10 - For the sake of clarity, the parts that do not normally need to be removed have not been reproduced in some of the diagrams.
11 - The terms RIGHT and LEFT in this manual refer to the position of the operator facing the axle from the side opposite the drive.
12 - After repair work has been completed, accurately touch up any coated part that may have been damaged.

ITA

1 - Le operazioni descritte sono riferite all'assale bloccato su cavalletto ed alcuni particolari appoggiati su un banco di lavoro.
2 - Quando si asporta un braccio dell'assale, sistemare sotto l'altro braccio un cavalletto di sicurezza antiribaltamento.
3 - Se si opera su un'assale montato sulla macchina, assicurarsi di aver sistemato dei cavalletti di sostentamento e di aver immobilizzato longitudinalmente la macchina.
4 - Non permettere che persone estranee entrino nella zona di lavoro; delimitare questa zona, appendere dei cartelli di avviso di lavori in corso ed asportare le chiavi di avviamento della macchina.
5 - Usare solo ed esclusivamente attrezzi puliti e di buona qualità; scartare chiavi od attrezzi usurati o danneggiati, di bassa qualità od improvvisati. Assicurarsi che le chiavi dinamometriche siano state controllate e tarate.
6 - Durante le operazioni di riparazione, indossare sempre guanti e scarpe antiscivolo.
7 - Pulire immediatamente le zone eventualmente imbrattate d'olio.
8 - I lubrificanti, le guarnizioni, gli eventuali stracci di pulizia ed i solventi usati devono essere smaltiti come rifiuti speciali e comunque secondo le normative vigenti nel Paese ove vengono revisionati gli assali.
9 - Per la pulizia, usare solo solventi deboli escludendo categoricamente trielina, diluenti e solventi a base di toluolo, xilolo, ecc.; usare solo solventi leggeri quali cherosene, ragie minerali o solventi ecologici a base d'acqua.
10 - Per chiarezza di illustrazione ed esposizione, sulle figure di alcuni gruppi mancano dei particolari che, normalmente, possono essere lasciati montati. Rimuovere solo i particolari descritti.
11 - I termini DESTRA e SINISTRA usati nel manuale sono riferiti alla persona che guarda l'assale dal lato opposto alla presa di moto.
12 - Al termine delle riparazioni, per evitare dannose ossidazioni, ritoccare con cura le parti verniciate eventualmente danneggiate.

D

1 - Die beschriebenen Vorgänge werden an der Achse vorgenommen, wenn diese auf einem Bock blockiert ist. Zur Bearbeitung der Einzelteile, werden diese auf die Werkbank gelegt.
2 - Wenn eine Achse abgenommen wird, einen Sicherheitsbock unter den zweiten Arm legen.
3 - Werden Arbeiten an der Achse vorgenommen, wenn diese noch an der Maschine montiert ist, Böcke zur Halterung unter die Achse stellen und die Maschine der Länge nach blockieren.
4 - Es dürfen sich keine fremde Personen in der Nähe der Maschine während der Arbeiten aufhalten; diesen Bereich absperren und mit Schilder kennzeichnen, die auf die laufenden Arbeiten hinweisen. Zündschlüssel von der Maschine abnehmen.
5 - Nur saubere Werkzeuge guter Qualität verwenden; alte, beschädigte oder improvisierte Hilfsmittel nicht verwenden. Sicherstellen, daß die Dynamometer geprüft und geeicht worden sind.
6 - Bei Reparaturen, stets Handschuhe und rutschfeste Schuhe tragen.
7 - Mit Öl beschmutzte Stellen, sofort reinigen.
8 - Gebrauchte Schmiermittel, Dichtungen, Reinigungslappen und Lösemittel müssen als Sondermüll und auf jeden Fall laut den örtlich geltenden Vorschriften entsorgt werden.
9 - Zur Reinigung ausschließlich schwache Lösemittel wie Petroleum, Terpentin oder wasserhaltige Lösemittel verwenden. Auf keinen Fall Trichloräthylen, tuolol- oder xylolhlatige Lösemittel usw. verwenden.
10 - Um die Arbeitsvorgänge verständlich abzubilden, werden in einigen Fotos die Aggregate ohne Einzelteile gezeigt, die sonst bei der Arbeit nicht abmontiert werden müssen.
Nur die beschriebenen Teile abmontieren.
11 - Unter RECHTS und LINKS versteht man in diesem Handbuch die Seite einer Person, die zur Achse schaut und zwar dem Antrieb entgegengesetzt.
12 - Nach beendeten Arbeiten und um Rostbildungen zu vermeiden, die Teile an denen der Lack ggf. beschädigt worden ist, anstreichen.

ESP

1 - Las operaciones descritas se refieren al eje bloqueado en un caballete y a algunas partes apoyadas en el banco de trabajo.
2 - Cuando se saca un brazo del eje, colocar debajo del otro un caballete de seguridad antivuelco.
3 - Si se trabaja con un eje montado en la máquina, asegurarse de haber colocado caballetes soporte y de haber inmovilizado longitudinalmente la máquina.
4 - No permitir que personas extrañas entren en la zona de trabajo; delimitar esta zona, colgar carteles de aviso de hombres trabajando y sacar las llaves de arranque de la máquina.
5 - Usar sólo y exclusivamente herramientas limpias y de buena cualidad; descartar llaves o herramientas gastadas o dañadas, de calidad mediocre o improvisadas. Asegurarse de que las llaves dinamométricas han sido controladas y calibradas.
6 - Durante las operaciones de reparación, llevar siempre guantes y calzado antideslizamiento.
7 - Limpiar inmediatamente las zonas que pudieran estar sucias de aceite.
8 - Los lubricantes, las juntas, los trapos para la limpieza y los disolventes usados hay que eliminarlos como desechos especiales y, de todas formas, de acuerdo con las normativas vigentes en el país en el que se revisan los ejes.
9 - Para limpiar, utilizar sólo disolventes débiles excluyendo en absoluto tricloroetileno, diluyentes y disolventes a base de toluol, silol, etc.; usar sólo disolventes ligeros como queroseno, aguarrás minerales o disolventes ecológicos a base de agua.
10 - Para que resulte clara la exposición y la ilustración, en las figuras de algunos grupos faltan algunas piezas que por lo general se pueden dejar montadas. Sacar sólo las partes descritas.
11 - Las palabras DERECHA E IZQUIERDA usadas en el manual se refieren a la persona que mira el eje del lado opuesto a la toma de movimiento.
12 - Al final de las reparaciones, para evitar oxidaciones, retocar cuidadosamente las partes pintadas que estuvieran dañadas.

F

1 - Les opérations décrites se rapportent à l'essieu bloqué sur chevalet et de quelques pièces posées sur un établi de travail.
2 - Quand on enlève un essieu monté sur la machine, ajuster sous l'autre bras un chevalet de sécurité contre tout basculement.
3 - Si on oeuvre sur un essieu monté sur la machine, s'assurer d'avoir aménagé des chevalets de soutien et d'avoir bloqué la machine en longueur.
4 - Ne jamais permettre à des étrangers de pénétrer dans la zone de travail; délimiter cette zone, mettre des pancartes de signalisation de travaux en cours et enlever les clés de contact de la machine.
5 - N'utiliser que des outils propres et de bonne qualité; éliminer clé ou autres outils usés, abîmés, de mauvaise qualité ou improvisés. Veiller à ce que les clés dynamométriques aient été contrôlées et calibrées.
6 - Pendant les opérations de réparation, endosser toujours gants et chaussures antidérapantes.
7 - Nettoyer tout de suite les éventuelles zones souillées d'huile.
8 - Les lubrifiants, les garnitures, les éventuels chiffons servant au nettoyage et les solvants utilisés devront être récoltés et traités comme rebut spécial conformément aux lois en vigueur dans le pays où les essieux sont en révision.
9 - Pour le nettoyage, n'utiliser que des solvants à base de toluol, xylol, etc.; n'utiliser que des solvants légers tels que kérosène, essences minérales, ou solvants écologiques à base d'eau.
10 - En ce qui concerne la clarté en matière d'illustration et exposition, sur les figures de certains groupes, il y a des pièces manquantes qui normalement peuvent rester montées.
Enlever uniquement les pièces décrites.
11 - Les termes DROITE et GAUCHE utilisés dans ce manuel se rapportent à la personne regardant l'essieu du côté opposé à celui de la prise de mouvement.
12 - A la fin des opérations, afin d'éviter un risque d'oxydation nuisible, retoucher soigneusement les parties vernies éventuellement abîmées.

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SIMBOLI

	Disassembly of assembly groups Smontaggio di sottogruppi Zerlegen von Baugruppen Desmontaje de subgrupos Demontage des sous-groupes
	Reassemble to from assembly groups Montaggio di sottogruppi Zusammenbauen von Baugruppen Ensamblaje de subgrupos Montage des sous-groupes
	Remove obstruction parts Smontaggio di particolari ingombri Abbauen-Ausbauen Desmontaje de componentes abultados Demontage des pieces encombrante
	Reinstall-remount parts which had obstructed disassembly Montaggio di particolari ingombri Einbauen-Ausbauen Montaje de componentes abultados Montage des pieces encombrante
	Attention ! Important notice Attenzione, indicazione importante Achtung, wichtiger Hinweis ¡Cuidado ! Indicación importante Attention, indication importante
	Check - adjust e.g. torque, dimensions, pressures, etc. Controllare - regolare p.e. coppie, misure, pressioni ecc. Prüfen - Einstellen z.B. Momente, Maße, Drucke u.s.cs. Controlar y ajustar, por ej. pares, medidas, presiones, etc. Controler, regler p.e. couples, mesures, pressions ecc.
	T = Special tool P = page T = Attrezzature speciali P = Pagina T = Spezialwerkzeug P = Seite T = Herramientas especiales P = Página T = Outils P = Page
	Note direction of installation Rispettare direzione di montaggio Einbaurichtung beachten Respetar la dirección de ensamblaje Respecter direction de montage
	Visual inspection Esaminare con controllo visuale Kontrollieren -Prüfen Examinar mediante inspección visual Controler, examiner, controle visuel
	Possibly still serviceable, renew if necessary Eventualmente riutilizzare (sostituire se necessario) Bedingt weiderverwendbar Puede volver a utilizarse (reemplazar, si es preciso) Eventuellement a utiliser a noveau (remplacer si nécessaire)
	Renew at each reassembly Sostituire ad ogni montaggio Beim Zusammenbau immer erneuern Puede reemplazarse a cada ensamblaje Remplacer avec chaque montage
	Unlock - lock e.g. split pin, locking plate, etc. Togliere-mettere la sicura Entsichern-Sichern Quitar-colocar el seguro Enlever-mettre la securite
	Lock-adhere (liquid sealant) Mettere la sicura, incollare (mastice liquido) Sichern-Kleben (flüssige Dichtung) Colocar el seguro, pegar (mastique líquido) Mettre la securite, coller (mastic liquide)
	Guard against material damage, damage to parts Evitare danni materiali, danni a pezzi Materialschaden verhüten Evitar dañar los materials o las piezas Eviter dommages au materiaux, dommages au pieces
	Mark before disassembly, observe marks when reassembly Marchiare prima dello smontaggio (per il montaggio) Vor dem Ausbau markieren (für den Zusammenbau) Marcar antes de desmontar (para facilitar el ensamblaje) Marquer avant le demontage (pour le montage)
	Filling - topping up - refilling e.g. oil, cooling water, etc. Caricare - riempire (olio - lubrificante) Einfüllen - Auffüllen - Nachfüllen (Öl-Schmiermittel) Cargar - llenar (aceite lubricante) Charger - remplir (huile - lubrifiant)
	Drain off oil, lubricant Scaricare olio, lubrificante Öl, bzw. Schmiermittel Ablassen Descargar aceite lubricante Vidanger, lubrifiant
	Tighten Tendere Spannen Tensar Tendre
bar	Apply pressure into hydraulic circuit Inserire pressione nel circuito idraulico Leitung unter Druck setzen Introducir presión en el circuito hidráulico Inserer pression dans le circuit hydraulique
	To clean Pulire Reinigen Limpiar Nettoyer
	Lubricate - grease Lubrificare - ingrassare Schmieren - einfetten Lubrificar - Engrasar Lubrifier - Graisser

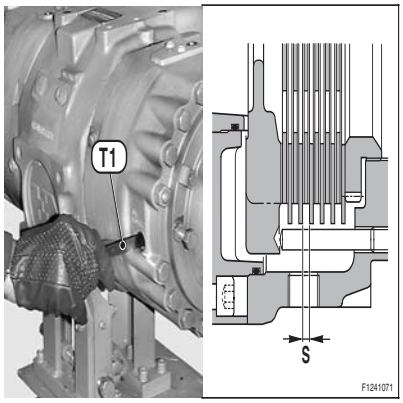
DANA

CHECKING WEAR AND REPLACING THE BRAKING DISKS - CONTROLLO USURA E SOSTITUZIONE DISCHI FRENO - VERSCHLEISS KONTROLLIEREN UND BREMSSCHEIBEN AUSWECHSELN - CONTROL DEL DESGASTE Y SUSTITUCION DE LOS DISCOS DEL FRENO - CONTRÔLE USURE ET SUBSTITUTION DES DISQUES FREINS



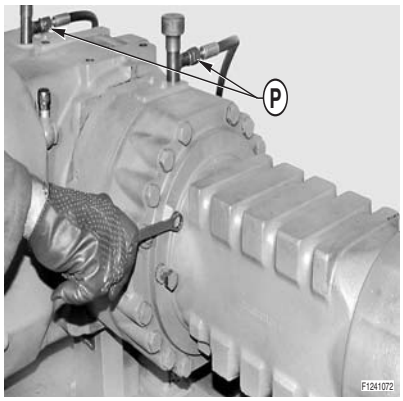
GB a

CHECKING WEAR
CAUTION! Perform operations on both arms.
Remove the oil-level plug (1).



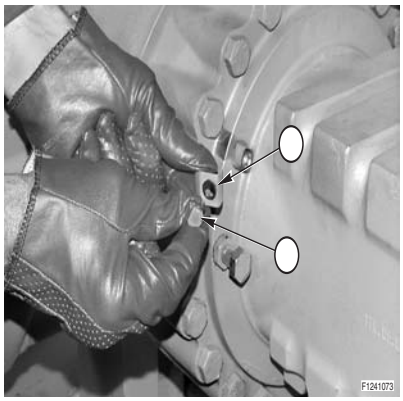
bar GB b

Introduce tool T1 between the disks and check shim "**S**".
Minimum size of "**S**": 4.5 mm.



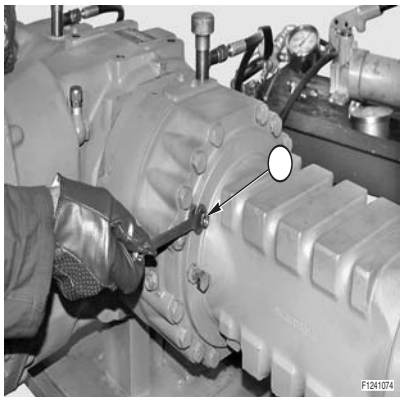
bar GB c

ADJUSTING THE BRAKES
Connect an external pump to the union piece "**P**" of the negative brake and introduce a pressure of 15÷30 bar to eliminate the pressure of the Belleville washers (11).



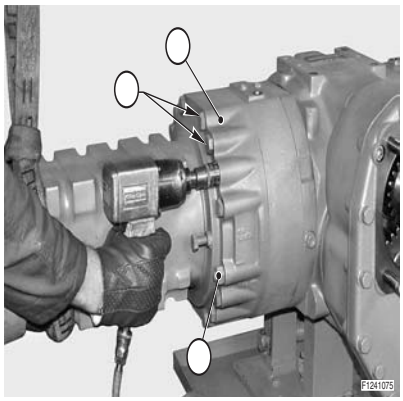
GB d

Remove screw (2) and safety plate (3).



GB e

Turn the brake clearance adjustment pinion (4) clockwise and as far as the limit stop.
Release pressure and disconnect the tubes.
NOTE. Remove the lower plug (5) and drain the oil.



GB f

REPLACING THE BRAKING DISKS
Sling the arm (6) to be removed and connect it to a hoist.
Loosen and remove screws (7) and nuts (8).

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a

ITA **CONTROLLO USURA**
ATTENZIONE! Eseguire le operazioni per i due bracci.
Asportare il tappo (1) di livello olio.

D **VERSCHLEISS KONTROLLIEREN**
ACHTUNG! Die Vorgänge an beiden Armen vornehmen.
Öleinfüllstopfen (1) abnehmen.

ESP **CONTROL DESGASTE**
ATENCION! Efectuar las operaciones por los dos ejes.
Sacar el tapon (1) de nivel aceite.

F **CONTROLE USURE**
ATTENTION! Effectuer les opérations aux deux bras.
Enlever le bouchon (1) du niveau d'huile.

b

ITA Introdurre l'attrezzo **T1** tra i dischi e controllare lo spessore "**S**".
"**S**" minimo: 4,5 mm

D Werkzeug **T1** zwischen den Scheiben einsetzen und die Stärke "**S**" kontrollieren.
"**S**" Minimum: 4,5 mm

ESP Introducir la herramienta **T1** entre los discos y controlar el espesor "**S**".
«S» minimo: 4,5 mm.

F Introduire l'outil **T1** entre les disques et contrôler la cale "**S**".
"**S**" minimum: 4,5 mm

c

ITA **REGISTRAZIONE FRENI**
Collegare al raccordo "**P**" del freno negativo una pompa esterna ed immettere una pressione di 15÷30 bar per eliminare la pressione delle molle a tazza (11).

D **BREMSEN EINSTELLEN**
Anschlußstück "**P**" der Federspeicherbremse an eine äußere Pumpe anschließen und Druck bei 15÷30 bar einlassen, um Tellerfedern (11) zu entlasten.

ESP **REGISTRACION FRENOS**
Conectar al empalme «P» del freno negativo una pompa esterna y introducir una presion de 15÷30 bar para eliminar la presion de los muelles a taza (11).

F **REGLAGE DES FREINS**
Brancher au raccord "**P**" du frein négatif une pompe externe et envoyer une pression de 15÷30 bar pour éliminer la pression des ressorts belleville (11).

d

ITA Asportare la vite (2) e la piastrina di sicurezza (3).

D Schraube (2) und Sicherheitsplättchen (3) abnehmen.

ESP Sacar el tornillo (2) y la placa de securidad (3).

F Enlever les vis (2) et la plaquette de sécurité (3).

e

ITA Ruotare in senso orario il pignone (4) di regolazione gioco freni fino a fondo corsa.
Rilasciare la pressione e scollegare i tubi.
NOTA. Rimuovere il tappo inferiore (5) e scaricare l'olio.

D Das Kegelrad (4) zur Einstellung des Bremsspiels bis zum Endanschlag drehen.
Druck ablassen und die Leitungen abtrennen.
BEMERKUNG. Unteren Stopfen (5) abnehmen und das Öl.

ESP Girar en sentido horario el pinon (4) de regulaciòn juego frenos hasta final carrera.
Dejar la presion y desconectar los tubos.
NOTA. Remover el tapon inferior (5) y descargar el aceite.

F Tourner le pignon de réglage du jeu des freins (4) dans le sens des aiguilles d'une montre jusqu'en fin de course.
Libérer la pression et débrancher les tubes.
REMARQUE: Enlever le bouchon inférieur (5) et vidanger l'huile.

f

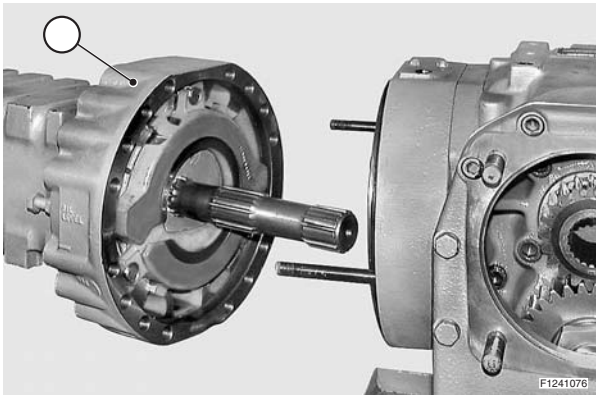
ITA **SOSTITUZIONE DISCHI FRENO**
Imbragare il braccio (6) da asportare e collegarlo ad un mezzo di sollevamento.
Allentare ed asportare le viti (7) ed i dadi (8).

D **BREMSSCHEIBEN AUSWECHSELN**
Den abzunehmenden Arm (6) anschlagen und an eine Hebezeug befestigen.
Schrauben (7) und Muttern (8) lockern und abschrauben.

ESP **SUBSTITUCION DISCOS FRENOS.**
Atar el eje (6) de sacar y conectarlo a un medio de levantamiento.
Aflojar y sacar los tornillos (7) y las tuercas (8).

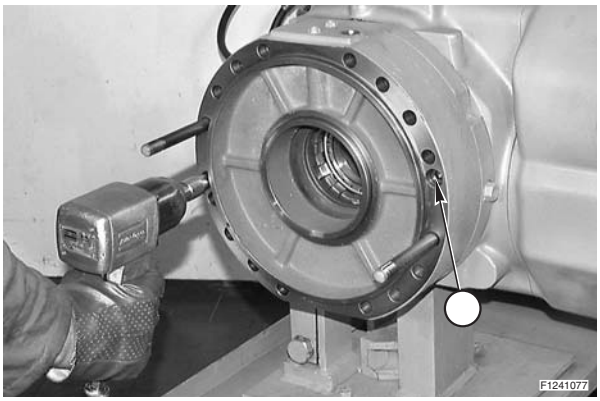
F Substitution des disques frein
Elinguer le bras (6) à enlever et brancher celui-ci à un moyen de relevage.
Desserrer et enlever les vis (7), les écrous (8).

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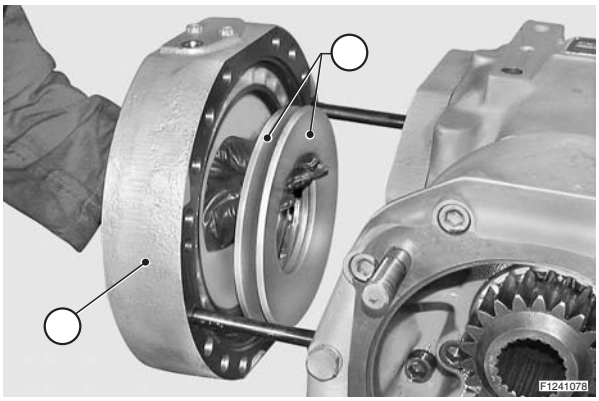
GB a

Remove arm (6) together with brakes and axle shafts; lay down the arm vertically.



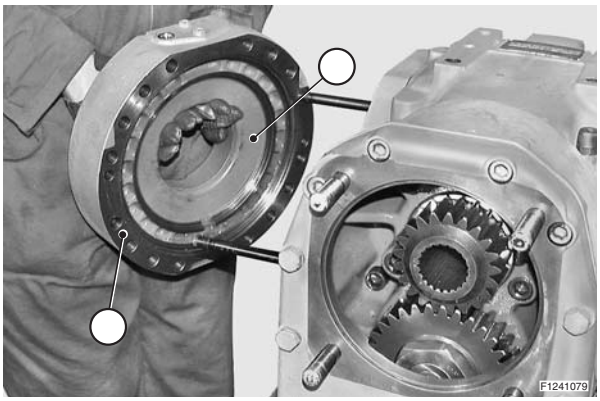
GB b

Loosen screws (9) in an alternate manner and remove them.



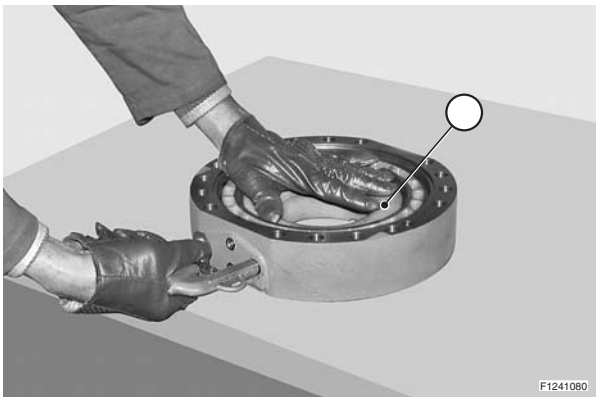
GB c

Move the cylinder (10) outwards while supporting the Belleville washers (11).
Remove the Belleville washers (11) and note down direction of assembly.



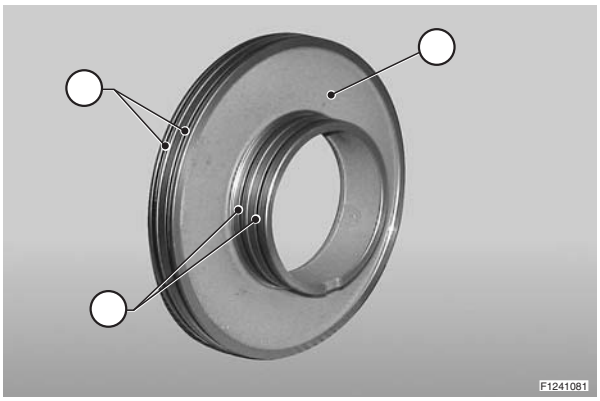
GB d

Remove the cylinder (10) complete with piston (12).



GB e

Slowly introduce low-pressure compressed air through the connection member for the negative brake, in order to extract the piston (12).
CAUTION! Hold the piston (12) back, as it may be suddenly ejected and damaged.



GB f

Remove O-rings (13) and (14) from the piston (12).
NOTE. The O-rings (13) and (14) must be replaced each time the unit is disassembled.

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a

ITA Rimuovere il braccio (6) completo di freni e semiassi; deporre il braccio in modo verticale.

D Den Arm (6) samt Bremsen und Halbachsen abnehmen; den Arm senkrecht ablegen.

ESP Remover el eje (6) completo de frenos y semi-ejes; colocar el eje de manera vertical.

F Enlever le bras (6) complet de freins et demi-essieux; déposer le bras en vertical.

b

ITA Allentare in modo alternato le viti (9) ed asportarle.

D Abwechselnd die Schrauben (9) lockern und abschrauben.

ESP Aflojar de manera alternada los tornillos (9) y sacarlas.

F Desserrer les vis (9) en alternance, puis les enlever.

c

ITA Spostare verso l'esterno il cilindro (10) sostenendo le molle a tazza (11).
Rimuovere le molle (11) ed annotare il senso di montaggio.

D Den Zylinder (10) nach außen verstellen und dabei die Tellerfedern (11) stützen.
Federn (11) abnehmen und die Montagerichtung notieren.

ESP Desplazar hacia el esterior el cilindro (10) sosteniendo los muelles a taza (11).
Remover los muelles (11) y anotar el sentido de montaje.

F Déplacer le cylindre (10) vers l'extérieur en soutenant le ressort belleville (11).
Enlever le ressort (11) et prendre note du sens de son montage.

d

ITA Rimuovere il cilindro (10) completo di pistone (12).

D Zylinder (10) samt Kolben (12) abnehmen.

ESP Remover el cilindro (10) completo de piston (12).

F Enlever le cylindre (10) complet de piston (12).

e

ITA Immettere lentamente aria compressa a bassa pressione attraverso l'attacco per il freno negativo per estrarre il pistone (12).
ATTENZIONE! Trattenere il pistone (12) che può essere espulso velocemente ed essere danneggiato.

D Langsam Druckluft bei Niederdruck durch den Anschluß der Federspeicherbremse einlassen, um den Kolben (12) heraus zu drücken.
ACHTUNG! Den Kolben (12) halten, da er plötzlich heraus springen und beschädigt werden könnte.

ESP Introducir lentamente aire comprimida a baja presiòn atraves el empalme por el freno negativo para sacar el piston (12).
ATENCION! Tener el piston (12) que puede ser expulso rapidamente y estropearse.

F Envoyer lentement de l'air comprimé à basse pression à travers le raccord du frein négatif pour extraire le piston (12).
ATTENTION! Tenir le piston (12) qui pourrait être expulser rapidement et endommager.

f

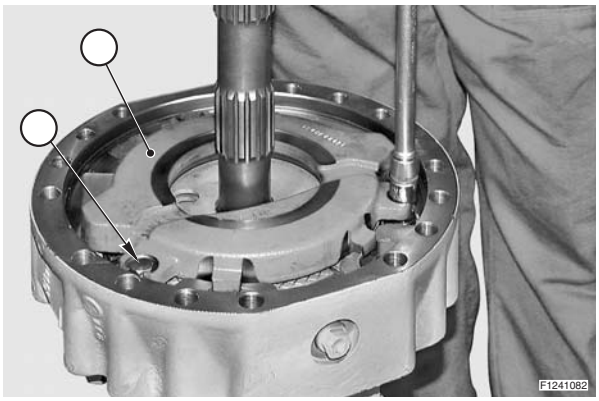
ITA Rimuovere dal pistone (12) gli anelli OR (13) e (14).
NOTA. Gli anelli OR (13) e (14) devono essere sostituiti ad ogni smontaggio.

D Kolben (12) und O-Ringe (14) und (14) abnehmen.
BEMERKUNG. Die O-Ringe (13) und (14) müssen jedesmal ausgewechselt werden, wenn das Teil zerlegt wird.

ESP Remover del piston (12) los anillos OR (13) y (14).
NOTA. Los anillos OR (13) y (14) deben de ser sobstituidos cada desmontaje.

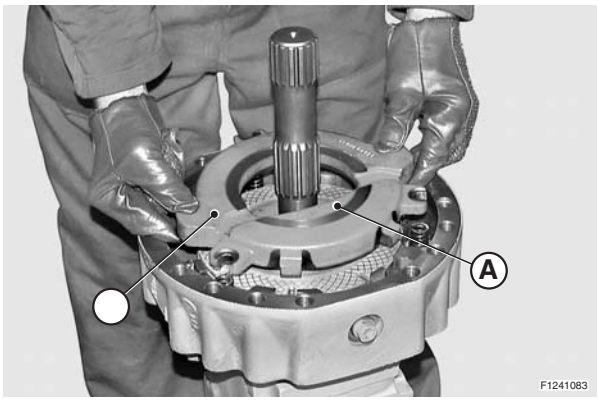
F Enlever le piston (12), les anneaux O'RING (13) et (14).
REMARQUE. Les anneaux O'RING (13) et (14) sont à substituer à chaque démontage.

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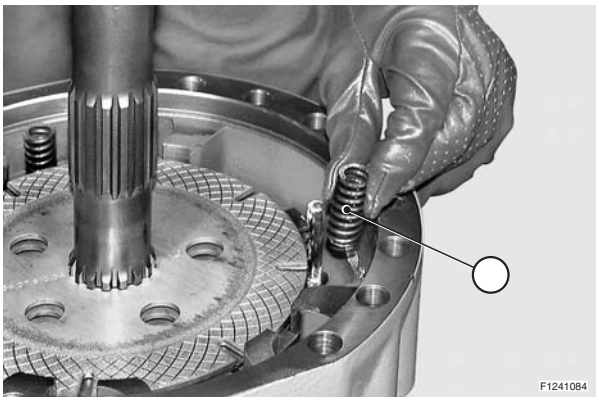
GB a

Remove checking and guiding screws (15) from the pressure plate (16).
NOTE. Loosen screws (15) in sequence and proportionally.



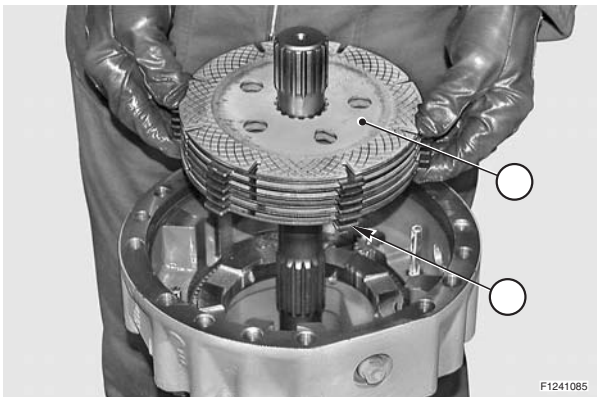
GB b

Remove the pressure plate (16).
CAUTION! Note down the direction of assembly; flow regulator wall "**A**" and oil drain holes must face the oil drain plug.



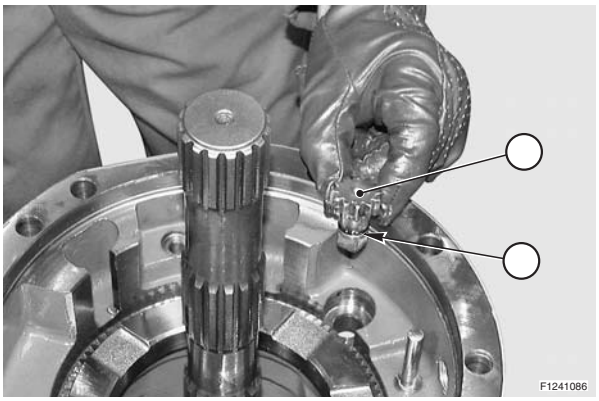
GB c

Remove springs (17).
NOTE. Accurately check the condition of springs. They should not be warped.
Any deformation of the springs requires spring replacement.



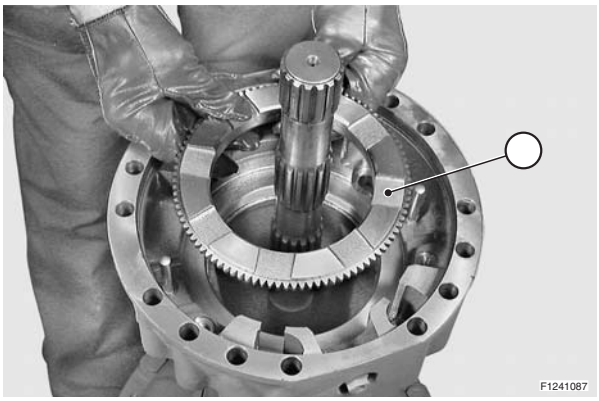
GB d

Remove braking discs (18) and (19), noting down direction of assembly.
NOTE. If disks are not to be replaced, avoid changing their position.



GB e

Remove pinion (4) complete with O-ring (20).
NOTE. The O-ring must be replaced each time the unit is disassembled.



GB f

Unscrew and extract the braking disk clearance adjustment crown wheel (21).

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a

ITA Rimuovere le viti (15) di ritegno e guida dello spingidisco (16).
NOTA. Allentare le viti (15) in modo sequenziale ed in uguale misura.

D Befestigungsschrauben (15) und die Führung der Druckplatte (16) abnehmen.
BEMERKUNG. Abwechselnd Schrauben (15) im gleichen Maß lockern.

ESP Remover los tornillos (15) de retenciòn y guìa del empuya-disco (16).
NOTA. Aflojar los tornillos (15) de manera secuencial y en la misma mesura.

F Enlever vis (15) de fixation et guide du plateau de pression (16).
REMARQUE: Desserrer les vis (15) en séquence et en égale mesure.

b

ITA Rimuovere lo spingidisco (16).
ATTENZIONE! Annotare il senso di montaggio; la parete frangiflusso "**A**" e gli scarichi olio, devono essere rivolti verso il tappo di scarico olio.

D Druckplatte (16) abnehmen.
ACHTUNG! Montagerichtung notieren; der Strahlregler "**A**" und die Ölablaßöffnungen müssen in Richtung des Ölablaßstopfens gerichtet sein.

ESP Remover el empuja-disco (16).
ATENCION. Anotar el sentido de montaje; la pared rompe-flujo "**A**" y los descarge aceite, deben de ser dirijidos hacia el tapon de descarga aceite.

F Enlever le plateau de pression (16).
ATTENTION! Prendre noter du sens du montage; la paroi brise-jet "**A**" et les écoulements d'huile sont tournés vers le bouchon de vidange d'huile.

c

ITA Rimuovere le molle (17).
NOTA. Controllare attentamente lo stato delle molle che non devono essere deformate.
Ogni deformazione deve portare alla sostituzione.

D Federn (17) abnehmen.
BEMERKUNG. Die Federn sorgfältig kontrollieren; sie dürfen nicht verformt sein. Sollte dies der Fall sein, Federn auswechseln.

ESP Remover los muelles (17).
NOTA. Controlar atentamente el estado de los muelles que no deben de ser deformes.
A cada deformaciòn deben de ser cambiados.

F Enlever les ressorts (17).
REMARQUE. Contrôler attentivement l'état des ressorts, ils ne doivent pas être déformés.
Toute déformation veut dire substitution.

d

ITA Rimuovere i dischi di frenatura (18) e (19) annotando l'ordine di montaggio.
NOTA. Se i dischi non devono essere sostituiti, evitare lo scambio di posizione.

D Bremsscheiben (18) und (19) abnehmen und Montagerichtung notieren.
BEMERKUNG. Falls die Scheiben ausgewechselt werden müssen, ihre Position nicht verwechseln.

ESP Remover los discos de frenadura (18) y (19) anotando el orden de montaje.
NOTA. Si los discos no deben de ser sobstituidos, evitar el cambio de possiciòn.

F Enlever les disques de freinage (18) et (19) et prendre note de l'ordre du montage.
REMARQUE. Si les disques doivent être substitués, éviter d'échanger leur position.

e

ITA Rimuovere il pignone (4) completo di anello OR (20).
NOTA. L'anello OR deve essere sostituito ad ogni smontaggio.

D Das Kegelrad (4) samt O-Ring (20) entfernen.
BEMERKUNG. Den O-Ring bei jedem Zerlegen auswechseln.

ESP Remover el pinon (4) completo de anillo OR (20).
NOTA. El anillo OR debe de ser sobstituido a cada desmontaje.

F Enlever le pignon (4) complet de l'anneau O'RING (20).
REMARQUE. L'anneau O-Ring est à remplacer à chaque démontage.

f

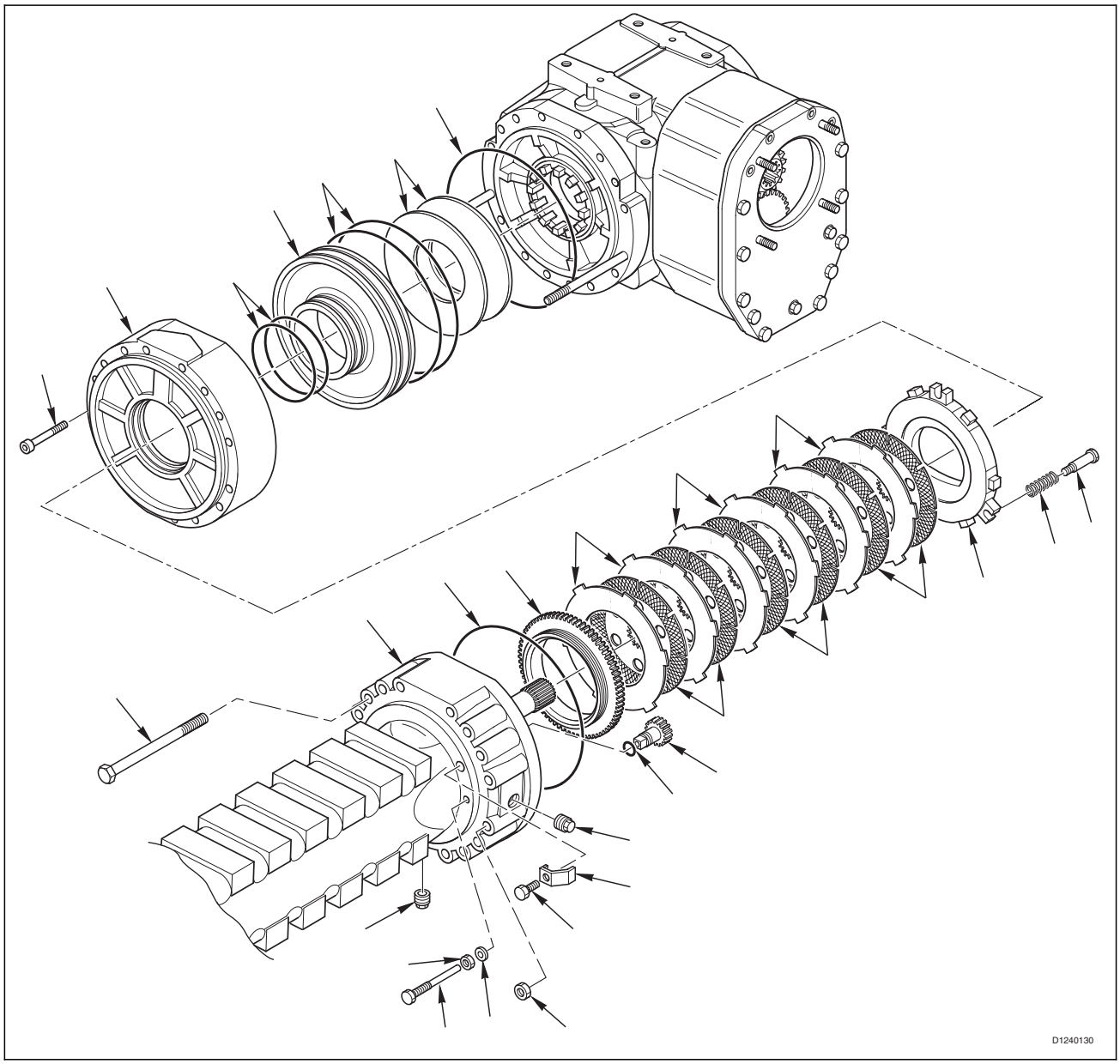
ITA Svitare ed asportare la corona (21) di regolazione del gioco dischi di frenatura.

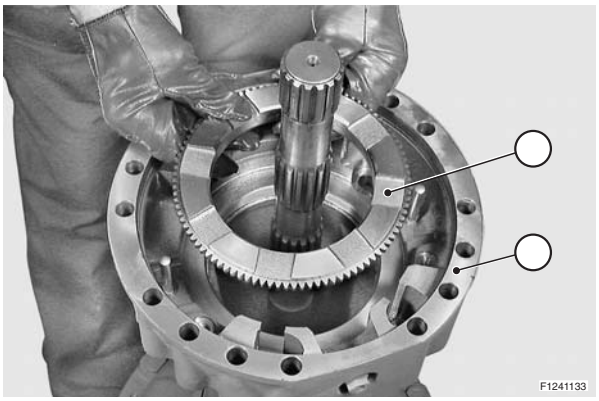
D Den Kranz (21) zur Einstellung des Bremsscheibenspiels abnehmen.

ESP Destornillar y sacar la corona (21) de regulaciòn del juego discos de frenadura.

F Dévisser et enlever la couronne (21) de réglage du jeu des disques de freinage.

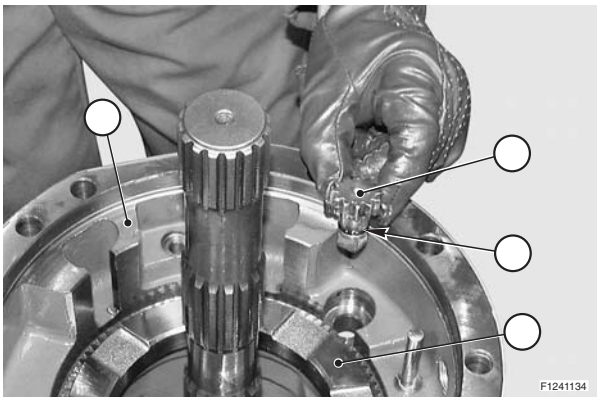
https://truckmanualshub.com/





GB a

Lubricate the threaded portion of the crown wheel (21) and screw it down into the arm (6) as far as it will go.



GB b

Replace the O-ring (20) of pinion (4).
Lubricate and install the pinion in the slot provided on the arm (6), inserting the toothing into crown wheel (21).

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a

ITA Lubrificare la filettatura della corona (21) ed avvitarla a fondo nel braccio (6).

D Das Gewinde des Kranzes (21) schmieren und in den Arm (6) festschrauben.

ESP Lubrificar la rosca de la corona (21) y atornillar a hondo en el eje (6).

F Lubrifier le filetage de la couronne (21), puis visser celle-ci à fond dans le bras (6).

b

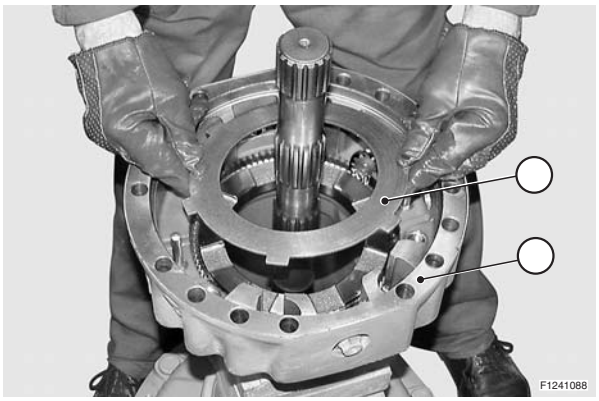
ITA Sostituire l'anello OR (20) del pignone (4). Lubrificare il pignone e montarlo nella sede del braccio (6) innestando la dentatura nella corona (21).

D O-Ring (20) des Kegelrads (4) auswechseln. Kegelrad schmieren und in den Sitz des Arms (6) montieren; dabei die Zähne des Kranzes (21) einrasten.

ESP Sobstituir el anillo OR (20) del pinon (4). Lubrificar el pinon y montarlo en la sed del eje (6) introduciendo la dentadura en la corona (21).

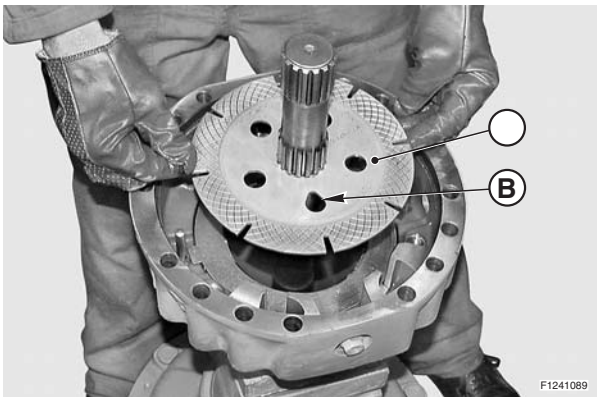
F Substituer l'anneau O'RING (20) du pignon (4). Lubrifier le pignon, puis monter celui-ci dans le logement du bras (6) en introduisant en même temps la denture dans la couronne (21).

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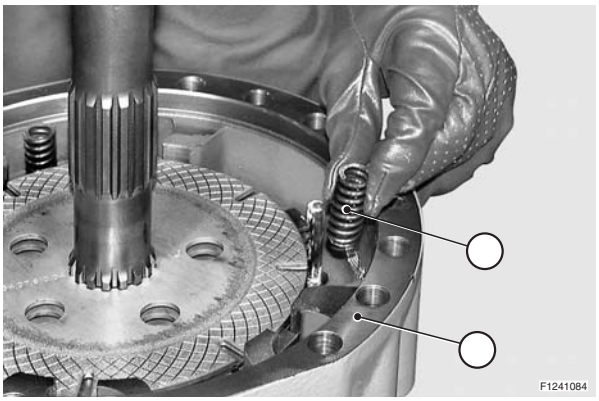
GB a

Lightly lubricate the first steel braking disk (18), then install it on the arm (6).



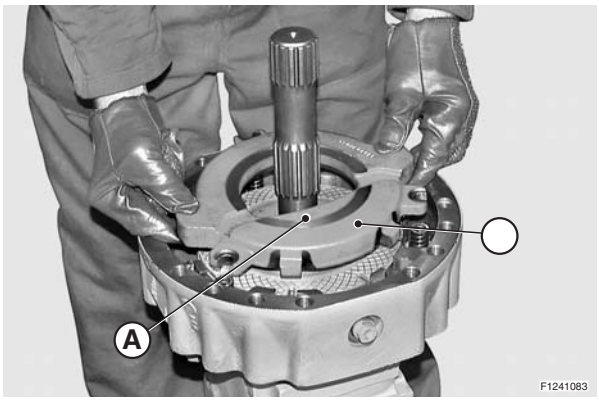
GB b

Lubricate the first friction disk (19) and install it on the axle shaft . Complete the assembly, alternating steel disks and friction disks.
CAUTION! Oval holes "**B**" of friction disks must be lined up.



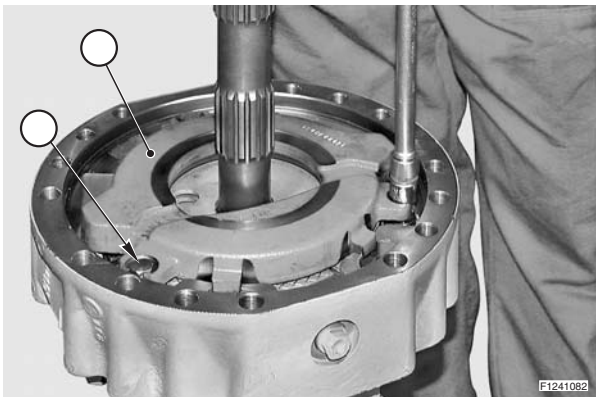
GB c

Position springs (17) in the appropriate slots of the arm (6).



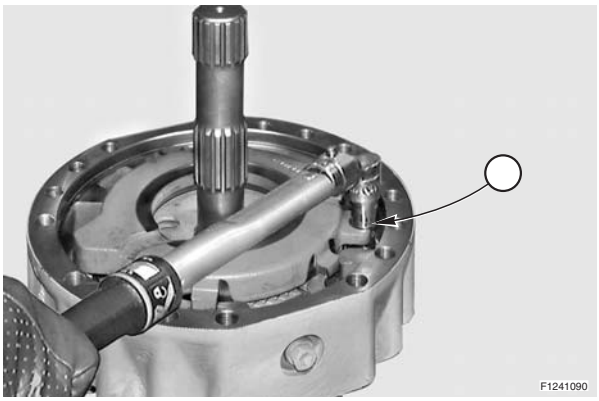
GB d

Fit the pressure plate (16).
CAUTION! Accurately check orientation: flow regulator "**A**" and oil drains must be oriented towards the arm's oil drain plug.



GB e

Lock the pressure plate into position (16) with screws (15).
CAUTION! Tighten screws in sequence and a little at a time.



GB f

Lock screws (15) with a dynamometric wrench.
Torque wrench setting: 20 – 30 Nm.

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a

ITA Lubrificare leggermente il primo disco di frenatura in acciaio (18) e montarlo nel braccio (6).

D Die erste Bremsscheibe aus Stahl (18) etwas schmieren und in den Arm (6) montieren.

ESP Lubrificar ligermente el primer disco de frenadura en acero (18) y montarlo en el eje (6).

F Lubrifier légèrement le premier disque de freinage en acier (18), puis monter celui-ci dans le bras (6).

b

ITA Lubrificare il primo disco di attrito (19) e montarlo sul semiasse.
Completare il montaggio alternando dischi di acciaio e dischi di attrito.
ATTENZIONE! I dischi di attrito devono avere il foro ovale "**B**" allineato.

D Die erste Reibscheibe (19) schmieren und auf die Halbachse montieren.
Dann die Stahlscheiben abwechselnd mit den Reibscheiben montieren.
ACHTUNG! Die Langlöcher "**B**" der Reibscheiben müssen gefluchtet sein.

ESP Lubrificar el primer disco de strito (19) y montarlo sobre el semi-eje.
Completar el montaje alternando discos de acero y discos de atrito.
ATENCION! Los discos de atrito deben tener el agujero oval «B» en linea.

F Lubrifier le premier disque de friction (19), puis monter ce dernier sur le demi-essieu.
Achever le montage en alternant les disques en acier et les disques de friction.
ATTENTION! Les disques de friction doivent avoir le trou ovale "**B**" aligné.

c

ITA Posizionare nelle sedi del braccio (6) le molle (17).

D In den Sitz des Arms (6) die Federn (17) einsetzen.

ESP Colocar en las sedes del eje (6) los muelles (17).

F Mettre en place les ressorts (17) dans les logements du bras (6).

d

ITA Montare lo spingidisco (16).
ATTENZIONE! Controllare attentamente l'orientamento; il frangiflusso "**A**" e gli scarichi olio, devono essere orientati verso il tappo di scarico olio del braccio.

D Die Druckplatte (16) montieren.
ACHTUNG! Sorgfältig die Montagerichtung kontrollieren; den Stahlregler "**A**" und die Ölablaßöffnungen müssen zum Ablaßstopfen des Arms gerichtet sein.

ESP Montar el empuja-disco (16).
ATENCION! Controlar atentamente el orientamiento; el rompe-flujo "**A**" y los descarga aceite, deben de ser orientados hacia el tapon de descarga aceite del eje.

F Monter le plateau de pression (16).
ATTENTION! Contrôler attentivement la direction; la paroi brise-jet "**A**" et les écoulements d'huile doivent être dirigés vers le bouchon de vidange d'huile du bras.

e

ITA Fissare la posizione dello spingidisco (16) con le viti (15).
ATTENZIONE! Serrare le viti in modo sequenziale ed in più tempi.

D Die Druckplatte (16) mit den Schrauben (15) befestigen.
ACHTUNG! Die Schrauben der Reihe nach und schrittweise festziehen.

ESP Fijar la posiciòn del empuja-disco (16) con los tornillos (15).
ATENCION! Apretar los tornillos de manera secuencial y en mas tiempos.

F Fixer le plateau de pression (16) à sa place avec les vis (15).
ATTENTION! Serrer les vis en plusieurs temps en ordre séquentiel.

f

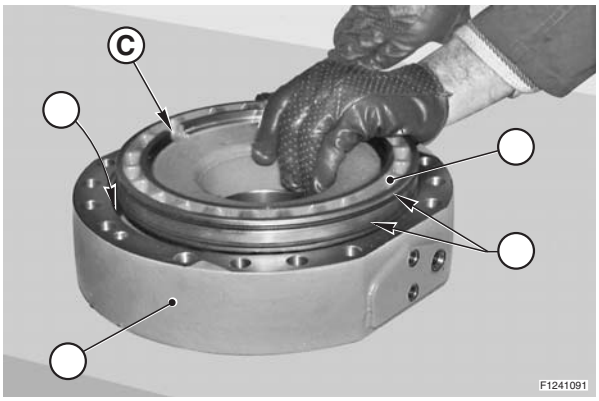
ITA Bloccare le viti (15) con chiave dinamometrica.
Coppia di serraggio: 20÷30 Nm

D Schrauben (15) mit dem Dynamometer blockieren.
Anzugsmoment: 20÷30 Nm.

ESP Bloquear los tornillos (15) con llave dinamometrica.
Par de serraje: 20÷30 Nm.

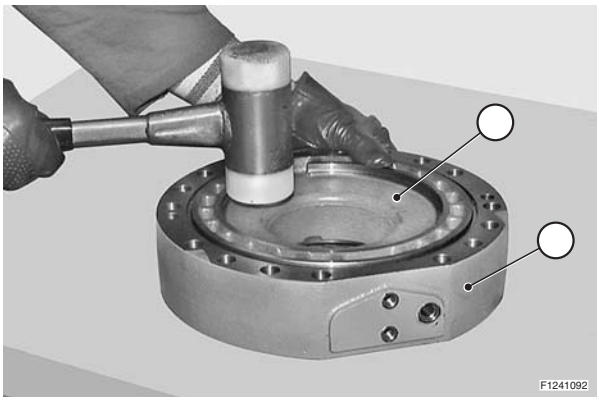
F Bloquer les vis (15) à l'aide de la clé dynamométrique.
Couple de serrage: 20÷30 Nm.

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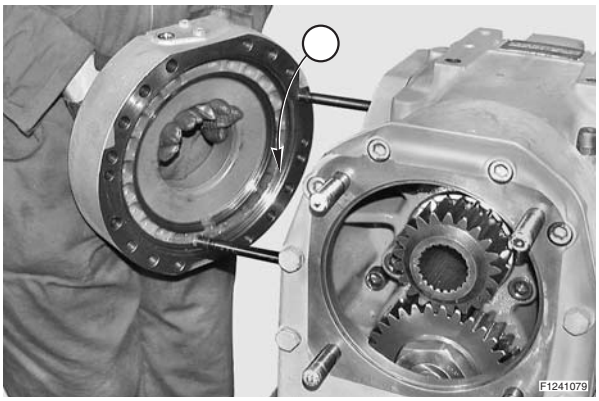
GB a

Fit O-rings (13) and (14) onto the piston (12).
Lubricate the piston and the O-rings and install the unit into the cylinder (10).
NOTE. Piston relief «**C**» must face downwards.



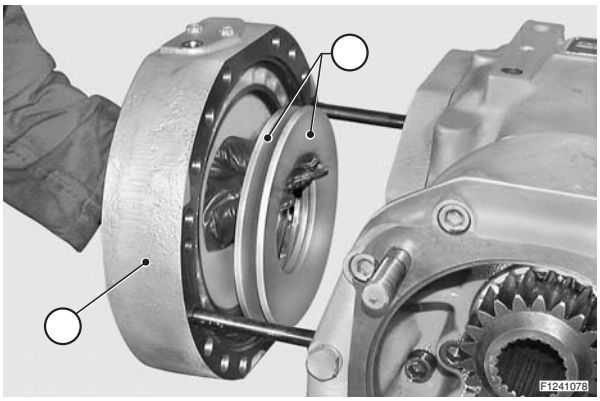
GB b

Using a plastic hammer, ram the piston (12) into the cylinder (10).
NOTE. Lightly hammer all around the edge in an alternate sequence.



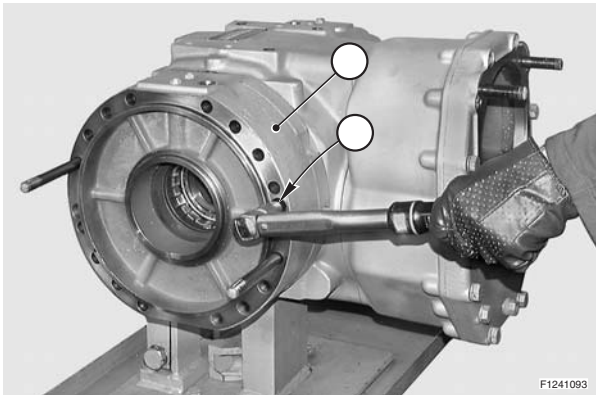
GB c

Check the condition and the position of the O-ring (22); lubricate the O-ring and position the cylinder on the studs without fastening.



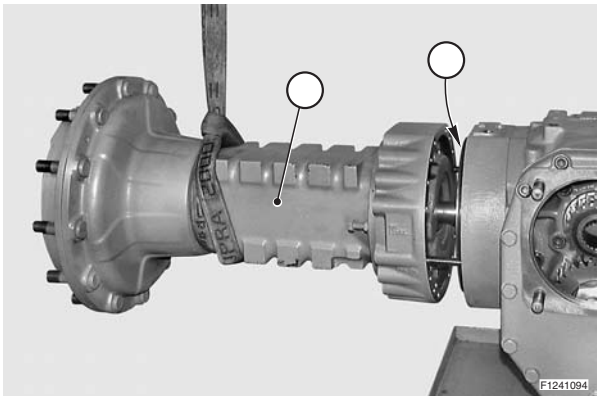
GB d

Position the Belleville washers (11) and engage the cylinder (10).
NOTE. Check the sense of direction of washers (11) and relative centring.



GB e

Lock the cylinder (10), tightening the screws (9) with a dynamometric wrench set to a torque of 86 – 89 Nm.



GB f

Check integrity and position of the arm's O-ring (23); install the complete arm (6).
NOTE. To assist axle shaft centring, slightly move the wheel hub.

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a

ITA Montare sul pistone (12) gli anelli OR (13) e (14). Lubrificare il pistone e gli anelli OR e montare il gruppo nel cilindro (10).
NOTA. Lo scarico "**C**" del pistone deve essere rivolto verso il basso.

D Auf den Kolben (12) die O-Ringe (13) und (14) montieren. Den Kolben und die O-Ringe schmieren und das Aggregat in den Zylinder (10) montieren.
BEMERKUNG. Die Ablaßöffnung "**C**" des Kolbens muß nach unten gerichtet sein.

ESP Montar sobre el piston (12) los anillos OR (13) y (14). Lubrificar el piston y los anillos OR y montar el grupo en los cilindros (10).
NOTA. El escargo "**C**" del piston debe de ser dirijido hacia el bajo.

F Monter sur le piston (12), les anneaux O'RING (13) et (14). Lubrifier le piston et les anneaux O'RING, puis monter le groupe dans le cylindre (10).
REMARQUE. L'écoulement "**C**" du piston doit être tourné vers le bas.

b

ITA Utilizzando un mazzuolo in materiale plastico, inserire a fondo il pistone (12) nel cilindro (10).
NOTA. Battere leggeri colpi distribuiti in modo alternato su tutta la circonferenza.

D Mit einem Gummihammer den Kolben (12) in den Zylinder (10) bis zum Anschlag einschlagen.
BEMERKUNG. Den Kolben abwechselnd rund um die gesamte Kreislinie leicht schlagen.

ESP Utilizando un martillo de materia plastica, introducir a fondo el piston (12) en el cilindro (10).
NOTA. Pegar ligeros golpes distribuidos de manera alternada sobre toda la circonferencia.

F A l'aide d'un maillet en matière plastique, introduire le piston (12) à fond dans le cylindre (10).
REMARQUE. Donner de légers coups réguliers tout autour de la circonférence.

c

ITA Controllare lo stato ed il posizionamento dell'anello OR (22); lubrificare l'anello OR e posizionare il cilindro sui prigionieri senza mandarlo in battuta.

D Den Zustand und die Position des O-Ringes (22) kontrollieren; den O-Ring schmieren und den Zylinder auf die Stiftschrauben positionieren, ohne ihn bis zum Anschlag ganz einzusetzen.

ESP Controlar el estado y la colocaciòn del anillo OR (22); lubrificar el anillo OR y colocar el cilindro sobre los prigioneros sin llevarlo a tope.

F Contrôler l'état et la position de l'anneau O'RING (22); lubrifier l'anneau O'RING et positionner le cylindre sur les prisonniers sans l'envoyer en butée.

d

ITA Posizionare le molle a tazza (11) e mandare in battuta il cilindro (10).
NOTA. Controllare il senso di orientamento delle molle a tazza (11) e la loro centratura.

D Tellerfedern (11) positionieren und den Zylinder (10) bis zum Anschlag einsetzen.
BEMERKUNG. Orientierung der Tellerfedern (11) und ihre Zentrierung kontrollieren.

ESP Colocar los muelles a taza (11) y mandar a tope el cilindro (10).
NOTA. Controlar el sentido de orientamiento de los muelles a taza (11) y su centraje.

F Positionner les ressorts belleville (11) et insérer à fond le cylindre (10).
REMARQUE. Contrôler l'orientation des ressorts belleville (11) et leur centrage.

e

ITA Bloccare il cilindro (10) con le viti (9) serrate con chiave dinamometrica ad un coppia di 86÷89 Nm.

D Den Zylinder (10) mit den Schrauben (9) mit einem Dynamometer und einem Anzugsmoment von 86÷89 Nm blockieren.

ESP Bloquear el cilindro (10) con los tornillos (9) apretados con llave dinamometrica a un par de 86÷89 Nm.

F Bloquer le cylindre (10) avec les vis (9), serrer à l'aide de la clé dynamométrique à un couple de 86÷89 Nm.

f

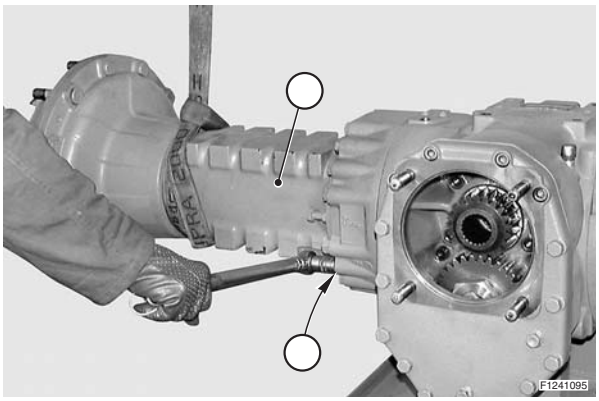
ITA Verificare l'integrità ed il posizionamento dell'anello OR (23) del braccio; installare il braccio completo (6).
NOTA. Per agevolare la centratura del semiasse, muovere lentamente il mozzo portaruota.

D Am Arm den Zustand und die Position des O-Ringes (23) kontrollieren; den gesamten Arm (6) installieren.
BEMERKUNG. Um die Halbachse leichter zentrieren zu können, die Radhalternabe etwas bewegen.

ESP Averiguar la integridad y la colocaciòn del anillo OR (23) del eje; colocar el eje completo (6).
NOTA. Para facilitar el centraje del semi-eje, mover lentamente el cubo porta-rueda.

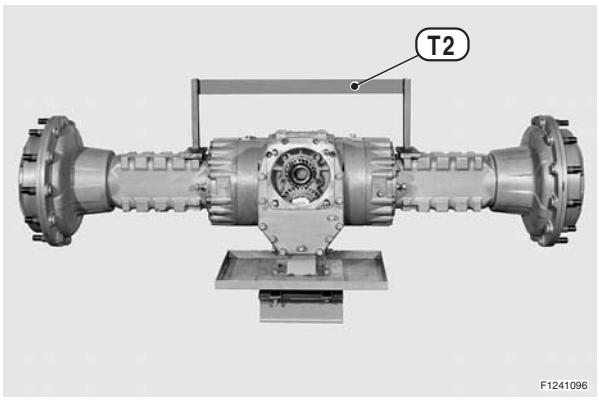
F Vérifier le bon état et le positionnement de l'anneau O'RING (23) du bras; installer le bras complet (6).
REMARQUE. Afin de rendre plus aisé le centrage du demi-essieu, bouger lentement le moyeu porte-roue.

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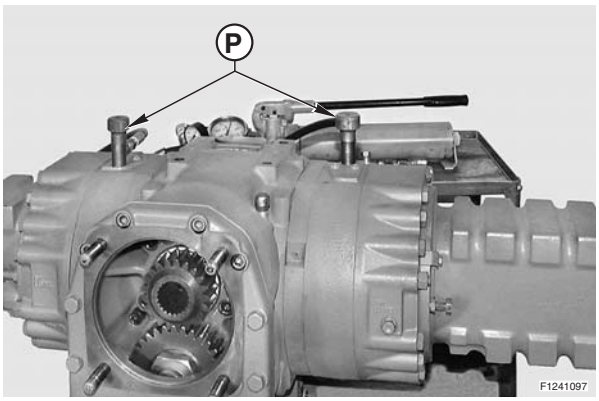
GB a

Temporarily lock the arm (6) with nuts (8) previously coated with Loctite 242; tighten lightly to make the unit touch the main body.



GB b

Check the flatness of the arms, using tool T2; then lock the arms into their final position, using screws (7) adequately coated with Loctite 242.
Torque wrench setting: 182 – 202 Nm.
NOTE. Tighten using the criss-cross method.



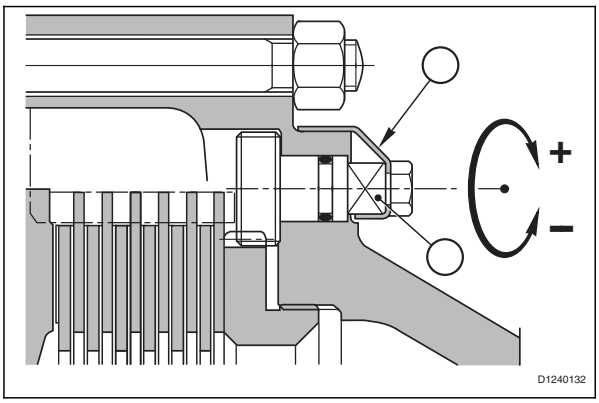
bar GB c

Connect an external pump to the union piece "**A**" of the negative brake and introduce pressure to 15 – 30 bar.



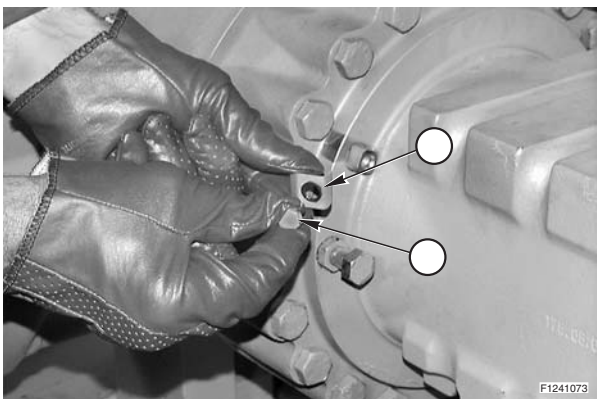
GB d

Rotate the adjustment pinion (4) anticlockwise (–) to eliminate all existing clearance between the braking disks.
Rotate up to a torque of 8 – 10 Nm.



GB e

Rotate pinion (4) clockwise (+) to determine the required clearance of 1 mm.
NOTE. A turn of the adjuster produces a clearance of 0.25 mm (1mm = 4 turns).



GB f

Install safety plate (3) and lock with screw (2).
Torque wrench setting: 10 – 11 Nm.

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a

ITA Fissare provvisoriamente il braccio (6) con i dadi (8) spalmati con Loctite 242 e serrati leggermente per frizionare il gruppo sul corpo centrale.

D Vorübergehend den Arm (6) mit den mit Loctite 242 geschmierten Muttern (8) befestigen und Muttern zuschrauben bis das Aggregat an dem Zentralkörper anliegt.

ESP Fijar provisoriamente el eje (6) con las tuercas (8) pasados con Loctite 242 y apretados ligermente para fricionar el grupo sobre el cuerpo central.

F Fixer provisoirement le bras (6) avec les écrous (8) enduits avec du Loctite 242, et serrer ceux-ci pour frotter le groupe du corps central.

b

ITA Controllare la planarità dei bracci con l'attrezzo **T2** e fissarli definitivamente con le viti (7) spalmate con Loctite 242.
Coppia di serraggio: 182÷202 Nm
NOTA. Serrare con il metodo incrociato.

D Die Ebenheit der Arme mit dem Werkzeug **T2** kontrollieren und endgültig mit den mit Loctite 242 geschmierten Schrauben (7) befestigen.
Anzugsmoment: 182÷202 Nm
BEMERKUNG. Im Kreuz fest drehen.

ESP Controlar la planaridad de los ejes con la herramienta **T2** y fijarlos definitivamente con los tornillos (7) pasar con Loctite 242.
Par de serraje: 182÷202 Nm
NOTA. Apretar de manera cruzada.

F Contrôler la planéité des bras à l'aide de l'outil **T2**, puis fixer ceux-ci définitivement avec les vis (7) enduites de Loctite 242.
Couple de serrage: 182÷202 Nm.
REMARQUE. Serrer avec la méthode croisée.

c

ITA Collegare al raccordo "**P**" del freno negativo una pompa esterna ed immettere una pressione di 15÷30 bar.

D An das Anschlußstück "**P**" der Federspeicherbremse eine äußere Pumpe schließen und Druck bei 15÷30 bar einlassen.

ESP Conectar al empalme "**P**" del freno negativo una pompa externa y introducir presion de 15÷30 bar.

F Brancher au raccord "**P**" du frein négatif une pompe externe et envoyer une pression de 15÷30 bar.

d

ITA Ruotare in senso antiorario (–) il pignone di registro (4) per eliminare totalmente il gioco tra i dischi di frenatura. Ruotare fino ad ottenere una coppia di 8÷10 Nm.

D Gegen den Uhrzeigersinn (–) das Kegelrad (4), drehen, bis kein Spiel zwischen den Bremsscheiben mehr übrig bleibt. Anzugsmoment: 8÷10 Nm.

ESP Girar en sentido anti-horario (–) el pinon de registro (4) para eliminar totalmente el juego entre discos de frenadura.
Girar hasta obtener un par de 8÷10 Nm.

F Tourner le pignon de réglage (4) dans le sens contraire aux aiguilles d'une montre(-) le régleur (4) pour faire disparaître entièrement le jeu existant entre les disques de freinage.
Tourner jusqu'à obtenir un couple de 8÷10 Nm.

e

ITA Ruotare il pignone (4) in senso orario (+) per determinare il gioco prescritto di 1 mm.
NOTA. Un giro del registro crea un gioco di 0,25 mm (1 mm = 4 giri).

D Das Kegelrad (4) in den Uhrzeigersinn (+) drehen, bis das vorgeschriebene Spiel von 1 mm erreicht ist.
BEMERKUNG. Eine Umdrehung gleicht einem Spiel von 0,25 mm (1 mm = 4 Umdrehungen).

ESP Girar el pinon (4) en sentido horario (+) para determinar el juego prescrito de 1 mm.
NOTA. Un giro del registro crea un juego de 0,25 mm (1mm = 4 giros).

F Tourner le pignon (4) dans le sens des aiguilles d'une montre (+) pour définir le jeu prescrit de 1 mm.
REMARQUE. Un tour de régleur donne un jeu de 0,25 mm (1mm = 4 tours).

f

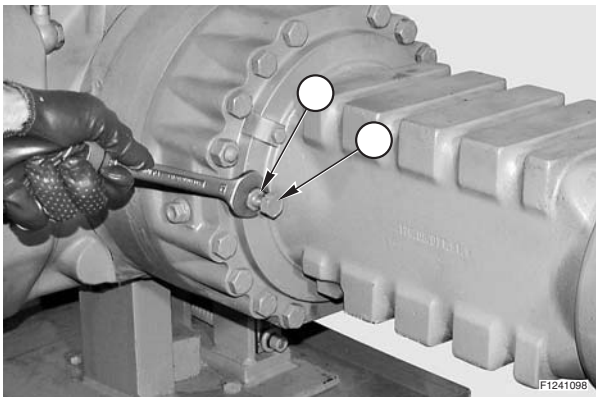
ITA Montare la piastrina di sicurezza (3) e bloccarla con la vite (2).
Coppia di serraggio: 10÷11 Nm

D Die Sicherheitsplatte (3) montieren und mit der Schraube (2) blockieren.
Anzugsmoment: 10÷11 Nm

ESP Montar la plaqua de seguridad (3) y bloquearla con los tornillos 829.
Par de serraje: 10÷11 Nm

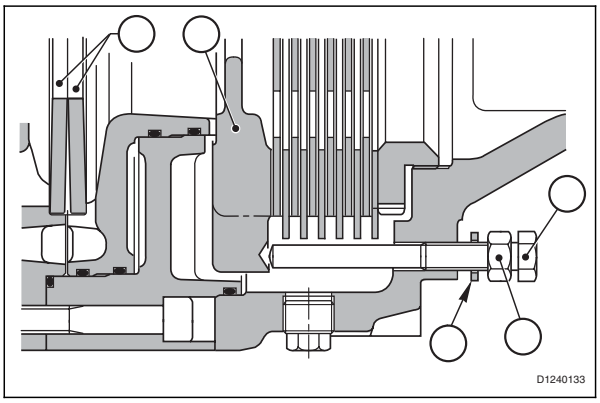
F Monter la plaquette de sécurité (3), bloquer celle-ci à l'aide de la vis (2).
Couple de serrage: 10÷11 Nm

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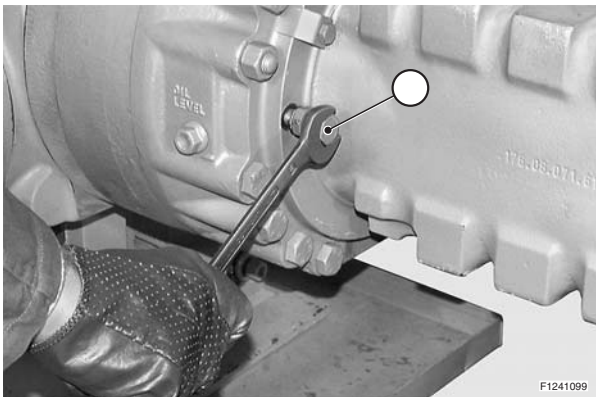
GB a

MANUAL EMERGENCY RELEASE
Loosen nuts (24) of screws (25) provided for the mechanical and manual release of the braking units, then move the nuts backwards by approx. 8 mm.



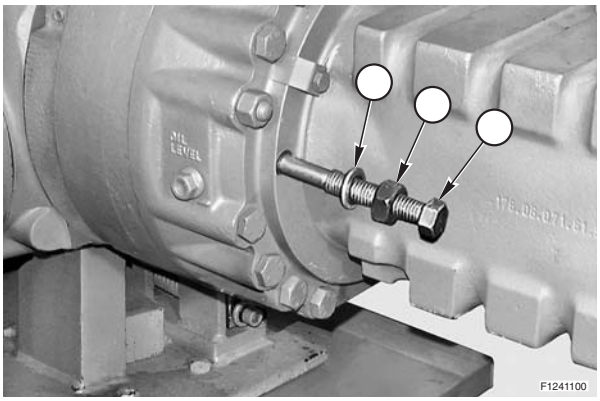
GB b

Tighten screws (25) so as to fasten them onto the pressure plate (16).



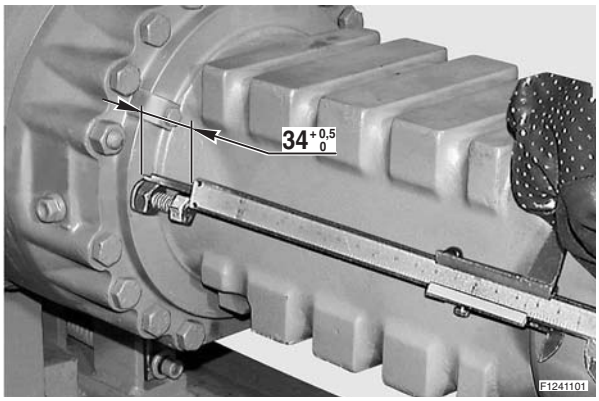
GB c

Using a wrench, tighten the screws (25) in an alternate sequence by 1/4 turn at a time so as to compress the Belleville washers (11) and disengage the braking disks.
IMPORTANT. Tighten max. by one turn.



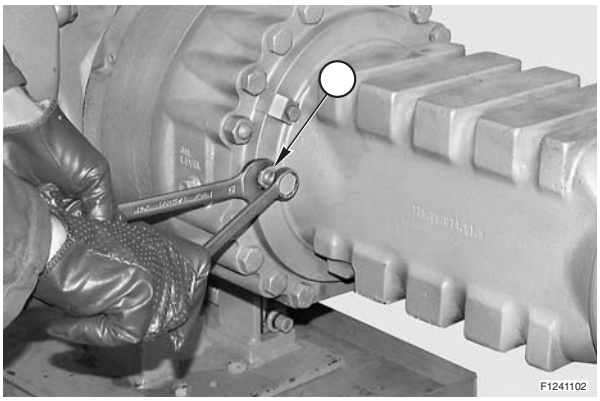
GB d

ADJUSTMENT AFTER MANUAL RELEASE
Remove screws (25) complete with nuts (24) and seals (26). Replace seals (26), apply silicone-based Tecno Lupe /101 grease to the screws (25) and install all parts into the arm.



GB e

Adjust screws (25) to obtain a jut of $34^{+0,5}_{0}$ mm in relation to the arm.



GB f

Lock into position with nuts (24).
CAUTION! Hold screws (25) into position while locking the nuts (24); after locking, check the jut of screws (25) once more.

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a

ITA **SBLOCCAGGIO MANUALE D'EMERGENZA**
Allentare i dadi (24) delle viti (25) per lo sblocco meccanico manuale dei gruppi di frenatura e far arretrare i dadi di circa 8 mm.

D **MANUELLE NOT-ENTSICHERUNG**
Die Muttern (24) der Schrauben (25) zur mechanischen manuellen Entsicherung der Bremsaggregate lockern und die Muttern um 8 mm zurück drehen.

ESP **DESBLOQUEO MANUAL DE EMERGENCIA**
Aflojar las tuercas (24) de los tornillos (25) para el desbloqueo mecanico manual de los grupos de frenadura y hacer pasar las tuercas de 8 mm approx.

F **DEBLOCAGE MANUEL D'EMERGENCE**
Desserrer les écrous (24) des vis (25) pour le déblocage mécanique manuel des groupes de freinage en faisant reculer les écrous d'environ 8 mm.

b

ITA Avvitare le viti (25) fino a mandarle in battuta sullo spingidisco (16).

D Schrauben (25) bis zum Anschlag an die Druckplatte (16) zudrehen.

ESP Atornillar los tornillos (25) hasta llegar al tope sobre el empuja-disco (16).

F Visser les vis (25) puis les envoyer en butée sur le plateau de pression (16).

c

ITA Utilizzando una chiave, avvitare le viti (25) in modo alternato di 1/4 di giro alla volta, per comprimere le molle a tazza (11) e liberare i dischi di frenatura.
IMPORTANTE. Avvitare per max. un giro.

D Mit einem Schlüssel, die Schrauben (25) abwechselnd jeweils um 1/4 Umdrehung zudrehen, um die Tellerfedern (11) einzudrücken und die Bremsscheiben freizusetzen.
WICHTIG. Maximal um eine Umdrehung zuschrauben.

ESP Utilizando una llave, atornillar los tornillos (25) de manera alternada de 1/4 de giro a la vez, para comprimir los muelles a taza (11) y librar los discos de frenadura.
IMPORTANTE. Atornillar por max. un giro.

F A l'aide d'une clé, visser les vis (25) alternativement 1/4 de tour à la fois, pour contraindre le ressort belleville (11) et dégager les disques de freinage.
IMPORTANT. Visser pour max. un tour.

d

ITA **REGOLAZIONE DOPO LO SBLOCCAGGIO MANUALE**
Rimuovere le viti (25) complete dei dadi (24) e delle guarnizioni (26).
Sostituire le guarnizioni (26), lubrificare le viti (25) con grasso al silicone Tecno Lupe /101 e montare il tutto nel braccio.

D **EINSTELLUNG NACH DER MANUELLEN ENTSICHERUNG**
Die Schrauben (25) mit den Muttern (24) und den Dichtungen (26) abnehmen.
Die Dichtungen (26) auswechseln, die Schrauben (25) mit Silikonfett Tecno Lupe/101 schmieren und das ganze Teil in den Arm montieren.

ESP **REGULACION DESPUES DEL DESBLOQUEO MANUAL**
Remover los tornillos (25) completas de guarniciones (26).
Sobstituir las guarniciones (26), lubrificar los tornillos (25) con grasa al silicone Tecno Lupe/101 y montar todo en el eje.

F **REGLAGE FAISANT SUITE AU DEBLOCAGE MANUEL**
Enlever les vis (25) complètes d'écrous (24) et de garnitures (26).
Substituer les garnitures (26), lubrifier les vis (25) avec de la graisse au silicone Tecno Lupe/101, monter le tout dans le bras.

e

ITA Regolare le viti (25) fino ad avere una sporgenza rispetto al braccio di $34^{+0,5}_{0}$ mm

D Schrauben (25) einstellen, bis der Überstand zum Arm $34^{+0,5}_{0}$ mm beträgt.

ESP Regular los tornillos (25) hasta obtener una parte saliente respecto al eje de $34^{+0,5}_{0}$ mm

F Régler les vis (25) jusqu'à avoir une saillie de $34^{+0,5}_{0}$ mm par rapport au bras.

f

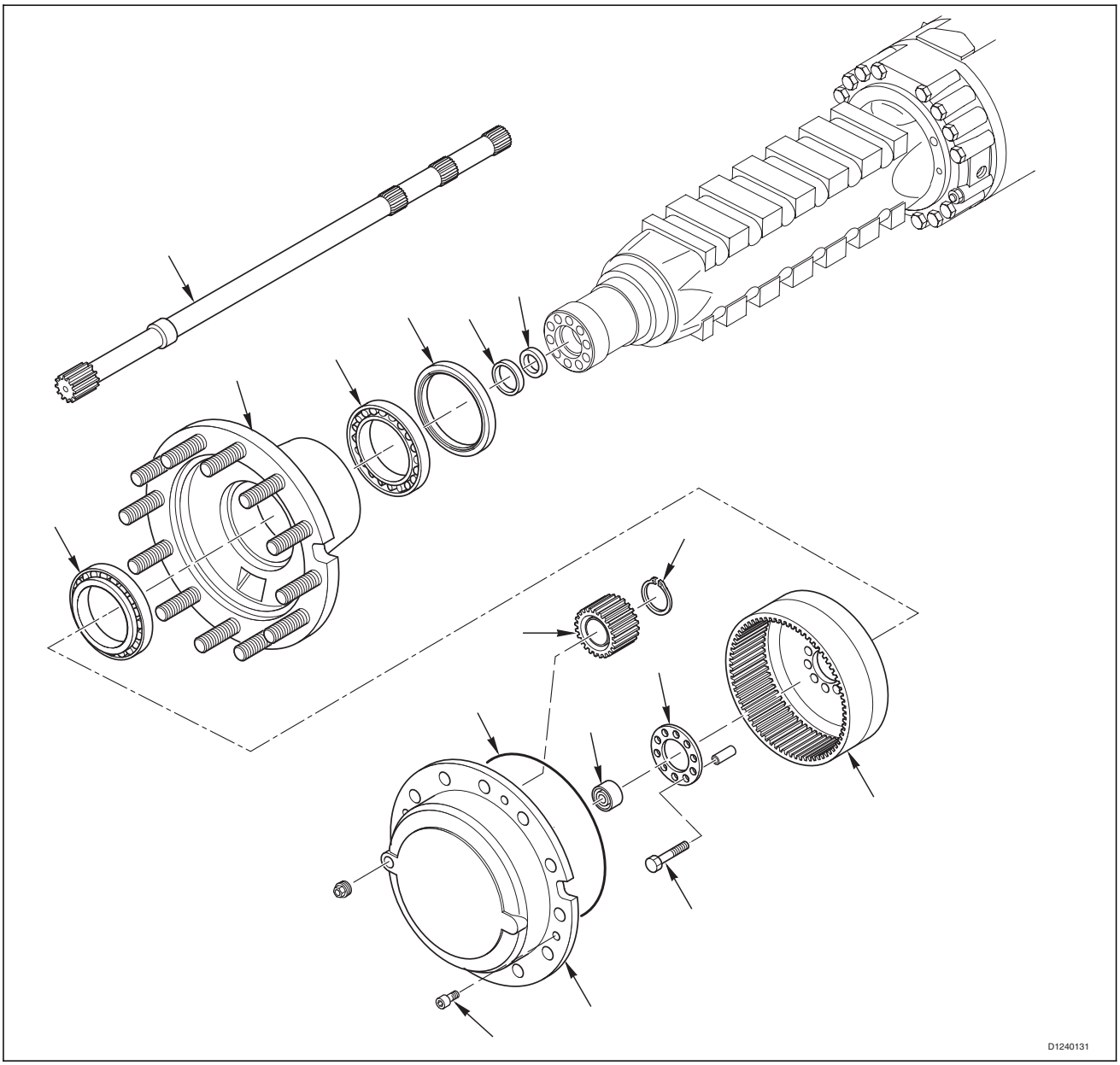
ITA Bloccare la posizione con i dadi (24).
ATTENZIONE! Mantenere la posizione delle viti (25) quando si bloccano i dadi (24); dopo il bloccaggio, ricontrollare la sporgenza delle viti (25).

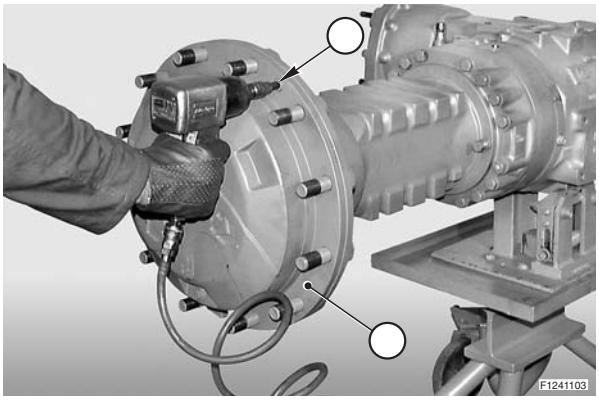
D Die Position mit den Muttern (24) blockieren.
ACHTUNG! Die Position der Schrauben (25) darf sich beim Festziehen der Muttern (24) nicht ändern; nach der Blockierung den Überstand der Schrauben (25) nochmals kontrollieren.

ESP Bloquear la colocaciòn con las tuercas (24).
ATENCION! Mantener la posicion de los tornillos (25) cuando se bloquean las tuercas (24); despues del bloqueo, recontrolar la parte saliente de los tornillos (25).

F Bloquer dans la position à l'aide des écrous (24).
ATTENTION! Tenir les vis (25) en place quand on bloque les écrous (24); après avoir fixé, contrôler la saillie des vis (25).

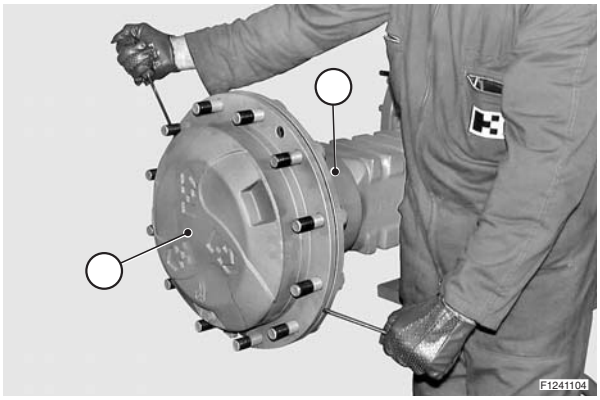
https://truckmanualshub.com/





GB a

Remove the locking screws (1) of planetary cover (2).



GB b

Using two screwdrivers or two levers inserted in the slots provided, pry the planetary cover (2) away from the wheel hub (3).

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SICHERHEIT - NORMAS CONCERNIENTES A LA SEGURIDAD - NOTES EN MATIERE DE SECURITE NOTES ON SAFETY PRECAUTIONS - NOTE RIGUARDANTI LA SICUREZZA - BEMERKUNGEN ZUR

GB The axle shafts can only be removed once the extraction of the planetary cover has been performed. Different procedures need to be followed depending on the kind of repair work required:

1 - Disassembly with axle connected to the machine with machine resting on safety stands.

2 - Disassembly with the axle disconnected from the machine and supported by the appropriate equipment (at the bench).

The explanations given herein refer to the removal operation as is carried out on the bench, but the stages apply to all versions.

ITA La rimozione dei semiassi può essere eseguita solo dopo la rimozione del coperchio portasatelliti ed in modo diversificato, in funzione del tipo di riparazione da eseguire:

1 - Smontaggio con assale montato sulla macchina appoggiata su cavalletti di sicurezza.

2 - Smontaggio con assale smontato dalla macchina e sostenuto da apposita attrezzatura (al banco).

Le spiegazioni riportate si riferiscono alla rimozione eseguita al banco, ma le fasi sono comuni.

D Die Halbachse kann erst abmontiert werden, wenn der Deckel des Planetenradhalters abgenommen worden ist; außerdem wird sie je nach Reparatur unterschiedlich abmontiert:

1 - Mit Achse abmontieren, die an der Maschine montiert und durch Sicherheitsblöcke gestützt ist.

2 - Achse zuerst von der Maschine abmontieren und auf eine Werkbank legen.

Nachstehende Beschreibung bezieht sich auf das Zerlegen an der Werkbank, doch ist die Vorgehensweise in beiden Fällen dieselbe.

ESP La remociòn de los semi-ejes puede ser efectuada solo despues de la remociòn de las tapas lleva-satelites y de manera deversificada, en funcion del tipo de reparacion de efectuar:

1 - Desmontaje con axal montado sobre la maquina colocada sobre caballetes de seguridad;

2 - Desmontaje con axial desmontado desde la maquina y sustentado de apositas herramientas (al banco).

Las explicaciones reportadas se refieren a la remociòn efectuada al banco, ma las fases son comunes.

F Le dégagement des demi-essieux ne peut se faire qu'après avoir enlevé le couvercle porte-satellites d'une façon diversifiée, en fonction du type de réparations à effectuer:

1 - Démontage essieu monté sur machine déposée sur des bâtis de sécurité.

1 - Démontage essieu démonté de la machine et soutenu par un outil spécial (sur banc).

Les explications reportées se réfèrent au dégagement effectué au banc, mais les phases sont communes.

a

ITA Rimuovere le viti (1) di fissaggio del coperchio portasatelliti (2).

D Schrauben (1) abschrauben, die den Deckel des Planetenradhalters (2) befestigen.

ESP Remover los tornillos (1) de fisaje de la tapa portasatelites (2).

F Enlever les vis (1) de fixation du couvercle porte-satellites (2).

b

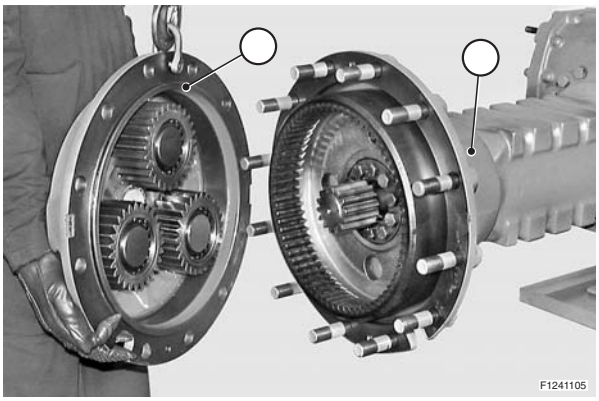
ITA Utilizzando due cacciaviti o due leve inserite nelle cave predisposte, staccare il coperchio portasatelliti (2) dal mozzo portaruota (3).

D Zwei Schraubenzieher oder zwei Hebel in die vorgesehenen Nuten stecken und den Deckel (2) des Planetenradhalters von den Radhalternaben (3) abheben.

ESP Utilizando dos destornilladores o dos palancas insertadas en las ranuras predispuestas, destacar la tapa lleva-satelites (2) del cubo lleva-rueda (3).

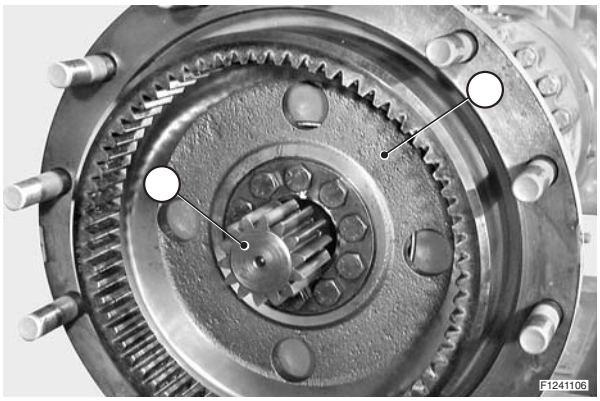
F A l'aide de deux tournevis ou de deux leviers dans les creux prédisposés, dégager le couvercle porte-satellites (2) du moyeu porte-roue (3).

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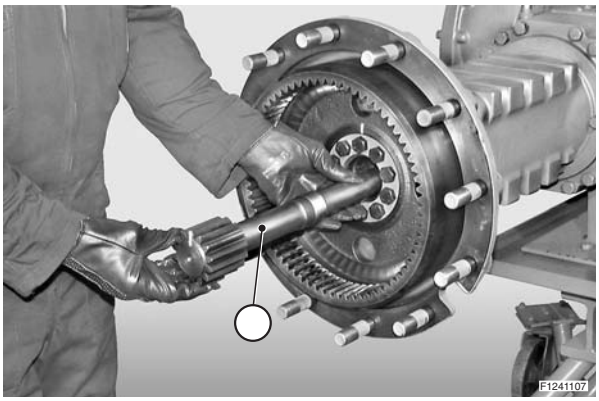
GB a

Rotate the wheel hub (3) until one of the screw holes (1) appears at the top.
Apply a "U" piece to the screw hole; connect to a hoist and remove the cover (2).



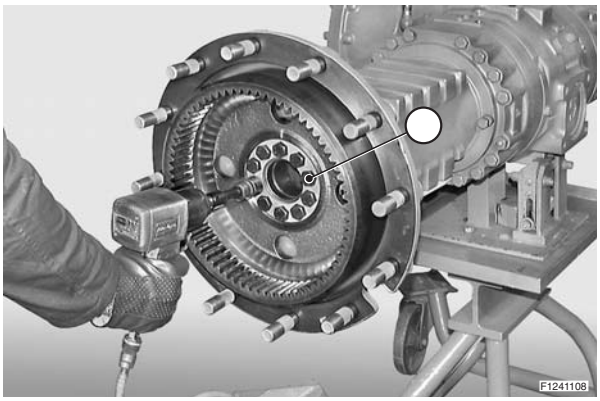
GB b

Only in case of replacement of component parts not requiring the disassembly of the crown wheel (5).
Countermark the position between one of the teeth of the axle shaft (4) and the crown wheel (5).



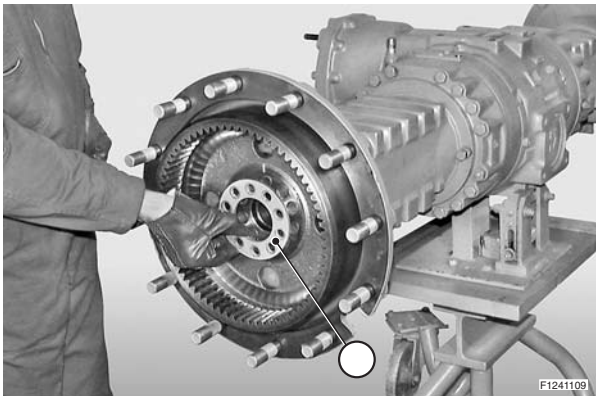
GB c

Remove the axle shaft (4).
NOTE. The removal of the axle shaft allows for the substitution of the snap ring as described in the following paragraphs.



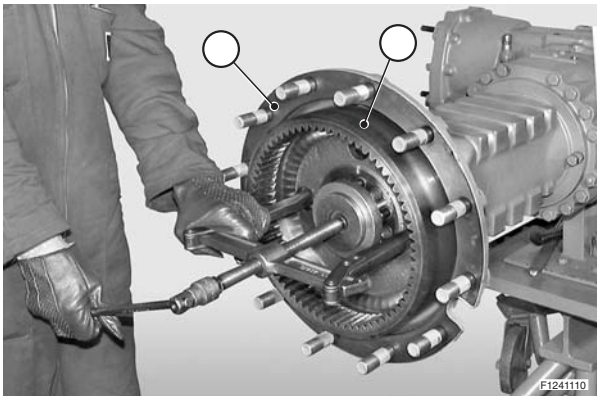
GB d

Loosen the screws (6) and remove them.



GB e

Remove the safety flange (7).



GB f

Partially tighten five of the ten screws (6) in an alternate and proportional manner.
Using an extractor and applying a counter pressure to the screws (6), disengage the crown wheel (5) from the hub (3).

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a

ITA Ruotare il mozzo portaruota (3) fino a portare un foro per le viti (1) in posizione alta.
Applicare un grillo ad "U" nel foro vite; collegare un mezzo di sollevamento e rimuovere il coperchio (2).

D Die Radhalternabe (3) drehen bis ein Loch für die Schrauben (1) in der oberen Position liegt.
Einen U-förmigen Bügel in das Schraubenloch stecken; ein Hebezeug anschließen und den Deckel (2) abnehmen.

ESP Girar el cubo lleva-rueda (3) hasta hacer un agujero para los tornillos (1) en posiciòn alta.
Aplicar un grillo a "U" en el agujero tornillos; conectar un medio de levantamiento y remover la tapa (2).

F Tourner le moyeu porte-roue (3) jusqu'à à amener un des trous pour les vis (1) en haut.
Appliquer une manille en "**U**" dans le trou de vis; appliquer un moyen de relevage et enlever le couvercle (2).

b

ITA **Solo se si devono sostituire dei componenti che non richiedono lo smontaggio della corona (5).**
Contrassegnare la posizione tra un dente del semiasse (4) e la corona (5).

D **Nur wenn Bestandteile ausgewechselt werden müssen, für die der Kranz (5) nicht abmontiert werden muß.**
Die Position zwischen einem Zahn der Halbachse (4) und dem Kranz (5) markieren.

ESP **Solo si se deben de sobstituir algunos componentes que no comportan el desmontaje de la corona (5).**
Senalar la colocaciòn entre un diente del semi-eje (4) y la corona (5).

F Uniquement si on doit substituer des composants qui ne veulent pas le démontage de la couronne (5).
Marquer la position entre une dent du demi-essieu (4) et la couronne (5).

c

ITA Asportare il semiasse (4).
NOTA. L'asportazione del semiasse permette la sostituzione dell'anello di tenuta come descritto di seguito.

D Die Halbachse (4) abnehmen.
BEMERKUNG. Bei abgenommener Halbachse kann der Dichtring, wie nachstehend beschrieben, ausgewechselt werden.

ESP Sacar el semi-eje (4).
NOTA. Sacar el semi-eje permite la sobstituciòn del anillo de tenida como descrito a seguir.

F Enlever le demi-essieu (4).
REMARQUE. Le dégagement du demi-essieu consent la substitution de l'anneau d'étanchéité comme décrit par la suite.

d

ITA Allentare le viti (6) ed asportarle.

D Schrauben (6) abschrauben.

ESP Aflojar los tornillos (6) y sacarlos.

F Desserrer les vis (6) puis les enlever.

e

ITA Asportare la flangia di sicurezza (7).

D Sicherheitsflansch (7) abnehmen.

ESP Sacar la arandela de seguridad (7).

F Enlever la flasque de sécurité (7).

f

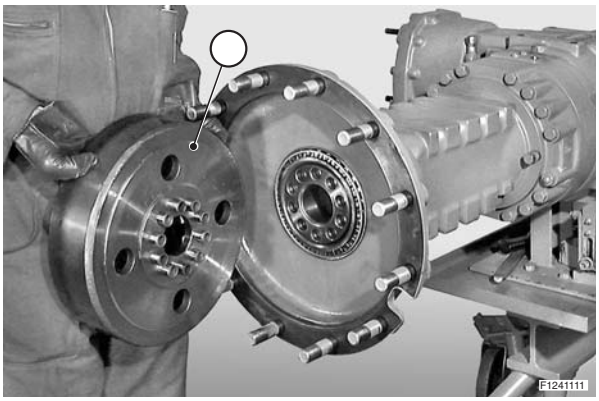
ITA Avvitare parzialmente, in modo alternato ed in uguale misura, cinque delle dieci viti (6).
Utilizzando un estrattore e facendo reazione sulle viti (6) disimpegnare la corona (5) dal mozzo (3).

D Abwechselnd und im gleichen Maß fünf von den zehn Schrauben (6) zuschrauben.
Mit einem Abzieher den Kranz (5) aus der Nabe (3) ziehen und dabei auf die Schrauben (6) wirken.

ESP Atornillar parcialmente, de manera alternada y en igual mesera, cinco de las diez tornillos (6).
Utilizando un extractor y haciendo reaciòn sobre los tornillos (6) desempenar la corona (5) del cubo (3).

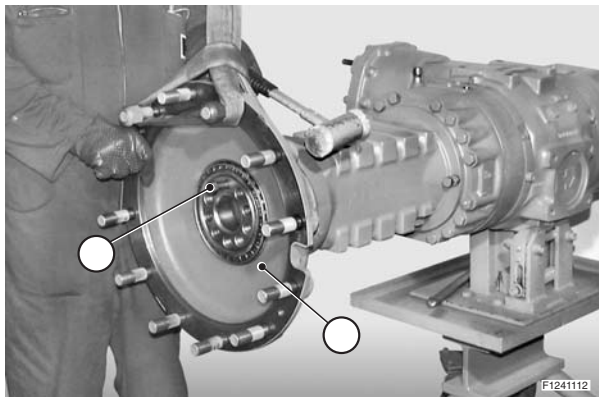
F Visser partiellement, en alternance et de la même façon cinq des dix vis (6).
A l'aide d'un extracteur, tout en faisant réagir les vis (6), dégager la couronne (5) du moyeu (3).

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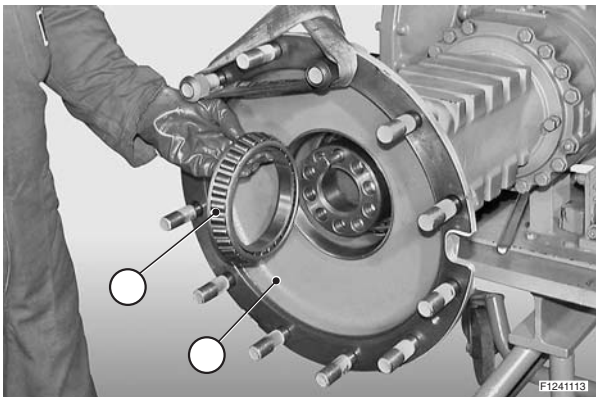
GB a

Remove screws (6) and crown wheel (5).



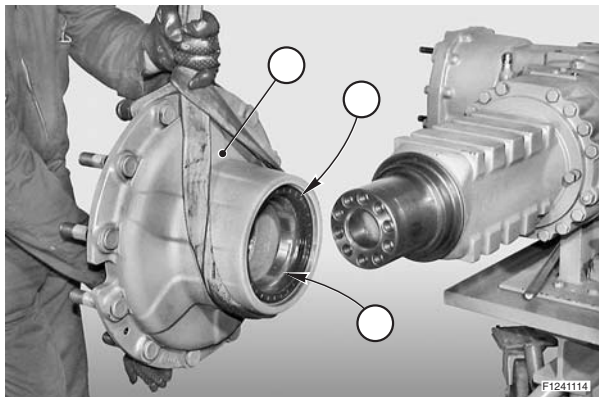
GB b

Sling the hub (3) and connect it to a hoist; partially tighten a screw (6) and with the help of a hammer, shift the hub (3) and the external bearing (8).



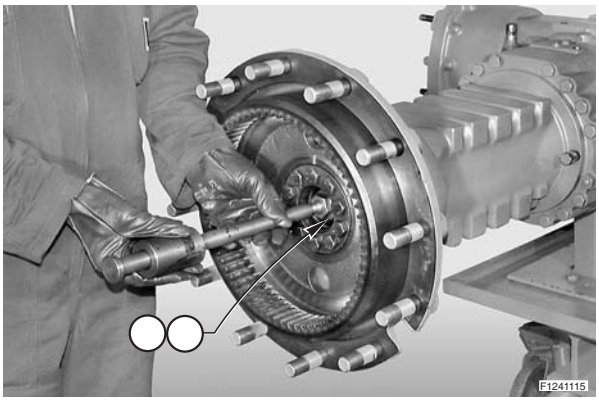
GB c

Remove the bearing (8) and the hub (3).



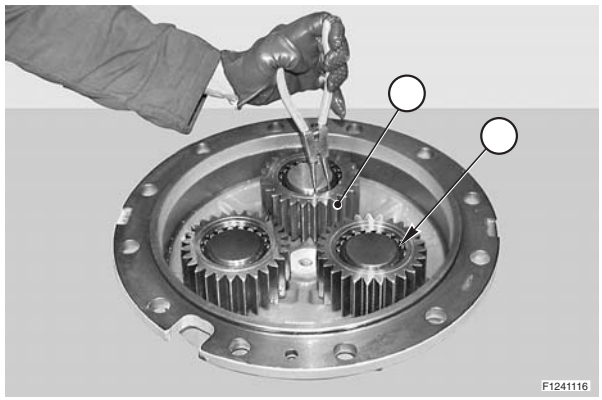
GB d

Extract the hub (3) complete with snap ring (9) and internal bearing (10).



GB e

Using an extractor, remove at the same time the snap ring (11) and the centring ring (12).
NOTE. Note down the direction of assembly of snap and centring rings.



GB f

Remove the safety spring rings (13) of the planetary gears (14).

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a

ITA Rimuovere le viti (6) e la corona (5).

D Schrauben (6) und Kranz (5) abnehmen.

ESP Remover los tornillos (6) y la corona (5).

F Enlever les vis (6) et la couronne (5).

b

ITA Imbragare il mozzo (3) e collegarlo ad un mezzo di sollevamento; avvitare parzialmente una vite (6) e, con un mazzuolo, smuovere il mozzo (3) ed il cuscinetto esterno (8).

D Nabe (3) anschlagen und an ein Hebezeug befestigen; Schrauben (6) etwas zudrehen und mit einem Hammer die Naben (3) und das äußere Lager (8) bewegen.

ESP Atar el cubo (3) y conectarlo a un medio de levantamiento; atornillar parcialmente un tornillo (6) y, con un martillo, mover el cubo (3) y el cojinete externo (8).

F Elinguer le moyeu (3) puis relier celui-ci à un moyen de relevage; visser partiellement une vis (6), puis à l'aide d'un maillet, bouger le moyeu (3) et le palier externe (8).

c

ITA Rimuovere il cuscinetto (8) ed il mozzo (3).

D Lager (8) und Nabe (3) abnehmen.

ESP Remover el cojinete (8) y el cubo (3).

F Enlever le palier (8) et le moyeu (3).

d

ITA Asportare il mozzo (3) completo di anello di tenuta (9) e cuscinetto interno (10).

D Nabe (3) samt Dichtring (9) und inneres Lager (10) abnehmen.

ESP Sacar el cubo (3) completo de anillo de retenciòn (9) y cojinete interno (10).

F Enlever le moyeu (3) complet de bague d'étanchéité (9) et de palier interne (10).

e

ITA Utilizzando un estrattore, rimuovere contemporaneamente l'anello di tenuta (11) e l'anello centratore (12).
NOTA. Annotare il senso di montaggio degli anelli di tenuta e di centratura.

D Mit einem Abzieher gleichzeitig den Dichtring (11) und den Zentrierring (12) abnehmen.
BEMERKUNG. Montagerichtung der Dicht- und Zentrierringe notieren.

ESP Utilizando un extractor, remover contemporaneamente el anillo de retenciòn (11) y el anillo centrador (12).
NOTA. Anotar el sentido de montaje de los anillos de retenciòn y de centraje.

F A l'aide d'un extracteur enlever en même temps l'anneau d'étanchéité (11) et l'anneau centreur (12).
REMARQUE. Prendre note du sens de montage des anneaux d'étanchéité et de centrage.

f

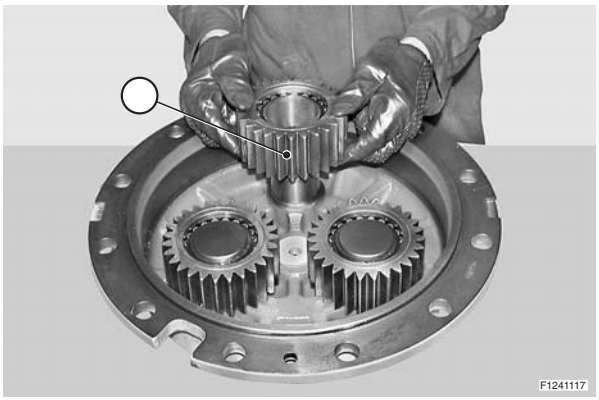
ITA Rimuovere gli anelli elastici (13) di ritegno satelliti (14).

D Kolbenringe (13) und Planetenhalter (14) abnehmen.

ESP Remover los anillos elasticos (13) de retenciòn satelites (14).

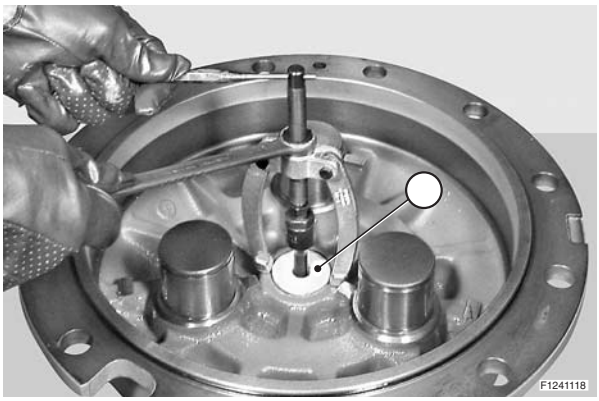
F Enlever les anneaux ressorts (13) de fixation des satellites (14).

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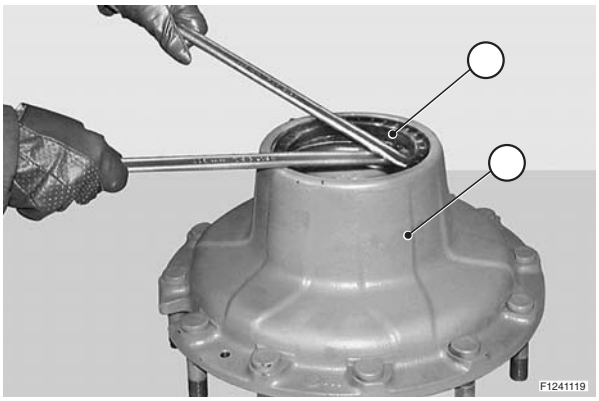
GB a

Remove the planetary gears (14).
NOTE. Note down direction of assembly of planetary gears.



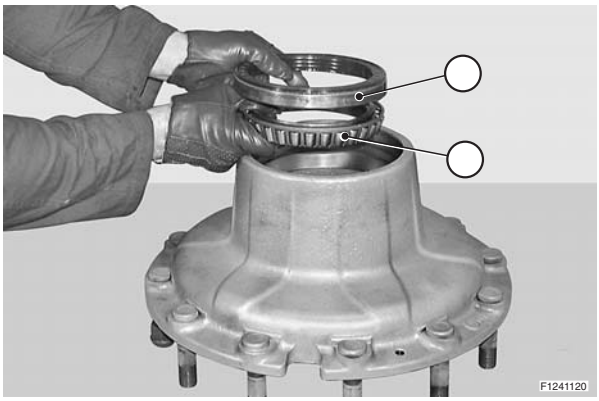
GB b

Only if necessary.
Using an extractor, remove the shim washer (15) from the planet carrier.



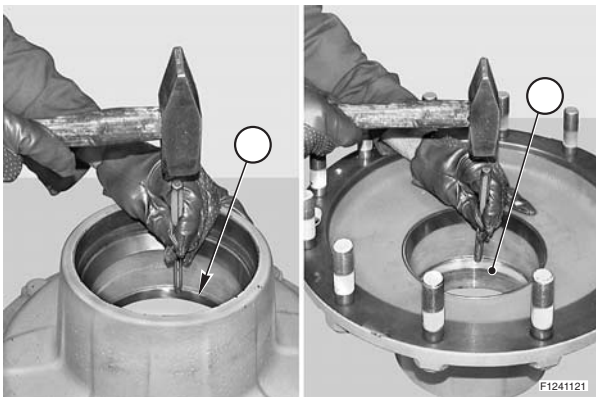
GB c

Remove the snap ring (9) from the hub (3).
NOTE. Note down direction of assembly.
CAUTION! The snap ring may not be reused.



GB d

Remove the internal bearing (10).



GB e

Remove the external thrust blocks of bearings (8) and (10), using a pin-driver.
NOTE. Hammer in an alternate sequence to prevent crawling and deformation of the thrust blocks.

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a

ITA Asportare gli ingranaggi satelliti (14).
NOTA. Annotare il senso di montaggio dei satelliti.

D Planetengetriebe (14) abnehmen.
BEMERKUNG. Montagerichtung notieren.

ESP Sacar los engranajes satelites (14).
NOTA. Anotar el sentido de desmontaje de los satelites.

F Enlever les engrenages satellites (14).
REMARQUE. Prendre note du sens de montage.

b

ITA **Solo se necessario.**
Utilizzando un estrattore, rimuovere dal portasatelliti la rondella di rasamento (15).

D Nur wenn notwendig.
Mit einem Abzieher vom Planetenradhalter die Zwischenlegscheibe (15) abnehmen.

ESP **Solo si necesario.**
Utilizando un extractor, remover del lleva-satelites la arandela de rasamiento (15).

F Uniquement si besoin.
A l'aide d'un extracteur, enlever du porte-satellite la rondelle de rasage (15).

c

ITA Rimuovere dal mozzo (3) l'anello di tenuta (9).
NOTA. Annotare il senso di montaggio.
ATTENZIONE! L'anello di tenuta non può essere riutilizzato.

D Von der Nabe (3) den Dichtring (9) abnehmen.
BEMERKUNG. Montagerichtung notieren.
ACHTUNG! Der Dichtring darf nicht wieder verwendet werden.

ESP Remover del cubo (3) los anillos de retenciòn (9).
NOTA. Anotar el sentido de montaje.
ATENCION! El anillo de retenciòn no puede ser reutilizado.

F Oter du moyeu (3) l'anneau d'étanchéité (9).
REMARQUE. Prendre note du sens de montage.
ATTENTION! L'anneau d'étanchéité ne peut pas être réutilisé.

d

ITA Rimuovere il cuscinetto interno (10).

D Das innere Lager (10) abnehmen.

ESP Remover el cojinete interior (10).

F Enlever le palier interne (10).

e

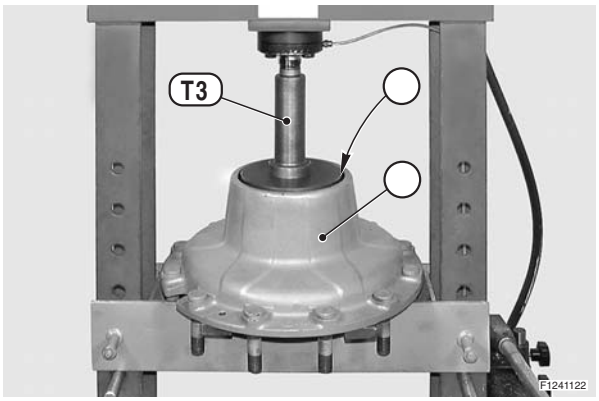
ITA Rimuovere le ralle esterne dei cuscinetti (8) e (10) utilizzando un cacciaspine.
NOTA. Battere in modo alternato per evitare impuntamenti e deformazioni delle ralle.

D Die äußeren Scheiben (8) und (10) mit einem Dübel abnehmen.
BEMERKUNG. Abwechselnd schlagen, um ein Durchschlagen und Verformungen der Scheiben zu vermeiden.

ESP Remover las ranguas externas de los cojinetes (8) y (10) utilizando un extractor de clavijas.
NOTA. Pegar de manera alternada para evitar empuntamientos y deformaciònes de las ranguas.

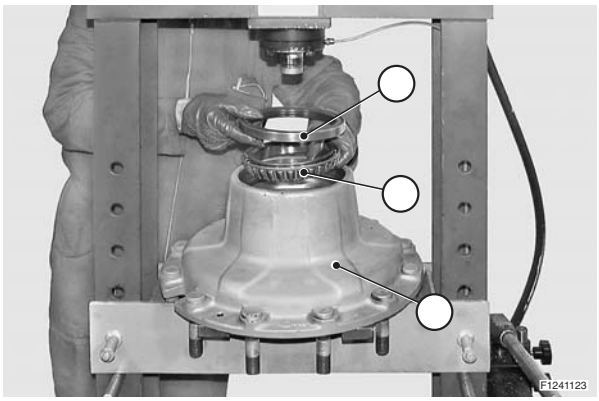
F Enlever les crapaudines externes des paliers (8) et (10) à l'aide d'un chasse-clou.
REMARQUE. Donner des coups alternés pour éviter talonnages et déformations des crapaudines.

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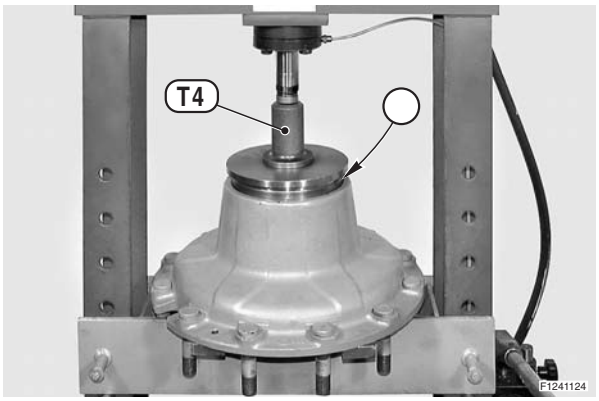
GB a

Position the wheel hub (3) under a press; lubricate the seat of the external bearing and, using tool **T3**, install the thrust block of the bearing (10).



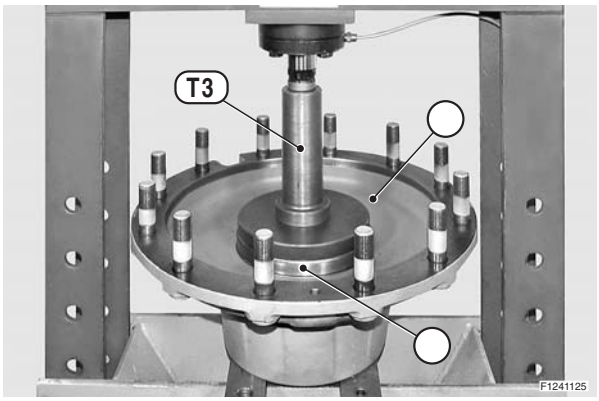
GB b

Install the bearing (10).
Apply an appropriate sealant to the outer surface of the snap ring (9).
Position the snap ring (9) into the hub (3).
NOTE. Check orientation of the ring.



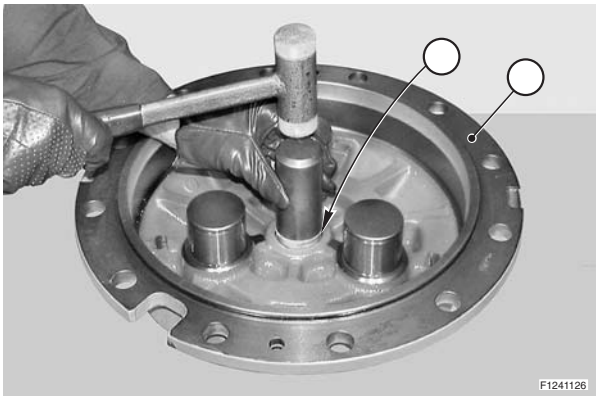
GB c

Position tool **T4** and press the snap ring (9) down into its seat.



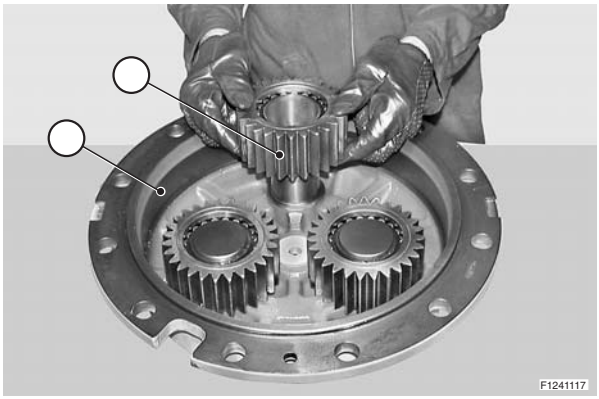
GB d

Turn the hub (3) upside down, lubricate the seat of the bearing and, using tool **T3**, install the thrust block of the bearing (8).



GB e

Only if shim washer has previously been removed.
Apply a sealant for removable seals to the outer surface of the shim washer (15) and, using a driver, fit it into the planetary gear cover (2).



GB f

Fit the planetary gear (14) onto the planetary gear cover (2).
CAUTION! The jointed portion of the internal ring of the bearings must face the bottom of the pin.

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a

ITA Posizionare il mozzo ruota (3) sotto una pressa; lubrificare la sede del cuscinetto esterno e, utilizzando l'attrezzo **T3**, montare la ralla del cuscinetto (10).

D Die Radnabe (3) unter eine Presse positionieren; den Sitz des äußeren Lagers schmieren und mit dem Werkzeug **T3** die Scheibe des Lagers (10) montieren.

ESP Colocar el cubo rueda (3) bajo una prensa; lubrificar la sed del cojinete externo y, utilizando la herramienta **T3**, montar la rangua del cojinete (10).

F Positionner le moyeu roue (3) sous la presse; lubrifier le logement du palier externe, puis à l'aide de l'outil **T3**, monter la crapaudine du palier (10).

b

ITA Installare il cuscinetto (10).
Spalmare la superficie esterna dell'anello di tenuta (9) con sigillante per guarnizioni.
Posizionare l'anello di tenuta (9) nel mozzo (3).
NOTA. Controllare l'orientamento dell'anello.

D Lager (10) installieren.
Äußere Fläche des Dichtringes (9) mit etwas Dichtmasse schmieren.
Dichtring (9) in die Nabe (3) positionieren.
BEMERKUNG. Richtung des Ringes kontrollieren.

ESP Colocar el cojinete (10).
Pasar la superficie externa del anillo de retenciòn (9) con sigilante para guarniciones.
Colocar el anillo de retenciòn (9) en el cubo (3).
NOTA. Controlar el orientamiento del anillo.

F Installer le palier (10).
Enduire la superficie externe de l'anneau d'étanchéité (9) avec de la colle à garnitures.
Positionner l'anneau d'étanchéité (9) dans le moyeu (3).
REMARQUE. Contrôler la bonne direction de l'anneau.

c

ITA Posizionare l'attrezzo **T4** e pressare in sede l'anello di tenuta (9).

D Das Werkzeug T4 positionieren und den Dichtring (9) in seinen Sitz drücken.

ESP Colocar la herramienta y apretar en sed el anillo de retenciòn (9).

F Placer l'outil **T4** et presser dans son logement l'anneau d'étanchéité (9).

d

ITA Capovolgere il mozzo (3), lubrificare la sede cuscinetto e, utilizzando l'attrezzo **T3**, montare la ralla del cuscinetto (8).

D Die Nabe (3) wenden, den Lagersitz schmieren und mit dem Werkzeug **T3** die Nabe des Lagers (8) montieren.

ESP Volcar el cubo (3), lubrificar la sed cojinete y, utilizando la herramienta **T3**, montar la rangua del cojinete (8).

F Faire basculer le moyeu (3), lubrifier le logement du palier, puis à l'aide de l'outil **T3**, monter la crapaudine dans le palier (8).

e

ITA **Solo se è stata rimossa.**
Spalmare la superficie esterna della rondella di rasamento (15) con sigillante per guarnizioni removibili e, utilizzando uno spintore, montarla nel coperchio portasatelliti (2).

D **Nur wenn zuvor abgenommen.**
Äußere Fläche der Zwischenlegscheibe (15) mit Dichtmasse für abnehmbare Dichtungen schmieren und mit einem Stößel diese Zwischenlegscheibe in den Deckel des Planetenradhalters (2) montieren.

ESP **Solo si ha sido desplazada.**
Pasar la superficie externa de la arandela de rasamiento (15) con sigilante para guarniciònes removibles y, utilizando un empuje, montarla en la tapa lleva-satelites (2).

F Uniquement si elle a été enlevée.
Enduire la superficie externe de la rondelle de rasage (15) avec de la colle pour garnitures amovibles, à l'aide d'un poussoir monter celle-ci dans le couvercle porte-satellites (2).

f

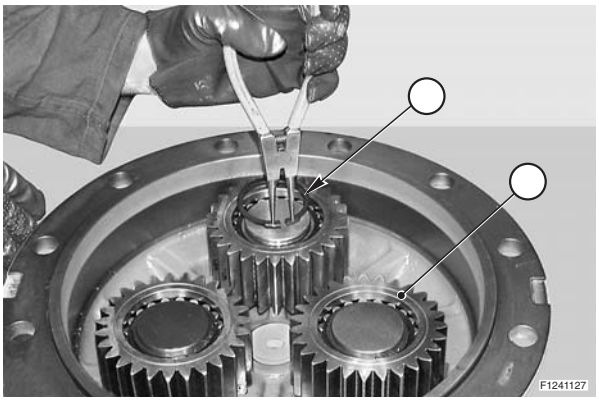
ITA Montare sui perni del coperchio portasatelliti (2) gli ingranaggi planetari (14).
ATTENZIONE! La parte raccordata dell'anello interno dei cuscinetti deve essere rivolta verso il fondo del perno.

D Auf die Stifte des Deckels des Planetenradhalters (2) die Planetengetriebe (14) montieren.
ACHTUNG! Das Anschlußstück des inneren Lagerringes muß zur unteren Seite des Stiftes gerichtet sein.

ESP Montar sobre los pernos de la tapa lleva-satelites (2) los engranajes planetares (14).
ATENCION! La parte empalmada del anillo interno de los cojinetes debe de ser dirijida hacia el fondo de la rotula.

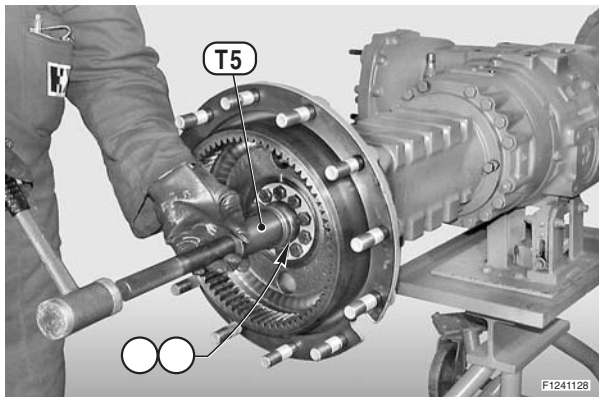
F Monter sur les pivots du couvercle porte-satellites (2) les engrenages planétaires (14).
ATTENTION! La partie raccordée de l'anneau à l'intérieur du palier doit être tournée vers la partie basse du pivot.

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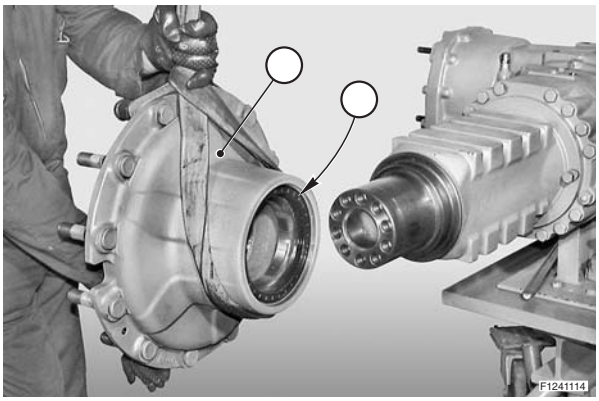
GB a

Lock into position the planetary gears (14) with the snap rings (13).



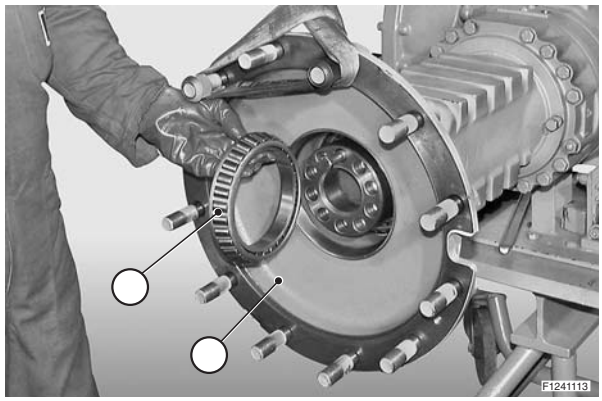
GB b

Lubricate and fit the centring ring (12) and snap ring (11) onto tool **T5**; install the rings into the arm.
CAUTION! Pay particular attention to the direction of assembly of the rings.



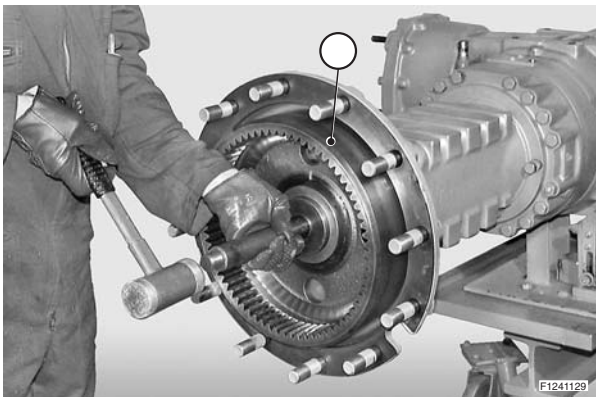
GB c

Grease the snap ring (9) and the hub of the arm.
Install the wheel hub (3).



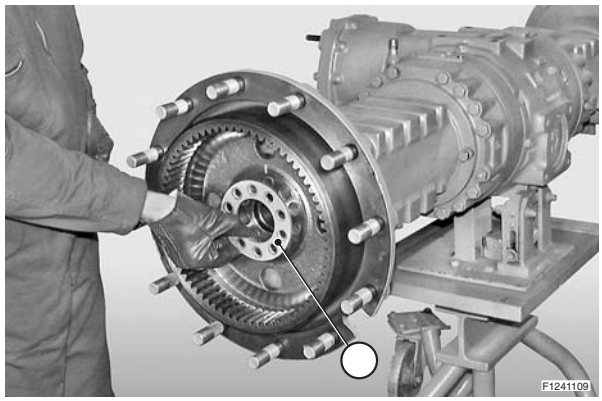
GB d

Install the external bearing (8).
NOTE. Move the bearing to the limit stop by hammering lightly all around the edge.



GB e

Install the crown wheel (5) and, using a driver with adequate diameter, fasten it onto the hub of the arm.



GB f

Using Tecno Lupe /101, grease the surface of the safety flange (7) that touches the crown wheel.

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a

ITA Fissare la posizione degli ingranaggi satelliti (14) con gli anelli elastici (13).

D Die Position der Planetengetriebe (14) mit den Kolbenringen (13) festigen.

ESP Fijar la posiciòn de los engranajes satelites (14) con los anillos elasticos (13).

F Fixer les engrenages porte-satellites (14) à leur place avec les anneaux ressorts (13).

b

ITA Lubrificare e montare sull'attrezzo **T5** l'anello centratore (12) e l'anello di tenuta (11); montare gli anelli nel braccio.
ATTENZIONE! Controllare attentamente il senso di montaggio degli anelli.

D Das Werkzeug **T5** schmieren und darauf den Zentrierring (12) und den Dichtring (11) montieren; die Ringe in den Arm montieren.
ACHTUNG! Montagerichtung der Ringe sorgfältig kontrollieren.

ESP Lubrificar y montar sobre la herramienta **T5** el anillo central (12) y el anillo de retenciòn (11); montar los anillos en el eje.
ATENCION! Controlar atentamente el sentido de montaje de los anillos.

F Lubrifier et monter sur l'outil **T5** l'anneau centreur (12) et l'anneau d'étanchéité (11); monter les anneaux dans le bras.
ATTENTION! Contrôler attentivement le sens du montage des anneaux.

c

ITA Lubrificare con grasso l'anello di tenuta (9) ed il mozzo del braccio.
Montare il mozzo portaruota (3).

D Mit Fett den Dichtring (9) und die Armnabe schmieren.
Radhalternabe (3) montieren.

ESP Lubrificar con grasa el anillo de retenciòn (9) y el cubo del eje.
Montar el cubo lleva-rueda (3).

F Lubrifier avec de la graisse l'anneau d'étanchéité (9), le moyeu du bras.
Monter le moyeu porte-roue (3).

d

ITA Montare il cuscinetto esterno (8).
NOTA. Mandare a fondo corsa il cuscinetto con leggeri colpi di mazzuolo distribuiti su tutta la circonferenza.

D Äußeres Lager (8) montieren.
BEMERKUNG. Das Lager bis zum Anschlag mit leichten Hammerschlägen an der gesamten Kreislinie einsetzen.

ESP Montar el cojinete esterno (8).
NOTA. Mandar a tope el cojinete con ligeros colpes de martillo repartidos sobre toda la circonferencia.

F Monter le palier externe (8).
REMARQUE. Envoyer en butée le palier avec de légers coups de maillet distribués tout autour de la circonférence.

e

ITA Montare la corona (5) e, utilizzando uno spintore di diametro adatto, mandarla in battuta sul mozzo del braccio.

D Den Kranz (5) montieren und mit einem geeigneten Stößel den Kranz bis zum Anschlag an der Armnabe einsetzen.

ESP Montar la corona (5) y, utilizando un empuje de diametro apto, mandarla a tope sobre el cubo del eje.

F Monter la couronne (5), puis à l'aide d'un poussoir d'un diamètre adapté, envoyer celle-ci en butée sur le moyeu du bras.

f

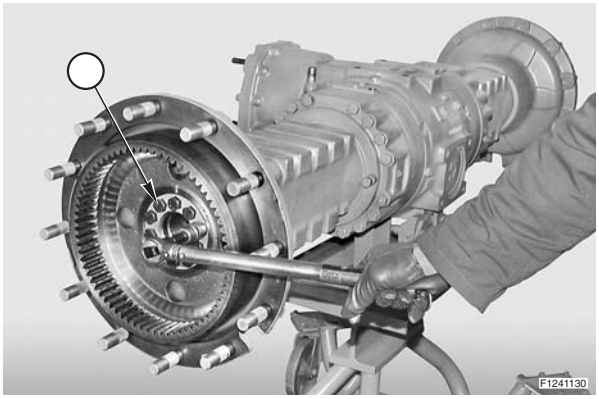
ITA Lubrificare con grasso Tecno Lupe /101 la superficie della flangia di sicurezza (7) a contatto con la corona.

D Mit Fett Typ Tecno Lupe/ 101 die Fläche des Sicherheitsflanschs (7), der am Kranz anliegt, schmieren.

ESP Lubrificar con grasa Tecno Lupe/101 la superficie de la brida de seguridad (7) a contacto con la corona.

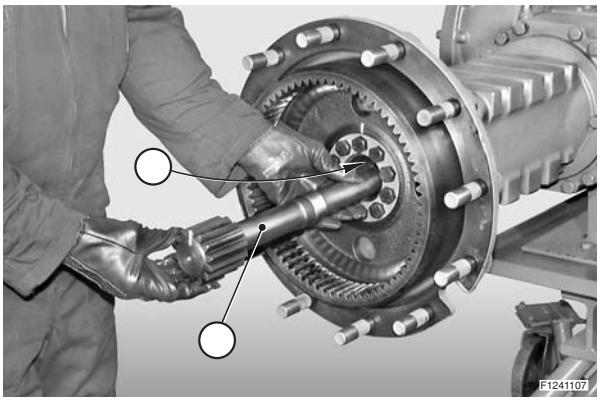
F Lubrifier avec de la graisse Tecno Lupe/ 101 la superficie de la flasque de sécurité (7) au contact de la couronne.

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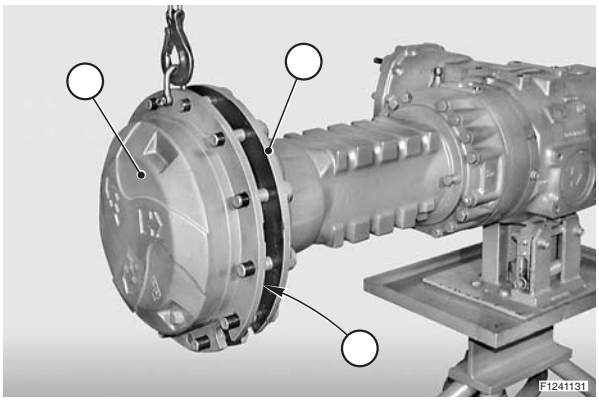
GB a

Coat the screws (6) with Loctite 270 and screw them.
Tighten screws (6) in two stages, using the criss-cross method.
Initial torque wrench setting: 120 Nm
Final torque wrench setting: 219 – 242 Nm



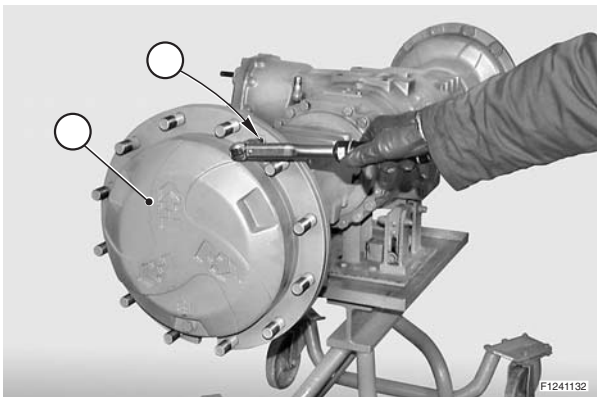
GB b

Lubricate the snap ring (11), the toothed portions and the sealing surface of the axle shaft.
Install the axle shaft (4), making sure that it is properly inserted into braking disks and differential unit.



GB c

Fit the planetary gear cover (2) onto the wheel hub (3).
CAUTION! 1 - Check the condition and position of the O-ring (16).
2 - Line up the locating release points.



GB d

Lock the planetary gear cover (2) onto the wheel hub (3) with screws (1).
Screws torque wrench setting: 40 – 0 Nm.

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a

ITA Spalmare le viti (6) con Loctite 270 ed avvitarle.
Serrare le viti (6) in due tempi e con il metodo del serraggio incrociato.
Coppia di serraggio iniziale: 120 Nm
Coppia di serraggio finale: 219÷242 Nm

D Die Schrauben (6) mit Loctite 270 schmieren und festschrauben.
Schrauben (6) im Kreuz schrittweise festziehen.
Anzugsmoment zuerst: 120Nm
Anzugsmoment am Ende: 219÷242 Nm

ESP Pasar los tornillos (6) con Loctite 270 y atornillarlos.
Apretar los tornillos (6) en doss tiempos con el metodo de torsion cruzada.
Par de torsion inicial: 120 Nm.
Par de torsion final: 219÷242 Nm.

F Enduire les vis (6) avec du Loctite 270 puis visser.
Serrer les vis (6) en deux temps avec la méthode du serrage croisé.
Couple de serrage initial: 120Nm
Couple de serrage final: 219÷242 Nm.

b

ITA Lubrificare l'anello di tenuta (11), le dentature e la superficie di tenuta del semiasse.
Montare il semiasse (4) assicurandosi che si innesti nei dischi freni e nel differenziale.

D Dichtring (11), Zähne und Dichtfläche der Halbachse schmieren.
Halbachse (4) montieren und darauf achten, daß sie in die Bremsscheiben und in das Differential einrastet.

ESP Lubrificar el anillo de retenciòn (11), las dentaduras y la superficie del semieje.
Montar el semieje (4) asegurandose que se encaje en los discos y en el diferencial.

F Lubrifier l'anneau d'étanchéité (11), les dents, la superficie étanche des demi-essieux.
Monter le demi-essieu (4) en veillant à ce qu'il s'enclenche bien dans les disques freins et dans le différentiel.

c

ITA Montare il coperchio portasatelliti (2) sul mozzo portaruota (3).
ATTENZIONE! 1 - Controllare lo stato e la posizione della guarnizione OR (16).
2 - Allineare gli scarichi di riferimento.

D Den Deckel des Planetenradhalters (2) auf die Nabe des Radhalters (3) montieren.
ACHTUNG! 1 - Zustand und Position der O-Ringe (16) kontrollieren.
2 - Die Bezugsstellen bzw. Ablaßöffnung fluchten.

ESP Montar la tapa lleva-satelites (2) sobre el cubo lleva-rueda (3).
ATENCION! 1 - Controlar el estado y la posiciòn de la guarniciòn OR (16).
2 - Alinear los descarges de referencia.

F Monter le couvercle porte-satellite (2) sur le moyeu porte-roue (3).
ATTENTION! 1 - Contrôler l'état et la position des garnitures O'Ring (16).
2 - Aligner les points de décharge de référence.

d

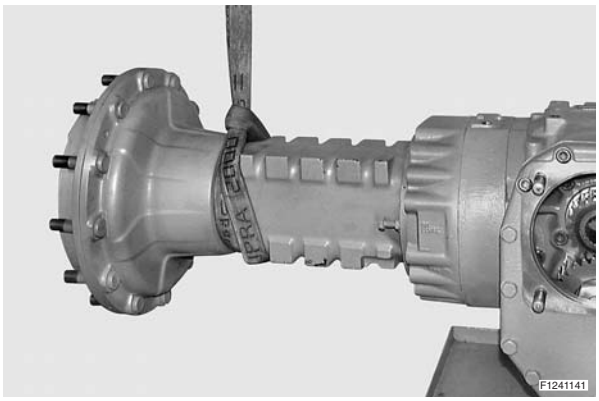
ITA Bloccare il coperchio portasatelliti (2) sul mozzo portaruota (3) con le viti (1).
Coppia di serraggio viti: 40÷50 Nm

D Den Deckel des Planetenradhalters (2) an der Radhalternabe (3) mit den Schrauben (1) blockieren.
Anzugsmoment der Schrauben: 40÷50 Nm

ESP Bloquear la tapa lleva-satelietes (2) sobre el cubo lleva-rueda (3) con los tornillos (1).
Par de torsion tornillos: 40÷50 Nm

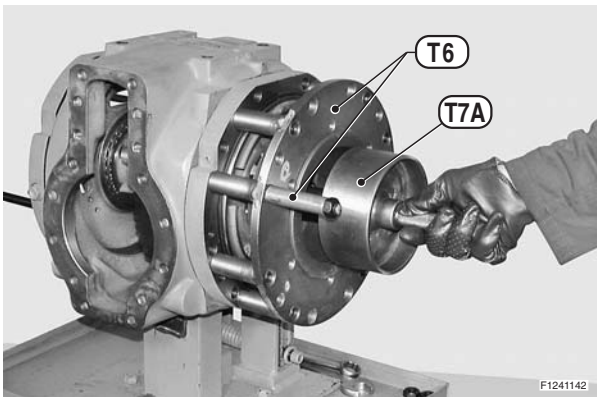
F Bloquer le couvercle porte-satellite (2) sur le moyeu porte-roue (3) à l'aide des vis (1).
Couple de serrage des vis: 40÷50 Nm.

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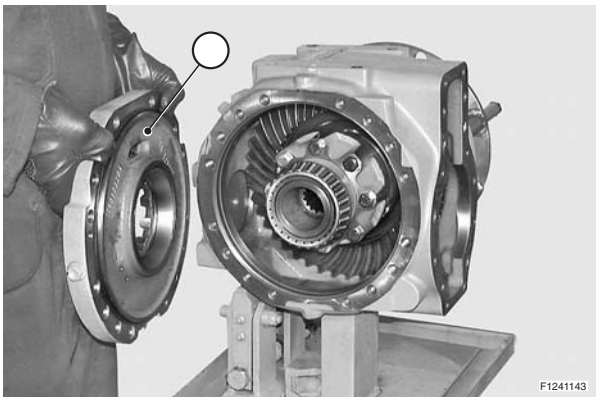
GB a

REMOVAL OF THE DIFFERENTIAL UNIT
Remove the whole arms, the cylinders, and the whole reduction unit.
For details, see «CHECKING WEAR AND REPLACING THE BRAKING DISKS» and «REMOVAL OF REDUCTION GEAR».



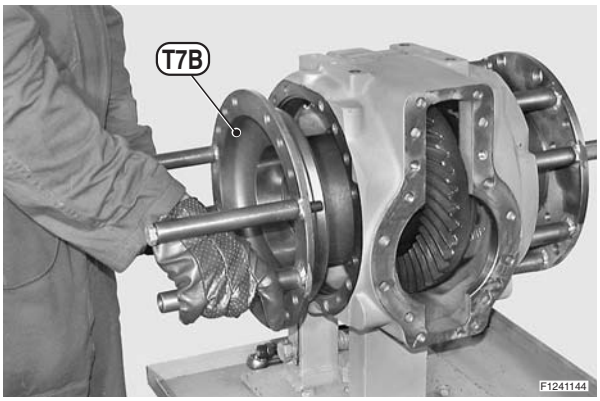
GB b

Apply tool **T6** - for crown wheel side centring - with relative distance pieces and lock it with two nuts.
Apply centring tool **T7A** as well.



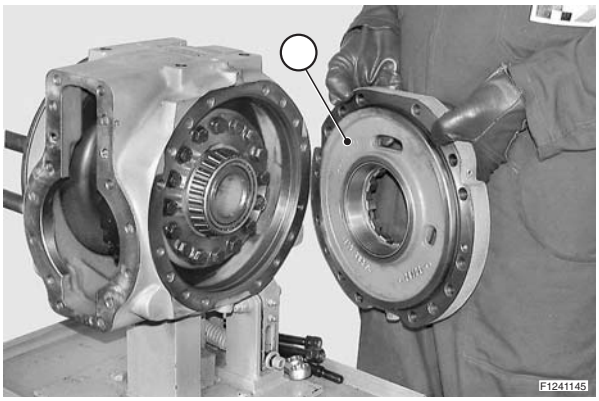
GB c

Remove the stud screws and remove the intermediate cover (1) on the crown wheel opposite side.



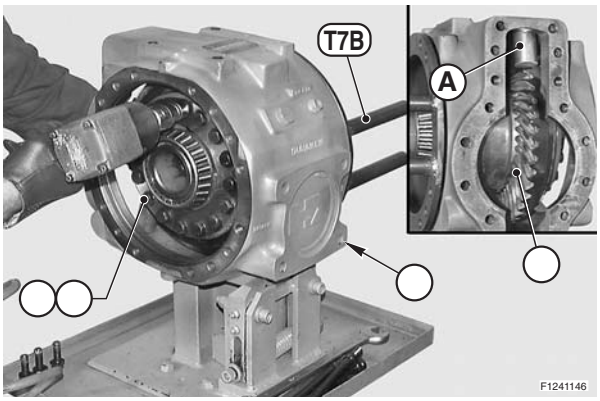
GB d

Install centring tool **T7B** on the opposite side of the crown wheel.



GB e

Remove centring tools **T6** and **T7A** from crown wheel side; remove the studs and the intermediate cover (2) on the crown wheel side.



GB f

Position a stop block «A» made from tender material (aluminium, etc.) between the main body (3) and the toothed portion of the crown wheel (4).
With the crown (4) resting on block "**A**", remove and extract the screws (5) and the spring washers (6).

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a

ITA **RIMOZIONE DIFFERENZIALE**
Rimuovere i bracci completi, i cilindri freni ed il riduttore completo.
Per i dettagli, vedere «CONTROLLO USURA E SOSTITUZIONE DISCHI FRENO» e «RIMOZIONE RIDUTTORE».

D **DIFFERENTIAL ABNEHMEN**
Die kompletten Arme, die Bremszylinder und den kompletten Reduzierer abnehmen.
Siehe «VERSCHLEISS KONTROLLIEREN UND BREMSSCHEIBEN AUSWECHSELN» und «REDUZIERER ABNEHMEN».

ESP **REMOCION DIFERENCIAL**
Remover los ejes completos, los cilindros frenos y el reductor completo.
Para los detalles, vease «CONTROL DESGASTE Y SOBSTITUCION DISCOS FRENOS» y «REMOCION REDUCTOR».

F **DEGAGEMENT DU DIFFERENTIEL**
Enlever les bras entièrement, les cylindres freins et le réducteur tout entier.
Pour de plus amples détails, voir "CONTROLE DE L'USURE ET SUBSTITUTION DU DISQUE FREIN" et "DEGAGEMENT DU REDUCTEUR".

b

ITA Applicare l'attrezzo **T6** di centraggio dal lato corona con i relativi distanziali e fissarlo con due dadi.
Applicare anche l'attrezzo **T7A** di centratura.

D Das Werkzeug **T6** zur Zentrierung an der Kranzseite mit den entsprechenden Distanzstücken anbringen und das Werkzeug mit zwei Muttern befestigen.
Das Werkzeug **T7A** zur Zentrierung anbringen.

ESP Aplicar la herramienta **T6** de centraje del lado corona con los relativos distanciales y fijarla con dos tuercas.
Aplicar tambien la herramienta **T7A** de centradura.

F Appliquer l'outil **T6** de centrage du côté couronne avec les entretoises correspondantes et fixer l'outil avec deux écrous.
Appliquer également l'outil de centrage **T7A**.

c

ITA Rimuovere le viti prigioniere e rimuovere il coperchio intermedio (1) dal lato opposto corona.

D Die Stiftschrauben und den Zwischendeckel (1) von der dem Kranz entgegengesetzte Seite abnehmen.

ESP Remover los tornillos prigioneros y remover la tapa intermedia (1) del lado opuesto corona.

F Enlever les vis prisonnières et enlever le couvercle intermédiaire (1) du côté opposé à la couronne.

d

ITA Montare l'attrezzo **T7B** di centraggio sul lato opposto corona.

D Das Werkzeug **T7B** zur Zentrierung an der dem Kranz entgegengesetzte Seite montieren.

ESP Montar la herramienta **T7B** de centraje sobre el lado opuesto corona.

F Monter l'outil de centrage **T7B** du côté opposé à la couronne.

e

ITA Rimuovere gli attrezzi **T6** e **T7A** di centraggio del lato corona; asportare i prigionieri e rimuovere il coperchio intermedio (2) lato corona.

D Die Werkzeuge **T6** und **T7A** zur Zentrierung an der Kranzseite entfernen; die Stiftschrauben und den Zwischendeckel (2) an der Kranzseite abnehmen.

ESP Remover las herramientas **T6** y **T7A** de centraje del lado corona; sacar los prigioneros y remover la tapa intermedia (2) lado corona.

F Enlever les outils **T6** et **T7A** de centrage du côté couronne; enlever les prisonniers et déplacer le couvercle intermédiaire (2) du côté couronne.

f

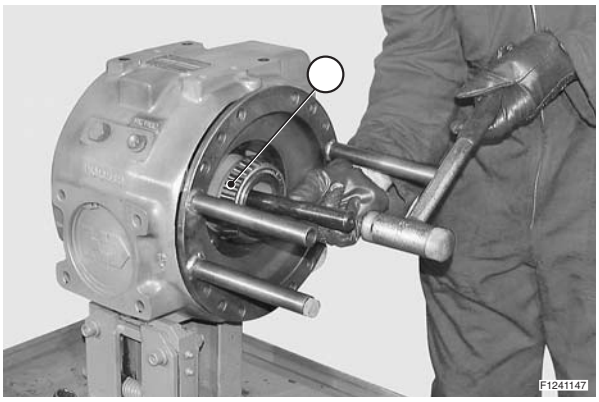
ITA Posizionare tra il corpo centrale (3) e la dentatura della corona (4) un blocchetto "**A**" di contrasto in materiale tenero (alluminio ecc.).
Mantenendo in appoggio la corona (4) sul blocchetto "**A**", rimuovere ed asportare le viti (5) e le rondelle elastiche (6).

D Zwischen dem Zentralkörper (3) und den Zähnen des Kranzes (4) den Block "**A**" aus weichem Material (Aluminium usw.) legen.
Den Kranz (4) am Block "**A**" anliegen lassen und die Schrauben (5) und die Federscheiben (6) abnehmen.

ESP Colocar entre el cuerpo central 83) y la dentadura de la corona (4) un bloque "**A**" de contraste de material tierno (aluminio ect.).
Manteniendo en apoyo la corona (4) sobre el bloque "**A**", remover y sacar los tornillos (5) y las arandelas elasticas (6).

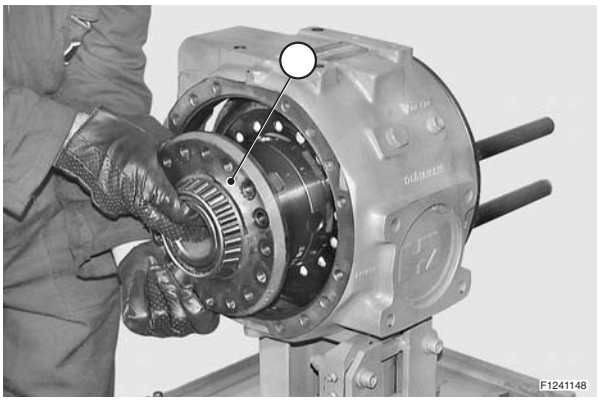
F Placer entre le corps central (3) et la denture de la couronne (4) un petit bloc "**A**" en matériel léger (aluminium etc.) de contraste.
En maintenant la couronne (4) sur le petit bloc "**A**", dévisser et enlever les vis (5), et ensuite les rondelles élastiques (6).

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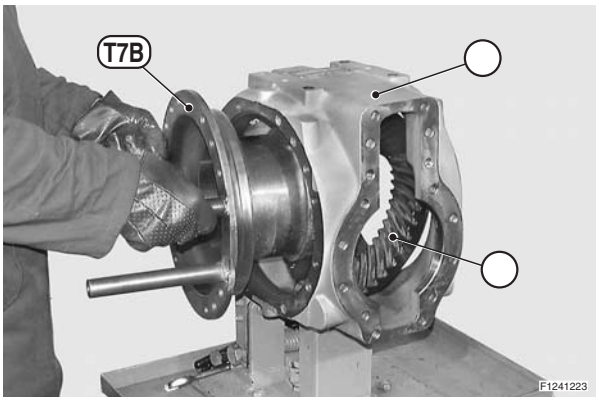
GB a

Using a driver, push the differential unit (7) or (8) towards the opposite side of the crown so as to disengage it from the crown (4).



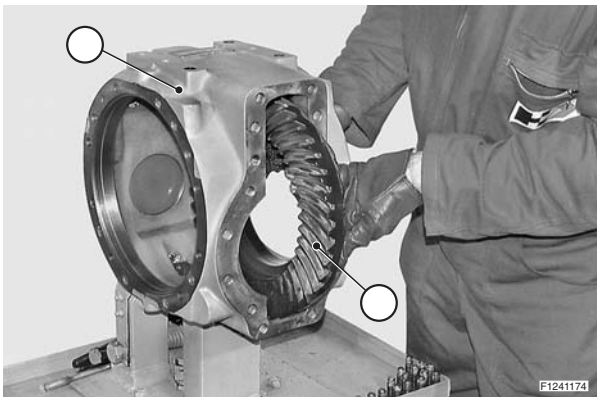
GB b

Extract the whole differential unit (7) or (8).



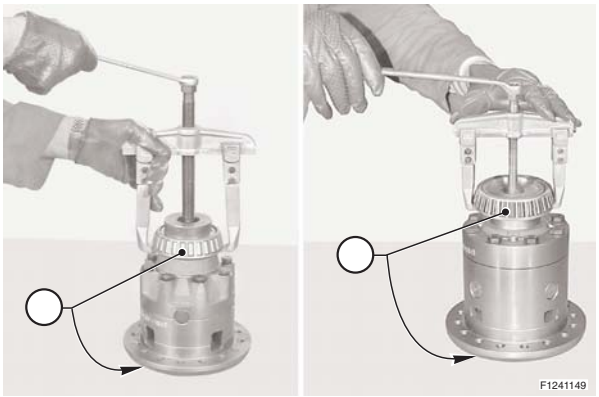
GB c

Remove tool **T7B** from the crown opposite side.



GB d

Extract the crown (4).



GB e

DISASSEMBLY OF THE DIFFERENTIAL UNIT
Using an extractor, remove bearings (9) from the differential unit.



GB f

DISASSEMBLY OF THE NO-SPIN DIFFERENTIAL UNIT
Insert stay "**B**" provided for holding into position the no-spin unit (14) and screw tight the wing nut.

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a

ITA Utilizzando uno spintore, spingere il differenziale (7) o (8) verso il lato opposto corona fino a disimpegnarlo dalla corona (4).

D Mit einem Stößel das Differential (7) oder (8) in die dem Kranz entgegengesetzte Seite drücken und aus dem Kranz (4) freisetzen.

ESP Utilizando un empuje, empujar el diferencial (7) o (8) hacia el lado opuesto corona hasta desempenarlo de la corona (4).

F A l'aide d'un poussoir, pousser le différentiel (7) ou (8) du côté opposé à la couronne jusqu'à le dégager de la couronne (4).

b

ITA Estrarre il gruppo differenziale (7) o (8) completo.

D Das komplette Differentialaggregat (7) oder (8) abziehen.

ESP Sacar el grupo diferencial (7) o (8) completo.

F Extraire le groupe différentiel (7) ou (8) tout entier.

c

ITA Rimuovere l'attrezzo **T7B** montato sul lato opposto corona.

D Das Werkzeug **T7B** abnehmen, das an der dem Kranz entgegengesetzte Seite montiert ist.

ESP Remover la herramienta **T7B** montado sobre el lado opuesto corona.

F Déplacer l'outil **T7B** monté du côté opposé à la couronne.

d

ITA Estrarre la corona (4).

D Kranz (4) abziehen.

ESP Extraer la corona (4).

F Extraire la couronne (4).

e

ITA **SMONTAGGIO DIFFERENZIALE**
Utilizzando un estrattore, asportare i cuscinetti (9) dal gruppo differenziale.

D **DIFFERENTIAL ABMONTIEREN**
Mit einem Abzieher die Lager (9) vom Differentialaggregat abnehmen.

ESP **DESMONTAJE DIFERENCIAL**
Utilizando un extractor, sacar los cojinetes (9) del grupo diferencial.

F **DEMONTAGE DU DIFFERENTIEL**
A l'aide d'un extracteur, enlever les paliers (9) du groupe différentiel.

f

ITA **SMONTAGGIO DIFFERENZIALE NO-SPIN**
Inserire il tirante "**B**" di trattenimento del gruppo no-spin (14) ed avvitare a fondo il dado ad alette.

D **DAS NO-SPIN DIFFERENTIAL ABMONTIEREN**
Sie Spannstange "**B**" einsetzen, um das No-Spin Aggregat (14) festzuhalten und die Flügelmutter festziehen.

ESP **DESMONTAJE DIFERENCIAL NO-SPIN**
Introducir el tirante "**B**" de detencion del grupo no-spin (14) y atornillar hasta el fondo la tuerca a aletas.

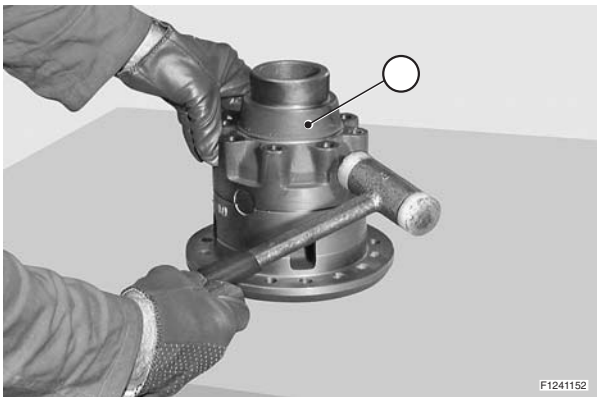
F **DEMONTAGE DU DIFFERENTIEL NO-SPIN**
Introduire la tringle "**B**" de retenue du groupe no-spin (14), puis visser l'écrou à ailettes à fond.

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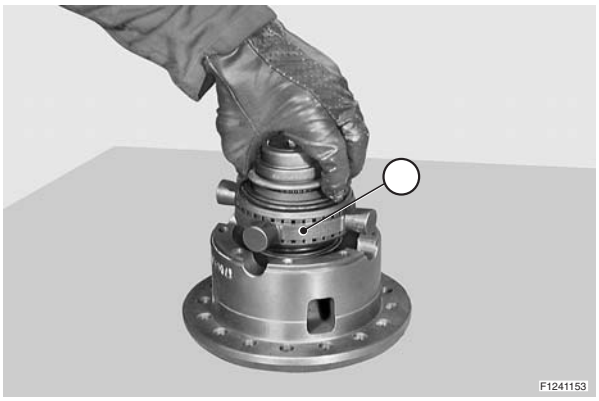
GB a

Remove the screws (10) and the spring washers (11) jointing the differential unit half box (12).



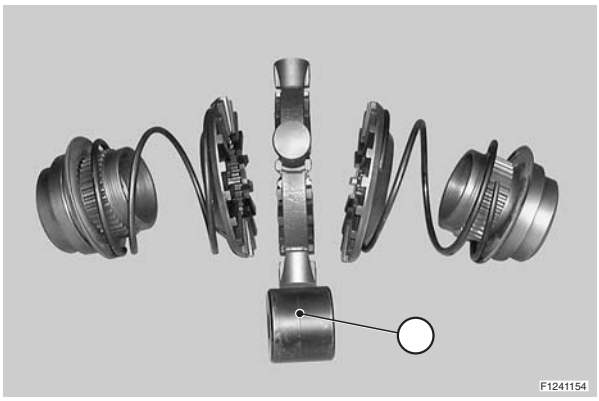
GB b

Using a plastic hammer, take the half box (12) to pieces.
NOTE. Note down the coupling marks.



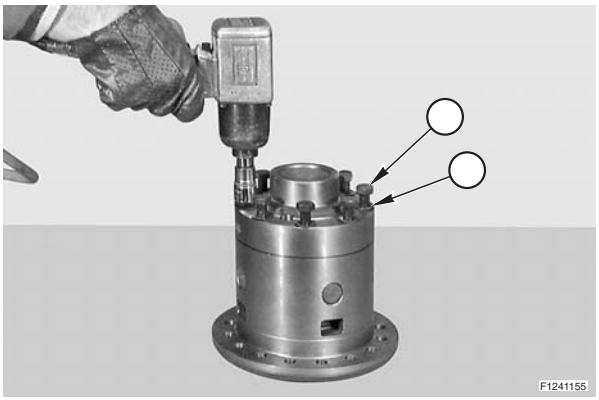
GB c

Extract the no-spin unit (13).



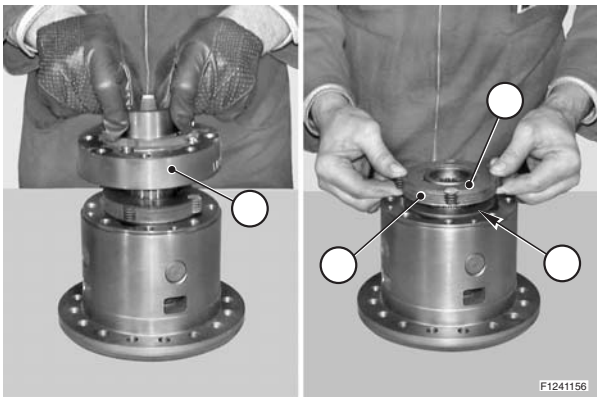
GB d

Unscrew the wing nut of stay "**B**" and take the no-spin unit to pieces in order to remove the distance piece (14) that prevents the axial sliding of the axle shafts.



GB e

DISASSEMBLY OF THE 45% SELF-LOCKING DIFFERENTIAL UNIT
Remove the screws (16) and the spring washers (17) jointing the differential unit.



GB f

Remove the differential cover (18), any shims (19) and the friction (20) complete with ring (21).
CAUTION! 1 - Do not change the position of the disks forming the friction.
2 - Check that the overall thickness of friction exceeds 17.3 mm; if lower, substitute both friction units.

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a

ITA Rimuovere le viti (10) e le rondelle elastiche (11) di unione della semiscatola differenziale (12).

D Schrauben (10) und Federscheiben (11) abnehmen, die das halbe Differentialgehäuse (12) zusammen halten.

ESP Remover los tornillos (10) y las arandelas elasticas (11) de union de la semi-caja diferencial (12).

F Enlever les vis (10) et les rondelles élastiques (11) d'union de la moitié du boîtier différentiel (12).

b

ITA Utilizzando un mazzuolo in materiale plastico scomporre la semiscatola differenziale (12).
NOTA. Annotare la marcatura di accoppiamento.

D Mit einem Gummihammer das halbe Differentialgehäuse (12) zerlegen.
BEMERKUNG. Die Kupplungsmarkierung notieren.

ESP Utilizando un martillo en material plastico decomponer la semicaja diferencial (12).
NOTA. Anotar la marcatura de acoplamiento.

F A l'aide d'un maillet en matière plastique décomposer la moitié du boîtier différentiel (12).
REMARQUE. Prendre note de la marque d'accouplement.

c

ITA Estrarre il gruppo no-spin (13).

D Das No-Spin Aggregat (13) abziehen.

ESP Sacar el grupo no-spin (13).

F Extraire le groupe no-spin (13).

d

ITA Svitare il dado ad alette del tirante "**B**" e scomporre il gruppo no-spin per rimuovere il distanziale (14) contro lo scorrimento assiale dei semiassi.

D Die Flügelmutter der Spannstange "**B**" abschrauben und das No-Spin Aggregat zerlegen, um das Differential (14) an der Achsengleitung der Halbachsen abnehmen zu können.

ESP Destornillar la tuerca a aletas del tirante "**B**" y decomponer el grupo no-spin para remover el distancial (14) contra el deslizamiento axial de los semi-ejes.

F Dévisser l'écrou à ailettes de la tringle "**B**" et décomposer le groupe no-spin pour enlever le différentiel (14) contre le coulisseau axial des demi-essieux.

e

ITA **SMONTAGGIO DIFFERENZIALE AUTOBLOCCANTE AL 45%**
Rimuovere le viti (16) e le rondelle elastiche (17) di unione del corpo differenziale.

D **DAS ZU 45% SELBSTHEMMENDE DIFFERENTIAL ABMONTIEREN**
Schrauben (16) und Federscheiben (17), die den Differentialkörper verbinden, abnehmen.

ESP **DESMONTAJE DIFERENCIAL AUTOBLOQUEO AL 45%**
Remover los tornillos (16) y las arandelas elasticas (17) de union del cuerpo diferencial.

F **DEMONTAGE DU DIFFERENTIEL AUTOBLOQUANT A 45%**
Enlever les vis (16), les rondelles élastiques (17) d'union du corps différentiel.

f

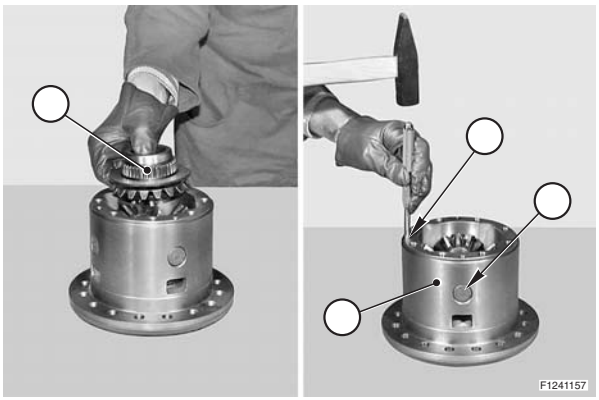
ITA Rimuovere il coperchio differenziale (18), gli eventuali spessori (19) e la frizione (20) completa dell'anello (21).
ATTENZIONE! 1 - Non scambiare di posizione i dischi componenti la frizione.
2 - Controllare che lo spessore totale della frizione sia superiore a 17,3 mm; se è inferiore sostituire ambedue le frizioni.

D Differentialdeckel (18) und evtl. Unterlegscheiben (19) und die Kupplung (20) mit dem Ring (21) abnehmen.
ACHTUNG! 1 - Die Position der Kupplungsscheiben nicht verwechseln.
2 - Die Gesamtstärke der Kupplung muß mehr als 17,3 mm betragen; sollte dies nicht der Fall sein, beide Kupplungen auswechseln.

ESP Remover la tapa diferencial (18), los eventuales espesores (19) y la fricion (20) completa del anillo (21).
ATENCION! 1 - No cambiar de posicion los discos componentes la fricion.
2 - Controlar que el espesor total de la fricion sea superior a 17,3 mm; si es inferior sobstituir las dos friciones.

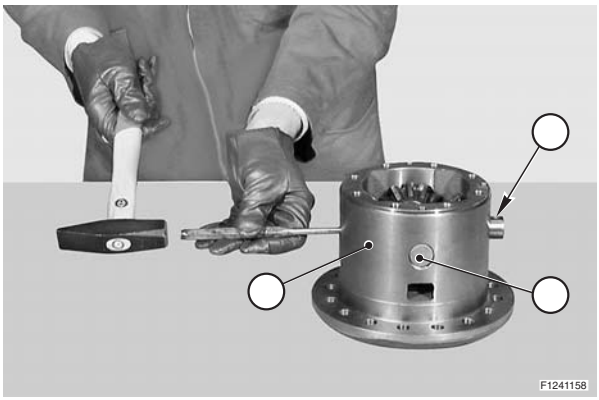
F Enlever le couvercle différentiel (18), les éventuelles cales (19) et la friction (20) complète d'anneau (21).
ATTENTION! 1 - Ne pas changer la position des disques composant la friction.
2 - Contrôler que la calage total de la friction soit supérieur à 17,3 mm; s'il est inférieur substituer les deux frictions.

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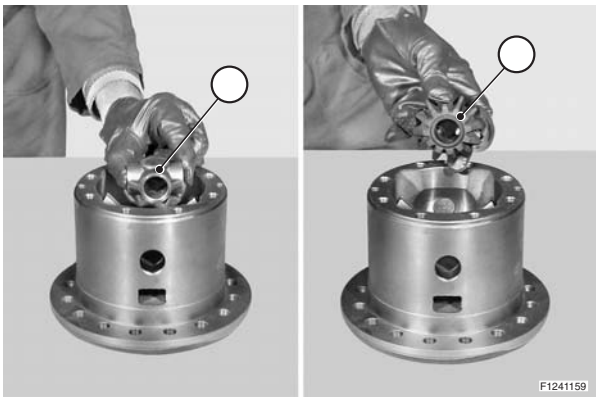
GB a

Remove the planetary gear (22).
Mark the 37 mm value on a pin-driver; using the same pin-driver, insert the spring pins (25) into the journals (23) and (24).
NOTE. The spring pins are centred in journals (23) and (24) when the countermark is lined up with the edge of the body of the differential unit (26).



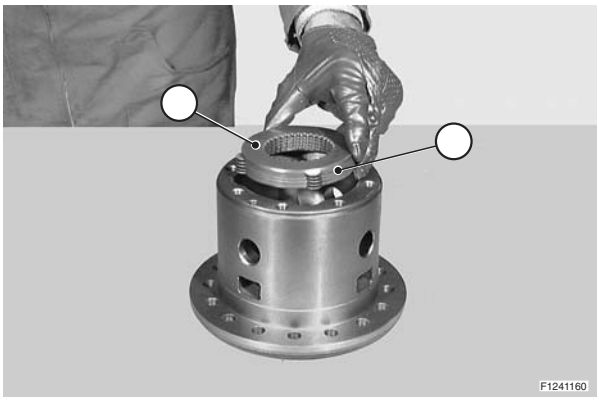
GB b

Remove the long planetary carrier journal (23) and the two short journals (24).



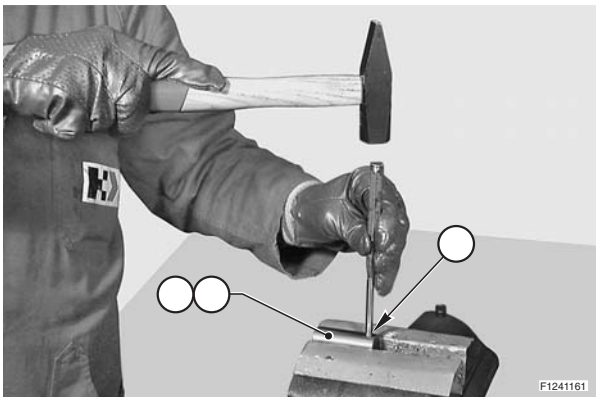
GB c

Extract the cross journal (27), the planet wheels (28) complete with shim washers (29) and the second planetary gear (22).



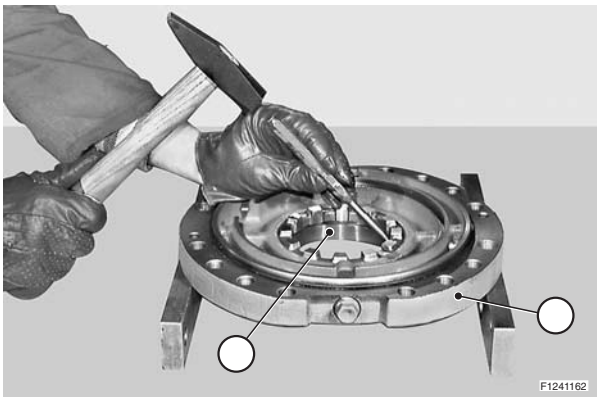
GB d

Remove the 2nd friction (20) complete with ring (21). Also remove any shims (19).
CAUTION! 1 - Do not change the position of the disks forming the friction.
2 - Check that the overall thickness of friction exceeds 17.3 mm; if lower, substitute both friction units.



GB e

Extract the spring pins (25) from journals (23) and (24).



GB f

Only if bearings are replaced.
Remove the thrust blocks of bearings (9) from the intermediate covers (1) and (2).

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a

ITA Rimuovere l'ingranaggio planetario (22).
Segnare su un cacciaspine un contrassegno a 37 mm; utilizzando lo stesso cacciaspine, inserire nei perni (23) e (24) le spine elastiche (25).
NOTA. Le spine elastiche sono centrate nei perni (23) e (24) quando il contrassegno arriva a filo del corpo differenziale (26).

D Das Planetengetriebe (20) abnehmen. An einem Dübel das Maß von 37 mm markieren; mit diesem Dübel die Federstifte (25) in die Stifte (23) und (24) einsetzen.
BEMERKUNG. Die Federstifte sind in den Stiften (23) und (24) zentriert, wenn das markierte Maß auf der Höhe des Differentialkörpers (26) liegt.

ESP Remover el engranaje planetario (22). Senalizar sobre un extractor de clavijas un contra-segno a 37 mm; utilizando el mismo extractor de clavijas, introducir en los pernos (23) y (24) las clavijas elasticas (25).
NOTA. Las clavijas elasticas son centradas en los pernos (23) y (24) cuando el contrasegno llega al hilo del cuerpo diferencial (26).

F Enlever l'engrenage planétaire (22). Marquer d'une estampille le chasse-clou à 37 mm; a l'aide de ce même chasse-clou, introduire dans les pivots (23) et (24) les goupilles élastiques (25).
REMARQUE. Les goupilles élastiques sont centrées dans les pivots (23) et (24) quand l'estampille atteint le bord du corps différentiel (26).

b

ITA Rimuovere il perno porta satelliti lungo (23) ed i due perni corti (24).

D Den langen Planetenradhalterstift (23) und die beiden kurzen Planetenradhalterstifte (24) entfernen.

ESP Remover la rotula porta satelites largo (23) y las dos rotulas cortas (24).

F Enlever le pivot porte-satellite long (23) et les deux pivots courts (24).

c

ITA Estrarre la crociera (27), i satelliti (28) completi delle rondelle di rasamento (29) ed il 2° ingranaggio planetario (22).

D Das Kreuz (27), die Planetengetriebe (28) samt Zwischenlegscheiben (29) und das 2. Planetengetriebe (30) abziehen.

ESP Sacar la cruceta (27), los satelites (28) completos de las arandelas de rasamiento (29) y el 2° engranaje planetario (22).

F Extraire le croisillon (27), les satellites (28) complet de rondelles de rasage (29), puis le 2° engrenage planétaire (22).

d

ITA Rimuovere la 2ª frizione (20) completa dell'anello (21). Rimuovere anche gli eventuali spessori (19).
ATTENZIONE! 1 - Non scambiare di posizione i dischi componenti la frizione.
2 - Controllare che lo spessore totale della frizione sia superiore a 17,3 mm; se è inferiore sostituire ambedue le frizioni.

D Die 2. Kupplung (20) mit Ring (21) abnehmen. Eventuelle Unterlegscheiben (19) auch entfernen.
ACHTUNG! 1 - Die Position der Kupplungsscheiben nicht verwechseln.
2 - Kontrollieren, ob die Gesamtstärke der Kupplung mehr als 17,3 mm beträgt; anderenfalls beide Kupplungen auswechseln.

ESP Remover la 2° fricion (30) completa del anillo (21). Remover tambien los eventuales espesores (19).
ATENCION! 1 - No cambiar de posicion los discos componentes la fricion.
2 - Controlar que el espesor total de la fricion sea superior a 17,3 mm; si es inferior sobstituir las dos friciones.

F Enlever la 2° friction (20) complète d'anneau (21). Enlever également les éventuelles cales (19).
ATTENTION! 1 - Ne pas changer la position des disques composant la friction.
2 - Contrôler que la calage total de la friction soit supérieur à 17,3 mm; s'il est inférieur substituer les deux frictions.

e

ITA Estrarre le spine elastiche (25) dai perni (23) e (24).

D Die Federstifte (25) von den Stiften (23) und (24) abziehen.

ESP Sacar las clavijas elasticas (25) de las rotulas (23) y (24).

F Extraire les goupilles élastiques (25) des pivots (23) et (24).

f

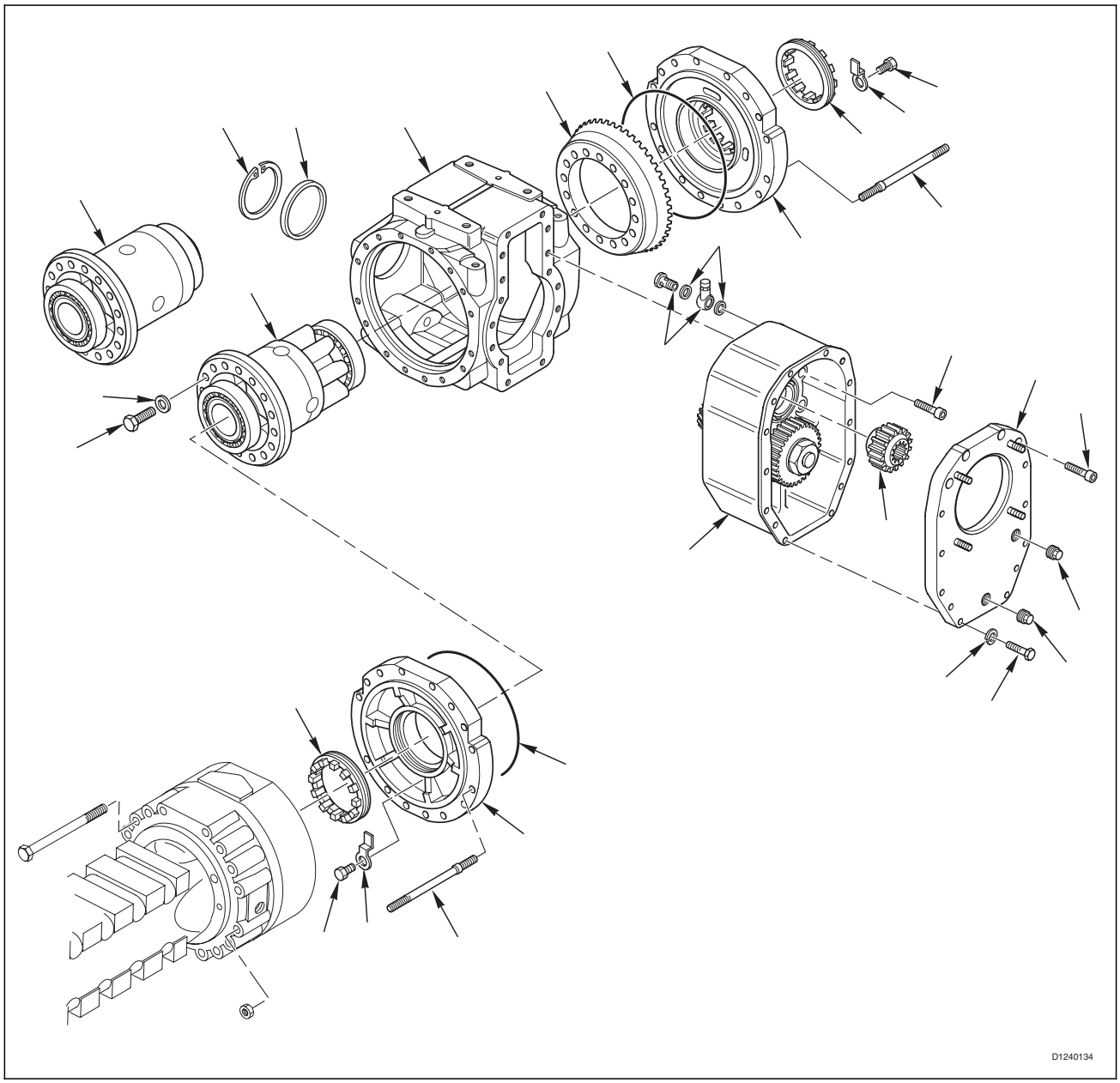
ITA **Solo se si sostituiscono i cuscinetti**
Rimuovere le ralle dei cuscinetti (9) dai coperchi intermedi (1) e (2).

D Nur falls die Lager ausgewechselt werden.
Die Scheiben von den Lagern (9) der Zwischendeckel (1) und (2) abnehmen.

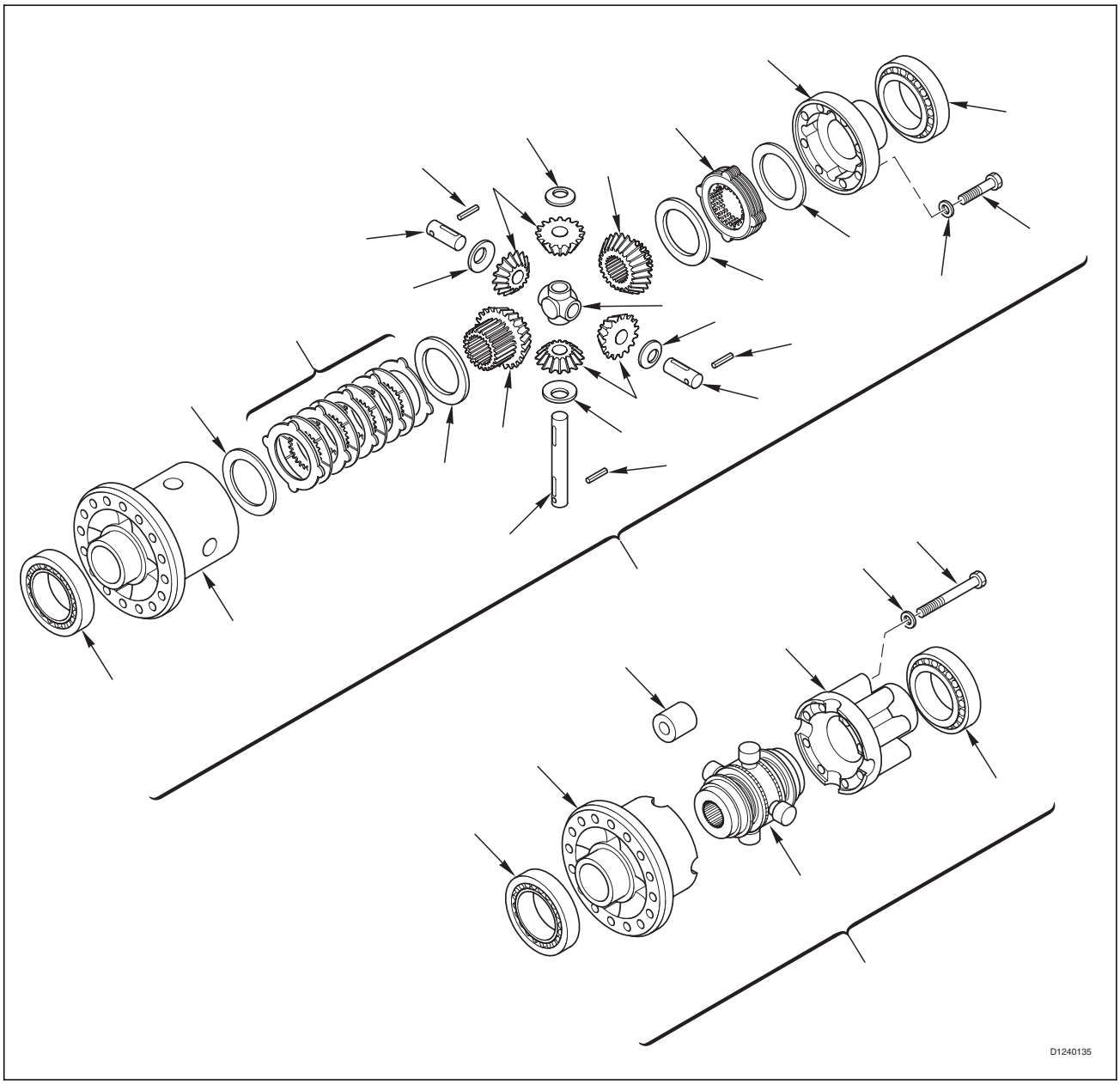
ESP Solo si se sobstituiyen los cojinetes
Remover las ranguas de los cojinetes (9) de las tapas intermedias (1) y (2).

F Uniquement en cas de substitution des paliers.
Enlever les crapaudines des paliers (9) des couvercles intermédiaires (1) et (2).

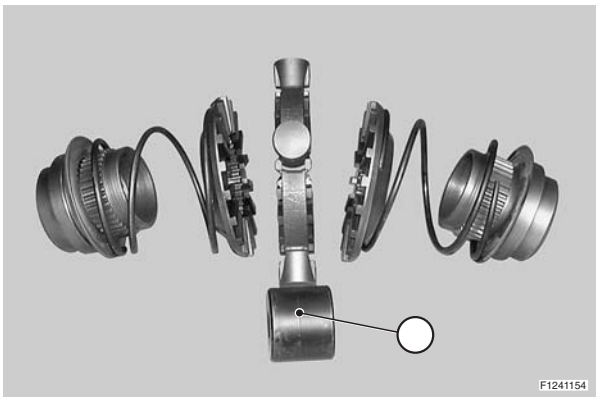
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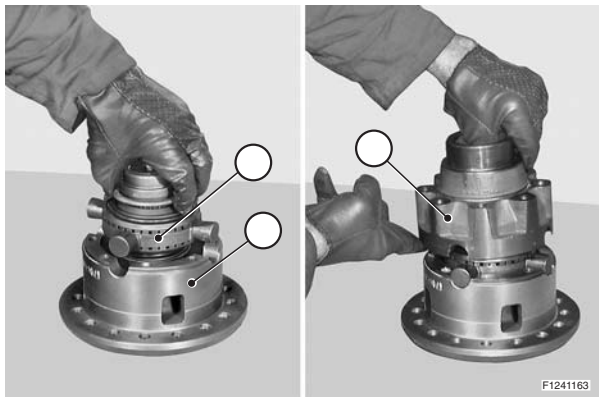


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GB a

ASSEMBLY OF THE NO-SPIN DIFFERENTIAL UNIT
Assemble the no-spin unit (13), inserting the distance piece (14) and using stay "**B**".



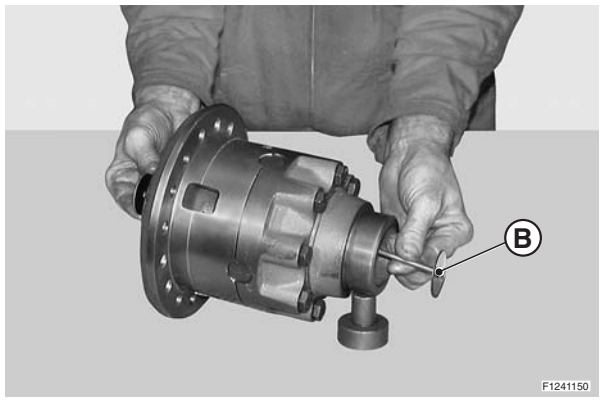
GB b

Fit the no-spin unit into the differential unit half box (15).
Centre the half box (12) and fasten.
CAUTION! Make sure the connection marks coincide.



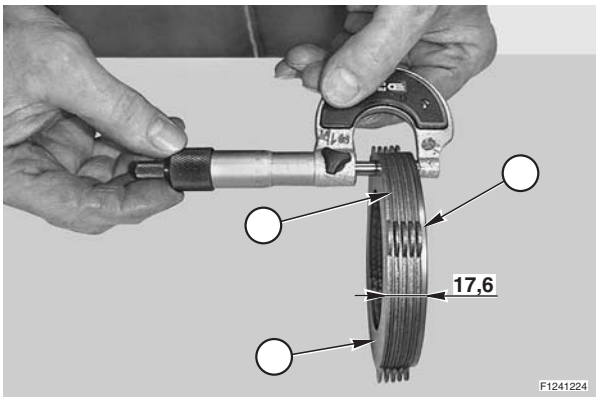
GB c

Fit the spring washers (11) onto the screws (10).
Coat the screws (10) with Loctite 270 and screw tight to form the differential box. Tighten screws using the criss-cross method and a torque of 86 – 89 Nm.



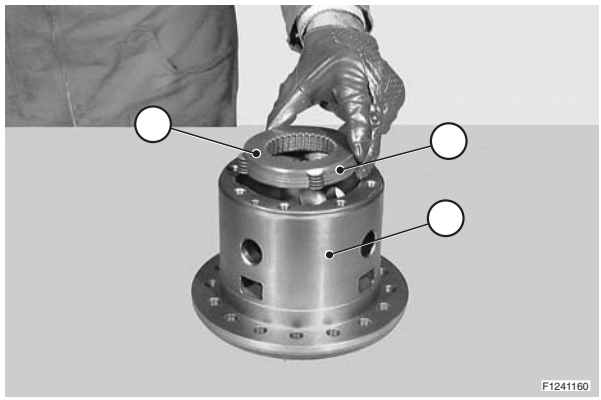
GB d

Remove stay "**B**".



GB e

ASSEMBLY OF THE 45% SELF-LOCKING DIFFERENTIAL UNIT
Using a depth gauge, check the shim of friction units complete with rings (21). If thickness is lower than 17.6 mm, add more shims (19).
CAUTION! Shims must be placed right behind the body of the differential unit (26).



GB f

Insert in the body of the differential unit (26) any required shims (19) and the friction (20) complete with ring (21).
CAUTION! Ring (21) must touch the planetary gear (22).

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a

ITA **ASSEMBLAGGIO DIFFERENZIALE NO-SPIN**
Assemblare il gruppo no-spin (13) inserendo il distanziale (14) ed utilizzando il tirante "**B**".

D **NO-SPIN DIFFERENTIAL ZUSAMMENBAUEN**
Das No-Spin (13) Aggregat zusammenbauen; dazu das Distanzstück (14) mit der Spannstange "**B**" einsetzen.

ESP **MONTAJE DIFERENCIAL NO-SPIN**
Asemblaje el grupo no-spin (13) introduciendo el diferencial (14) y utilizando el tirante "**B**".

F **ASSEMBLAGE DU DIFFERENTIEL NO-SPIN**
Assembler le groupe no-spin (13) en introduisant l'entretoise (14), puis à l'aide de la tringle "**B**".

b

ITA Montare il gruppo no-spin nella semiscatola differenziale (15).
Centrare la semiscatola (12) e mandarla in battuta.
ATTENZIONE! Controllare che le marcature di accoppiamento coincidano.

D Das No-Spin Aggregat in das halbe Differentialgehäuse (15) montieren.
Das halbe Gehäuse (12) zentrieren und bis zum Anschlag einsetzen.
ACHTUNG! Kontrollieren, ob die Kupplungsmarkierungen übereinstimmen.

ESP Montar el grupo no-spin en la semi-caja diferencial (15).
Centrar la semi-caja (12) y mandarla a tope.
ATENCION! Controlar que las marcaduras de acoplamiento coincidan.

F Monter le groupe no-spin dans la moitié du boîtier différentiel (15).
Centrer la moitié du boîtier (12) et l'envoyer en butée.
ATTENTION! Contrôler que les estampilles d'accouplement correspondent.

c

ITA Infilare sulle viti (10) le rondelle elastiche (11).
Spalmare le viti (10) con Loctite 270 ed avvitarle a fondo per comporre la scatola differenziale.
Serrare le viti con il metodo incrociato ad una coppia di serraggio di 86÷89 Nm.

D Federscheiben (11) in die Schrauben (10) einsetzen.
Die Schrauben (10) mit Loctite 270 schmieren und festziehen, um das Differentialgehäuse zusammenzubauen.
Die Schrauben im Kreuz und mit einem Anzugsmoment von 86÷89 Nm festziehen.

ESP Insertar sobre tornillos (10) las arandelas elasticas (11).
Pasar los tornillos (10) con Loctite 270 y atornillar hasta el fondo para componer la caja diferencial.
Apretar los tornillos con el metodo cruzado y un par de serraje de 86÷89 Nm.

F Passer sur les vis (10) les rondelles élastiques (11).
Enduire les vis (10) avec du Loctite 270, puis visser celles-ci à fond pour recomposer le boîtier différentiel.
Serrer les vis avec la méthode croisée à un couple de serrage de 86÷89 Nm.

d

ITA Rimuovere il tirante "**B**".

D Spannstange "**B**" abnehmen.

ESP Remover el tirante "**B**".

F Enlever la tringle "**B**".

e

ITA **ASSEMBLAGGIO DIFFERENZIALE AUTOBLOCCANTE AL 45%**
Controllare con un calibro di profondità lo spessore delle frizioni complete degli anelli (21). Se lo spessore è inferiore a 17,6 mm, aggiungere degli spessori (19).
ATTENZIONE! Gli spessori devono essere posizionati a ridosso del corpo differenziale (26).

D **ZU 45% SELBSTHEMMENDE DIFFERENTIAL ZUSAMMENBAUEN**
Mit Hilfe einer Tiefenlehre die Stärke der Kupplungen mit den Ringen (21) messen. Sollte das Maß weniger als 17,6 mm betragen, noch Unterlegscheiben (19) hinzufügen.
ACHTUNG! Die Unterlegscheiben müssen am Differentialkörper (26) anliegen.

ESP **MONTAJE DIFERENCIAL AUTO-BLOQUEO AL 45%**
Controlar con un calibro de profundidad el espesor de las friciones completas de los anillos (21). Si el espesor es inferior a 17,6 mm, sumar de los espesorees (19).
ATENCION! Los espesores deben de ser colocados detràs del cuerpo diferencial (26).

F **ASSEMBLAGE DU DIFFERENTIEL AUTOBLOQUANT A 45%**
Contrôler à l'aide d'un calibre de profondeur l'épaisseur des frictions complètes d'anneaux (21). Si le calage est inférieur à 17,6 mm, ajouter des cales (19).
ATTENTION! Les cales doivent être placées à l'abri du corps différentiel (226).

f

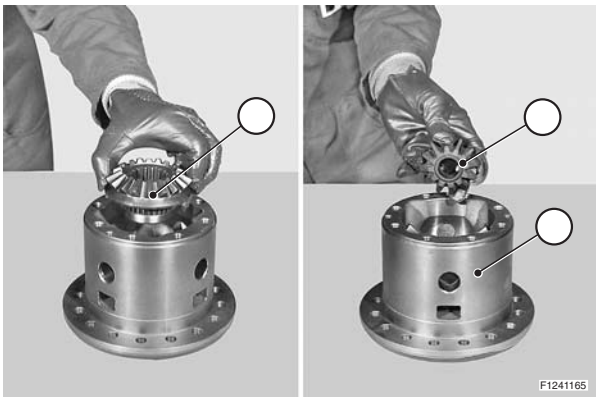
ITA Inserire nella corpo differenziale (26) gli eventuali spessori (19) e la frizione (20) completa dell'anello (21).
ATTENZIONE! L'anello (21) deve rimanere a contatto dell'ingranaggio planetario (22).

D In den Differentialkörper (26) eventuelle Unterlegscheiben (19) und die Kupplung (20) samt Ring (21) einsetzen.
ACHTUNG! Der Ring (21) muß am Planetengetriebe (22) anliegen.

ESP Introducir en el cuerpo diferencial (26) los eventuales espesores (19) y la fricion (20) completa del anillo (21).
ATENCION! El anillo (33) debe quedar a contacto del engranaje planetario (22).

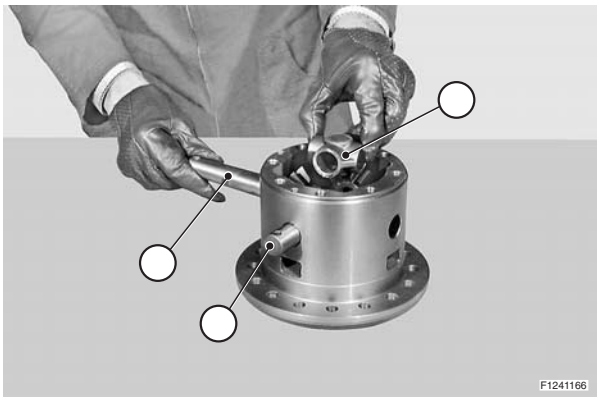
F Introduire le corps différentiel (26), les éventuelles cales (19) et la friction (20) complète d'anneau (21.
ATTENTION! L'anneau (21) doit rester au contact de l'engrenage planétaire (22).

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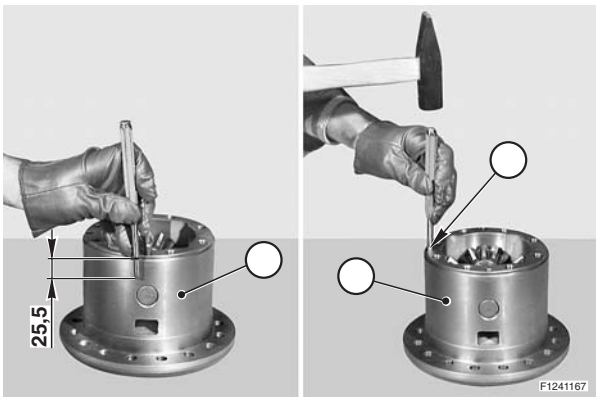
GB a

Install the planetary gear (22) and three of the planet wheels (28), complete with shim washers (29).
Hold the planet wheels (28) and relative washers (29) into position with pins (24).



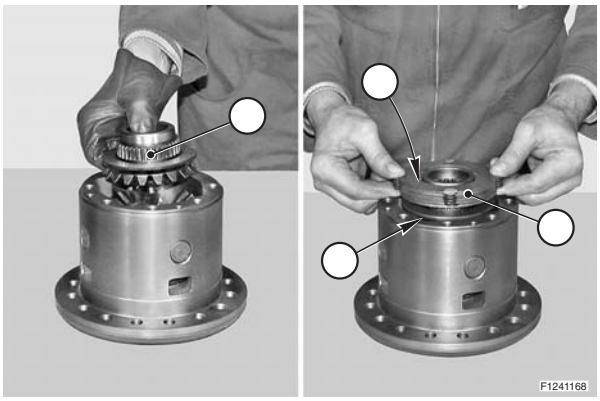
GB b

Install the cross journal (27), holding it into position with the long journal (23).
Before inserting journal (23) completely, install the last planet wheel (28) and the relative washer (29).



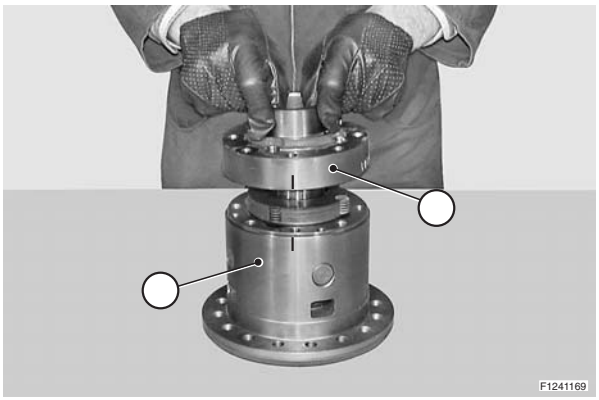
GB c

Countermark a point at 25.5 mm on a pin-driver; using the same pin-driver, engage the journals (23) and (24) with the spring pins (25).
NOTE. When the countermark is lined up with the edge of the body of the differential unit (26), the journals are engaged by half.



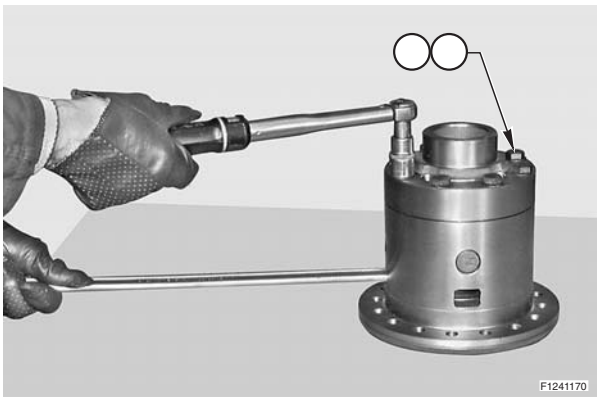
GB d

Install the second planetary gear (22) and the friction (20) complete with ring (21) and any shims required (19).
CAUTION! Ring (21) must be installed right behind the planetary gear (22) and the shims (19) right behind the differential cover (18).



GB e

Position the differential cover (18).
NOTE. Make sure that the assembly marks coincide.



GB f

Fit the spring washers (17) onto the screws (16).
Coat the screws (16) with Loctite 270 and screws tight.
Tighten screws using the criss-cross method and a torque of 135 – 138 Nm.

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a

ITA Montare l'ingranaggio planetario (22) e tre degli ingranaggi satelliti (28) completi di rondelle di rasamento (29).
Mantenere in posizione gli ingranaggi satelliti (28) e le relative rondelle (29) con i perni (24).

D Das Planetengetriebe (22) und drei der Planetengetriebe (28) samt Zwischenlegscheiben (29) montieren.
Die Planetengetriebe (28) und die Zwischenlegscheiben (29) mit den Stiften (24) in der Position festhalten.

ESP Montar el engranaje planetario (22) y tres de los engranajes satelites (28) completos de las arandelas de rasadura (29).
Mantener en posicion los engranajes satelites (28) y las relativas arandelas (29) con las rotulas (24).

F Monter l'engrenage planétaire (22) et trois des engrenages satellites (28) complets de rondelles de rasage (29).
Maintenir les engrenages satellites (28) et relatives rondelles (29) à leur place avec les pivots (24).

b

ITA Montare la crociera (27) e mantenerla in posizione con il perno lungo (23).
Prima di inserire completamente il perno (23), montare l'ultimo satellite (28) e la relativa rondella (29).

D Das Kreuz (27) montieren und in der Position mit einem langen Stift (23) festhalten.
Bevor der Stift (23) ganz eingesetzt wird, das letzte Planetengetriebe (28) und die Unterlegscheibe (29) montieren.

ESP Montar la cruceta (27) y mantenerla en posicion con la rotula larga (28).
Antes de insertar completamente la rotula (23), montar el ultimo satelite (28) y la relativa arandela (29).

F Monter le croisillon (27) et maintenir celui-ci à sa place à l'aide du pivot long (23).
Avant d'introduire entièrement le pivot (23), monter le dernier satellite (28) et sa rondelle (29).

c

ITA Segnare sul cacciaspine un contrassegno a 25,5 mm; utilizzando lo stesso cacciaspine impegnare i perni (23) e (24) con le spine elastiche (25).
NOTA. Le spine impegnano metà dei perni quando il contrassegno arriva a filo del corpo differenziale (26).

D An dem Dübel das Maß von 25,5 mm markieren; mit demselben Dübel die Stifte (23) und (24) mit den Federstiften (25) einsetzen.
BEMERKUNG. Die Stifte sind durch die Federstifte zur Hälfte eingesetzt, wenn die Markierung auf halber Höhe des Differentialkörpers (26) liegt.

ESP Senalar sobre el extractor de clavijas un contra-segno a 25,5 mm; utilizando el mismo extractor de clavijas empegnar las rotulas (23) y (24) con las clavijas elasticas (25).
NOTA! Las clavijas empegnan midad de las rotulas cuando el contra-segno llega al borde del cuerpo diferencial (26).

F Marquer d'une estampille le chasse-clou à 25,5 mm; a l'aide de ce même chasse-clou, engager les pivots (23) et (24) et les goupilles élastiques (25).
REMARQUE. Les goupilles arrivent à la moitié des pivots quand l'estampille atteint le bord du corps différentiel (26).

d

ITA Montare il secondo ingranaggio planetario (22) e la frizione (20) completa dell'anello (21) e degli eventuali spessori (19).
ATTENZIONE! L'anello (21) deve essere montato a ridosso dell'ingranaggio planetario (22) e gli eventuali spessori (19) a ridosso del coperchio differenziale (18).

D Das zweite Planetengetriebe (22) und die Kupplung (20) mit dem Ring (21) und eventuelle Unterlegscheiben (19) montieren.
ACHTUNG! Der Ring (21) muß nach der Montage am Planetengetriebe (22) und die eventuellen Unterlegscheiben (19) müssen am Differentialdeckel (18) anliegen.

ESP Montar el segundo engranaje planetario (22) y la fricion (20) completa del anillo (21) y de los eventuales espesores (19).
ATENCION! El anillo (21) debe deser montado detras del engranaje planetario (22) y los eventuales espesores (19) detras de la tapa diferencial (18).

F Monter le second engrenage planétaire (22), la friction (20) complète d'anneau (21) et des éventuelles cales (19).
ATTENTION! L'anneau (21) est à monter à l'abri de l'engrenage planétaire (22) et les éventuelles cales (19) à l'abri du couvercle différentiel (18).

e

ITA Posizionare il coperchio differenziale (18).
NOTA. Controllare che le marcature di montaggio coincidano.

D Den Differentialdeckel (18) positionieren.
BEMERKUNG. Kontrollieren, ob die Montagemarkierungen übereinstimmen.

ESP Colocar la tapa diferencial (18).
NOTA. Colocar que las marcaduras de montaje coincidan.

F Mettre le couvercle différentiel (18) en place.
REMARQUE. Contrôler que les estampilles de montage coïncident.

f

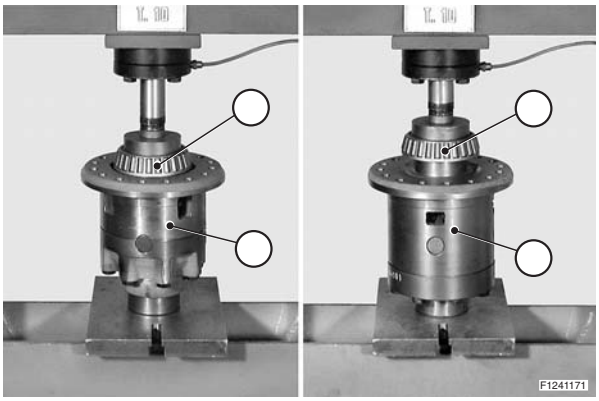
ITA Infilare sulle viti (16) le rondelle elastiche (17).
Spalmare le viti (16) con Loctite 270 ed avvitarle a fondo.
Serrare le viti con il metodo incrociato ad una coppia di serraggio di 135÷138 Nm.

D Auf die Schrauben (16) die Federscheiben (17) montieren.
Die Schrauben (16) mit Loctite 270 schmieren und festziehen. Die Schrauben im Kreuz mit einem Anzugsmoment von 135÷138 Nm festziehen.

ESP Introducir sobre los tornillos (16) las arandelas elasticas (17).
Pasar los tornillos (16) con Loctite 270 y atornillarlos a fondo.
Apretar los tornillos con el metodo cruzado a un par de serraje de 135÷138 Nm.

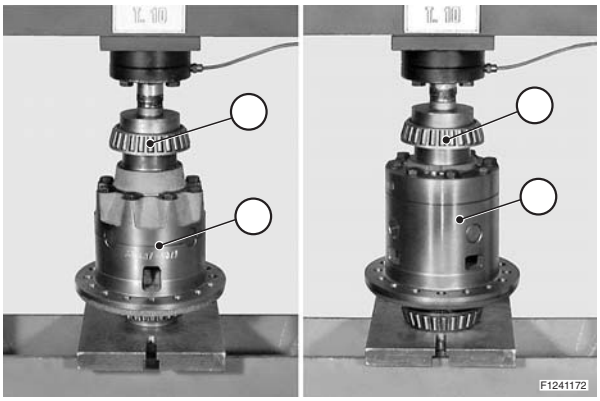
F Passer sur les vis (16) les rondelles élastiques (17).
Enduire les vis (16) avec du Loctite 270 et visser celles-ci à fond.
Serrer les vis avec la méthode croisée à un couple de serrage de 135÷138 Nm.

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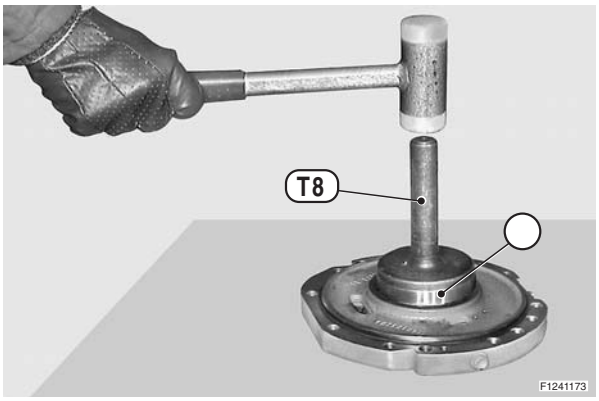
GB a

INSTALLATION OF THE DIFFERENTIAL UNIT
Position the differential unit (7) or (8) under a press and, using a driver with an adequate diameter, install the first bearing (9).



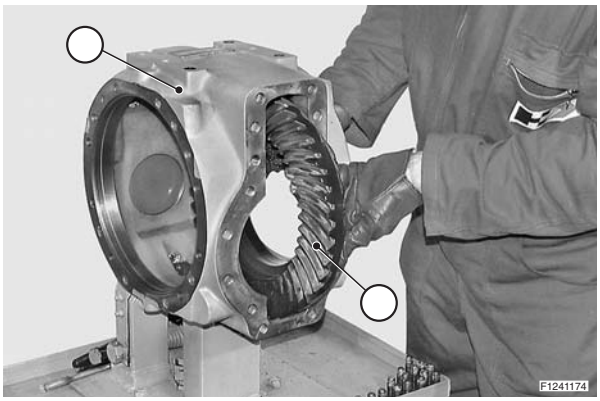
GB b

Turn the unit upside down and install the second bearing (9).
CAUTION! Pay particular attention; position a shim with adequate diameter in order to engage the internal ring of bearing (9) without engaging the cage.



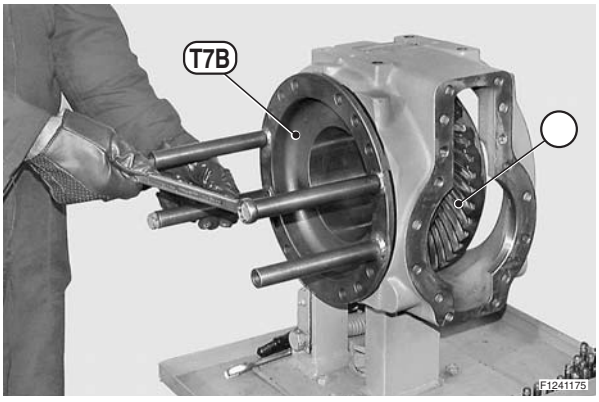
GB c

Only if bearings are replaced
Using tool **T8**, insert the thrust blocks of the bearings (9) into the intermediate covers (1) and (2).



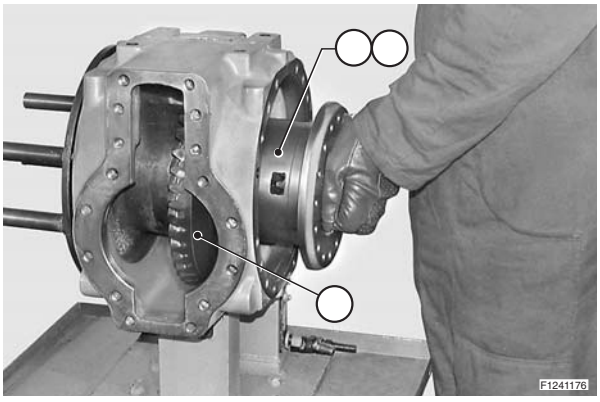
GB d

Position the crown wheel (4) in the main body (3).



GB e

Fit tool **T7B** on the crown wheel opposite side, holding it in position with two studs and two nuts.
NOTE. Engage the crown (4) onto tool **T7B**.



GB f

Install the differential unit (7) or (8), by fitting it into the hole of tool **T7B**.
Install the crown (4) onto the differential unit (7) or (8), and fasten it to the flange.
NOTE. Make sure the holes of the flange match those of the crown.

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a

ITA **INSTALLAZIONE DIFFERENZIALE**
Posizionare il differenziale (7) o (8) sotto una pressa ed utilizzando uno spintore di diametro adatto montare il primo cuscinetto (9).

D **DIFFERENTIAL ZUSAMMENBAUEN**
Das Differential (7) oder (8) unter eine Presse legen und mit einem geeigneten Dynamometer-Stößel das erste Lager (9) montieren.

ESP **INSTALACION DIFERENCIAL**
Colocar el diferencial (7) y (8) bajo una prensa y utilizando un empuje de diametro adapto montar el primer cojinete (9).

F **INSTALLATION DU DIFFERENTIEL**
Mettre le différentiel (7) ou (8) en place sous la presse, à l'aide d'un poussoir au diamètre adéquat, monter le premier palier (9).

b

ITA Capovolgere il gruppo e montare il secondo cuscinetto (9).
ATTENZIONE! Prestare molta attenzione e posizionare uno spessore di diametro adatto al fine di impegnare l'anello interno del cuscinetto (9) senza impegnare la gabbia.

D Das Aggregat wenden und das zweite Lager montieren (9).
ACHTUNG! Den Vorgang mit großer Sorgfalt durchführen und einen für die Stärke geeigneten Dynamometer verwenden, um den Ring des inneren Lagers (9) einzusetzen, ohne den Käfig einzuklemmen.

ESP Volcar el grupo y montar el segundo cojinete (9).
ATENCION! Tener mucho cuidado y colocar un espesor de diametro apto al fin de empegnar el anillo interno del cojinete (9) si empegnar la jaula.

F Faire basculer le groupe et monter le second palier (9).
ATTENTION! Faire très attention, mettre une cale au diamètre adéquat afin d'engager l'anneau interne du palier (9) sans y engager la cage.

c

ITA **Solo se si sostituiscono i cuscinetti**
Utilizzando l'attrezzo **T8** inserire le ralle dei cuscinetti (9) nei coperchi intermedi (1) e (2).

D Nur wenn die Lager ausgewechselt werden.
Mit dem Werkzeug T8 die Scheiben der Lager (9) in die Zwischendeckel (1) und (2) einsetzen.

ESP Solo si se sobstituyen los cojinetes
Utilizando la herramienta **T8** Introducir las ranguas de los cojinetes (9) en las tapa intermedias (1) y (2).

F **Uniquement en cas de substitution des paliers**
A l'aide de l'outil **T8**, introduire la crapaudine des paliers (9) dans les couvercles intermédiaires (1) et (2).

d

ITA Posizionare la corona (4) dentro il corpo centrale (3).

D Den Kranz (4) in den zentralen Körper (3) einsetzen.

ESP Colocar la corona (4) dentro del cuerpo central (3).

F Mettre la couronne (4) en place dans le corps central (3).

e

ITA Montare l'attrezzo **T7B** sul lato opposto corona, trattenendolo con due prigionieri e due dadi.
NOTA. Impegnare la corona (4) sull'attrezzo **T7B**.

D Das Werkzeug T7B auf der dem Kranz entgegengesetzten Seite montieren und mit zwei Stiftschrauben und zwei Muttern festhalten.
BEMERKUNG. Den Kranz (4) in das Werkzeug T7B einrasten.

ESP Montar la herramienta **T7B** sobre el lado opuesto corona, deteniendo con dos prigionieros y dos tuercas.
NOTA. Empegnar la corona (4) sobre la herramienta **T7B**.

F Monter l'outil **T7B** du côté opposé à la couronne, en le tenant à l'aide de deux prisonniers et de deux écrous.
REMARQUE. Engager la couronne (4) sur l'outil **T7B**.

f

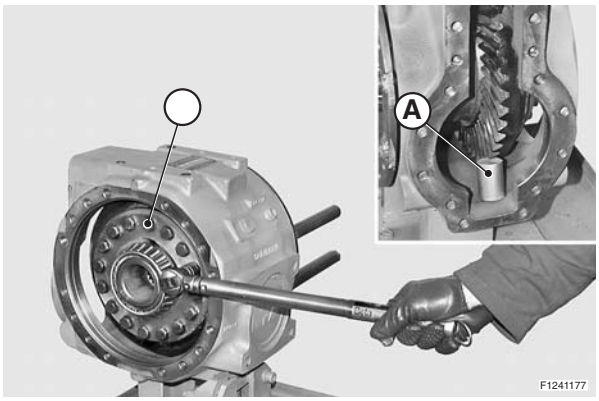
ITA Montare il gruppo differenziale (7) o (8) impegnandolo nel foro dell'attrezzo **T7B**.
Montare la corona (4) sul differenziale (7) o (8) mandandola in battuta sulla flangia.
NOTA. Far coincidere i fori della flangia con i fori della corona.

D Das Differentialaggregat (7) oder (8) montieren und im Loch des Werkzeuges T7B einrasten.
Den Kranz (4) auf das Differential (7) oder (8) montieren und bis zum Anschlag am Flansch einsetzen.
BEMERKUNG. Die Flanschlöcher müssen mit den Kranzlöchern übereinstimmen.

ESP Montar el grupo diferencial (7) o (8) empegnandolo en el agujero de la herramienta **T7B**.
Montar la corona (4) sobre el diferencial (7) y (8) mandandola a tope sobre la brida.
NOTA. Hacer coincidir los agujeros de la brida con los agujeros de la corona.

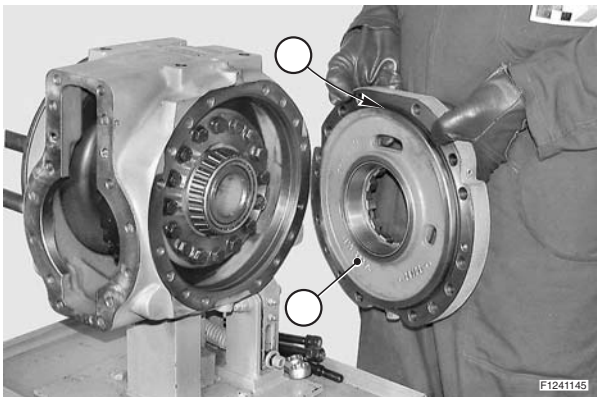
F Monter le groupe différentiel (7) ou (8) en l'engageant dans le trou de l'outil **T7B**.
Monter la couronne (4) sur le différentiel (7) ou (8) puis l'envoyer en butée sur la flasque.
REMARQUE. Faire correspondre les trous de la flasque avec les trous de la couronne.

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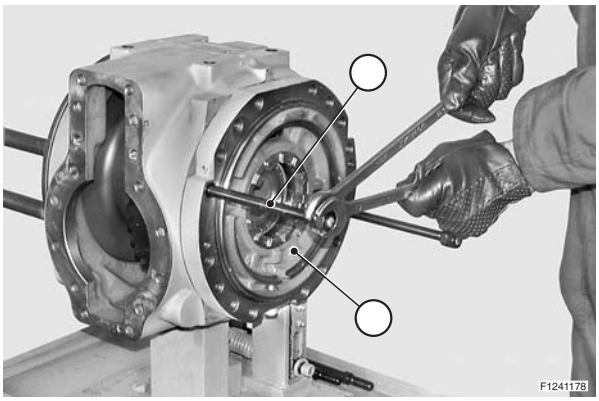
GB a

Fit spring washers (6) onto the screws (5).
Coat screws with Loctite 270 and screw them tight into the crown.
Position the stop block "**A**"; while holding the crown resting on the block, tighten the screws (5) to a torque of 135 – 138 Nm.
CAUTION! Tighten screws using the criss-cross method.



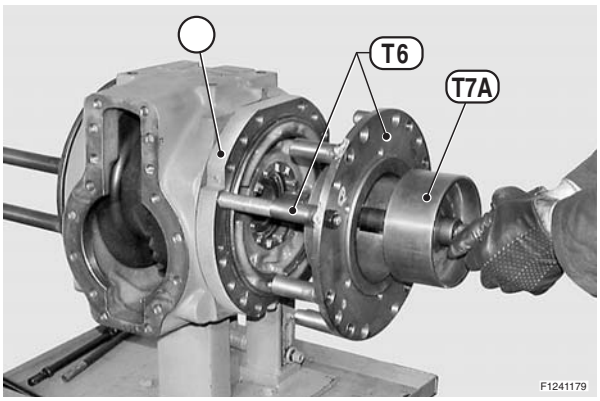
GB b

Check the condition and position of the O-ring (30); lubricate the seal and install the intermediate cover (2) on crown wheel side.



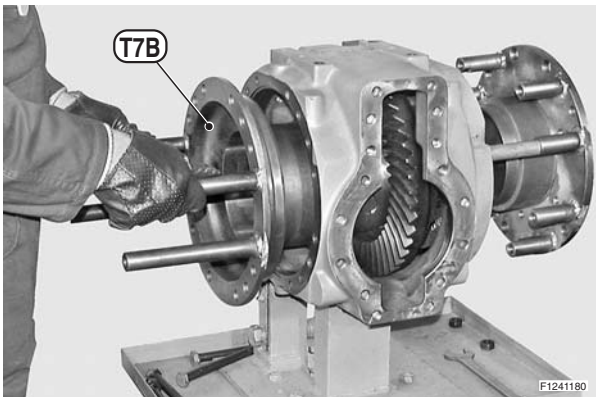
GB c

Lock the intermediate cover (2) with the journals (31) tightened to a torque of 129 – 143 Nm.



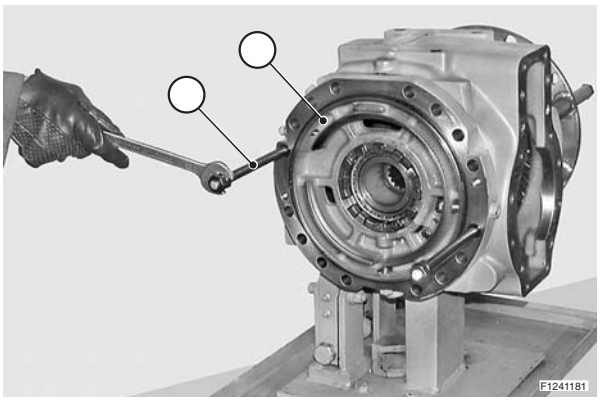
GB d

Install tool **T6** on the journals (31) on the crown wheel side, placing distance pieces and locking with two nuts. Insert differential centring and support tool **T7A** into tool **T6**.
NOTE. Make sure that the differential unit is tightly engaged in the intermediate cover (2).



GB e

Remove tool **T7B** on crown opposite side.



GB f

Check state and position of O-ring (30); lubricate the seal and fit the intermediate cover (1) on the crown opposite side.
Lock the intermediate cover (1) with journals (31) tightened to a torque of 129 – 143 Nm and remove tools **T6** and **T7A**.

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a

ITA Montare sulle viti (5) le rondelle elastiche (6). Spalmare le viti con Loctite 270 ed avvitarle a fondo nella corona. Posizionare il blocchetto "**A**" di contrasto; mantenendo in appoggio la corona sul blocchetto, serrare le viti (5) ad una coppia di 135÷138 Nm.
ATTENZIONE! Serrare le viti con il metodo incrociato.

D Auf die Schrauben (5) die Federscheiben (6) montieren. Die Schrauben mit Loctite 270 schmieren und in den Kranz schrauben. Den Block "**A**" positionieren; den Kranz am Block anliegen lassen und die Schrauben (5) mit einem Anzugsmoment von 135÷138 Nm festziehen.
ACHTUNG! Die Schrauben im Kreuz festziehen.

ESP Montar sobre los tornillos (5) las arandelas elasticas (6). Pasar los tornillos con Loctite 270 y atornillarlos a fondo en la corona. Colocar el bloque "**A**" de contraste; manteniendo en apoyo la corona sobre el bloque, apretar los tornillos (5) y un par de 135÷138 Nm.
ATENCION! Apretar los tornillos con el metodo cruzado.

F Monter les vis (5), les rondelles élastiques (6). Enduire les vis avec du Loctite 270, puis visser celles-ci à fond dans la couronne. Mettre le petit bloc "**A**" de contraste; en maintenant la couronne posée sur le petit bloc, serrer les vis (5) à un couple de 135÷138 Nm.
ATTENTION! Serrer les vis avec la méthode croisée.

b

ITA Controllare lo stato ed il posizionamento dell'anello OR (30); lubrificare la guarnizione e montare il coperchio intermedio (2) lato corona.

D Den Zustand und die Position des O-Ringes (30) kontrollieren; die Dichtung schmieren und den Zwischendeckel (2) an der Kranzseite montieren.

ESP Controlar el estado y la colocacion del anillo OR (30); lubrificar la guarnicion y montar la tapa intermedia (2) lado corona.

F Contrôler l'état et le positionnement de l'anneau O'Ring (30); lubrifier la garniture, puis monter le couvercle intermédiaire (2) du côté couronne.

c

ITA Bloccare il coperchio intermedio (2) con i prigionieri (31) serrati ad una coppia di 129÷143 Nm.

D Den Zwischendeckel (2) mit den Stiftschrauben (31) blockieren und mit einem Anzugsmoment von 129÷143 Nm festziehen.

ESP Bloquear la tapa intermedia(2) con los prigioneros (31) apretados a un par de 129÷143 Nm.

F Bloquer le couvercle intermédiaire (2) à l'aide des prisonniers (31) serrés à un couple de 129÷143 Nm.

d

ITA Montare l'attrezzo **T6** sui prigionieri (31) lato corona, interponendo i relativi distanziali e bloccandolo con due dadi. Inserire nell'attrezzo **T6** l'attrezzo **T7A** di centratura e sostegno del differenziale.
NOTA. Assicurarsi che il differenziale sia impegnato a fondo nel coperchio intermedio (2).

D Das Werkzeug **T6** an den Stiftschrauben (31) an der Kranzseite montieren und dabei Distanzstücke einsetzen und mit zwei Muttern befestigen. In das Werkzeug **T6** das Werkzeug **T7A** zur Zentrierung und Halterung des Differentials einsetzen.
BEMERKUNG. Sicherstellen, daß das Differential fest im Zwischendeckel (2) sitzt.

ESP Montar la herramienta **T6** sobre los prigioneros (31) lado corona, interponiendo de los distanciales y bloqueando con dos tuercas. Introducir en la herramienta **T6** la herramienta **T7A** de centradura y sosten del diferencial.
NOTA. Asegurarse que el diferencial sea empegnado a fondo en la tapa intermedia (2).

F Monter l'outil **T6** sur les prisonniers (31) côté couronne, en y intercalant des entretoises, puis bloquer celui-ci avec deux écrous. Introduire dans l'outil **T6**, l'outil **T7A** de centrage et de support du différentiel.
REMARQUE. S'assurer que le différentiel soit engagé à fond dans le couvercle intermédiaire (2).

e

ITA Rimuovere l'attrezzo **T7B** del lato opposto corona.

D Werkzeug **T7B** an der dem Kranz entgegengesetzten Seite abnehmen.

ESP Remover la herramienta **T7B** del lado opuesto corona.

F Enlever l'outil **T7B** du côté opposé à la couronne.

f

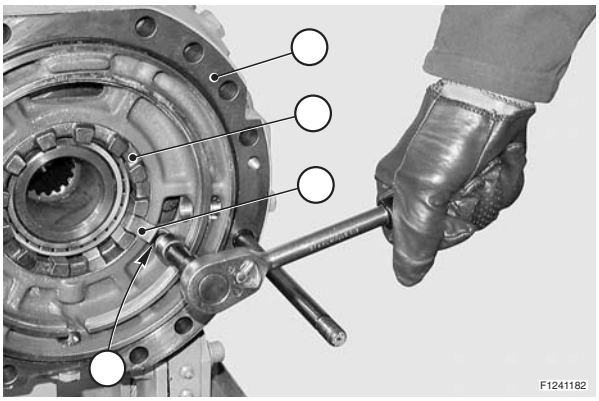
ITA Controllare lo stato ed il posizionamento dell'anello OR (30); lubrificare la guarnizione e montare il coperchio intermedio (1) lato opposto corona.
Fissare il coperchio intermedio (1) con i prigionieri (31) serrati ad una coppia di 129÷143 Nm e rimuovere gli attrezzi **T6** e **T7A**.

D Den Zustand und die Position des O-Ringes (30) kontrollieren; die Dichtung schmieren und den Zwischendeckel (1) an der dem Kranz entgegengesetzten Seite montieren. Den Zwischendeckel (1) mit den Stiftschrauben (31) und einem Anzugsmoment von 129÷143 Nm befestigen und die Werkzeuge **T6** und **T7A** entfernen.

ESP Controlar el estado y la colocacion del anillo OR (30); lubrificar la guarnicion y montar la tapa intermedia (1) lado opuesto corona.
Fijar la tapa intermedia (1) con los prigioneros (31) apretados a un par de 129÷143 Nm y remover las herramientas **T6** y **T7A**.

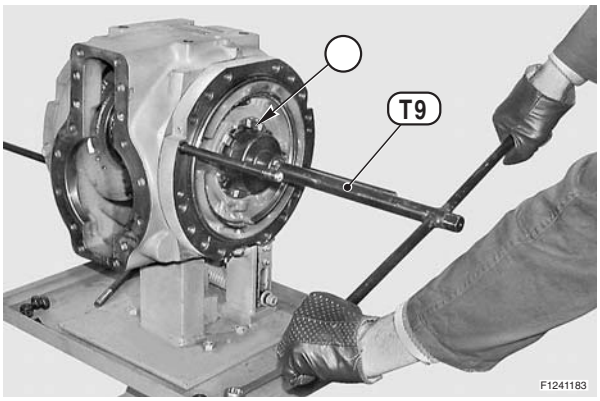
F Contrôler l'état et le positionnement de l'anneau O'Ring (30); lubrifier la garniture, puis monter le couvercle intermédiaire (1) du côté opposé à la couronne.
Fixer le couvercle intermédiaire (1) à l'aide des prisonniers (31) serrés à un couple de 129÷143 Nm, enlever les outils **T6** et **T7A**.

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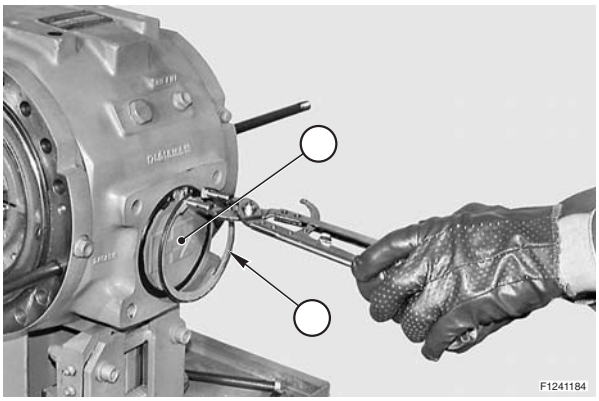
GB a

Remove the screws (33) and remove the safety tabs (34).



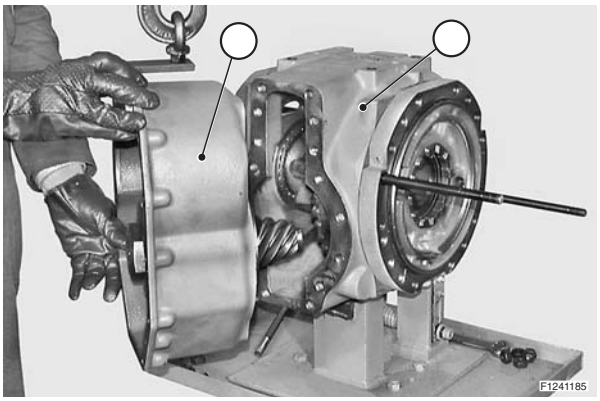
GB b

Using wrench **T9**, extract the adjustment ring nuts (32) and remove any residue of thread locking substances.
Screw ring nuts again after applying Loctite 242.



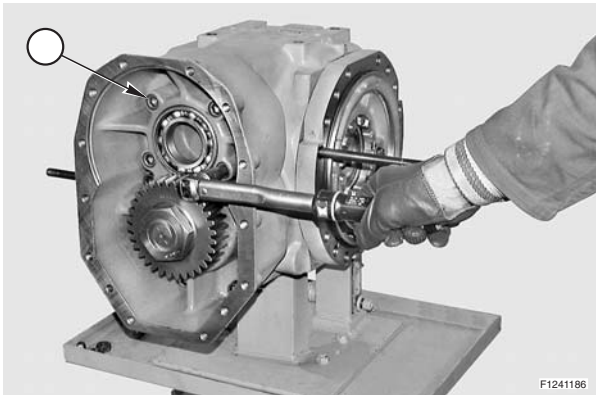
GB c

Remove the spring ring (35) and extract the cap (36) to allow checking of the clearance between pinion and crown to take place.



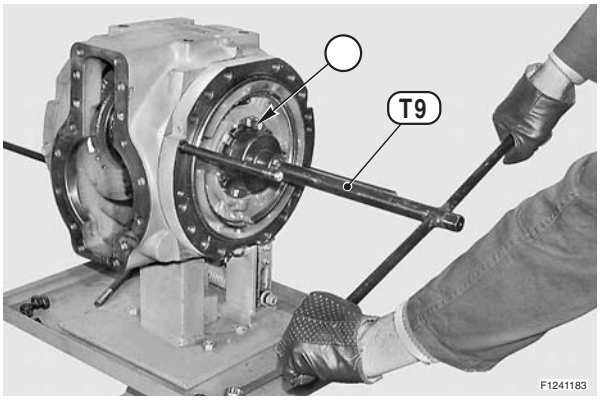
GB d

Coat the surface of the main body (3) with Loctite 510 and install the reduction gear (37) complete with pinion.
NOTE. Make sure that a continuous layer of sealant runs around the locking holes.



GB e

Coat screws (38) with Loctite 242 and screw tight. Tighten screws (38), using the criss-cross method and a tightening torque of 129 – 143 Nm.



GB f

Screw ring nut (32) on crown wheel side until clearance between pinion and crown equals zero, then unscrew by 1/4 turn approx.

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a

ITA Asportare le viti (33) e rimuovere le linguette di sicurezza (34).

D Die Schraube (33) abschrauben und den Sicherheitskeil (34) abnehmen.

ESP Sacar los tornillos (33) y remover les lengues de seguridad (34).

F Enlever le vis (33), puis déplacer le languettes de sécurité (34).

b

ITA Utilizzando la chiave **T9** rimuovere le ghiere (32) di registrazione ed asportare ogni traccia di frenafiletti. Riavvitare le ghiere dopo averle spalmate con Loctite 242.

D Mit einem Schlüssel **T9**, die Nutmuttern (32) zur Einstellung entfernen und jede alle überschüssigen Reste der Schraubensicherungslösung sorgfältig entfernen.
Nutmuttern mit Loctite 242 schmieren und wieder festschrauben.

ESP Utilizando la llave T9, remover las virolas (32) de registracion y sacar cada senal de frenaroscas. Restornillas las virolas despues de haberias pasadas con Loctite 242.

F A l'aide de la clé **T9**, enlever les écrous annulaires (32) de réglage et toute trace de l'agent d'arrêt de vis. Enduire les écrous annulaires avec Loctite 242 et visser.

c

ITA Asportare l'anello elastico (35) e rimuovere il tappo (36) per poter controllare il gioco tra pignone e corona.

D Den Kolbenring (35) abnehmen und den Stopfen (363) entfernen, um das Spiel zwischen Kegelrad und Kranz kontrollieren zu können.

ESP Sacar el anillo elastico (35) y remover la tapa (36) para poder controlar el juego entre pignon y corona.

F Enlever l'anneau élastique (35), enlever le bouchon (36) pour contrôler le jeu existant entre pignon et couronne.

d

ITA Spalmare la superficie del corpo centrale (3) con Loctite 510 ed installare il riduttore (37) completo di pignone.
NOTA. Assicurarsi che il sigillante crei un velo continuo attorno ai fori di fissaggio.

D Die Fläche des Zentralkörpers (3) mit Loctite 510 schmieren und den Reduzierer (37) samt Kegelrad installieren.
BEMERKUNG. Sicherstellen, daß die Dichtmasse einen gleichmäßigen Film um die Befestigungslöcher herum bildet.

ESP Pasar la superficie del cuerpo central (3) con Loctite 510 y instalar el reductor (37) completo de pignon.
NOTA. Asegurarse que el sigilante cree una pelicula continua alrededor a los agujeros de fisaje.

F Enduire la superficie du corps central (3) avec du Loctite 510, installer le réducteur (37) complet de pignon.
REMARQUE. S'assurer que la couche de colle entoure bien les trous de fixation.

e

ITA Spalmare le viti (38) con Loctite 242 e avvitarle a fondo. Serrare le viti (38) con il metodo incrociato ad una coppia di serraggio di 129÷143 Nm.

D Die Schrauben (38) mit Loctite 242 schmieren und festziehen. Die Schrauben (38) im Kreuz mit einem Anzugsmoment von 129÷143 Nm festziehen.

ESP Pasar los tornillos (38) con Loctite 242 y atornillas a fondo.
Apretar los tornillos (38) con el metodo cruzado y un par de torsion de 129÷143 Nm.

F Enduire les vis (38) avec du Loctite 242, puis visser celles-ci à fond.
Serrer les vis (38) avec la méthode croisée à un couple de serrage de 129÷143 Nm.

f

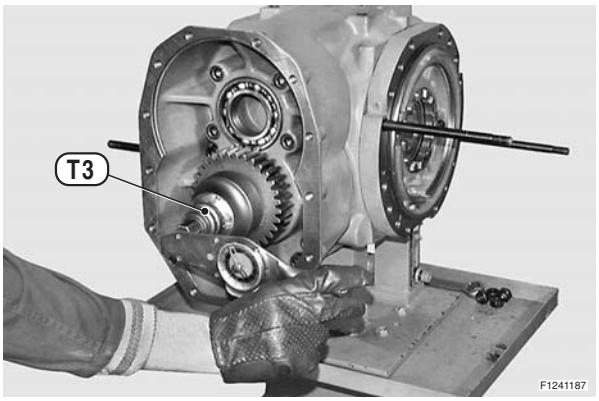
ITA Avvitare la ghiera (32) lato corona fino ad azzerare i giochi tra pignone e corona e poi svitare per circa 1/4 di giro.

D Nutmuttern (32) an der Kranzseite zuschrauben bis zwischen Rad und Kranz kein Spiel mehr übrig bleibt; danach um 1/4 Umdrehung aufschrauben.

ESP Atornillar las virolas (32) lado corona hasta acerar los juegos entre el pinion y corona y despues destornillar por cerca 1/4 de giro.

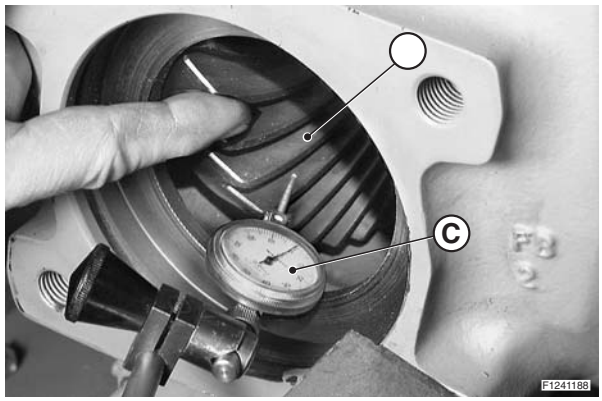
F Visser l'écrou annulaire (32) du côté couronne jusqu'à annuler le jeux entre pignon et couronne, puis dévisser 1/4 de tour.

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GB a

Allow pinion to turn a few times in both directions to allow bearings to set. Pre-load the bearings through the ring nut on crown opposite side to increase pinion torque up to a value of 140 – 210 Ncm checked by means of a torque meter.
CAUTION! If bearings are old, check static torque. If new, check continuous torque.



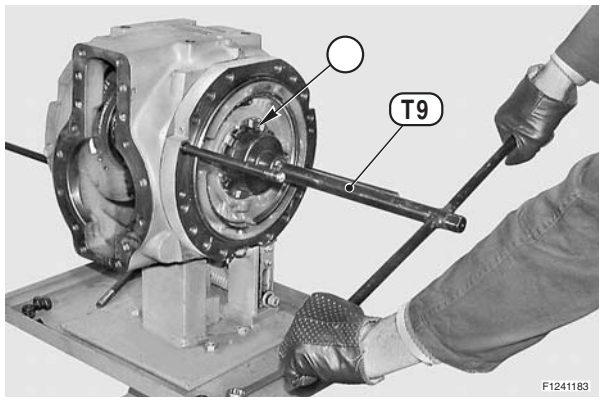
GB b

Introduce a comparator with rotary key "**C**" through the rear cap hole (43).
Position comparator on the centre of one of the crown teeth (4), pre-set it to 1 mm and reset it to zero.
Manually move the crown (4) in both directions to check the existing clearance between pinion and crown.

RATIO - RAPPORTO VERHÄLTNIS RAPORTE - RAPPORT	CLEARANCE - GIOCO - SPIEL JUEGO - JEU	
	MIN.	MAX.
6÷43	0,18	0,23

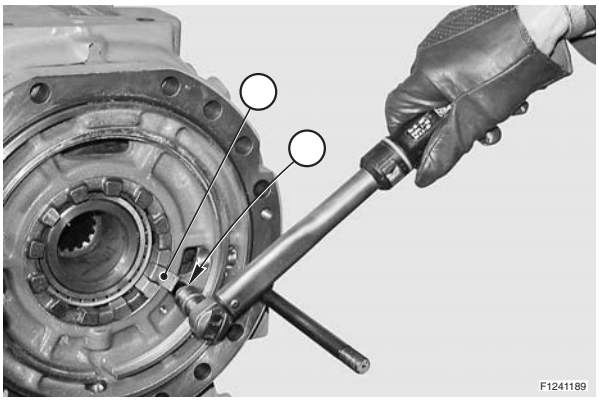
Difference between MIN and MAX clearance for whole circumference should not exceed 0.09 mm.
La differenza tra gioco MIN e MAX rilevata sull'intera circonferenza non deve superare il valore di 0,09 mm.
Der Unterschied zwischen dem MIN e MAX Spiel der gesamten Kreislinie darf den Wert von 0,09 mm nicht überschreiten.
La diferencia entre el juego Min y Max determinada sobre la entera circonferencia no debe de superar el valor de 0,09 mm.
La différence de jeu entre MIN et MAX relevée sur toute la circonférence ne doit pas aller au-delà de la valeur de 0,09 mm.

GB c



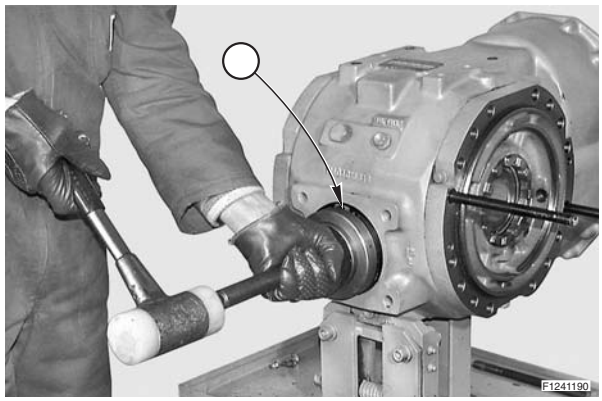
GB d

Mark the position of the ring nuts (32) in relation to the intermediate covers.
Using wrench **T9**, adjust clearance between pinion and crown by loosening one ring nut (32) and tightening the opposite proportionally.
Normal clearance: see table.



GB e

Install safety tabs (41) and lock them with screws (40).
Screws tightening torque: 10 – 11 Nm.



GB f

Using a driver, fit the cap (36) and position it in its seat with the snap ring (35).

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a

ITA Far compiere al pignone alcuni giri nei due sensi per assestare i cuscinetti. Precaricare i cuscinetti tramite la ghiera lato opposto corona, per incrementare la coppia di rotazione pignone fino a 140÷210 Ncm controllati con un torsiometro.
ATTENZIONE! Con cuscinetti usati, controllare la coppia di spunto; con cuscinetti nuovi, controllare la coppia di rotazione continua.

D Das Kegelrad um einige Umdrehungen in beide Richtungen drehen, um das Lager in die richtige Position zu bringen. Die Lager durch die Nutmutter an der dem Kranz entgegengesetzte Seite vorbelasten, um das Gegenmoment des Kegelrads bis auf 140÷210 Ncm zu erhöhen. Den Wert mit einem Drehungsmesser kontrollieren.
ACHTUNG! Bei gebrauchten Lagern, das Anlaufdrehmoment kontrollieren; bei neuen Lagern, das kontinuierliche Gegenmoment kontrollieren.

ESP Hacer efectuar al pignon algunos giros en los dos sentidos para ordenar los cojinetes. Precargar los cojinetes a traves de las virolas lado opuesto corona, para crecer el par de rotacion pignon hasta 140÷210 Ncm controlados con un torsiometro.
ATENCION! Con cojinetes usados, controlar el par de principio; con cojinetes nuevos, controlar el par de rotacion continua.

F Faire tourner le pignon plusieurs fois dans les deux sens pour ajuster les paliers. Précharger les paliers au moyen de l'écrou annulaire, du côté opposé à la couronne, pour augmenter le couple de rotation du pignon jusqu'à 140÷210 Ncm contrôlés par un torsiomètre.
ATTENTION! Avec des paliers usagés, contrôler le couple de pointe; avec des paliers neufs, contrôler le couple de rotation continu.

b

ITA Posizionare, attraverso il foro per il tappo posteriore (43), un comparatore a tasto orientabile "**C**".
Posizionarlo sul centro di un dente della corona (4), precaricarlo di circa 1 mm ed azzerarlo.
Muovere manualmente nei due sensi la corona (4) per controllare il gioco esistente tra pignone e corona.

D Durch das Loch des hinteren Stopfens (43) eine Meßuhr mit schwenkbarer Taste "**C**" einsetzen.
Die Meßuhr auf die Mitte eines Zahnes des Kranzes (4) positionieren und um 1mm vorbelasten; danach zurückstellen.
Von Hand in beide Richtungen den Kranz (4) bewegen, um das Spiel zwischen Kegelrad und Kranz zu kontrollieren.

ESP Colocar, atraves el agujero para la tapa posterior (43), un comparador a tecla orientable "**C**".
Colocarlo sobre el centro de un diente de la corona (4), precargarlo de 1 mm aprox y azerarlo.
Mover manualmente en los dos sentidos la corona (4) para controlar el juego esistente entre pignon y corona.

F Placer à travers le trou servant au bouchon arrière (43), un comparateur à touche orientable "**C**".
Positionner celui-ci au centre d'une des dents de la couronne (4), précharger celui-ci d'environ 1 mm et mettre à zéro.
Déplacer manuellement la couronne (4) dans les deux sens pour contrôler le jeu existant entre pignon et couronne.

d

ITA Contrassegnare la posizione delle ghiere (32) rispetto i coperchi intermedi.
Con la chiave **T9**, regolare il gioco tra pignone e corona allentando una ghiera (32) e serrando la ghiera opposta in egual misura.
Gioco normale: vedere tabella.

D Die Position der Nutmuttern (32) im Verhältnis zu den Zwischendeckeln markieren.
Mit dem Schlüßel **T9**, das Spiel zwischen Rad und Kranz einstellen, in dem eine Nutmutter (32) gelockert und die entgegengesetzte festgezogen wird.
Normales Spiel: siehe Tabelle.

ESP Contrasenalr la colocacion de las virolas (32) respecto a las tapaderas intermedias.
Con la llave **T9**, regular el juego entre el pignon y la corona aflojando una virola (32) y apretando la virola opuesta en la misma mesura.
Juego normal: vease el prospecto.

F Marquer la position de l'écrou annulaire (32) par rapport aux couvercles intermédiaires.
A l'aide de la clé **T9**, régler le jeu entre pignon et couronne en dévissant l'écrou annulaire (32) et en vissant l'écrou annulaire opposé de la même mesure.
Jeu normal: voir tableau.

e

ITA Montare le linguette di sicurezza (41) e fissarle con le viti (40).
Coppia di serraggio viti: 10÷11 Nm

D Den Sicherheitskeil (41) montieren und mit den Schrauben (40) befestigen.
Anzugsmoment der Schrauben: 10÷11 Nm

ESP Montar las lenguetas de seguridad (41) y fijarlas con los tornillos (40).
Par de serraje tornillos: 10÷11 Nm

F Monter les languettes de sécurité (41), fixer celles-ci à l'aide des vis (40).
Couple de serrage des vis: 10÷11 Nm.

f

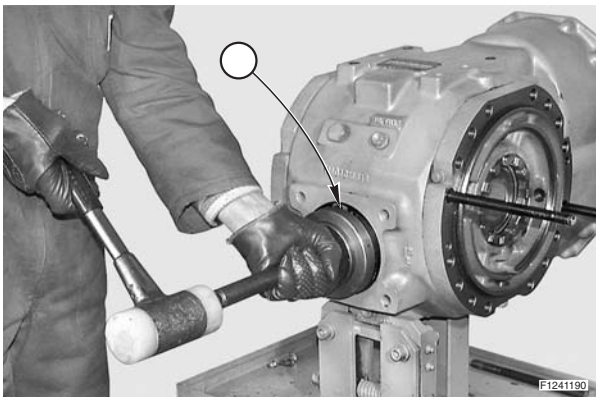
ITA Con uno spintore, montare il tappo (36) ed assicurarlo in sede con l'anello elastico (35).

D Mit einem Stößel den Stopfen (36) montieren und in seinem Sitz mit dem Kolbenring (35) befestigen.

ESP Con un empujador, montar la tapa (36) y asegurarlo en sed con el anillo elastico (36).

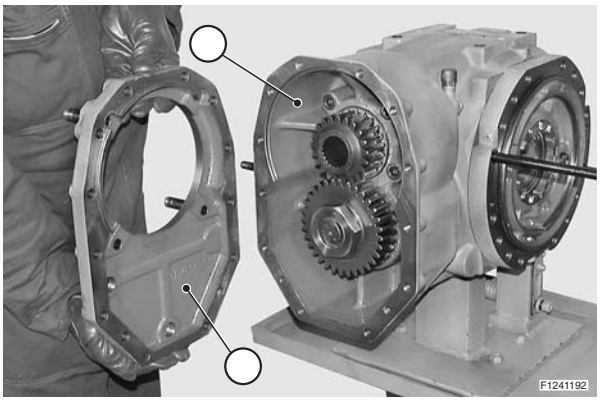
F A l'aide d'un poussoir, monter le bouchon (36), ajuster celui-ci dans son logement avec l'anneau élastique (35).

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GB a

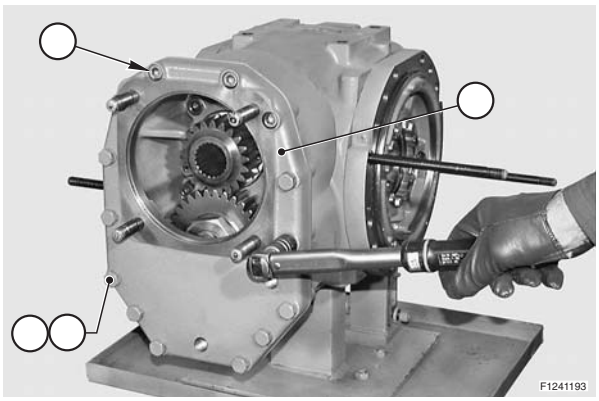
Using a driver and a plastic hammer, install the driving gear (39).



GB b

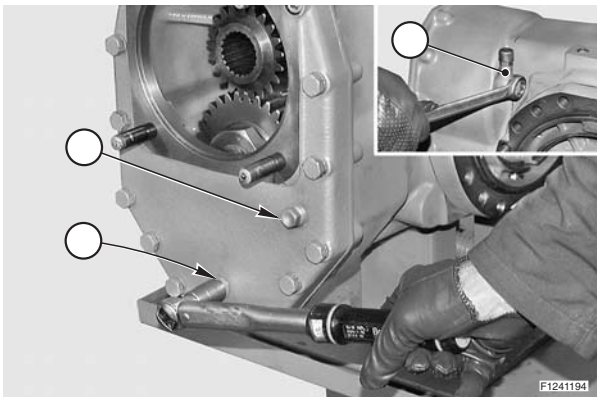
Apply Loctite 510 to the surface of the reduction gear body (37) and install the cover (40).

NOTE. Make sure that a continuous layer of sealant runs around the locking holes.



GB c

Lock the cover (40), using the snap washers (43) and the screws (42) and (41) adequately tightened to a torque of 82 – 91 Nm.
Tighten screws (42) and (41) with a tightening torque of 82 – 91 Nm.



GB d

Install the breath union piece (44) with the relative sealing washers (45) and plugs (47) and (46); tighten to a torque of 35 – 50 Nm.

GB e

Complete assembly of the axle by installing, in the following order, brake cylinders and complete arms.
For details, see «ASSEMBLING THE BRAKING UNITS».

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a

ITA Utilizzando uno spintore ed un mazzuolo in materiale plastico, montare l'ingranaggio conduttore (39).

D Mit einem Stößel und einem Gummihammer das Getriebe (39) montieren.

ESP Utilizando un empujador y un martillo en material plastico, montar el engranaje conductor (39).

F A l'aide d'un poussoir et d'un maillet en matière plastique, monter l'engrenage conducteur (39).

b

ITA Spalmare la superficie del corpo riduttore (37) con Loctite 510 ed installare il coperchio (40).
NOTA. Assicurarsi che il sigillante crei un velo continuo attorno ai fori di fissaggio.

D Die Fläche des Körpers des Reduzierers (37) mit Loctite 510 schmieren und den Deckel (40) installieren.
BEMERKUNG. Sicherstellen, daß die Dichtmasse einen gleichmäßigen Film um die Befestigungslöcher herum bildet.

ESP Pasar la superficie del cuerpo reductor (37) con Loctite 510 y instalar la tapa (40).
NOTA. Asegurarse que el sigilante cree una pelicula continua alrededor de los agujeros de fisaje.

F Enduire la superficie du corps réducteur (37) avec du Loctite 510, installer le couvercle (40).
REMARQUE. S'assurer que la couche de colle entoure bien les trous de fixation.

c

ITA Bloccare il coperchio (40) utilizzando le rondelle elastiche (43) e le viti (42) e (41) serrate con una coppia di 82÷91 Nm.

D Den Deckel (40) mit den Federscheiben (42) und (41) und den Schrauben (42) und (41) bei einem Anzugsmoment von 82÷91 Nm blockieren.

ESP Bloquear la tapa (40) utilizando las arandelas elasticas (43) y los tornillos (42) y (41) apretadas con un par de 82÷91 Nm.

F Bloquer le couvercle (40) à l'aide des rondelles élastiques (43) et des vis (42) et (41) serrées à un couple de 82÷91 Nm.

d

ITA Montare il raccordo di sfiato (44) con le relative rosette di tenuta (45) ed i tappi (47) e (46); serrarli con una coppia di 35÷50 Nm.

D Das abgezogene Verbindungsstück (44) mit den Dichtscheiben (45) und den Stopfen (47) und (46) montieren; Anzugsmoment 35÷50 Nm.

ESP Montar el recorde de escape (441) con las relativas rosas de tenida (45) y las tapas (47) y (46); apretarlos con un par de 35÷50 Nm.

F Monter le raccord d'évent (44), les relatives rosettes d'étanchéité (45) et les bouchons (47) et (46), serrer ceux-ci à un couple de 35÷50 Nm.

e

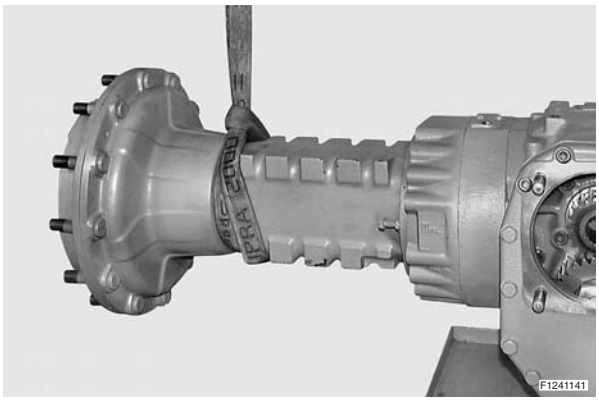
ITA Completare l'assemblaggio dell'assale installando nell'ordine i cilindri freni ed i bracci completi.
Per i dettagli, vedere «ASSEMBLAGGIO GRUPPI FRENO».

D Die Achse fertig zusammenbauen und der Reihe nach die Bremszylinder und die kompletten Arme installieren.
Siehe «ZUSAMMENBAU DER BREMSAGGREGATE».

ESP Completar el asemblaje del axial instalando en el orden los cilindros frenos y los ejes completos.
Para los detalles, vease «ASEMBLAJE GRUPOS FRENOS».

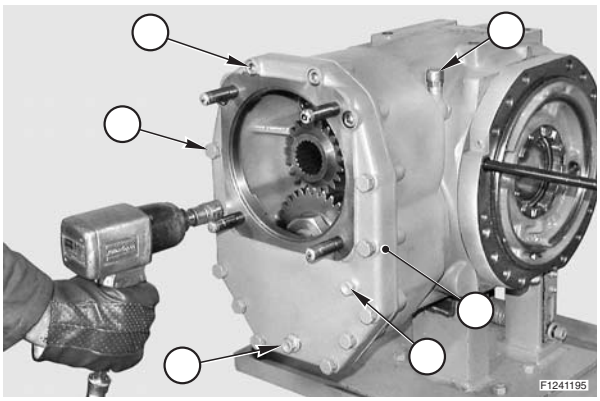
F Achever l'assemblage de l'essieu en y installant dans l'ordre les cylindres freins et les bras complets.
Pour de plus amples détails voir "ASSEMBLAGE DU GROUPE FREIN".

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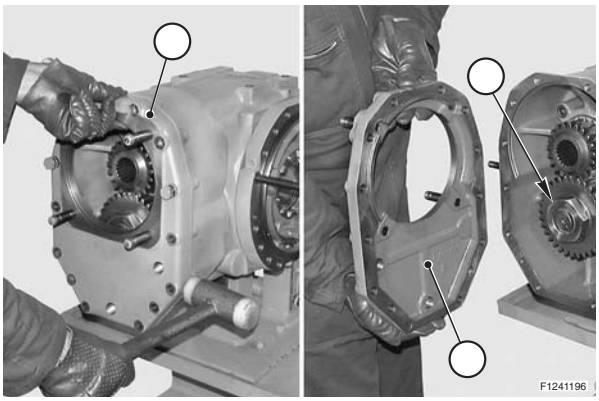
GB a

Remove the whole arms and the differential unit.
For details, see «CHECKING WEAR AND REPLACING THE BRAKING DISKS» and «REMOVAL OF DIFFERENTIAL UNIT».



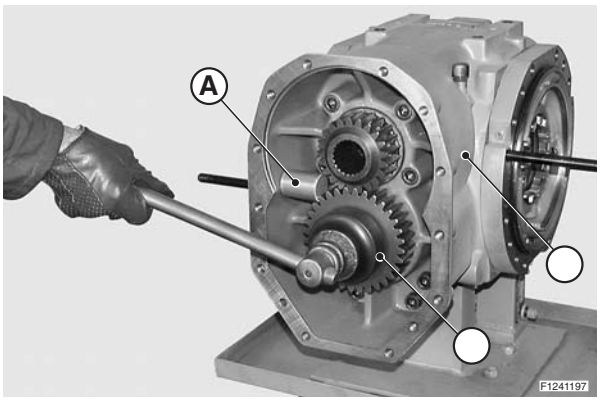
GB b

Loosen and remove screws (1) and (2) and the washers (3) locking the cover (4), the plugs (5) and (6) for oil fill and oil drain, and the bleed union piece (7).
NOTE. Leave two screws (2) in position for safety.



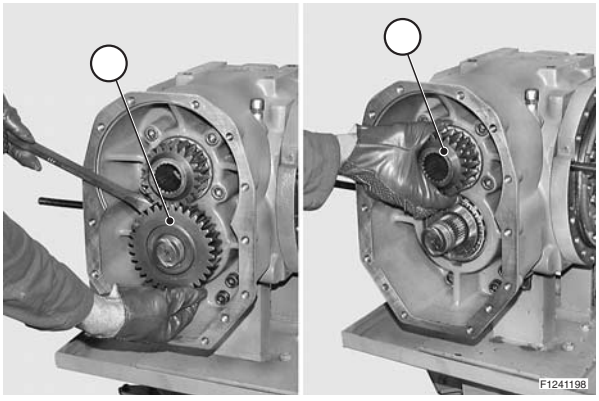
GB c

Using a plastic hammer, remove the cover (4) and move it away.
NOTE. If operations on the differential unit need to be performed, remove the complete reduction gear unit (screws (9) and (10)).



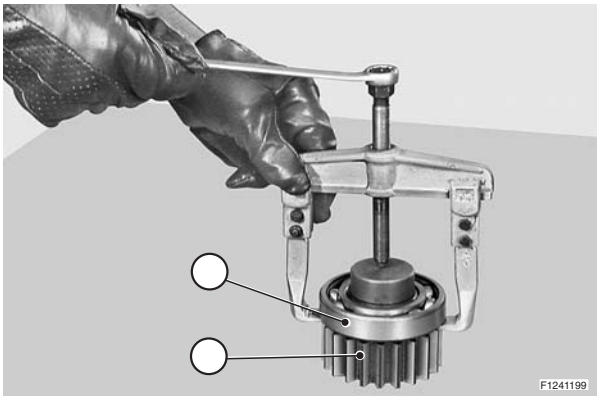
GB d

Place a block of tender material (aluminium, etc.) between the reduction body (11) and the gear (12) of the pinion.
Loosen and remove the pinion locking nut (13).



GB e

Remove the gear of the pinion (12) and the driving gear (14) complete with bearing (15).
NOTE. To remove the gear (14), use a lever.



GB f

Take the driving gear to pieces (14), extracting the bearing (15).
NOTE. If necessary, use an extractor.

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a

ITA Rimuovere i bracci completi ed il differenziale. Per i dettagli, vedere «CONTROLLO USURA E SOSTITUZIONE DISCHI FRENO» e «RIMOZIONE GRUPPO DIFFERENZIALE».

D Die kompletten Arme und das Differential abnehmen. Siehe «VERSCHLEISS KONTROLLIEREN UND BREMSSCHEIBEN AUSWECHSELN» und «DIFFERENTIALAGGREGAT ABNEHMEN».

ESP Remover los ejes completos y el duferencial. Para los detalles, vease «CONTROL DESGASTE Y SOBSTITUCION DISCOS FRENOS» y «REMOCION GRUPO DIFERENCIAL».

F Enlever les bras complets et le différentiel. Pour de plus amples détails, voir "CONTROLE USURE ET SUBSTITUTION DES DISQUES FREIN" et "DEPOSE DU GROUPE DIFFERENTIEL".

b

ITA Allentare ed asportare le viti (1) e (2) e le rondelle (3) di ritegno coperchio (4), i tappi (5) e (6) di carico e scarico olio ed il raccordo di sfiato (7).

NOTA. Lasciare in posizione per sicurezza due viti (2) contrapposte.

D Schrauben (1) und (2) abschrauben und die Unterlegscheiben (3) zur Halterung des Deckels (4), die Öleinfüll- und Ablaßstopfen (5) und (6) sowie das Endlüftungsstück (7) abnehmen.

BEMERKUNG. Die entgegengesetzten Schrauben (2) zur Sicherheit zurück lassen.

ESP Aflojar y sacar los tornillos (1) y (2) y las arandelas (3) de retencion tapa (4), los tapones (5) y (6) de carga y descarga aceite y el recorde de escape (7).

NOTA. Dejar en posicion de seguridad dos tornillos (2) contrapuestas.

F Desserrer et enlever les vis (1) et (2), les rondelles (3) de fixation du couvercle (4), les bouchons (5) et (6) de remplissage et vidange d'huile et le raccord d'évent (7).

REMARQUE. Pour plus de sûreté, garder deux vis (2) superposées.

c

ITA Utilizzando un mazzuolo in materiale plastico, rimuovere il coperchio (4) ed asportarlo.

NOTA. Se si deve intervenire sul gruppo differenziale, rimuovere il gruppo riduttore completo (viti (9) e (10)).

D Mit einem Gummihammer den Deckel (4) ausrasten und abnehmen.

BEMERKUNG. Soll am Differentialaggregat gearbeitet werden, das komplette Reduzieraggregat abnehmen (Schrauben (9) und (10)).

ESP Utilizando un martillo en material plastico, remover la tapa (4) y sacarla.

NOTA. Si se debe intervenir sobre el grupo diferencial, remover el grupo reductor completo (tornillos (9) y (10)).

F A l'aide d'un maillet en matière plastique, déplacer le couvercle (4) et puis l'enlever.

REMARQUE. S'il faut intervenir sur le groupe différentiel, enlever le groupe réducteur complet (vis (9) et (10)).

d

ITA Sistemare tra il corpo riduttore (11) e l'ingranaggio (12) del pignone un blocchetto "**A**" di materiale tenero (alluminio, ecc.).

Allentare ed asportare il dado (13) di ritegno pignone.

D Zwischen dem Reduziererkörper (11) und dem Getriebe (12) des Kegelrads einen Block aus weichen Material einsetzen (Aluminium usw.)

Mutter (13) zur Halterung des Kegelrads abschrauben.

ESP Colocar entre el cuerpo reductor (11) y el engranaje (12) del pinon un bloquete "**A**" de material tierno (aluminio, ect.).

Aflojar y sacar la tuerca (13) de retencion pinon.

F Ajuster, entre le corps réducteur (11) et l'engrenage (12) du pignon, un petit bloc "**A**" en matériel léger (aluminium etc.).

Desserrer et enlever l'écrou (13) de fixation pignon.

e

ITA Rimuovere l'ingranaggio del pignone (12) e l'ingranaggio conduttore (14) completo di cuscinetto (15).

NOTA. Per rimuovere l'ingranaggio (14), utilizzare una leva.

D Das Getriebe (12) des Kegelrads und das Getriebe (14) samt Lager (15) entfernen.

BEMERKUNG. Um das Getriebe (14) abnehmen zu können, einen Hebel verwenden.

ESP Remover el engranaje del pinon (12) y el engranaje conductor (14) completo de cojinete (15).

NOTA. Para remover el engranaje (14), utilizar una palanca.

F Déplacer l'engrenage du pignon (12) et l'engrenage conducteur (14) complet de palier (15).

REMARQUE. Pour déplacer l'engrenage (14), utiliser un levier.

f

ITA Scomporre l'ingranaggio conduttore (14) estraendo il cuscinetto (15).

NOTA. Se necessario, usare un estrattore.

D Das Getriebe (14) zerlegen; dazu das Lager (15) abziehen.

BEMERKUNG. Wenn nötig, einen Abzieher verwenden.

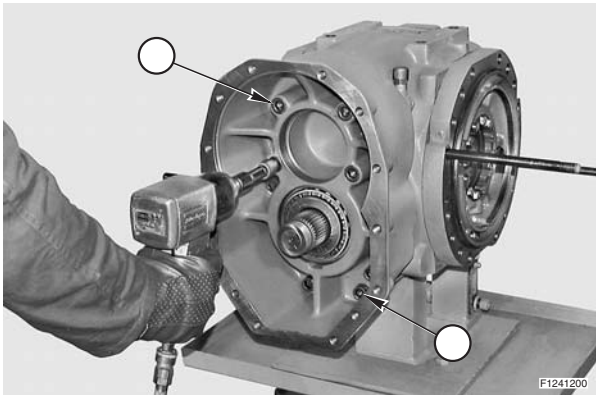
ESP Descomponer el engranaje conductor (14) sacando el cojinete (15).

NOTA. Si necesario, usar un extractor.

F Décomposer l'engrenage conducteur (14) en dégageant le palier (15).

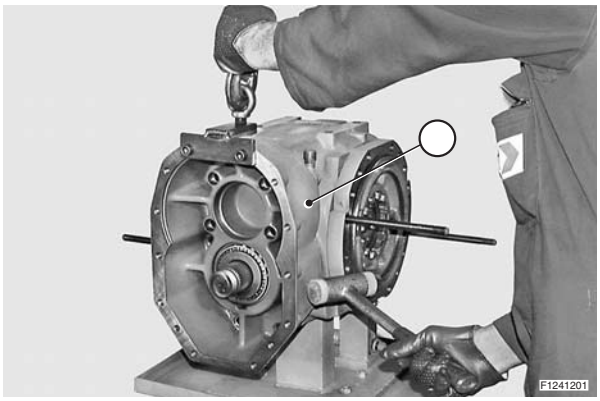
REMARQUE. Si besoin, utiliser un extracteur.

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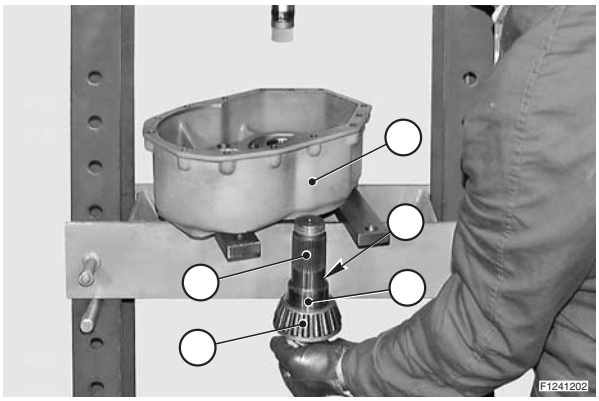
GB a

Loosen all screws (9) and (10) and remove the upper check screws (9) of the reduction gear body.
NOTE. Leave the two lower screws (10) in position for safety.



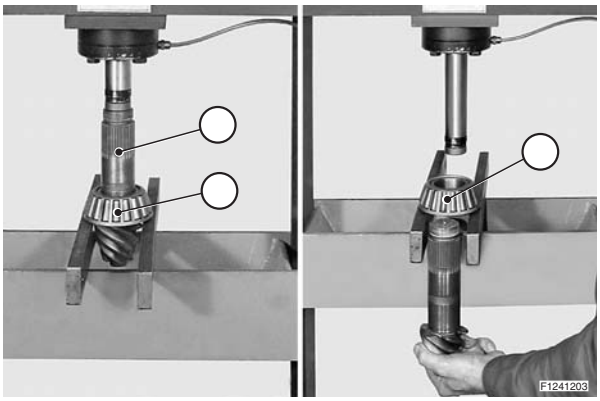
GB b

Connect the whole reduction gear body (11) to a hoist and remove the screws (10) previously left in place for safety.
Using a plastic hammer, pull away the whole reduction gear body (11).



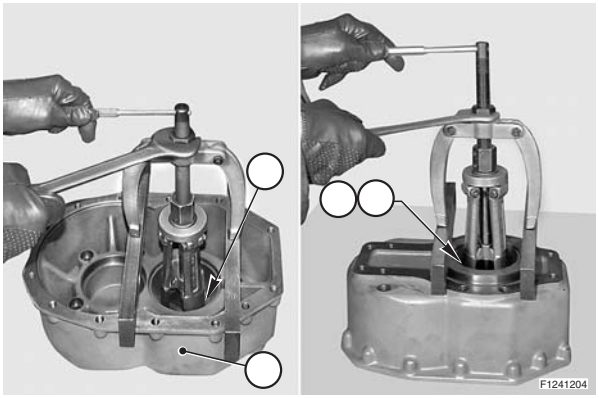
GB c

Position the reduction gear body (11) under a press and, using a driver, extract the pinion (16) complete with internal bearing (17), shims (19) and distance piece (20).



GB d

Remove distance piece (20) and shims (19) from the pinion(16).
Position the pinion under a press and remove the internal bearing (17).



GB e

With the help of an extractor, remove the thrust blocks (17) and (21) of the bearings, and the snap ring (22).
NOTE. Note down direction of assembly of snap ring (22).

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a

ITA Allentare tutte le viti (9) e (10) ed asportare le viti (9) superiori di ritegno del corpo riduttore.
NOTA. Lasciare in sede le due viti (10) inferiori per sicurezza.

D Alle Schrauben (9) und (10) lockern und die oberen Schrauben (9) zur Halterung des Reduziererkörpers abnehmen.
BEMERKUNG. Die beiden unteren Schrauben (10) zur Sicherheit zurück lassen.

ESP Aflojar todos los tornillos (9) y (10) y sacar los tornillos (9) superiores de retencion del cuerpo reductor.
NOTA. Dejar en su lugar los dos tornillos (10) inferiores para seguridad.

F Desserrer toutes les vis (9) et (10), enlever les vis supérieures (9) de fixation du corps réducteur.
REMARQUE. Garder les deux vis inférieures (10) dans leur siège pour plus de sécurité.

b

ITA Collegare il corpo riduttore completo (11) ad un mezzo di sollevamento ed asportare le viti (10) lasciate in sede per sicurezza.
Utilizzando un mazzuolo in materiale plastico, rimuovere il corpo riduttore (11) completo.

D Den kompletten Reduziererkörper (11) an ein Hebezeug befestigen und die zuvor zur Sicherheit zurückgelassenen Schrauben (10) abschrauben.
Mit einem Gummihammer, den kompletten Reduziererkörper (11) abnehmen.

ESP Conectar el cuerpo reductor completo (11) a un medio de elevacion y sacar los tornillos (10) dejadas en su lugar para seguridad.
Utilizando un martillo en material plastico, remover el cuerpo reductor (11) completo.

F Brancher le corps réducteur complet (11) à un moyen de relevage, puis enlever les vis laissée (10) dans leur siège pour plus de sécurité.
A l'aide d'un maillet en matière plastique, enlever le corps réducteur (11) complet.

c

ITA Posizionare il corpo riduttore (11) sotto una pressa e, utilizzando uno spintore, estrarre il pignone (16) completo di cuscinetto interno (17), spessori (19) ed il distanziale (20).

D Den Reduziererkörper (11) unter eine Presse legen und mit einem Stößel das Kegelrad (16) samt dem inneren Lager (17), den Unterlegscheiben (19) und dem Distanzstück (20) abziehen.

ESP Colocar el cuerpo reductor (11) debajo de una prensa y, utilizando un empujador (16) completo de cojinete interno (17), espesores (19) y el distancial (20).

F Placer le corps réducteur (11) sous une presse, à l'aide d'un poussoir extraire le pignon (16) complet de palier interne (17), cales (19) et entretoise (20).

d

ITA Rimuovere dal pignone (16) il distanziale (20) e gli spessori (19).
Posizionare il pignone sotto una pressa e rimuovere il cuscinetto interno (17).

D Vom Kegelrad (16) das Distanzstück (20) und die Unterlegscheiben (19) abnehmen.
Das Kegelrad unter eine Presse legen und das innere Lager (17) abnehmen.

ESP Remover del pinon (16) el distancial (20) y los espesores (19).
Colocar el pinon bajo una prensa y remover el cojinete interno (17).

F Enlever du pignon (16) l'entretoise (20) et les cales (19).
Placer le pignon sous une presse et enlever le palier interne (17).

e

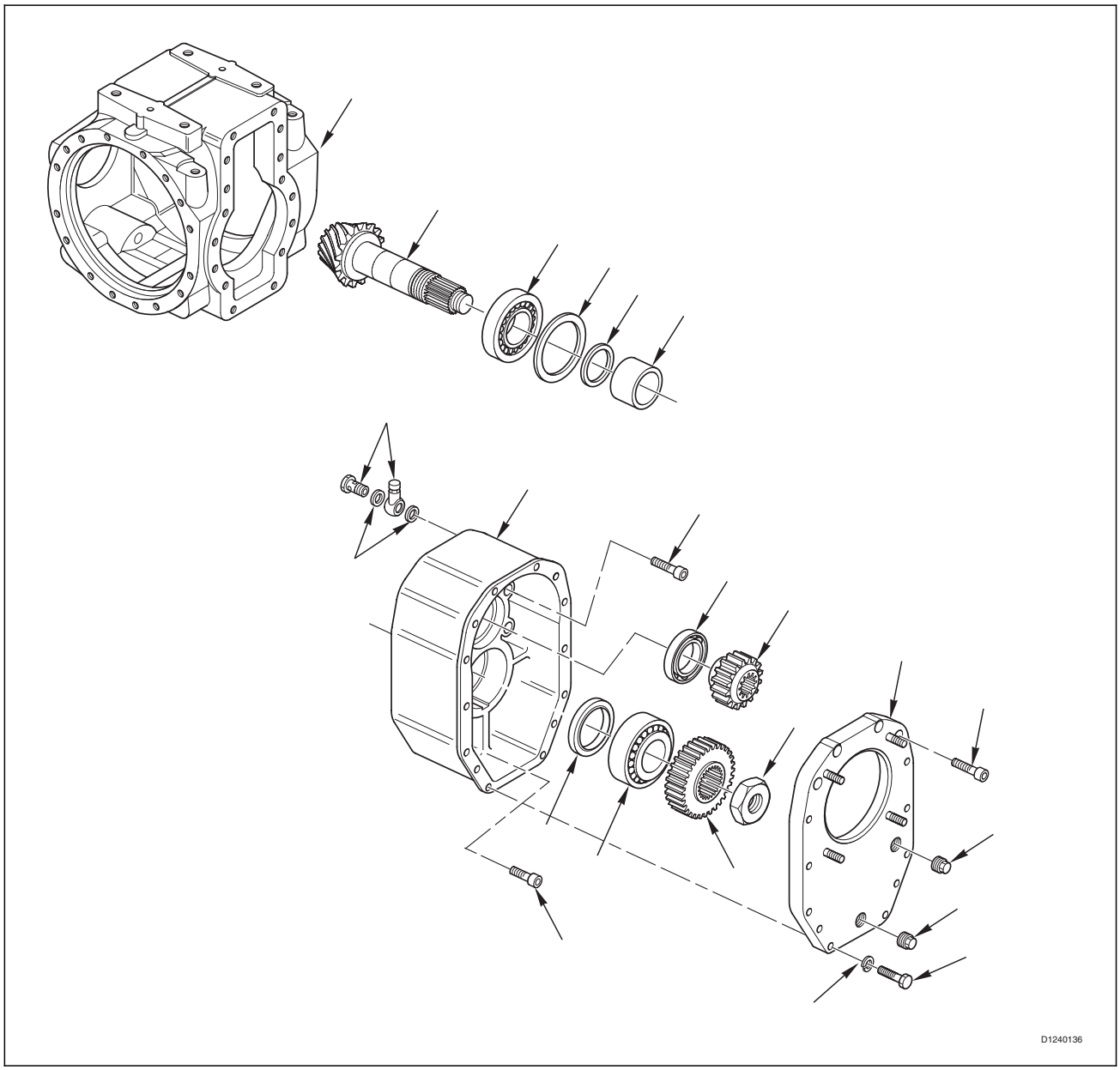
ITA Con un estrattore, rimuovere dal corpo riduttore (11) le ralle dei cuscinetti (17) e (21) e l'anello di tenuta (22).
NOTA. Annotare il senso di montaggio dell'anello di tenuta (22).

D Mit einem Abzieher vom Reduziererkörper (11) die Scheiben der Lager (17) und (21) und den Dichtring (22) entfernen.
BEMERKUNG. Montagerichtung des Dichtringes (22) notieren.

ESP Con un extractor, remover del cuerpo reductor (11) las ranguas de los cojinetes (17) y (21) y el anillo de retencion (22).
NOTA. Anotar el sentido de desmontaje del anillo de retencion (22).

F A l'aide d'un extracteur, enlever le corps réducteur (11), les crapaudines des paliers (17) et (21) et l'anneau d'étanchéité (22).
REMARQUE. Prendre note du sens de montage de l'anneau d'étanchéité (22).

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GB **CAUTION!** 1 - If disassembly has only been carried out to replace the snap ring (22), position the new ring and reassemble the unit, respecting the tightening torques specified in the following section and using the specified locking and sealing products.
2 - If disassembly is performed to replace either crown wheel and pinion, bearings, or planetary gears, take the unit to pieces and find shims and clearances as specified in the sections relative to the removal, disassembly, assembly and installation of the differential unit and bevel pinion.

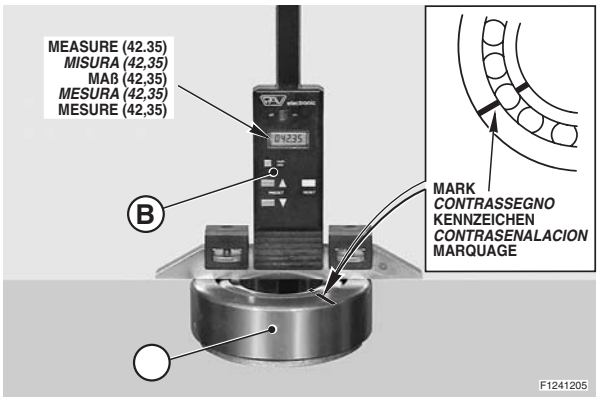
ITA **ATTENZIONE!** 1 - Se lo smontaggio è stato eseguito solo per la sostituzione dell'anello di tenuta (22), procedere al posizionamento del nuovo anello e rimontare il gruppo rispettando le coppie di serraggio indicate nel paragrafo seguente ed utilizzando i prodotti di bloccaggio e tenuta prescritti.
2 - Se lo smontaggio viene eseguito per la sostituzione della coppia conica, dei cuscinetti o degli ingranaggi satelliti, procedere alla scomposizione ed alla ricerca degli spessori e dei giochi come indicato nei paragrafi riguardanti la rimozione, lo smontaggio, l'assemblaggio e l'installazione del differenziale e del pignone conico.

D **ACHTUNG!** 1 - Falls das Teil zum Auswechseln des Dichtringes (22) zerlegt wurde, den neuen Ring einsetzen und das Aggregat wieder montieren; dabei die Anzugsmomente einhalten, die im nachstehenden Kapitel angegeben sind und die vorgeschriebenen Materialien zur Blokkierung und Abdichtung verwenden.
2 - Falls das Zerlegen zum Auswechseln des Kegelradpaars, der Lager oder der Planetengetriebe vorgenommen wird, den Anweisungen der Paragraphen zum Zerlegen, Abmontieren und Zusammenbauen sowie zur Installation des Differentials und des Kegelrads folgen und die Stärken und Spiele einhalten.

ESP **ATENCION!** 1 - Si el desmontaje ha sido efectuado solo para la sobstitucion del anillo de retencion (22), proceder al alojamiento del nuevo anillo y remontar el grupo respectando los pares de serraje indicadas en el paragrafo siguiente y utilizando los productos de bloqueo y tenida prescritos.
2 - Si el desmontaje viene efectuado para la sobstitucion del par conico, de los cojinetes o de los engranajes satelites, proceder a la descomposicion y a la busqueda de los espesores y de los juegos como indicados en los paragrafos concernientes la remocion, el desmontaje, el asemblaje y la instalacion del diferencial y del pinon conico.

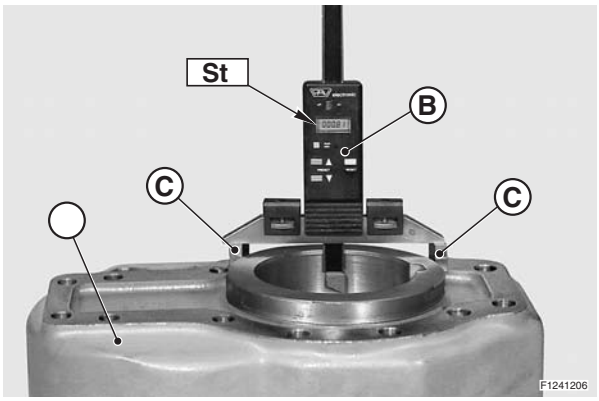
F **ATTENTION!** 1 - Si le démontage n'est effectué que pour substituer l'anneau d'étanchéité (22), positionner le nouvel anneau et remonter le groupe en respectant les couples de serrage indiqués dans le paragraphe suivant à l'aide des produits de blocage et d'étanchéité prescrits.
2 - Si le montage est effectué pour substituer le couple conique des paliers et des engrenages satellites, passer à la décomposition et à la recherche des cales et des jeux comme indiqué dans les paragraphes concernant la dépose, le démontage, l'assemblage et l'installation du différentiel et du pignon conique.

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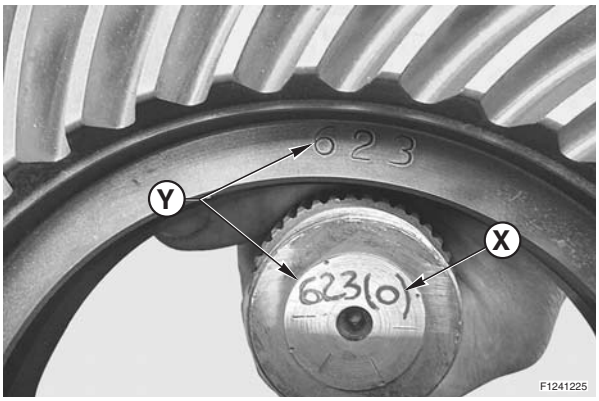
GB a

Mark the thrust block and the internal bearing (17) on a faceplate, allow the bearing to set by rotating them in both directions and by applying a vertical thrust. With a centesimal, digital depth gauge "**B**", check overall thickness of bearing (e.g.: 42.35 mm) and set the gauge to zero again.



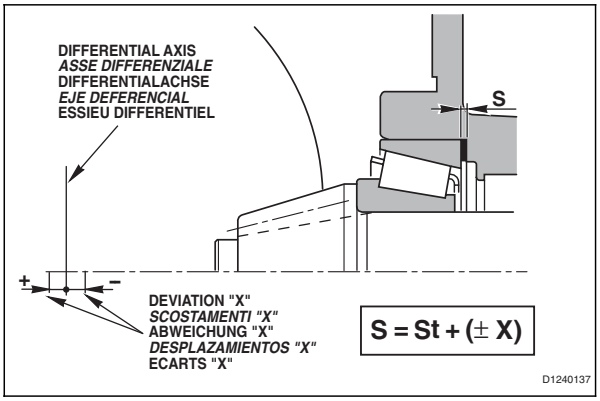
GB b

Lay two 20 mm gauged blocks "**C**" on the face of the reduction gear body (11). With depth gauge "**B**" (set to zero at the previous point), measure space between the "**C**" blocks and the striking surface of internal bearing (17). The size obtained (e.g.: 0.81 mm) is the theoretical shim "**St**" (18) to be inserted under the thrust block of bearing (17).



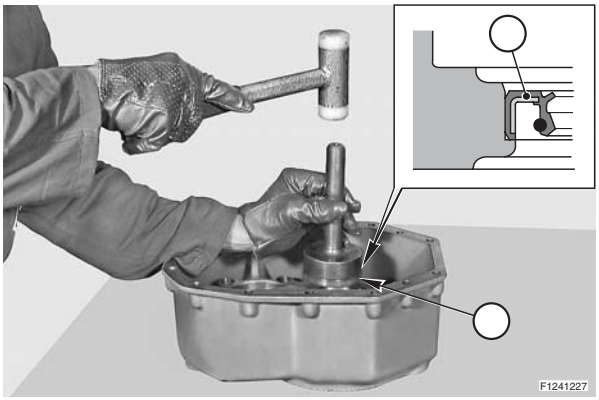
GB c

On the bar-hold of pinion (16), check the value "**X**" (in brackets) relative to the deviation from the theoretical centre distance.
NOTE. "**Y**" is the number of pinion/crown coupling.



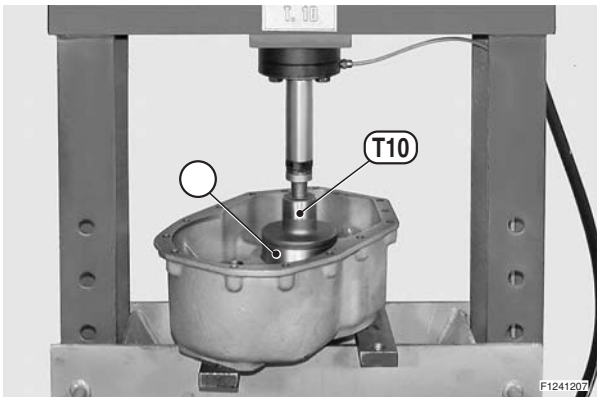
GB d

To calculate final thickness "**S**", add the negative value of "**X**" to "**St**" or, alternatively, subtract the positive value of "**X**".
For ex.: Deviation X = (–0.13 mm): S = St + X = 0.81 + 0.13 = 0.94 mm
Deviation X = (+ 0.12 mm): S = St – X = 0.81 – 0.12 = 0.69 mm
CAUTION! Round off to as close to 0.05 mm as possible.



GB e

Using a driver, mount the sealing ring (22) in the reduction unit (11).
NOTES. 1 - Carefully check the direction of assembly.
2 - Lubricate the outer surface of the sealing ring.



GB f

Place the reduction gear body (11) under a press and, using tool **T10**, insert the thrust block of external bearing (21).
CAUTION! Insert the thrust block of the bearing that is not countermarked.

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a

ITA Contrassegnare la ralla ed il cuscinetto (17) interno su un piano di riscontro, assestare il cuscinetto con delle rotazioni parziali nei due sensi ed esercitando una spinta verticale. Con un calibro di profondità digitale centesimale "**B**", rilevare lo spessore totale del cuscinetto (es 42,35 mm) ed azzerare il calibro.

D Die Scheibe und das innere Lager (17) an einer Bezugsfläche markieren, das Lager durch hin und her Drehen und einem senkrechten Druck richtig einsetzen. Mit einer digitalen hundertteiligen Tiefenlehre "**B**" die Gesamtstärke des Lagers messen (z.B. 42,35 mm) und die Lehre zurückstellen.

ESP Senalar la rangua t el cojinete (17) interno sobre una superficie de rescontre, ordenar el cojinete con unas rotaciones parciales en los dos sentidos y ejercitando un empuje vertical. Con un calibre de profundidad digital centesimal "**B**", relevar el espesor total del cojinete (es.:42,35 mm) y azerar el calibre.

F Estampiller la crapaudine et le palier (17) interne sur un marbre de contrôle, ajuster les paliers par des rotations partielles dans les deux sens tout en poussant verticalement. A l'aide d'un calibre de profondeur numérique centésimal "**B**", relever le calage total des paliers (ex. 42,35 mm), mettre le calibre à zéro.

b

ITA Appoggiare sul piano di appoggio del corpo riduttore (11) due blocchetti calibrati da 20 mm "**C**". Con il calibro di profondità "**B**" (azzerato nella fase precedente), rilevare la misura tra i blocchetti "**C**" ed il piano di battuta del cuscinetto interno (17). La misura risultante (es. 0,81 mm) è lo spessore "**St**" (18) teorico da inserire sotto la ralla del cuscinetto (17).

D Auf eine Auflagefläche des Reduziererkörpers (11) zwei kalibrierte Blöcke zu 20 mm "**C**" legen. Mit einer Tiefenlehre "**B**" (zuvor zurückgestellt) das Maß zwischen den Blöcken "**C**" und der Anschlagfläche des inneren Lagers (17) messen. Das ermittelte Maß (z.B. 0,81 mm) entspricht der theoretischen Unterlegscheibe "**St**" (18), die unter die Scheibe des Lagers (17) gelegt werden muß.

ESP Colocar sobre la superficie de apoyo del cuerpo reductor (11) dos bloques calibrados de 20 mm "**C**". Con el calibre de profundidad "**B**" (azerando en la fase precediente), relevar la mesura entre los bloquetes "**C**" y la superficie del tope del cojinete interno (17). La mesura resultante (es.: 0,81 mm) es el espesor "**St**" (18) teorico de introducir bajo la rangua del cojinete (17).

F Déposer sur un plan d'appui du corps réducteur (11), deux petits blocs calibrés à 20 mm "**C**". A l'aide du calibre de profondeur "**B**" (mis à zéro précédemment), relever la mesure existante entre les petits blocs "**C**" et le plan de butée du palier interne (17). La mesure résultante (ex. 0,81 mm) est le calage "**St**" (18) à introduire sous la crapaudine du palier (17).

c

ITA Controllare sul codolo del pignone (16) il valore "**X**" (racchiuso tra parentesi) dello scostamento rispetto l'interasse teorico.

NOTA. Il numero "**Y**" è il numero di accoppiamento pignone-corona.

D Den Wert "**X**" der Gleitung am Kegelradschaft (16) (in Klammern angegeben) im Verhältnis zum theoretischen Achsenabstand kontrollieren.

BEMERKUNG. Die Zahl "**Y**" entspricht dem Kegelrad-Kranz-Kopplungsgrad.

ESP Controlar sobre al espigon del pinon (16) el valor "**X**" (serrado entre parantesis) del desplazamiento respecto al intereje teorico.

NOTA. El numero "**Y**" y el numero de acoplamiento pinon-corona.

F Contrôler sur la queue du pignon (16) la valeur "**X**" (entre parenthèses) de l'écart par rapport à l'entraxe théorique.

REMARQUE. Le numéro "**Y**" est le numéro de l'accouplement pignon-couronne.

d

ITA Per calcolare lo spessore "**S**" definitivo, aggiungere a "**St**", il valore "**X**" negativo oppure sottrarre il valore "**X**" positivo.

Es.: Scostamento X = (– 0,13 mm): S = St + X = 0,81 + 0,13 = 0,94 mm
Scostamento X = (+ 0,12 mm): S = St – X = 0,81 – 0,12 = 0,69 mm

ATTENZIONE! Arrotondare al valore più prossimo dei 0,05 mm.

D Um die endgültige Stärke "**S**" auszurechnen, "**St**" und "**X**" addieren, wenn "**X**" négatif ist oder "**X**" von "**St**" abziehen, falls "**X**" postif ist.

Beispiel: Abweichung X = (– 0,13 mm): S = St + X = 0,81 + 0,13 = 0,94 mm
Abweichung X = (+ 0,12 mm): S = St – X – 0,81 – 0,12 = 0,69 mm

ACHTUNG! Auf einen Wert abrunden, der 0,05 mm am nächsten liegt.

ESP Para calcolar el espesor "**S**" definitivo, adicionar a "**St**", el valor "**X**" negativo o detraer el valor "**X**" positivo.

Es.: Desplazamiento X = (– 0,13mm): S = St + X = 0,81 + 0,13 = 0,94 mm
Desplazamiento X = (0,12mm): S = St – X = 0,81 – 0,12 = 0.69 mm

ATENCION! Acercar al valor mas cerca de 0,05 mm.

F Pour calculer l'épaisseur "**S**" définitif, additionner à "**St**" la valeur "**X**" négative ou soustraire la valeur "**X**" positive.

Ex. Ecart X = (– 0,13 mm): S = St + X = 0,81 + 0,13 = 0,94 mm
Ecart X = (+ 0,12 mm): S = St – X – 0,81 – 0,12 = 0,69 mm

ATTENTION! Arrondir à la valeur plus proche à 0,05 mm.

e

ITA Utilizzando uno spintore, montare nel corpo riduttore (11) l'anello di tenuta (22).

NOTE. 1 - Controllare attentamente il senso di montaggio.
2 - Lubrificare la superficie esterna dell'anello di tenuta.

D Mit einem Stößel den Dichtring (22) in den Reduziererkörper (11).

BEMERKUNG. 1 - Sorgfältig die Montagerichtung des Dichtrings kontrollieren.
2 - Äußere Fläche des Dichtrings schmieren.

ESP Utilizando un espesor, montar en el cuerpo reductor (11) el anillo de retencion (22).

NOTA. 1 - Controlar atentamente el sentido de montaje.
2 - Lubrificar la superficie exterior del anillo de retencion.

F A l'aide d'un poussoir, monter dans le corps réducteur (11) l'anneau d'étanchéité (22).

NOTE. 1 - Contrôler attentivement le sens de montage.
2 - Lubrifier la surface externe de l'anneau d'étanchéité.

f

ITA Sistemare il corpo riduttore (11) sotto una pressa e, utilizzando l'attrezzo **T10** inserire la ralla del cuscinetto esterno (21).

ATTENZIONE! Inserire la ralla del cuscinetto **non contrassegnato**.

D Den Reduziererkörper (11) unter eine Presse legen und mit dem Werkzeug **T10** die Scheibe des äußeren Lagers (21) einsetzen.

ACHTUNG! Die Scheibe des nicht gekennzeichneten Lagers einsetzen.

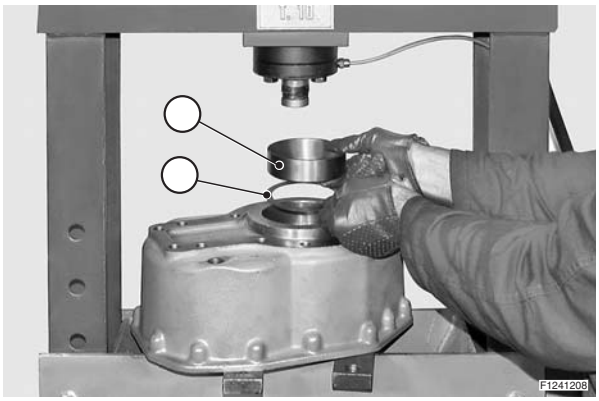
ESP Colocar el cuerpo reductor (11) debajo de una prenso y, utilizando la herramienta T10 insertar la rangua del cojinete esterno (21).

ATENCION! Introducir la rangua del cojinete no segnalado.

F Ajuster le corps réducteur (11) sous la presse, à l'aide de l'outil **T10** introduire la crapaudine du palier externe (21).

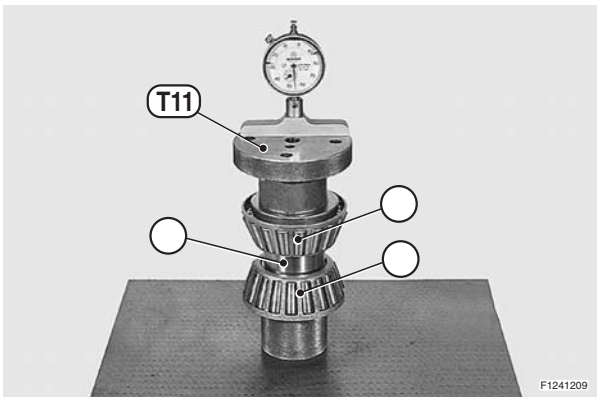
ATTENTION! Introduire la crapaudine du palier non estampillée.

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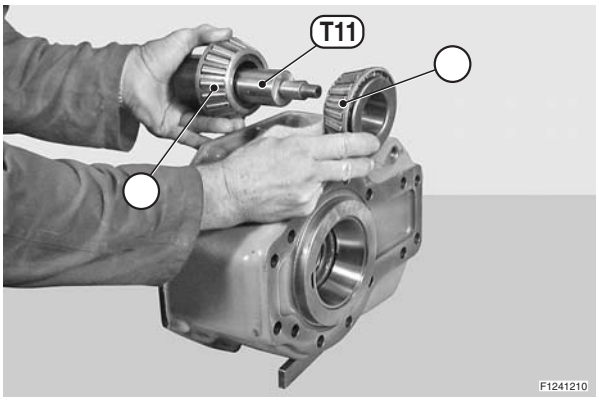
GB a

Turn the reduction gear body (11) upside down and insert shim "**S**"; then, with tool **T10**, insert the thrust block of the internal bearing (17).
CAUTION! Insert the thrust block of the **countermarked** bearing.



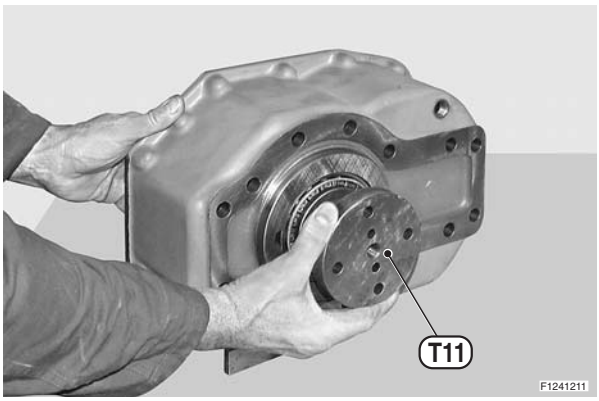
GB b

Fit tool **T12** onto tool **T11**. Then, install bearings (17) and (21) so that they are opposed to each other and spaced by the distance piece (20).
Position the depth comparator in one of the four radial holes; preset the comparator to 3 – 4 mm, then set it to zero.



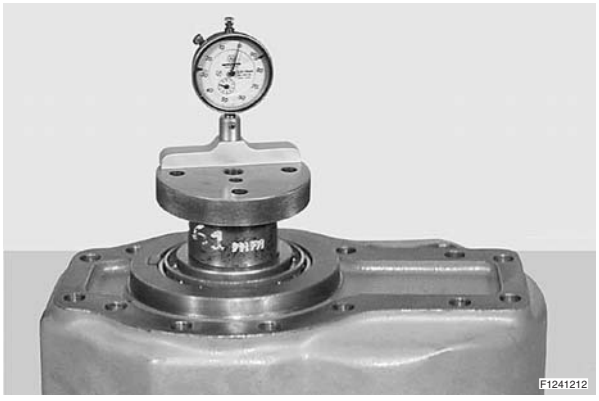
GB c

Remove the bearings from tool **T11** and fit them in the thrust blocks of the reduction gear body.
CAUTION! Check that the countermarked bearing is fitted in the centring hub of the body of the reduction gear and in the countermarked thrust block too.



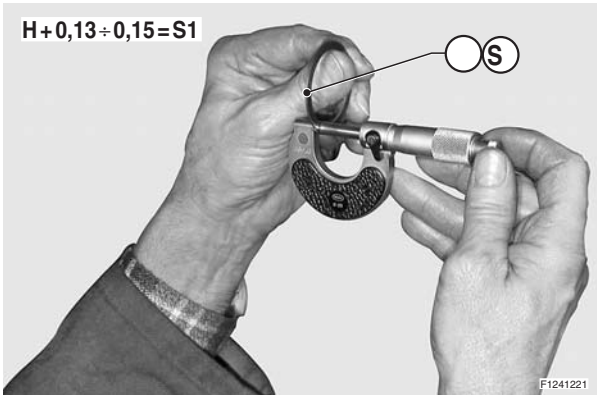
GB d

Install tool **T11** and tighten it manually to obtain a safe rolling torque.
NOTE. During tightening, perform a few rotations to set the bearings.



GB e

Introduce the previously reset comparator, in one of the four radial holes and measure. The deviation from zero indicates the nominal value "**H**" relative to the shims that are to be inserted.



GB f

The deviation found is to be added to a fixed value of 0.13(0.15 mm. in order to: obtain shim "**S1**" (to be inserted between internal bearing (17) and distance piece (20)) and, hence, produce the specified pre-load of bearings.
CAUTION! Perform accurate measurements - a variation of 0.001 mm causes a variation in the torque by 20 – 40 Nm

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a

ITA Capovolgere il corpo riduttore (11) ed inserire lo spessore "**S**" e con l'attrezzo **T10** la ralla del cuscinetto interno (17).
ATTENZIONE! Inserire la ralla del cuscinetto **contrassegnato**.

D Den Reduziererkörper (11) wenden und die Unterlegscheibe "**S**" einsetzen; mit dem Werkzeug **T10** die Scheibe des inneren Lagers (17) einsetzen.
ACHTUNG! Die Scheibe des gekennzeichneten Lagers einsetzen.

ESP Volcar el cuerpo reductor (11) y introducir el espesor "**S**" y con la herramienta **T10** la rangua del cojinete interno (17).
ATENCION! Introducir la rangua del cojinete segnalado.

F Faire basculer le corps réducteur (11), introduire la cale "**S**", et à l'aide de l'outil **T10** la crapaudine du palier interne (17).
ATTENTION! Introduire la crapaudine du palier estampillé.

b

ITA Montare sull'attrezzo **T11** l'attrezzo **T12**. Quindi montare i cuscinetti (17) e (21) contrapposti ed intervallati con il distanziale (20).
Posizionare un comparatore di profondità in uno dei quattro fori radiali; precaricare il comparatore di 3÷4 mm ed azzerarlo.

D Auf das Werkzeug **T11** das Werkzeug **T12** montieren. Dann die entgegengesetzten Lager (17) und (21) montieren und dazwischen das Distanzstück (20) legen.
Eine Meßuhr in eines der vier Radiallöcher positionieren; die Meßuhr auf 3÷4 mm vorbelasten und dann zurückstellen.

ESP Montar sobre la herramienta **T11** la herramienta **T12**. Entonces colocar los cojinetes (17) y (12) contrapuestos y intervalados con el distancial (20).
Colocar un comparador de profundidad en uno de los cuatro agujeros radiales, precargar el comparador de 3-4 mm y acerarlo.

F Monter sur l'outil **T11**, l'outil **T12**. Ensuite monter les paliers (17) et (21) en les superposant et intercalant avec l'entretoise (20).
Placer un comparateur de profondeur dans l'un des quatre trous radiaux; précharger le comparateur à 3÷4 mm, puis le mettre à zéro.

c

ITA Rimuovere i cuscinetti dall'attrezzo **T11** e montarli nelle ralle del corpo riduttore.
ATTENZIONE! Controllare che il cuscinetto contrassegnato sia montato nel mozzo di centratura del corpo riduttore e quindi nella ralla contrassegnata.

D Die Lager vom Werkzeug T11 abnehmen und in den Scheiben des Reduziererkörpers montieren.
ACHTUNG! Kontrollieren, ob das markierte Lager in den Zentriernaben des Reduziererkörpers und folglich in der markierten Scheibe montiert ist.

ESP Remover los cojinetes de la herramienta **T11** y montarlos en las ranguas del cuerpo reductor.
ATENCION! Controlar que el cojinete segnalado sea colocado en el cubo central del cuerpo reductor y por lo tanto en la rangua segnalada.

F Oter les paliers de l'outil **T11**, puis monter ces derniers dans les crapaudines du corps réducteur.
ATTENTION! Contrôler que le palier estampillé soit monté dans le moyeu de centrage du corps réducteur, donc, dans la crapaudine estampillée.

d

ITA Montare l'attrezzo **T11** e serrarlo manualmente fino ad avere una sicura coppia di rotolamento.
NOTA. Durante il serraggio, eseguire alcune rotazioni per assestare i cuscinetti.

D Das Werkzeug **T11** montieren und von Hand festziehen bis ein sicheres Gegenmoment erreicht ist.
BEMERKUNG. Beim Festziehen einige Umdrehungen vornehmen, um die Lager richtig in ihren Sitz zu bringen.

ESP Montar la herramienta **T11** y apretarla manualmente hasta obtener una segura pareja de rotacion.
NOTA. Durante la torsion, efectuar algunas rotaciones para ordenar los cojinetes.

F Monter l'outil **T11** et serrer celui-ci à la main jusqu'à obtenir un couple de roulement assuré.
REMARQUE. En serrant, effectuer quelques tours de rotation pour ajuster les paliers.

e

ITA Introdurre in uno dei fori radiali il comparatore azzerato precedentemente ed eseguire la lettura.
Lo scostamento rispetto lo zero, indica il valore nominale "**H**" degli spessori da inserire.

D In eines der Radiallöcher die zuvor zurückgestellte Meßuhr einsetzen und das Maß ablesen.
Die Abweichung im Verhältnis zur Null, gibt den Nennwert "**H**" der einzulegenden Unterlegscheiben an.

ESP Introducir en uno de los agujeros radiales el comparador acerado precedentemente y efectuar la lectura.
El desplazamiento respecto a lo cero, indica el valor nominal "**H**" de los espesores de introducir.

F Introduire dans l'un des trous radiaux le comparateur mis à zéro précédemment et en faire la lecture.
L'écart par rapport au zéro, indique la valeur nominale "**H**" des cales à introduire.

f

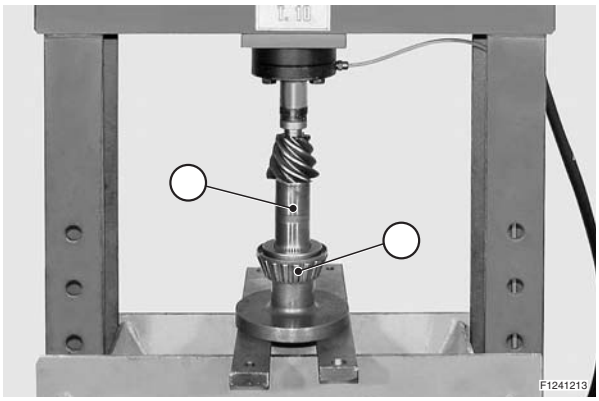
ITA Lo scostamento rilevato è da sommare ad una misura fissa di 0,13÷0,15 mm, per ottenere lo spessore "**S1**" (19) da inserire tra cuscinetto interno (17) e distanziale (20) e quindi, determinare il precarico stabilito per i cuscinetti.
ATTENZIONE! Curare le misurazioni in quanto la variazione di 0,01 mm fa variare la coppia di rotazione di 20÷40 Ncm.

D Die ermittelte Abweichung muß mit einem Festmaß von 0,3 (0,15 mm zusammengerechnet werden, um die Unterlegscheibe "**S1**" (19) zu ermitteln, die zwischen dem inneren Lager (17) und das Distanzstück (20) gelegt werden muß und um die Vorbelastung der Lager festlegen zu können.
ACHTUNG! Die Messungen sehr sorgfältig vornehmen, da ein Unterschied von 0,01 mm das Gegenmoment um 20÷40 Ncm verändert.

ESP El desplazamiento relevado es de sumarse a una mesura fija de 0,13-0,15 mm, para obtener el espesor "**S1**" (19) de introducir entre cojinete interno (17) y distancial (20) y entonces, determinar el precario establecido para los cojinetes.
ATENCION! Poner atencion a las mesuraciones porque la variacion de 0,01 mm hace cambiar de ratacion de 20÷40Ncm.

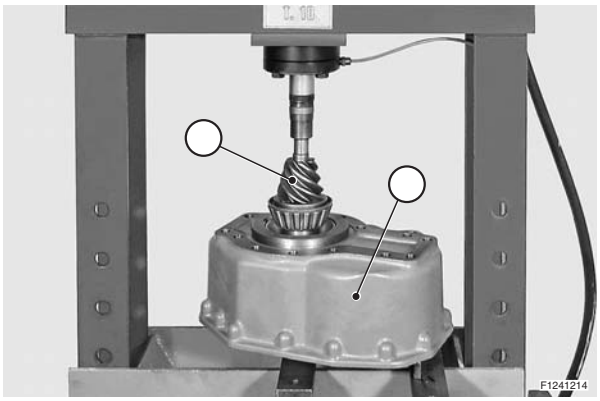
F L'écart relevé est à additionner à la mesure fixe 0,13÷0,15 mm pour obtenir la cale "**S1**" (19) à introduire entre le palier interne (17) et l'entretoise (20) et définir la précharge établie pour les paliers.
ATTENTION! Effectuer soigneusement les mesurages parce qu'une différence de 0,01 mm amène une variation du couple de rotation de 20÷40 Ncm.

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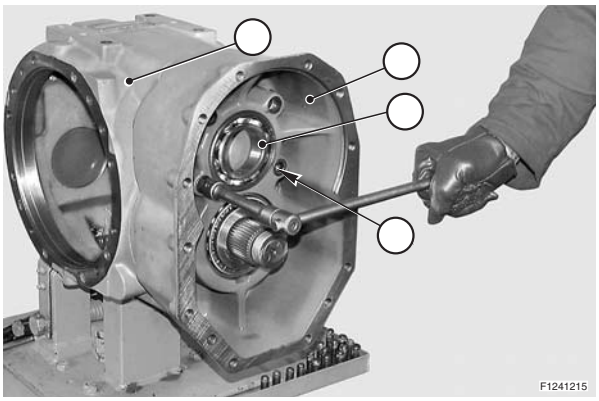
GB a

With the help of the press, install the internal, countermarked bearing (17) onto the pinion (16).
CAUTION! Lubricate pinion with oil.



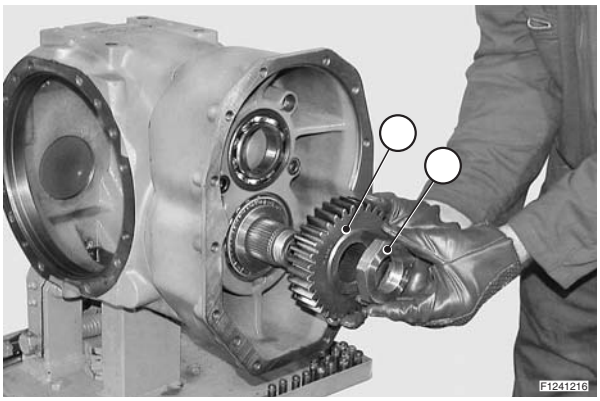
GB b

Fit the pinion (16), the shims (19), the distance piece (20) and the external bearing (21) into the body of the reduction gear (11) and assemble the unit with a press.
CAUTION! Lubricate pinion with oil.



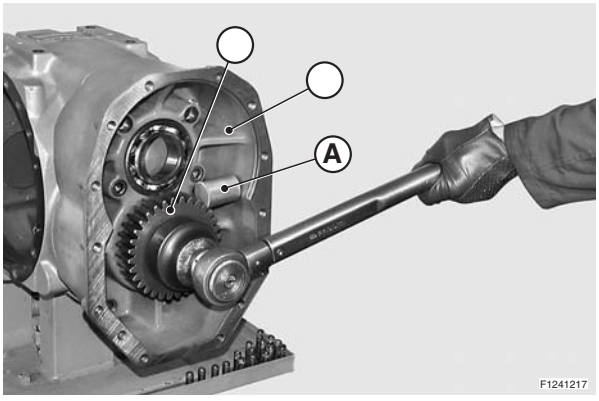
GB c

Fit the reduction gear (11) into the main body (23) without differential unit; lock temporarily with the two lower screws (9).
Fit the bearing (15) of the motion in gear and lock it.



GB d

Fit the gear (12) of the pinion; coat the nut (13) with Loctite 242 and hand-screw it.



GB e

Between the body of the reduction gear (11) and the gear (12) of the pinion, place block "**A**" used for disassembling, and tighten the nut (13) to a minimum required tightening torque of 500 Nm, using a box wrench and a dynamometric wrench.

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a

ITA Con la pressa, montare il cuscinetto interno e contrassegnato (17) sul pignone (16).
ATTENZIONE! Lubrificare il pignone con olio.

D Mit einer Presse, das innere und markierte Lager (17) auf das Kegelrad (16) montieren.
ACHTUNG! Rad mit Öl schmieren.

ESP Con la prensa, montar el cojinete interno y segnalado (17) sobre el pinon (16).
ATENCION! Lubrificar el pinon con aceite.

F A l'aide de la presse, monter le palier interne estampillé (17) sur le pignon (16).
ATTENTION! Lubrifier le pignon avec de l'huile.

b

ITA Montare nel corpo riduttore (11) il pignone (16), gli spessori (19), il distanziale (20) ed il cuscinetto esterno (21) ed assemblare il gruppo con la pressa.
ATTENZIONE! Lubrificare il pignone con olio.

D In den Reduziererkörper (11) das Kegelrad (16), die Unterlegscheiben (19), das Distanzstück (20) und das äußere Lager (21) montieren und das Aggregat mit der Presse zusammenbauen.
ACHTUNG! Rad mit Öl schmieren.

ESP Montar en el cuerpo reductor (11) el pinon (16) los espesores (19), el distancial (20) y el cojinete esterno (21) y asemblar el grupo con la prensa.
ATENCION! Lubrificar el pinon con aceite.

F Monter dans le corps réducteur (11), le pignon (16), les cales (19), l'entretoise (20) et le palier externe (21), assembler le groupe à l'aide de la presse.
ATTENTION! Lubrifier le pignon avec de l'huile.

c

ITA Montare il corpo riduttore (11) sul corpo centrale (23) privo di differenziale e fissarlo provvisoriamente con le due viti inferiori (9).
Montare il cuscinetto (15) dell'ingranaggio di entrata del moto e mandarlo in battuta.

D Den Reduziererkörper (11) auf den zentralen Körper (23) ohne Differential montieren und vorübergehend mit den zwei unteren Schrauben (9) befestigen.
Das Lager (15) des Einganggetriebes montieren und bis zum Anschlag einsetzen.

ESP Montar el cuerpo reductor (11) sobre el cuerpo central (23) sin el diferencial y fijarlo provisoriamente con los dos tornillos inferiores (9).
Asemblar el cojinete (15) del engranaje de entrada del movimiento y mandarlo a tope.

F Monter le corps réducteur (11) sur le corps central (23) sans différentiel et fixer provisoirement ce dernier avec les deux vis inférieures (9).
Monter le palier (15) de l'engrenage d'accès au mouvement, puis l'envoyer en butée.

d

ITA Montare l'ingranaggio (12) del pignone; spalmare il dado (13) con Loctite 242 ed avvitarlo manualmente.

D Das Getriebe (12) des Kegelrads montieren; Mutter (13) mit Loctite 242 schmieren und von Hand zuschrauben.

ESP Asemblar el engranaje (12) del pinon, pasar la tuerca (13) con Loctite 242 y atornillarla manualmente.

F Monter l'engrenage (12) du pignon; enduire l'écrou (13) avec du Loctite 242 et visser celui-ci à la main.

e

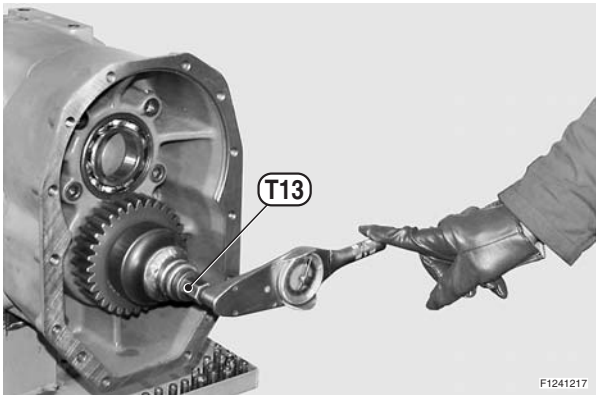
ITA Sistemare tra il corpo riduttore (11) e l'ingranaggio (12) del pignone il blocchetto "**A**" usato per lo smontaggio e serrare il dado (13) alla coppia minima di 500 Nm, utilizzando una chiave a bussola ed una chiave dinamometrica.

D Zwischen dem Reduziererkörper (11) und dem Getriebe (12) des Kegelrads den Block «A» legen, der zum Abmontieren verwendet wurde, und Mutter (13) mit einem Anzugsmoment von mindestens 500 Nm mit einem Inbußschlüssel und einem Dynamometer festziehen.

ESP Colocar entre el cuerpo reductor (11) y el engranaje (12) del pinon el bloquete "**A**" usado para el desmontaje y apretar la tierca (13) al valor minimo de 500 Nm, utilizando una llave a manguito y una llave dinamometrica.

F Placer, entre le corps réducteur (11) et l'engrenage (12) du pignon, le petit bloc "**A**" utilisé au démontage, serrer l'écrou (13) au couple minimum de 500 Nm à l'aide d'une clé à pipe et d'une clé dynamométrique.

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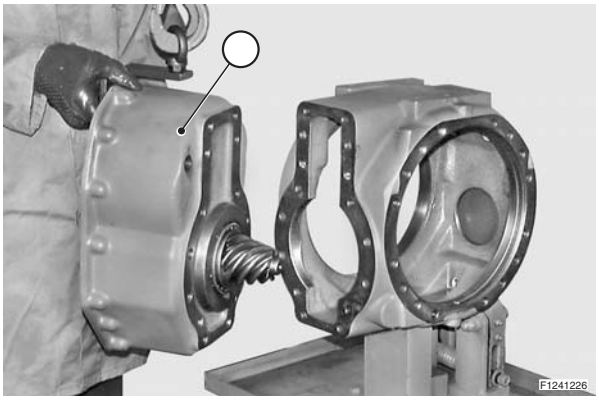
GB a

Allow the pinion to rotate a few times in both directions to enable bearings to set.
Apply bar-hold **T13** onto pinion (16) and, with a torque meter, check the torque of the pinion.
Torque: 140 – 150 Ncm.

CAUTION! If torque exceeds the maximum value, then the shim "**S1**" (19) placed between bearing (17) and distance piece (20) needs to be increased.
If torque does not reach the set value, increase the tightening torque setting of nut (13), in different stages, until the maximum admitted value of 700 Nm is obtained.

CAUTION! If torque does not reach the minimum value, then the shim "**S1**" (19) needs to be reduced.

CAUTION! In order to be able to calculate the increase or reduction of shim "**S1**", it is necessary to bear in mind that a 0.01 mm variation in the size of shim (19) results in the torque of the pinion (16) varying by 20 – 40 Ncm.



GB b

Remove the whole reduction gear body (11) and continue with the assembly of the differential unit and arms.
For details, see «ASSEMBLY AND INSTALLATION OF THE DIFFERENTIAL UNIT - ASSEMBLING THE BRAKING UNIT».

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a

ITA

Far compiere al pignone alcuni giri nei due sensi per assestare i cuscinetti.
Applicare sul pignone (16) il codolo **T13** e con un torsiometro, controllare la coppia di rotazione del pignone.
Coppia di rotazione: 140÷150 Ncm

ATTENZIONE! Se la coppia supera il valore massimo bisogna aumentare lo spessore "**S1**" (19) tra cuscinetto (17) e distanziale (20).
Se la coppia di rotazione non raggiunge il valore stabilito, aumentare la coppia di serraggio del dado (13) in più tempi fino a raggiungere il valore massimo ammesso di 700 Nm.

ATTENZIONE! Se la coppia di rotazione non raggiunge il valore minimo, è necessario diminuire lo spessore "**S1**" (19).

ATTENZIONE! Al fine di poter calcolare gli incrementi o la diminuzione dello spessore "**S1**", è necessario considerare che la variazione dello spessore (19) di 0,01 mm, fa variare la coppia di rotazione del pignone (16) di 20÷40 Ncm.

ESP

Hacer efectuar al pinon algunos giros en los dos sentidos para ordenar los cojinetes.
Aplicar sobre el pinon (16) el codolo **T13** y con un torsiometro, controlar el par de rotacion del pinon.
Par de rotacion: 140÷150 Ncm.

ATENCION! Si el par supera el valor maximo hay que augmentar el espesor "**S1**" (19) entre cojinete (17) y distancial (20).
Si el par de rotacion no llega al valor establecido, augmentar el par de torsion de la tuerca (13) en mas tiempos hasta llegar al valor maximo admitido de 700 Nm.

ATENCION! Si el par de rotacion no llega al valor minimo, es necesario disminuir el espesor "**S1**" (19).

ATENCION! Al fin de poder calcular los encrementos o la disminuciones del espesor "**S1**", es necesario considerar que la variacion del espesor (19) de 0,01 mm, hacer cambiar el par de rotacion del pinon (16) de 20÷40 Ncm.

D

Das Kegelrad um einige Umdrehungen in beide Richtungen drehen, um die Lager richtig einzusetzen.
Am Kegelrad (16) den Schaft **T13** anbringen und mit einem Drehungsmesser das Gegenmoment des Kegelrads kontrollieren.
Gegenmoment: 140÷150 Ncm.

ACHTUNG! Falls der Wert den Maximalwert überschreitet, braucht es eine größere Unterlegscheibe "**S1**" (19) zwischen Lager (17) und Distanzstück (20).
Falls das Gegenmoment den festgelegten Wert nicht erreicht, das Anzugsmoment der Mutter (13) schrittweise erhöhen, bis der maximal zulässige Wert von 700 Nm erreicht worden ist.

ACHTUNG! Falls das Gegenmoment den Mindestwert nicht erreicht, muß die Unterlegscheibe "**S1**" (19) kleiner sein.

ACHTUNG! Um das höhere oder niedrigere Maß der Unterlegscheibe "**S1**" ausrechnen zu können, darauf achten, daß ein Unterschied von 0,01 mm der Unterlegscheibe (19) das Gegenmoment des Kegelrads (16) um 20÷40 Ncm ändert.

F

Faire faire quelques tours au pignon dans les deux sens de manière à ajuster les paliers.
Appliquer sur le pignon (16), la queue **T13**, puis à l'aide d'un torsiomètre, contrôler le couple de rotation du pignon.
Couple de rotation: 140÷150 Ncm.

ATTENTION! Si le couple de rotation dépasse la valeur maximum, augmenter la cale "**S1**" (19) entre le palier (17) et l'entretoise (20).
Si le couple de rotation n'atteint pas la valeur établie, augmenter le couple de serrage de l'écrou (13), en plusieurs temps, jusqu'à atteindre la valeur maximum admise de 700 Nm.

ATTENTION! Si le couple de rotation n'atteint pas la valeur minimum, diminuer la cale "**S1**" (19).

ATTENTION! Pour pouvoir calculer les augmentations et les diminutions de la cale "**S1**", tenir compte que la différence de 0,01 de la cale (19) fait varier le couple de rotation du pignon (16) de 20÷40 Ncm.

b

ITA

Rimuovere il corpo riduttore completo (11) e procedere con il montaggio del differenziale e dei bracci.
Per i dettagli, vedere «ASSEMBLAGGIO ED INSTALLAZIONE GRUPPO DIFFERENZIALE - ASSEMBLAGGIO GRUPPO FRENO».

D

Den kompletten Reduziererkörper (11) abnehmen und das Differential und die Arme montieren.
Siehe «ZUSAMMENBAU UND INSTALLATION DES DIFFERENTIALAGGREGATS - ZUSAMMENBAU DES BREMSAGGREGATS».

ESP

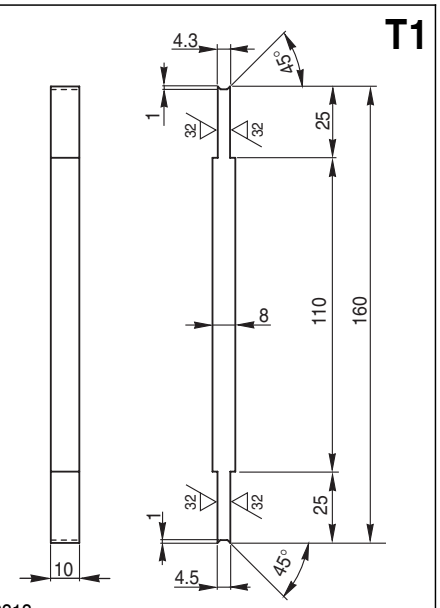
Remover el cuerpo reductor completo (11) y proceder con el montaje del diferencial y de los ejes.
Para los detalles, vease «ASEMBLAJE Y INSTALACION GRUPO DIFERENCIAL - ASEMBLAJE GRUPO FRENO».

F

Enlever le corps réducteur complet (11) et aller de l'avant avec le montage du différentiel et des bras.
Pour de plus amples détails, voir "ASSEMBLAGE ET INSTALLATION DU GROUPE DIFFERENTIEL - ASSEMBLAGE DU GROUPE FREIN".

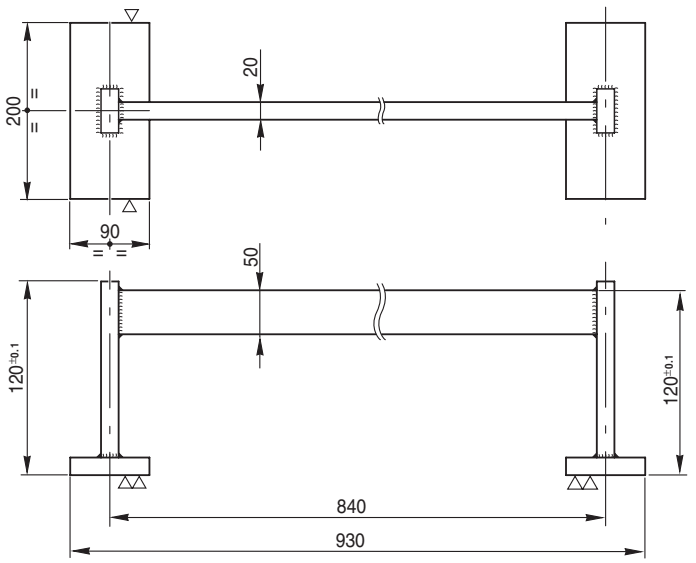
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T1



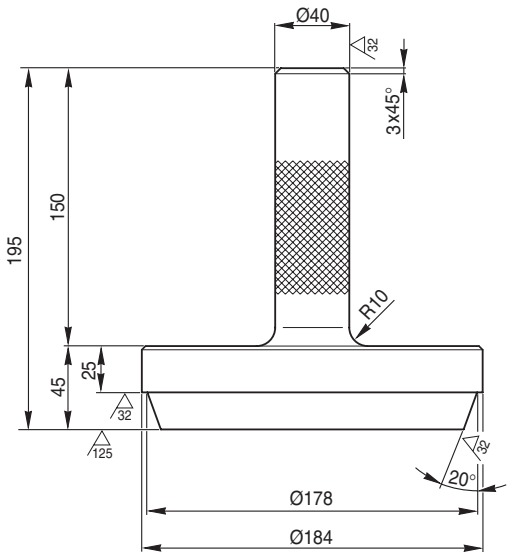
2313 D1240046

T2



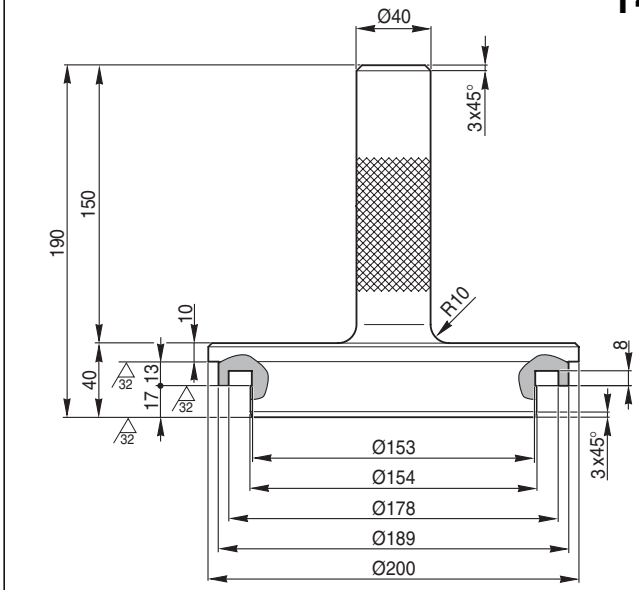
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T3



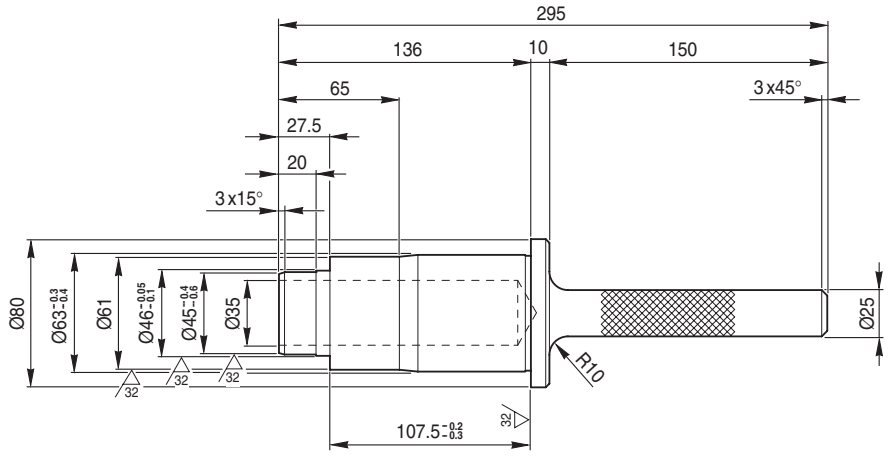
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T4



1742 D1240121

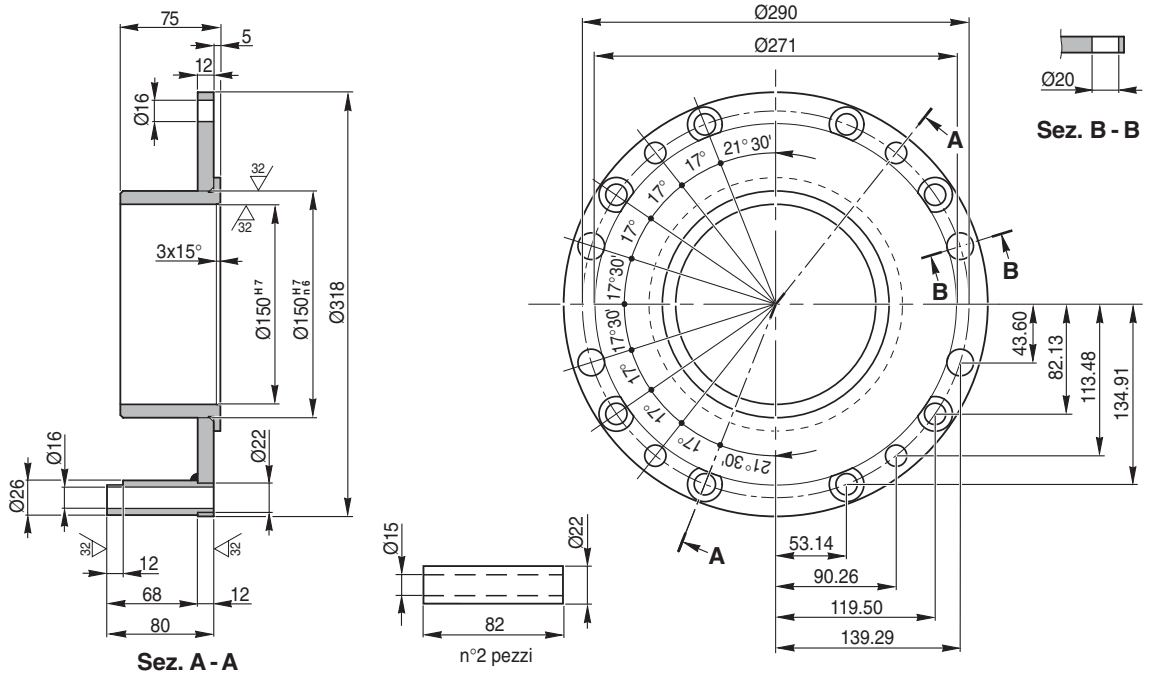
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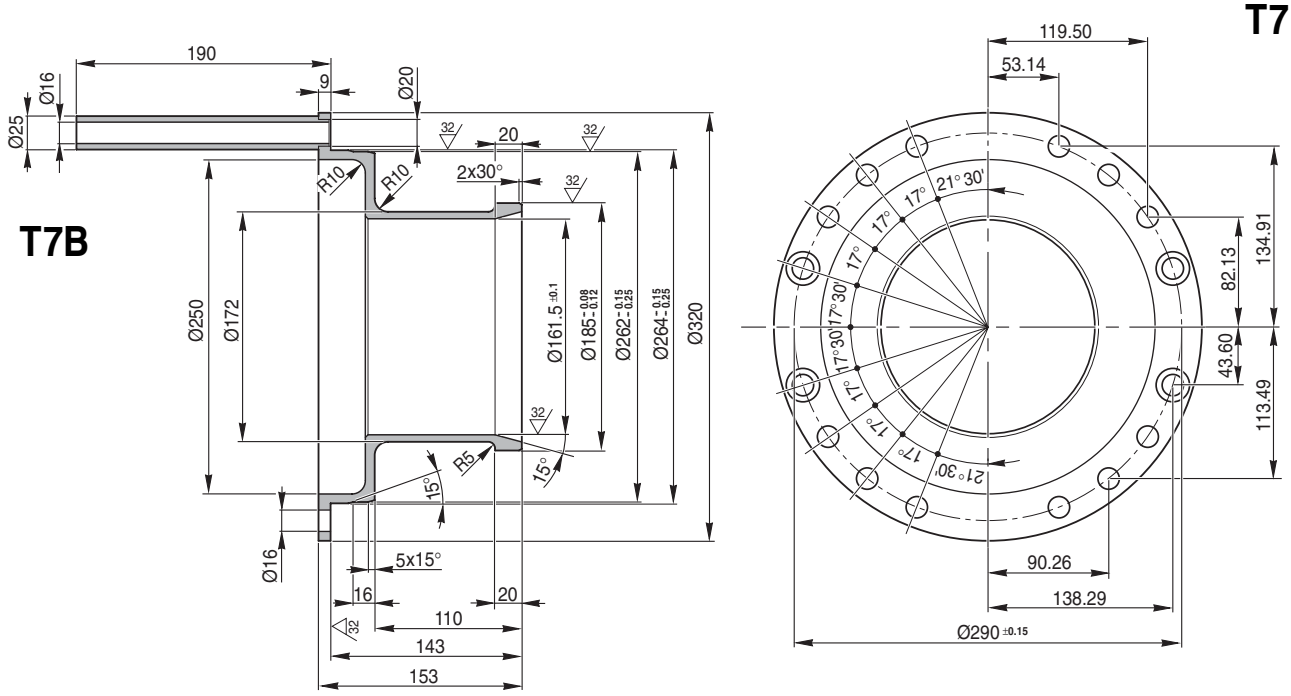
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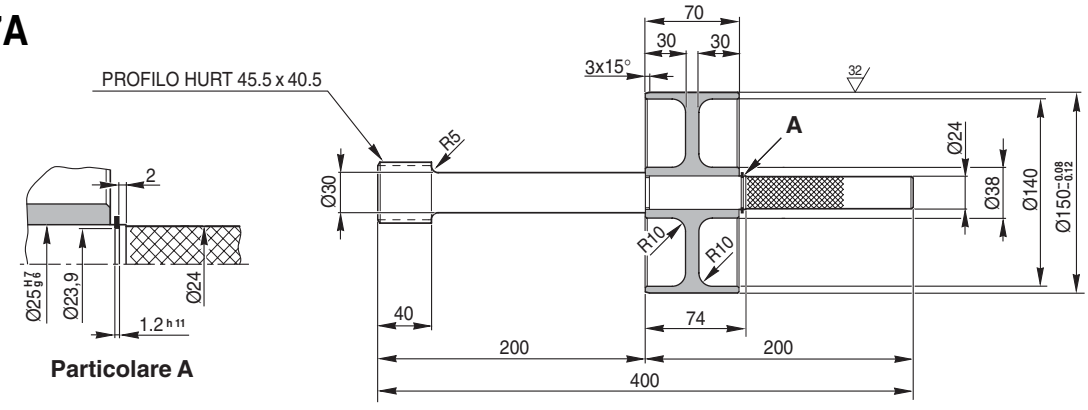
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D1240124

T7



T7A

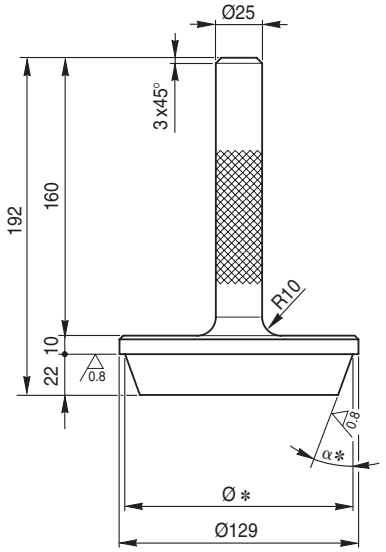


1769

D1240125

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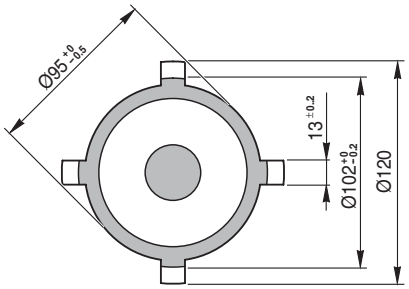
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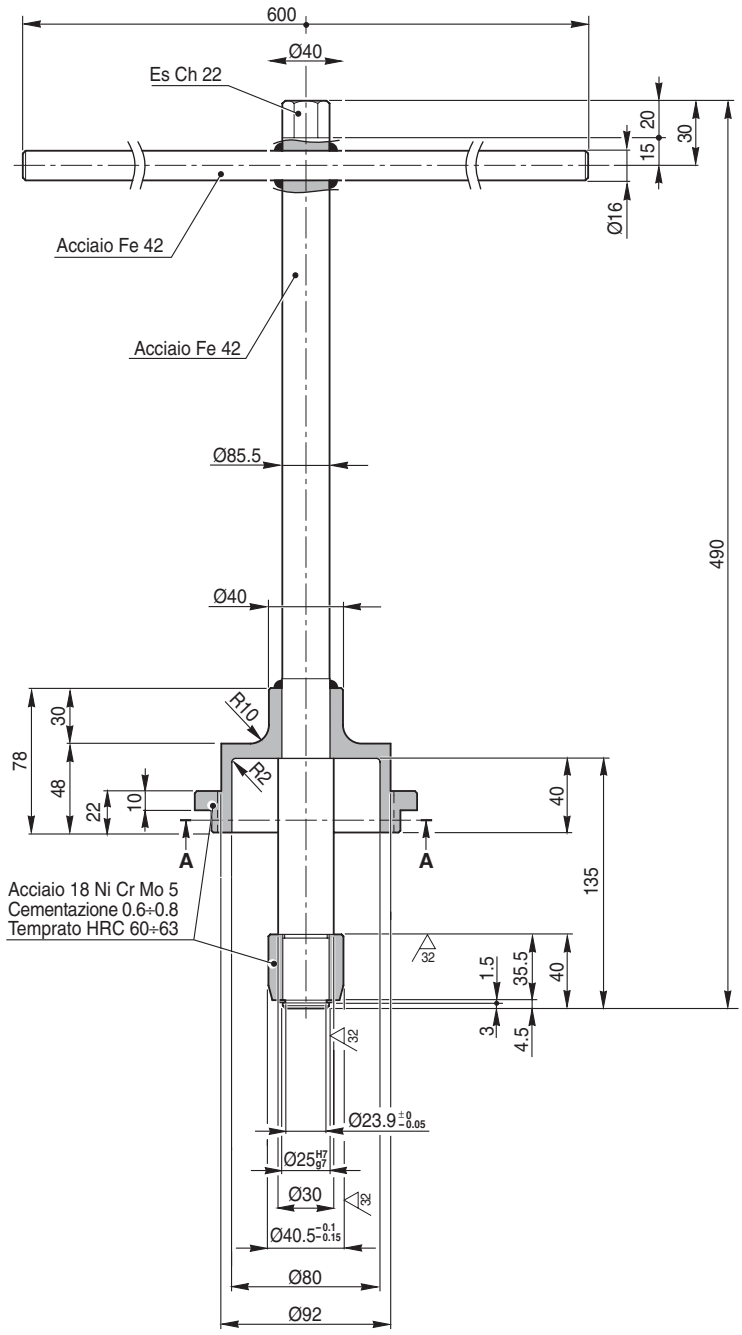
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✻ Ref. cuscinetto 32017 DIN720
✻ Lager Ref. 32017 DIN720
✻ Ref. cojinete 32017 DIN720
✻ Réf. palier 32017 DIN720

0355 D1240123

T9

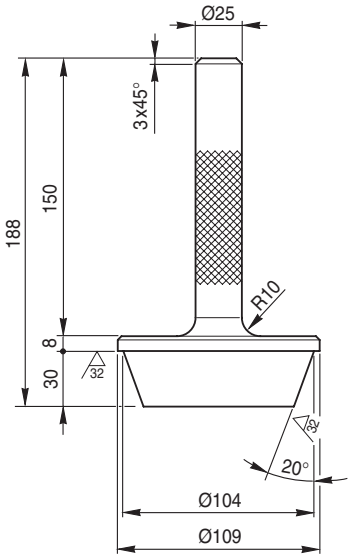


Sez. A-A



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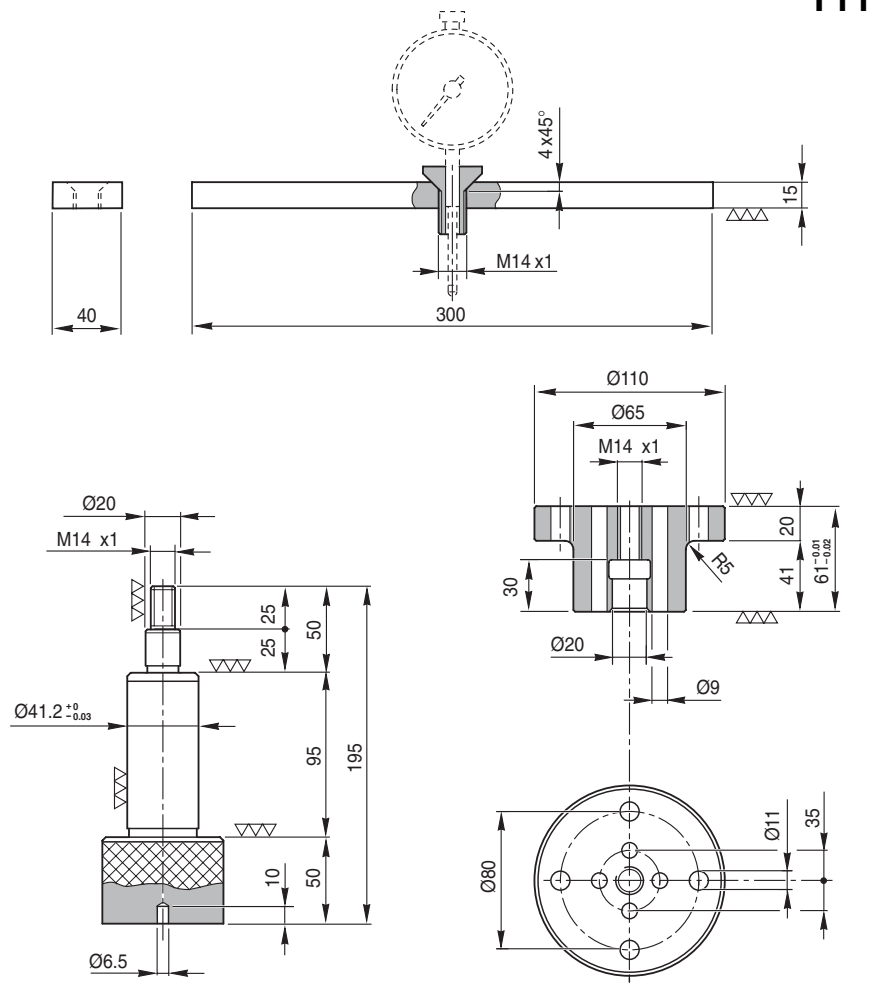
T10



1487/B D1240126

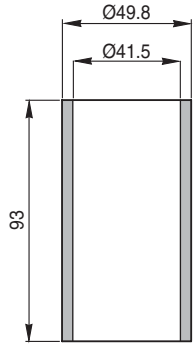
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T11



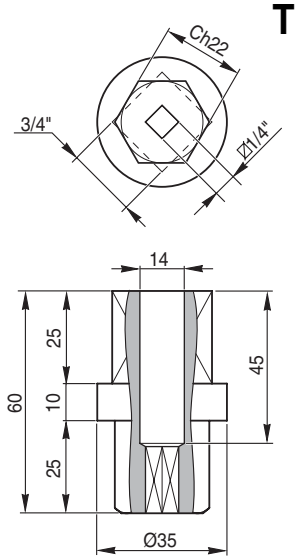
2312 D1240075

T12



2323 D1240127

T13



0870 D1240129

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17 Circuit diagrams

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Circuit diagrams

- The circuit diagrams valid at the date of printing are part of these repair instructions.
- The circuit diagrams valid for the machine serial number can be found in the spare parts catalogue for the machine.

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17.1 Wiring diagram

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Standardverkabelung: standard wireing:	dicke Linien thick lines	Platinenverdrahtung: connection on printed circuit board:	dünne Linien thin lines

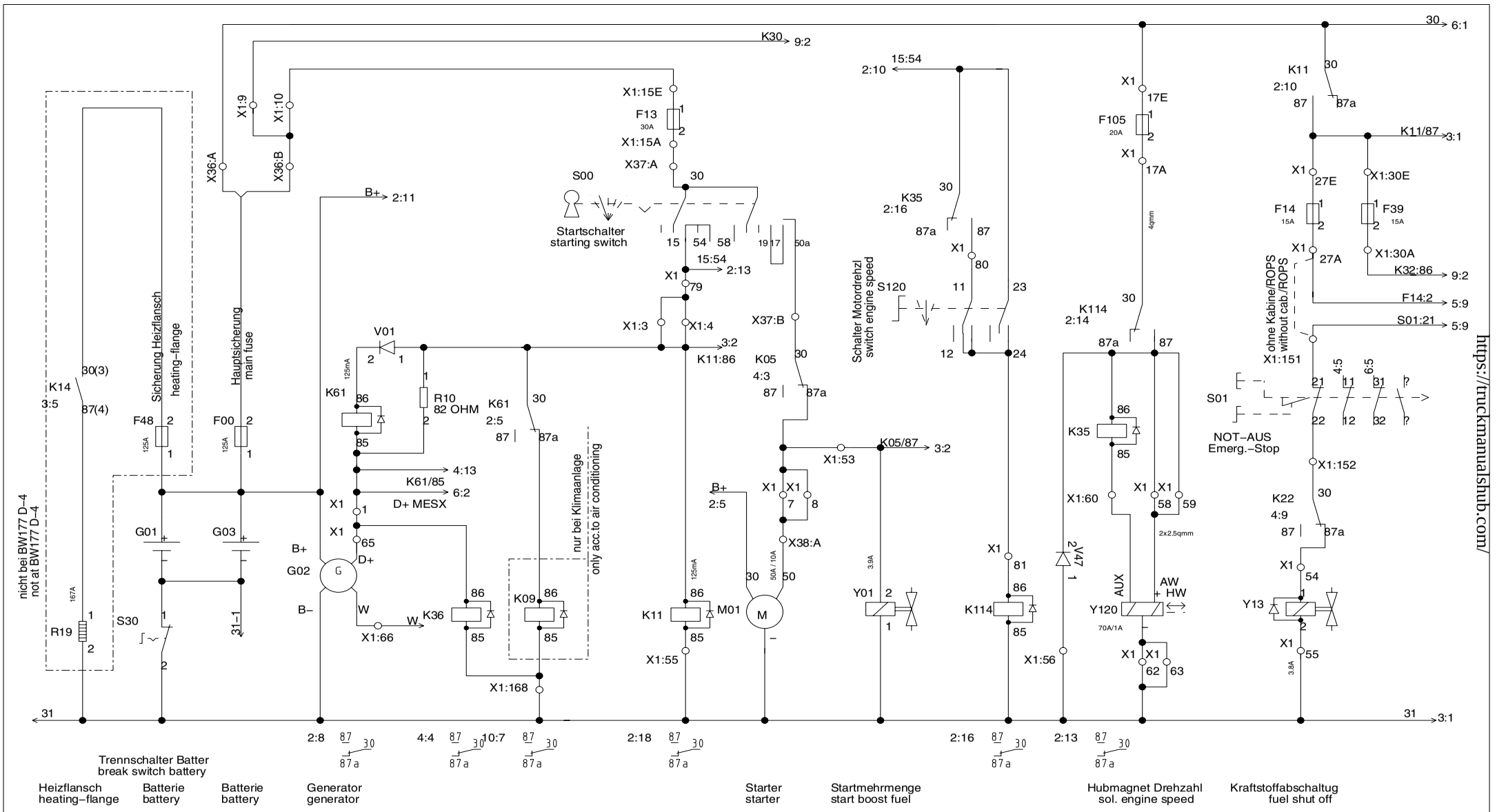
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Blatt Nr.: sheet no.:	Zeichnungsnummer drawing – no.	Funktionsgruppe	function unit
001	582 701 97	Stromlaufplan	Circuit Diagram
002	582 701 97	Versorgung, Starten, Motordrehzahl	supply, starting unit, engine–speed
003	582 701 97	Motor–Heizflansch, Signalhorn, Geschwindigkeit–Anz.	engine heating–flange cont., warning horn, speedometer
004	582 701 97	Bremse, Rückfahrwarneinr., Anzeige	brake, back up alarm, indicator
005	582 701 97	Fahrstufen, Sitzkontaktsch., Vibration	speed–ranges, seat–switch, vibr.
006	582 701 97	ZA Messtechnik	option measurement equipm.
007	582 701 97	BOMAG Compaction Management BCM	BOMAG Compaction Management BCM
008	582 701 97	ZA Beleuchtung und StvZO	opt. illumination and StvZO
009	582 701 97	ZA Kabine, Beleuchtung, Radio, Tachograph	opt. cabin, headlights, radio, tachograph
010	582 701 97	ZA Kabinenheizung, Klimaanlage, Zusatzheizung	opt. cabin–heater, air conditioning, add. heater
101	582 701 97	Bauteilliste	component listing

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	Gez.: 22.03.2005 Name: Seis	Stromlaufplan circuit diagram	Seite: 001 von: 001 page: from: 001	582 701 97
	Gepr.: 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: 001 sheet no.:

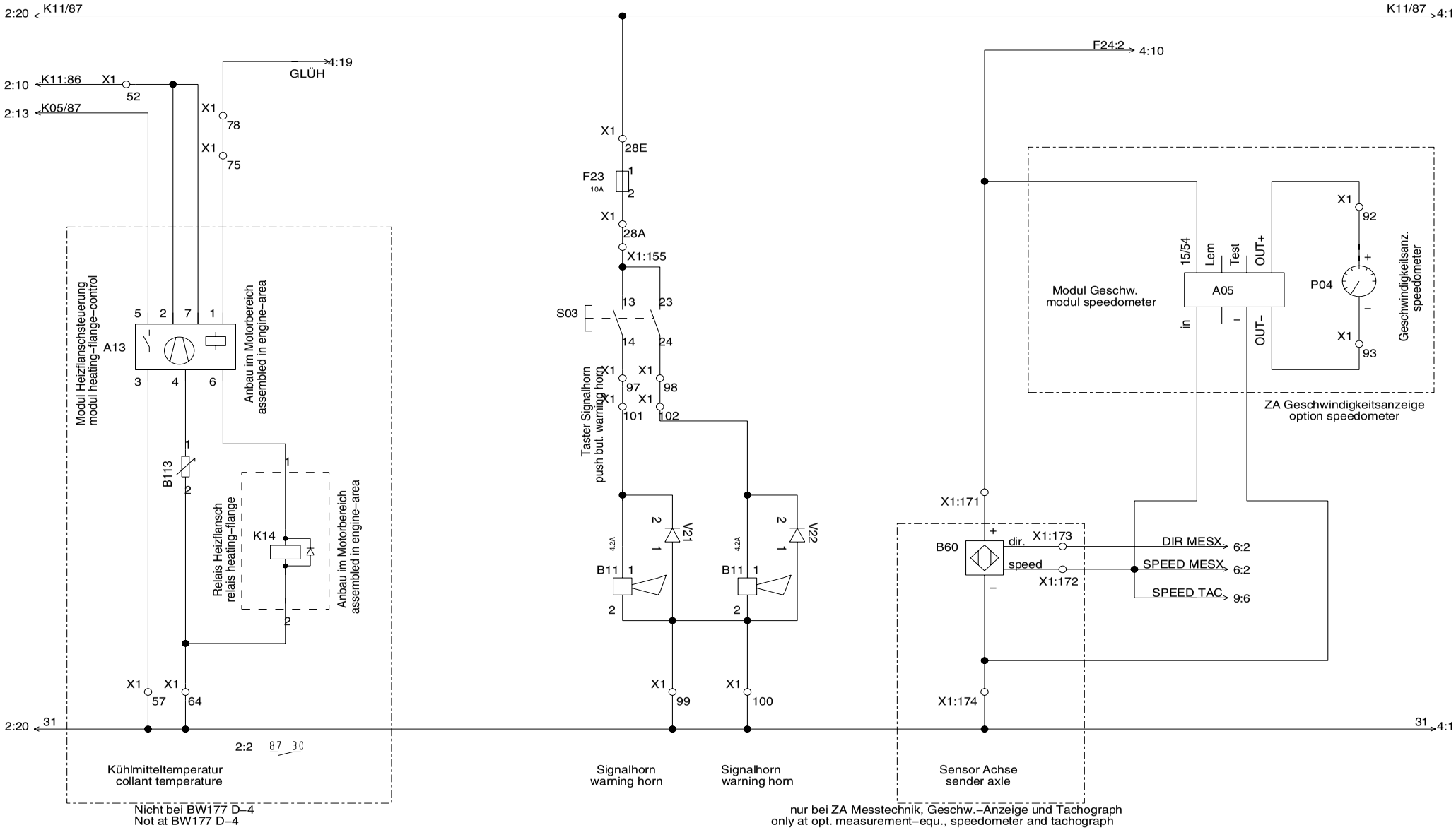
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	Gez.: 22.03.2005 Name: Seis	Versorgung, Starten, Motordrehzahl supply, starting unit, engine–speed	Seite: 1 von: 1 page: 1 from: 1	582 701 97
	Gepr. 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 002

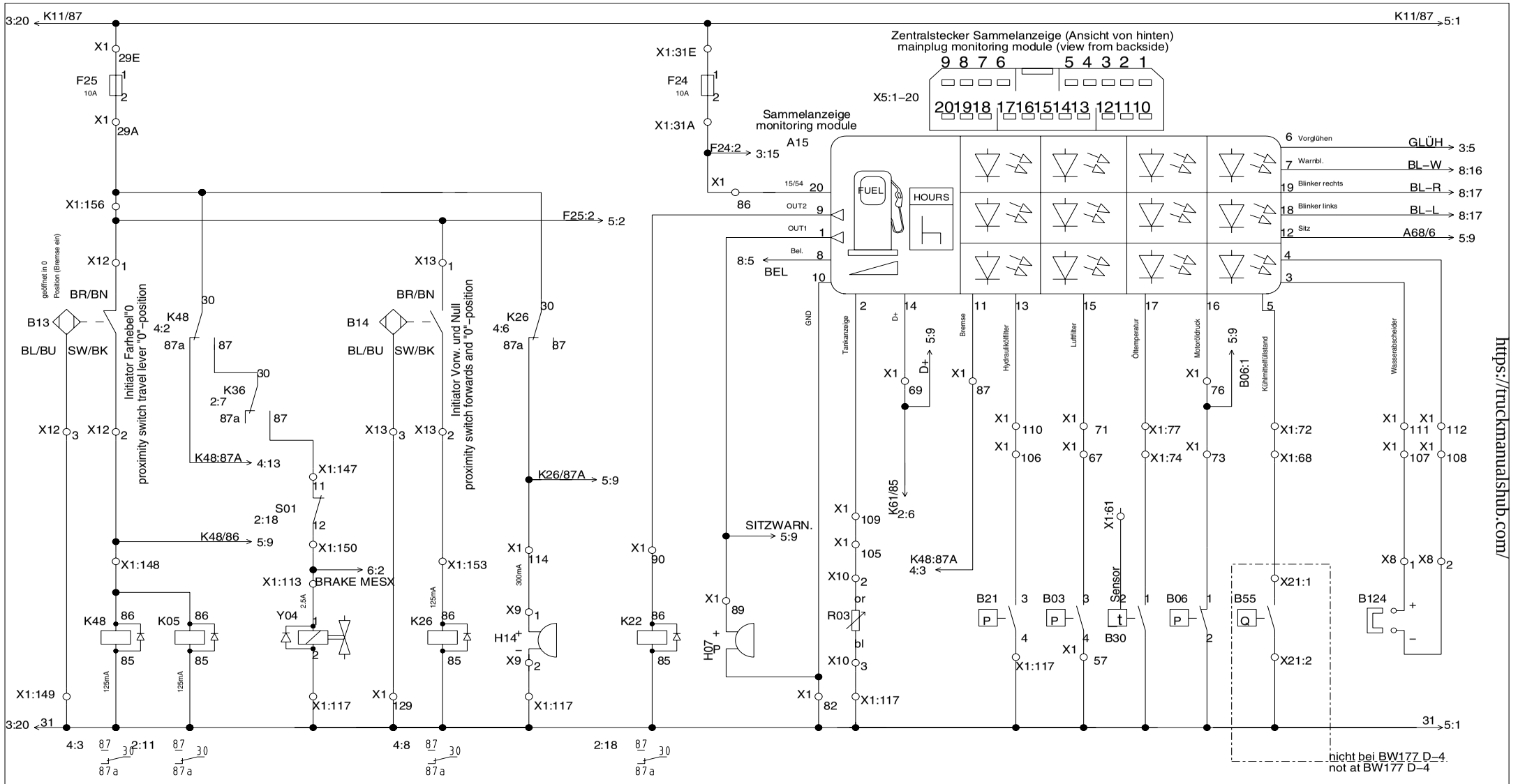
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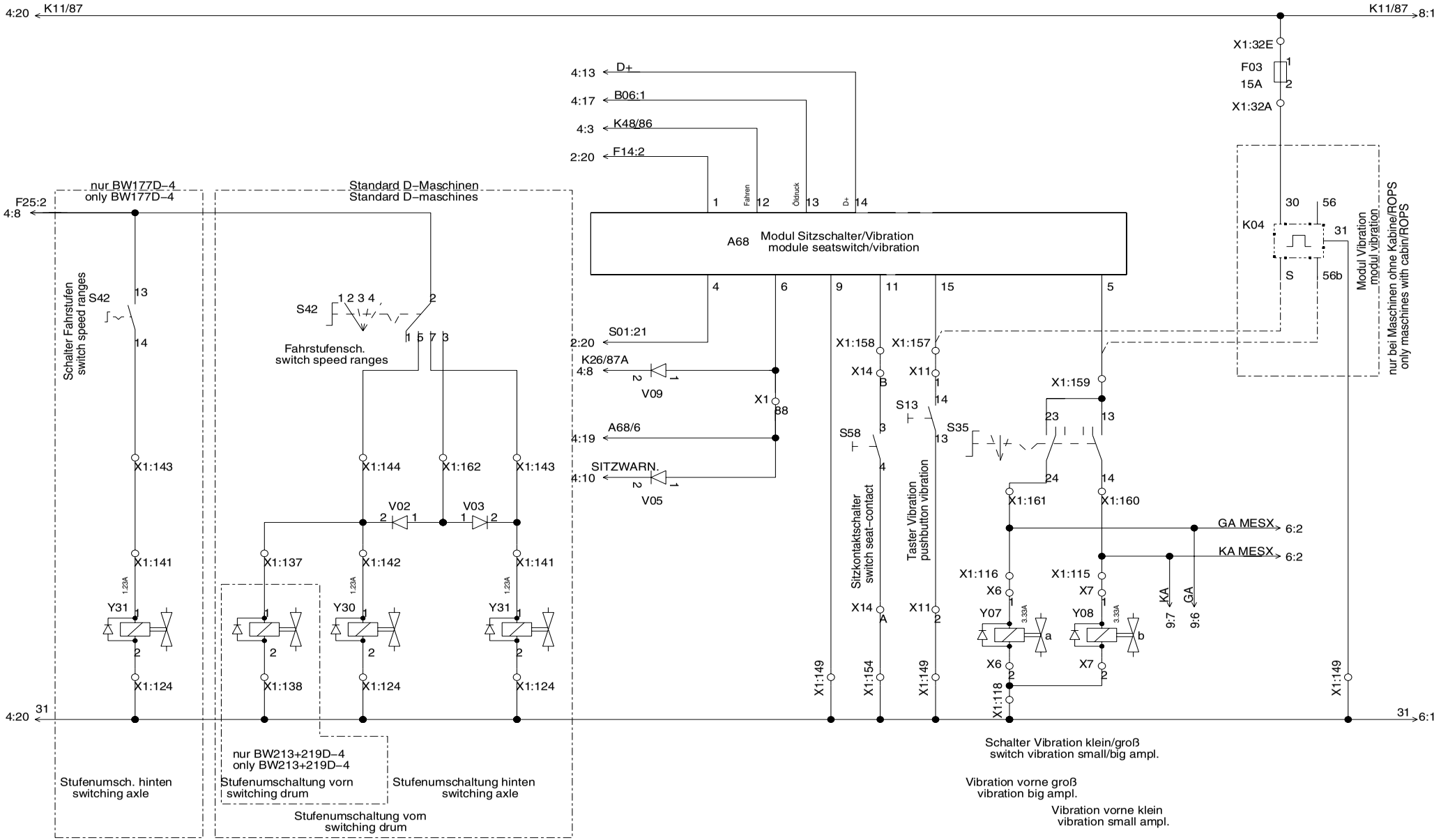
	Gez.: 22.03.2005 Name: Seis Gepr. 23.03.2005 Name: Seis	Motor–Heizflansch, Signalhorn, Geschwindigkeit–Anz. engine heating–flange cont., warning horn, speedometer	Seite: page: 1 von: from: 1 Ers.f.: Replaces:	582 701 97 Blatt Nr.: sheet no.: 003



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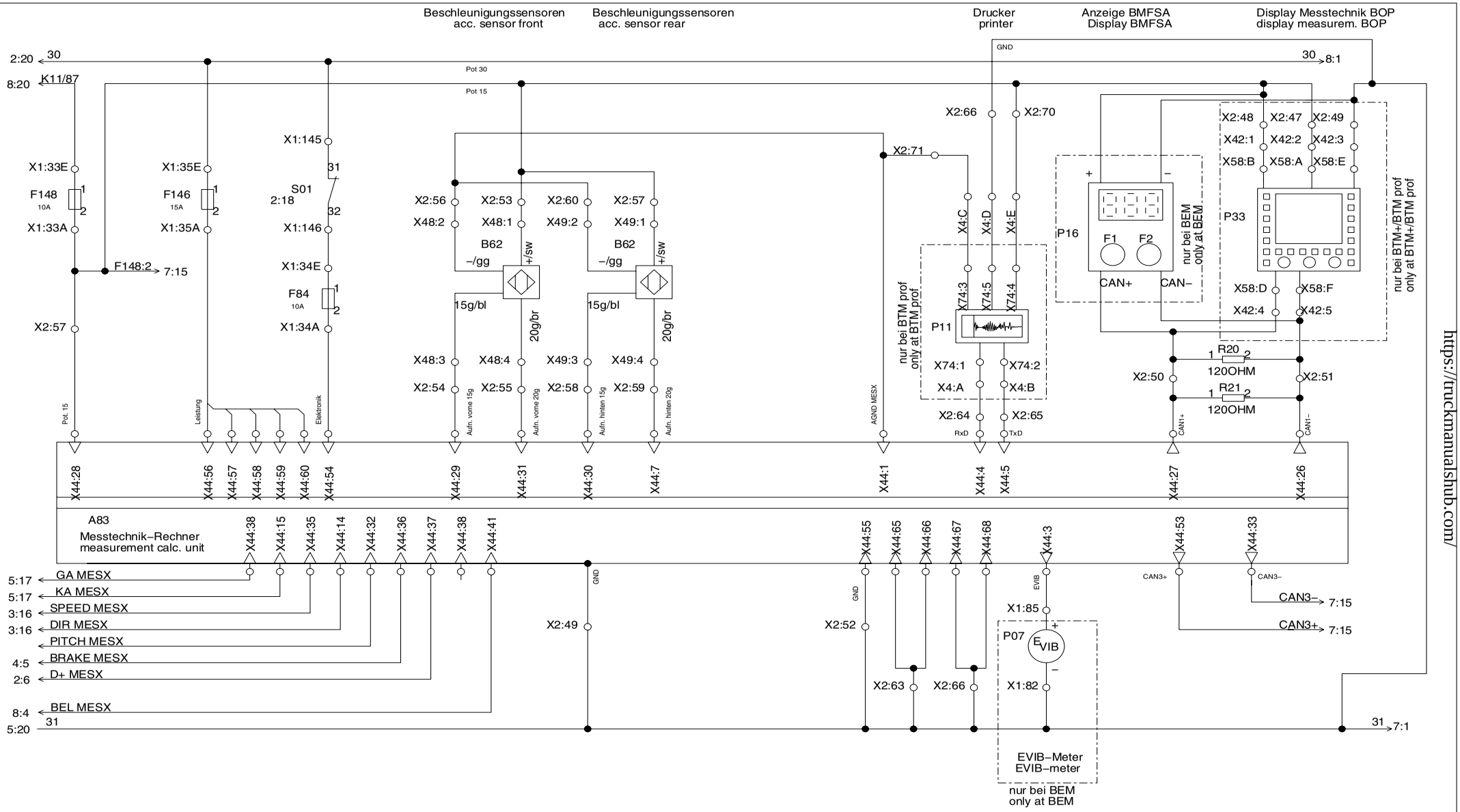
	Gez.: 22.03.2005 Name: Seis	Bremse, Rückfahrwarneinr., Anzeige brake, back up alarm, indicator	Seite: 1 von: 1 page:	582 701 97
	Gepr.: 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: 004 sheet no.:



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

	Gez.: 22.03.2005 Name: Seis	Fahrstufen, Sitzkontaktsch., Vibration speed–ranges, seat–switch, vibr.	Seite: 1 von: 1 page:	582 701 97	
	Gepr. 23.03.2005 Name: Seis		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 005	

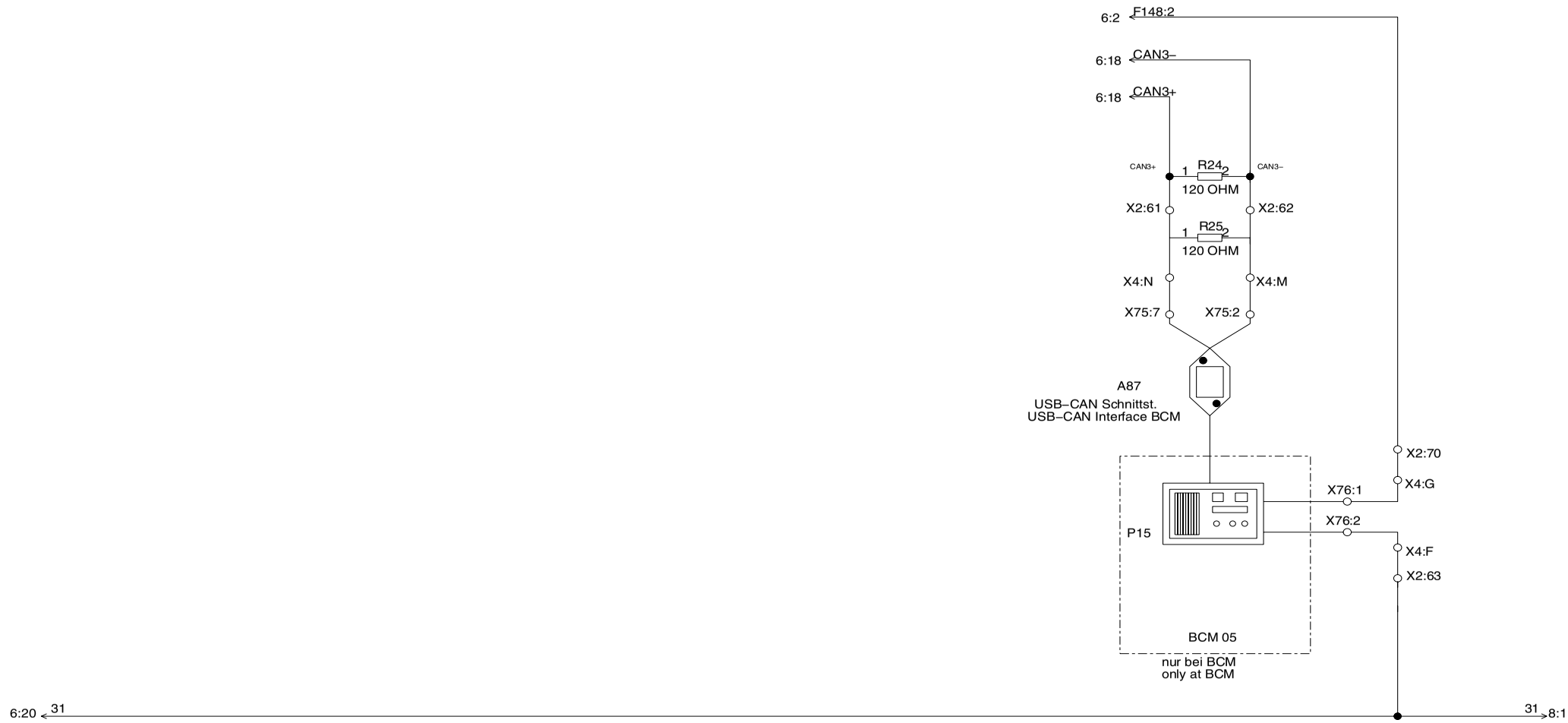
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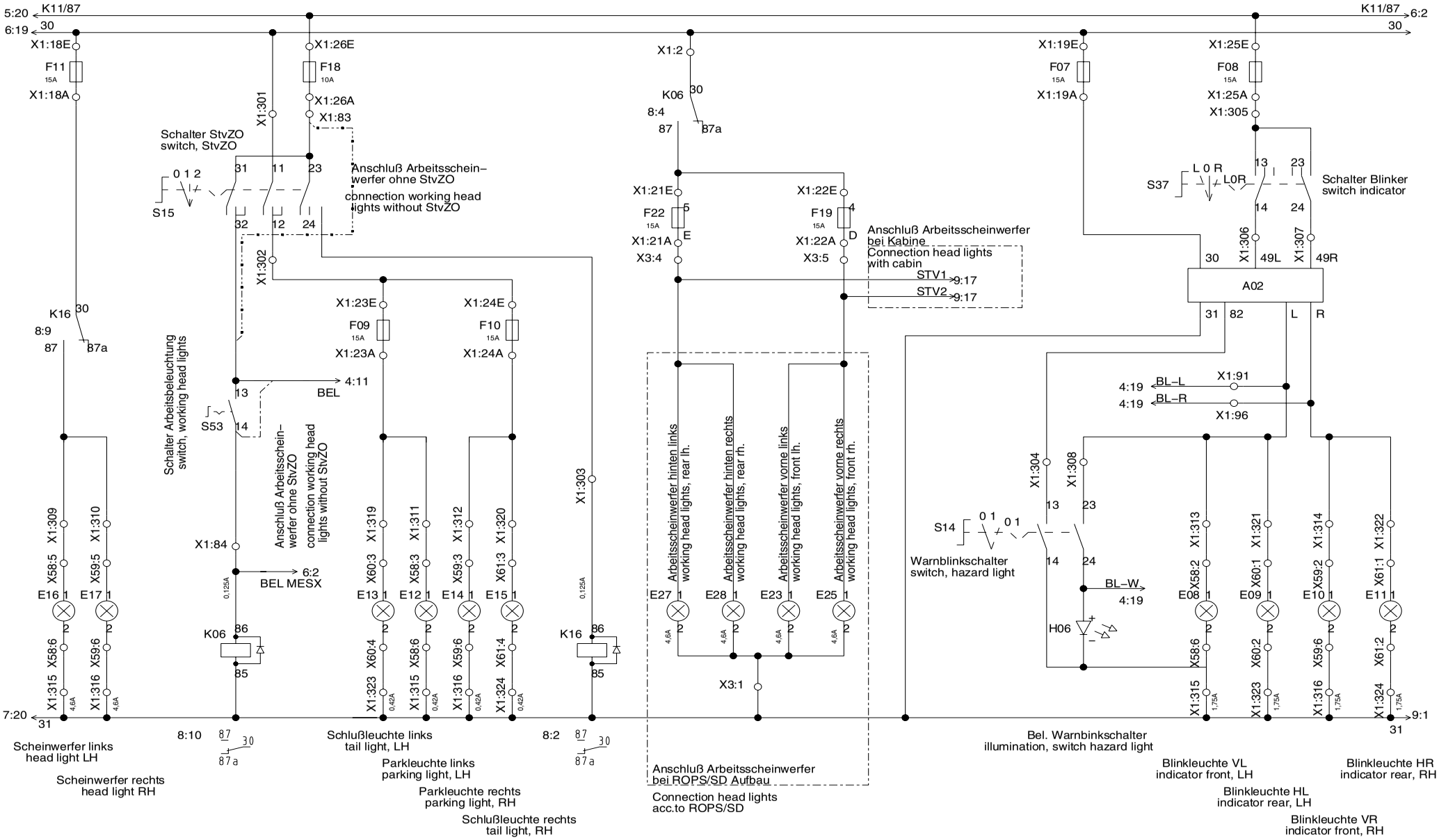
	Gez.: 22.03.2005 Name: Seis	ZA Messtechnik option measurement equipm.	Seite: 1 von: 1 page: 1 from: 1	582 701 97	
	Gepr. 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 006	



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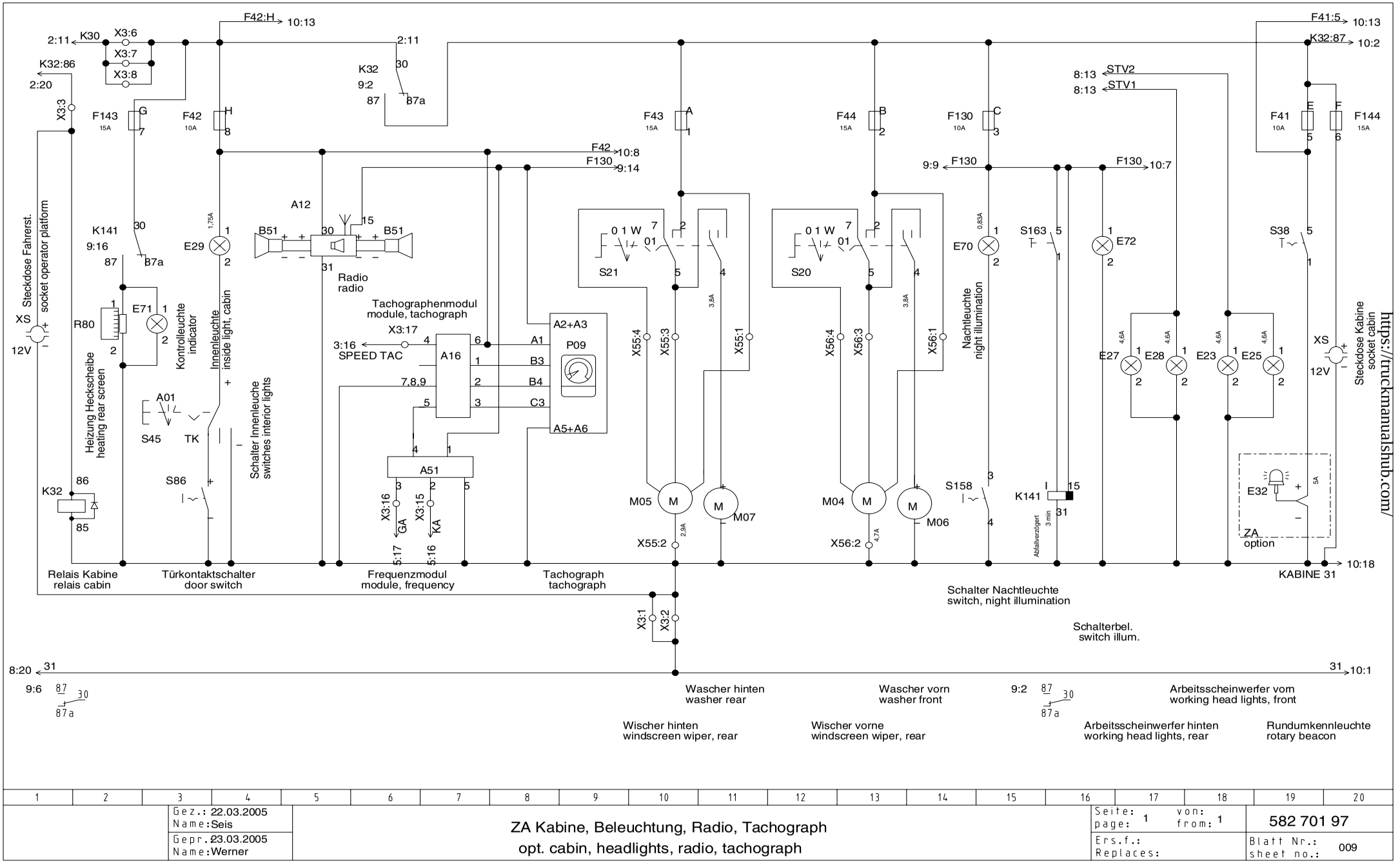
	Gez.: 22.03.2005 Name: Seis	BOMAG Compaction Management BCM	Seite: 1 von: 1 page: 1 from: 1	582 701 97	
	Gepr. 23.03.2005 Name: Werner	BOMAG Compaction Management BCM	Ers.f.: Replaces:	Blatt Nr.: 007 sheet no.: 007	



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	Gez.: 22.03.2005 Name: Seis	ZA Beleuchtung und StvZO opt. illumination and StvZO	Seite: 1 von: 1 page:	582 701 97
	Gepr. 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: 008 sheet no.:



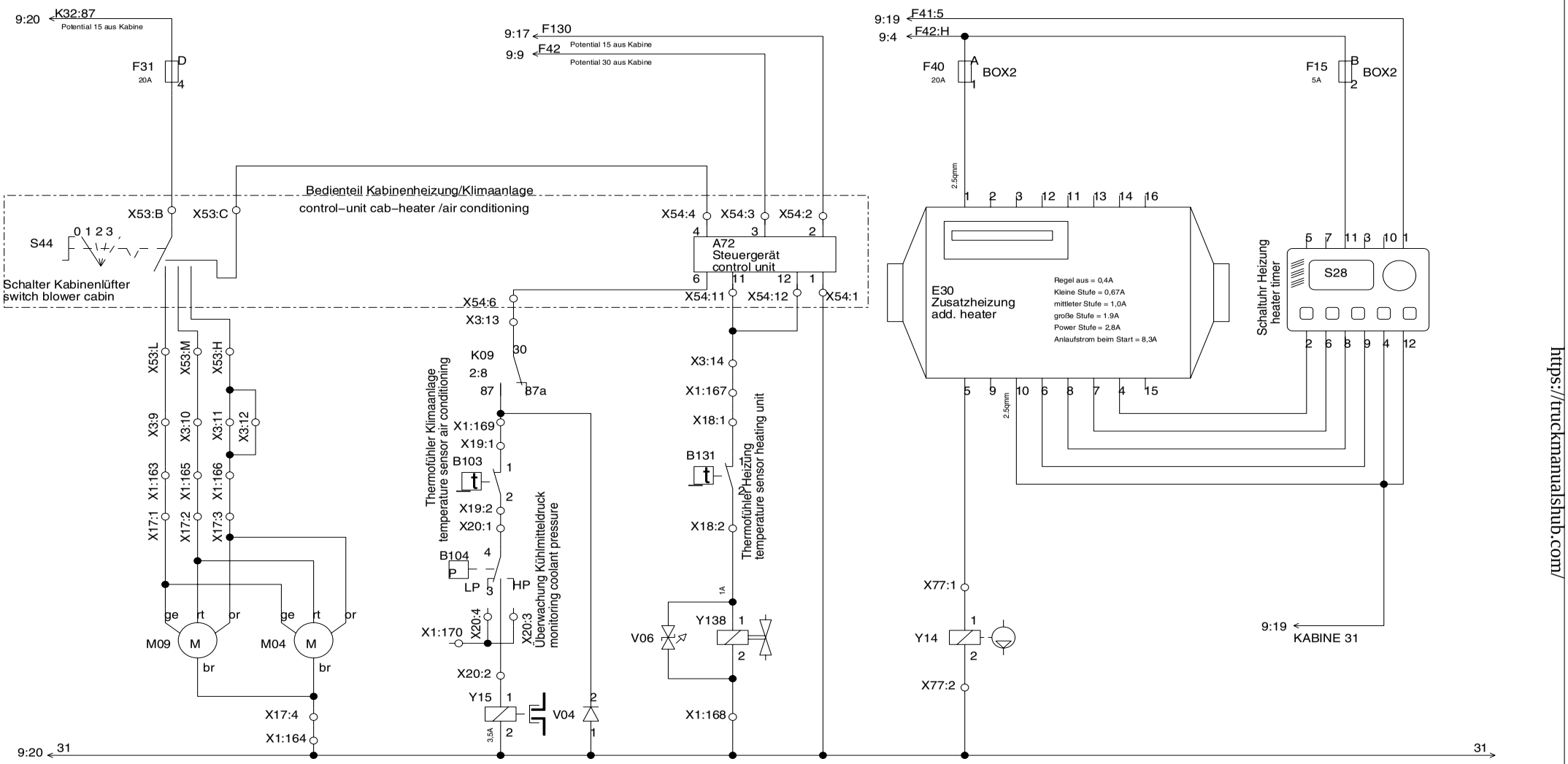
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	Gez.: 22.03.2005 Name: Seis	ZA Kabine, Beleuchtung, Radio, Tachograph opt. cabin, headlights, radio, tachograph	Seite: 1 von: 1 page: 1 from: 1
	Gepr. 23.03.2005 Name: Werner		Ers.f.: Replaces:

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sheet no.:



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	Gez.: 22.03.2005 Name: Seis	ZA Kabinenheizung, Klimaanlage, Zusatzheizung opt. cabin–heater, air conditioning, add. heater	Seite: page: 1 von: from: 1	582 701 97	
	Gepr. 23.03.2005 Name: Werner		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 010	

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Name	Bl.	Pf.	Benennung		TYP
	005	4			MAX. 1,67A
A02	008	17			
A05	003	17	Elektronik Geschwindigkeitsanzeige	Electronic system, speedometer	MODUL
A12	009	5	Radio	Radio	
A13	003	3	Steuergeraet Heizung	Control unit, heating	
A15	004	16	Ueberwachungsmodul	monitoring module	
A16	009	7	Elektronik Tachograph	Electronic system, tachograph	
A51	009	6	Platine Frequenzanzeige	Circuit board,frequenzy meter	
A68	005	10	Modul Sitzkontakt	Modul seat contact	MAX. 0,12A
A72	010	11	Steuergeraet Klimaanlage, Heizung	Control unit,air conditioning,heating	
A83	006	6	Elektronik Messtechnik	electronic measurement–equipment	
A87	007	15	USB–CAN Schnittstelle BCM	USB–CAN Interface BCM	
B03	004	15	Unterdruckschalter Luftfilter	Vacuum switch, air cleaner	
B06	004	17	Druckschalter Motoroel	Pressure switch, engine oil	
B11	003	9	Signalhorn	Warning horn	MAX.5A
B11	003	11	Signalhorn	Warning horn	MAX.5A
B13	004	2	Naeherungsinitiator Fahrhebel links	Proximity switch, travel lever, lh.	
B14	004	6	Naeherungsinitiator Fahrhebel rechts	Proximity switch, travel lever, rh.	
B21	004	14	Differenzdruckschalter Hydr.–Oelfilter	Pressure diff. switch, hydr. oil filter	
B30	004	16	Temperaturschalter Motoroel	Temperature switch, engine oil	
B51	009	5	Lautsprecher Radio	Speaker radio	
B51	009	6	Lautsprecher Radio	Speaker radio	
B55	004	17	Kuehlmittelstand Ausgleichsbehaelter	Coolant charge expansion tank	
B60	003	14	Aufnehmer Achsgeschwindigkeit	Sensor, axle speed	
B61	006	12	Aufnehmer Verstellzylinder	Sensor, ajustable zylinder	
B62	006	8	Beschleunigungsaufnehmer	Acceleration sensor	
B62	006	10	Beschleunigungsaufnehmer	Acceleration sensor	
B103	010	7	Temperaturschalter Klimaanlage	Temperature switch, air conditioning	
B104	010	7	Druckschalter Klimaanlage	Pressure switch, air conditioning	
B113	003	3	EMR Temperaturgeber Kuehlmittel	EMR Temperature switch, collant	
B124	004	19	Geber Wasserstandsabscheider Diesel	Sender, water separator fuel	
B131	010	10	Temperaturschalter Heizung	Temperature switch, heating	
E08	008	17	Blinkleuchte vorne links	Indicator, front, lh.	MAX. 1,75A
E09	008	18	Blinkleuchte hinten links	Indicator, rear, lh.	MAX. 1,75A
E10	008	19	Blinkleuchte vorne rechts	Indicator, front, rh.	MAX. 1,75A
E11	008	19	Blinkleuchte hinten rechts	Indicator, rear, rh.	MAX. 1,75A
E12	008	7	Parkleuchte links	Parking light, lh.	MAX. 0,42A
E13	008	6	Schlussleuchte links	Tail light, lh.	MAX. 0,42A
E14	008	7	Parkleuchte rechts	Parking light, rh.	MAX. 0,42A
E15	008	8	Schlussleuchte rechts	Tail light, rh.	MAX. 0,42A
E16	008	2	Scheinwerfer links	Head light, lh.	MAX. 4,6A
E17	008	2	Scheinwerfer rechts	Head light, rh.	MAX. 4,6A
E23	008	11	Arbeitsscheinwerfer vorne links	Working head light, front, lh.	MAX. 4,6A
E23	009	18	Arbeitsscheinwerfer vorne links	Working head light, front, lh.	4,6A
E25	008	12	Arbeitsscheinwerfer vorne rechts	Working head light, front, rh.	MAX. 4,6A
E25	009	19	Arbeitsscheinwerfer vorne rechts	Working head light, front, rh.	4,6A
E27	008	10	Arbeitsscheinwerfer hinten links	Working head light, rear, lh.	MAX. 4,6A
E27	009	17	Arbeitsscheinwerfer hinten links	Working head light, rear, lh.	4,6A
E28	008	11	Arbeitsscheinwerfer hinten rechts	Working head light, rear, rh.	MAX. 4,6A
E28	009	17	Arbeitsscheinwerfer hinten rechts	Working head light, rear, rh.	4,6A
E29	009	4	Innenleuchte Kabine	Inside light, cabin	1,75A
E30	010	13	Heizgeraet	Heating unit	
E32	009	19	Kennleuchte	Warning light	5A
E70	009	15	Nachtleuchte	Night lamp	0,83A
E71	009	3	Kontrolleuchte Schalter Heckscheibenheizung	indicator light switch rear screen	1,75A
E72	009	16	Beleuchtung Bedienschalter	illum. Switches	
F00	002	4	Hauptsicherung Batterie	Fuse, main, battery	125A
F03	005	18	Sicherung Vibration	Fuse, vibration	MAX. 1,23A
F07	008	15	Sicherung Warnblinker	Fuse, hazard light	15A
F08	008	18	Sicherung Blinker u. Arbeitsscheinw.	Fuse, indicators a. work. head light	15A
F09	008	6	Sicherung Park– u. Schlussl. links	Fuse, parking and tail light, lh.	10A
F10	008	8	Sicherung Park– u. Schlussl. rechts	Fuse, parking and tail light, rh.	10A
F11	008	2	Sicherung Scheinwerfer links	Fuse, head light, lh.	15A
F13	002	10	Sicherung Startschalter	Fuse, starter switch	30A
F14	002	18	Sicherung Hubmagnet Motor	Fuse, shut off solenoid, engine	15A
F15	010	18	Sicherung Heizgeraet	Fuse, heating unit	BOX2
F18	008	5	Vorsicherung Arbeitsscheinw. vorne	Primary fuse, work. head light, fr.	30A
F19	008	12	Sicherung Arbeitsscheinw. vorne li.	Fuse, working head light, front, lh.	30A
F22	008	10	Sicherung Arbeitsscheinwerfer hinten	Fuse, working head lights, rear	30A
F23	003	9	Sicherung Signalhorn	Fuse, warning horn	10A
F24	004	10	Sicherung Ueberwachungsmodul	Fuse, monitoring module	10A
F25	004	2	Sicherung Magnetv. Fahren u. Bremse	Fuse, sol. valve, travel and brake	10A
F31	010	3	Sicherung Kabinenluefter	Fuse, cabin ventilator	
F39	002	19	Hauptsicherung Kabine	Main fuse, cab	15A
F40	010	13	Sicherung Kabinenheizung	Fuse, heating unit cab	BOX2
F41	009	19	Sicherung Rundumkennleuchte	Fuse, rotary beacon	
F42	009	4	Sicherung Kabineninnenleuchte	Fuse, inside light cab	
F43	009	10	Sicherung Wischermotor hinten	Fuse, wipermotor rear	
F44	009	13	Sicherung Wischermotor vorn	Fuse, wipermotor front	
F48	002	3	Sicherung Gluehanlage	Fuse, glow plug system	125A
F84	006	5	Sicherung Steuerung (Klemme 54)	Fuse, controller (Pin 54)	10A
FM4	006	11	Platinensicherung	Multifuse	
F105	002	16	Sicherung Motordrehzahl	Fuse, motor speed	20A
F130	009	15	Sicherung Nachtleuchte	Fuse, night lamp	
F143	009	2	Sicherung Heckscheibenheizung	fuse rear screen heating unit	
F144	009	20	Sicherung Kabinensteckdose	Fuse cabin–socket	
F146	006	4	Sicherung Steuerung MESX (Potential 30)	Fuse Controller (Pot. 30)	
F148	006	2	Sicherung Steuerung MESX (Potential 15)	Fuse Controller (Pot. 15)	
G01	002	3	Batterie	Battery	103A
G02	002	5	Generator	Generator	
G03	002	4	Batterie	Battery	103A
H06	008	15	Meldeleuchte Warnblinker	Indicator light, hazard light	
H07	004	10	Warnsummer Betriebsstoerung	Warning buzzer, breakdown	MAX. 0,12A

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Gepr.: 23.03.2005
Name: Werner

Bauteilliste
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Name	Bl.	Pf.	Benennung		TYP
H14	004	8	Warnsummer Rueckwaertsfahrt	Back–up alarm buzzer	MAX. 0,12A
K04	005	18	Schrittrelais Vibration	Toggle relay, vibration	MAX. 1,23A
K05	004	3	Relais Startstrom	Relay, starting current	BOSCHW
K06	008	4	Relais Scheinwerfer hinten	Relay, head lights, rear	BOSCHW
K09	002	8	Relais Klimageraet	Relay, air conditioning	BOSCHW
K11	002	10	Relais Klemme 30 auf 15	Relay, terminal 30 to 15	BOSCHW
K14	003	5	Relais Vorgluehen	Relay, glow plug system	BOSCHL
K16	008	9	Relais Scheinwerfer vorne	Relay, head lights, front	BOSCHW
K22	004	9	Relais Hubmagnet Motor	Relay, shut off solenoid, engine	BOSCHW
K26	004	6	Relais Rueckfahrwarneinrichtung	Relay, back up alarm	BOSCHW
K32	009	2	Relais Kabine	Relay, cabin	BOSCHW
K35	002	16	Relais Selbsthaltung	Relay, holding contact	BOSCHW
K36	002	7	Relais Bremskontrolle	Relay, brake control	BOSCHW
K48	004	2	Relais Fahrhebel 0–Stellung	Relay, travel lever 0–position	BOSCHW
K61	002	5	Relais Ladekontrolle	Relay, charge control	BOSCHW
K114	002	14	Relais Motordrehzahl	Relay, engine rpm	BOSCHW
K141	009	16	Relais Heckscheibenheizung	relay, heating rear screen	BOSCHW
M01	002	11	Starter	Starter	2,3 KW
M04	009	13	Scheibenwischermotor vorne	Windscreen wiper motor, front	4,7A
M04	010	4	Scheibenwischermotor vorne	Windscreen wiper motor, front	
M05	009	10	Scheibenwischermotor hinten	Windscreen wiper motor, rear	2,9A
M06	009	14	Scheibenwaschermotor vorne	Windscreen washer motor, front	MAX. 3,8A
M07	009	11	Scheibenwaschermotor hinten	Windscreen washer motor, rear	MAX. 3,8A
M09	010	3	Kabinenluefter	Cabin ventilator	
P04	003	19	Geschwindigkeitsanzeige	Speedometer	
P07	006	15	Omegameter	Omegameter	
P09	009	8	Frequenz– und Geschwindigkeitsanzeige	Frequency– and Speedometer	
P11	006	14	Drucker	Printer	
P15	007	16	BCM 03 Bildschirm	BCM 03 terminal	
P16	006	16	Diagnose, Variomatic	Diagnostics, varimatic	
P33	006	18	Opus 21	Opus 21	
R03	004	12	Geber Tankanzeige	Sender, level gauge	
R10	002	6	Parallelwiderstand	Parallel resistor	82 OHM
R19	002	2	Heizflansch	heater flange	167A
R20	006	17	Widerstand	Resistor	120OHM
R21	006	17	Widerstand	Resistor	120OHM
R24	007	15	Widerstand	Resistor	120 OHM
R25	007	15	Widerstand	Resistor	120 OHM
R80	009	2	Heizung Heckscheibe	heating rear screen	
S00	002	10	Startschalter	Starter switch	
S01	002	18	Schalter NOT AUS	Switch, emergency off	
S03	003	9	Taster Signalhorn	Push button, warning horn	
S13	005	13	Vibrationsschalter Fahrhebel rechts	Switch, vibration, travel lever, rh.	
S14	008	15	Warnblinkschalter	Switch, hazard light	
S15	008	4	Beleuchtungsschalter StVZO	Switch, lighting StVZO	
S20	009	13	Schalter Scheibenwischer vorne	Switch, windscreen wiper, front	
S21	009	10	Schalter Scheibenwischer hinten	Switch, windscreen wiper, rear	
S28	010	17	Schalter Kabinenheizung	Switch, cabin heating	
S30	002	3	Batterietrennschalter	Switch, battery disconnect	
S35	005	15	Vibrationsschalter klein/gross	Switch, vibration low/high	
S37	008	18	Schalter Blinker	Switch, indicator	
S38	009	19	Schalter Kennleuchte	Switch, warning light	
S42	005	3	Stufenumschalter schnell–langsam	Speed range selector, fast–slow	
S42	005	7	Stufenumschalter schnell–langsam	Speed range selector, fast–slow	
S44	010	3	Schalter Kabinenluefter	Switch, cabin ventilator	
S45	009	4	Schalter Kabineninnenleuchte	Switch, cabin inside light	
S53	008	4	Schalter Arbeitsbeleuchtung	Switch, working lights	
S58	005	13	Schalter Aetherstartanlage	Push button, ether starting unit	
S86	009	4	Schalter Tuer, links	Switch door, lh.	
S120	002	14	Schalter Motordrehzahl	Switch, engine speed	
S158	009	15	Schalter Nachtbeleuchtung	Switch, cabin night lamp	
S163	009	16	Schalter Heckscheibenheizung	switch rear screen heating unit	
V01	002	6	Diode	Diode	4UF004
V02	005	6	Diode	Diode	MAX. 1,23A
V03	005	7	Diode	Diode	MAX. 1,23A
V04	010	8	Diode	Diode	FE5B
V05	005	10	Diode	Diode	MAX. 0,12A
V06	010	9	Diode	Diode	
V09	005	10	Diode	Diode	MAX. 0,12A
V21	003	10	Diode	Diode	
V22	003	11	Diode	Diode	
V47	002	15	Diode (A7)	Diode (A7)	FE5B
X1:1	002	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:2	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:3	002	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:4	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:7	002	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:8	002	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:9	002	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:10	002	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:52	003	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:53	002	12	WAGO,E–Kasten	WAGO,E–BOX	
X1:54	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:55	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:55	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:56	002	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:57	003	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:57	004	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:58	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:59	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:60	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:61	004	15	WAGO,E–Kasten	WAGO,E–BOX	

Gez.: 22.03.2005
Name: Seis
Gepr.: 23.03.2005
Name: Werner

Bauteilliste
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	Name	Bl.	Pf.	Benennung	Ers.	TYP
1	X1:62	002	16	WAGO,E-Kasten	WAGO,E-BOX	
	X1:63	002	16	WAGO,E-Kasten	WAGO,E-BOX	
	X1:64	003	3	WAGO,E-Kasten	WAGO,E-BOX	
2	X1:65	002	5	WAGO,E-Kasten	WAGO,E-BOX	
	X1:66	002	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:67	004	15	WAGO,E-Kasten	WAGO,E-BOX	
	X1:68	004	17	WAGO,E-Kasten	WAGO,E-BOX	
	X1:69	004	13	WAGO,E-KASTEN	WAGO, E-box	
3	X1:71	004	15	WAGO,E-KASTEN	WAGO, E-box	
	X1:72	004	17	WAGO,E-Kasten	WAGO,E-BOX	
	X1:73	004	17	WAGO,E-Kasten	WAGO,E-BOX	
	X1:74	004	16	WAGO,E-Kasten	WAGO,E-BOX	
	X1:75	003	4	WAGO,E-Kasten	WAGO,E-BOX	
4	X1:76	004	17	WAGO,E-KASTEN	WAGO, E-box	
	X1:77	004	16	WAGO,E-KASTEN	WAGO, E-box	
	X1:78	003	4	WAGO,E-Kasten	WAGO,E-BOX	
	X1:79	002	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:80	002	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:81	002	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:82	004	11	WAGO,E-Kasten	WAGO,E-BOX	
5	X1:82	006	15	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:83	008	5	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:84	008	4	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:85	006	15	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:86	004	10	WAGO,E-Kasten	WAGO,E-BOX	
6	X1:87	004	13	WAGO,E-KASTEN	WAGO, E-box	
	X1:88	005	11	WAGO,E-Kasten	WAGO,E-BOX	
	X1:89	004	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:90	004	9	WAGO,E-Kasten	WAGO,E-BOX	
7	X1:91	008	17	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:92	003	19	WAGO,E-Kasten	WAGO,E-BOX	
	X1:93	003	19	WAGO,E-Kasten	WAGO,E-BOX	
	X1:96	008	17	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:97	003	9	WAGO,E-Kasten	WAGO,E-BOX	
8	X1:98	003	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:99	003	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:100	003	11	WAGO,E-Kasten	WAGO,E-BOX	
	X1:101	003	9	WAGO,E-Kasten	WAGO,E-BOX	
	X1:102	003	10	WAGO,E-Kasten	WAGO,E-BOX	
9	X1:105	004	12	WAGO,E-Kasten	WAGO,E-BOX	
	X1:106	004	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:107	004	19	WAGO,E-Kasten	WAGO,E-BOX	
	X1:108	004	20	WAGO,E-Kasten	WAGO,E-BOX	
	X1:109	004	12	WAGO,E-KASTEN	WAGO, E-box	
10	X1:110	004	14	WAGO,E-KASTEN	WAGO, E-box	
	X1:111	004	19	WAGO,E-Kasten	WAGO,E-BOX	
	X1:112	004	20	WAGO,E-Kasten	WAGO,E-BOX	
	X1:113	004	5	WAGO,E-Kasten	WAGO,E-BOX	
	X1:114	004	8	WAGO,E-Kasten	WAGO,E-BOX	
11	X1:115	005	16	WAGO,E-Kasten	WAGO,E-BOX	
	X1:116	005	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:117	004	5	WAGO,E-Kasten	WAGO,E-BOX	
	X1:117	004	8	WAGO,E-Kasten	WAGO,E-BOX	
	X1:117	004	12	WAGO,E-Kasten	WAGO,E-BOX	
12	X1:117	004	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:118	005	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:124	005	3	WAGO,E-Kasten	WAGO,E-BOX	
	X1:124	005	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:124	005	8	WAGO,E-Kasten	WAGO,E-BOX	
13	X1:129	004	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:137	005	4	WAGO,E-Kasten	WAGO,E-BOX	
	X1:138	005	4	WAGO,E-Kasten	WAGO,E-BOX	
	X1:141	005	3	WAGO,E-Kasten	WAGO,E-BOX	
	X1:141	005	8	WAGO,E-Kasten	WAGO,E-BOX	
14	X1:142	005	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:143	005	3	WAGO,E-Kasten	WAGO,E-BOX	
	X1:143	005	8	WAGO,E-Kasten	WAGO,E-BOX	
	X1:144	005	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:145	006	5	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
15	X1:146	006	5	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:147	004	5	WAGO,E-Kasten	WAGO,E-BOX	
	X1:148	004	2	WAGO,E-Kasten	WAGO,E-BOX	
	X1:149	004	1	WAGO,E-Kasten	WAGO,E-BOX	
	X1:149	005	12	WAGO,E-Kasten	WAGO,E-BOX	
16	X1:149	005	13	WAGO,E-Kasten	WAGO,E-BOX	
	X1:149	005	19	WAGO,E-Kasten	WAGO,E-BOX	
	X1:150	004	5	WAGO,E-Kasten	WAGO,E-BOX	
	X1:151	002	18	WAGO,E-Kasten	WAGO,E-BOX	
	X1:152	002	18	WAGO,E-Kasten	WAGO,E-BOX	
17	X1:153	004	6	WAGO,E-Kasten	WAGO,E-BOX	
	X1:154	005	13	WAGO,E-Kasten	WAGO,E-BOX	
	X1:155	003	9	WAGO,E-Kasten	WAGO,E-BOX	
	X1:156	004	2	WAGO,E-Kasten	WAGO,E-BOX	
	X1:157	005	13	WAGO,E-Kasten	WAGO,E-BOX	
18	X1:158	005	13	WAGO,E-Kasten	WAGO,E-BOX	
	X1:159	005	16	WAGO,E-Kasten	WAGO,E-BOX	
	X1:15A	002	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:15E	002	10	WAGO,E-Kasten	WAGO,E-BOX	
	X1:160	005	16	WAGO,E-Kasten	WAGO,E-BOX	
19	X1:161	005	14	WAGO,E-Kasten	WAGO,E-BOX	
	X1:162	005	7	WAGO,E-Kasten	WAGO,E-BOX	
	X1:163	010	3	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:164	010	5	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:165	010	3	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
20	X1:166	010	4	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:167	010	10	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:168	002	8	WAGO,E-Kasten	WAGO,E-BOX	
	X1:168	010	10	WAGO ZENTRALELEKTRIK	WAGO E-BOX	
	X1:169	010	7	WAGO ZENTRALELEKTRIK	WAGO E-BOX	

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Name	Bl.	Pf.	Benennung	Ident	TYP
X1:170	010	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:171	003	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:172	003	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:173	003	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:174	003	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:17A	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:17E	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:18A	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:18E	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:19A	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:19E	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:21A	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:21E	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:22A	008	12	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:22E	008	12	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:23A	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:23E	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:24A	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:24E	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:25A	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:25E	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:26A	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:26E	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:27A	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:27E	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:28A	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:28E	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:29A	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:29E	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:301	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:302	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:303	008	9	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:304	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:305	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:306	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:307	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:308	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:309	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:30A	002	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:30E	002	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:310	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:311	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:312	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:313	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:314	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:319	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:31A	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:31E	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:320	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:321	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:322	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:323	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:323	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:324	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:324	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:32A	005	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:32E	005	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:33A	006	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:33E	006	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:34A	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:34E	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:35A	006	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:35E	006	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X2:47	006	19	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:48	006	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:49	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:49	006	19	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:50	006	17	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:51	006	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:52	006	13	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:53	006	8	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:54	006	7	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:55	006	8	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:56	006	7	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:57	006	2	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:57	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:58	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:59	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:60	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:61	007	15	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:62	007	16	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:63	006	13	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:63	007	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:64	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:65	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:66	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:66	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:67	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:68	006	12	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:69	006	12	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:70	006	15	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:70	007	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:71	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	

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X2:73	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:74	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:75	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:76	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:77	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:78	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X3:1	008	11	STECKER ROPS/SD	conn. ROPS/SR	
X3:1	009	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:2	009	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:3	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:4	008	10	STECKER ROPS/SD	conn. ROPS/SR	
X3:5	008	12	STECKER ROPS/SD	conn. ROPS/SR	
X3:6	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:7	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:8	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:9	010	3	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:10	010	3	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:11	010	4	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:12	010	4	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:13	010	7	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:14	010	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:15	009	7	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:16	009	6	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:17	009	6	STECKER KABINE/ROPS	conn. cabin/ROPS	
X4:A	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:B	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:C	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:D	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:E	006	15	KABINENST. MESST.	con. measurem.equipm.	
X4:F	007	18	KABINENST. MESST.	con. measurem.equipm.	
X4:G	007	18	KABINENST. MESST.	con. measurem.equipm.	
X4:M	007	16	KABINENST. MESST.	con. measurem.equipm.	
X4:N	007	15	KABINENST. MESST.	con. measurem.equipm.	
X6:1	005	14	DEUTSCH	DEUTSCH connector	
X6:2	005	14	DEUTSCH	DEUTSCH connector	
X7:1	005	16	DEUTSCH	DEUTSCH connector	
X7:2	005	16	DEUTSCH	DEUTSCH connector	
X8:1	004	19	DEUTSCH	DEUTSCH connector	
X8:2	004	20	DEUTSCH	DEUTSCH connector	
X9:1	004	8	DEUTSCH	DEUTSCH connector	
X9:2	004	8	DEUTSCH	DEUTSCH connector	
XS	009	1	Steckdose	Socket	
XS	009	20	Steckdose	Socket	
X10:2	004	12	AMP SUPERSEAL	AMP connector	
X10:3	004	12	AMP SUPERSEAL	AMP connector	
X11:1	005	13	DEUTSCH	DEUTSCH connector	
X11:2	005	13	DEUTSCH	DEUTSCH connector	
X12:1	004	2	DEUTSCH	DEUTSCH connector	
X12:2	004	2	DEUTSCH	DEUTSCH connector	
X12:3	004	1	DEUTSCH	DEUTSCH connector	
X13:1	004	6	DEUTSCH	DEUTSCH connector	
X13:2	004	6	DEUTSCH	DEUTSCH connector	
X13:3	004	6	DEUTSCH	DEUTSCH connector	
X14:A	005	13	DEUTSCH	DEUTSCH connector	
X14:B	005	13	DEUTSCH	DEUTSCH connector	
X17:1	010	3	STECKER LÜFTER HKL	conn. blower	
X17:2	010	3	STECKER LÜFTER HKL	conn. blower	
X17:3	010	4	STECKER LÜFTER HKL	conn. blower	
X17:4	010	5	STECKER LÜFTER HKL	conn. blower	
X18:1	010	10	STECKER THERMOFÜHLER	conn. sender temp.	
X18:2	010	10	STECKER THERMOFÜHLER	conn. sender temp.	
X19:1	010	7	STECKER EISSCHUTZ HKL	conn. anti–ice air–cond.	
X19:2	010	7	STECKER EISSCHUTZ HKL	conn. anti–ice air–cond.	
X20:1	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:2	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:3	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:4	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X21:1	004	17	STECKER KÜHLMITTEL	connector coolant sensor	
X21:2	004	17	STECKER KÜHLMITTEL	connector coolant sensor	
X36:A	002	4	EINSPEISUNG SCHALTKAS	supply e–box	
X36:B	002	4	EINSPEISUNG SCHALTKAS	supply e–box	
X37:A	002	10	ST. ZÜNDSCHLOß E–KAST	connector ignition switch	
X37:B	002	11	ST. ZÜNDSCHLOSS E–KAS	connector ignition switch, e–box	
X38:A	002	11	ST.STARTER E–KASTEN	connector starter e–box	
X42:1	006	18	STECKER OPUS21	conn. OPUS21	
X42:2	006	19	STECKER OPUS21	conn. OPUS21	
X42:3	006	19	STECKER OPUS21	conn. OPUS21	
X42:4	006	18	STECKER OPUS21	conn. OPUS21	
X42:5	006	18	STECKER OPUS21	conn. OPUS21	
X44:1	006	13	MESX STECKER	MESX Stecker	
X44:3	006	15	MESX STECKER	MESX Stecker	
X44:4	006	14	MESX STECKER	MESX Stecker	
X44:5	006	14	MESX STECKER	MESX Stecker	
X44:7	006	10	MESX STECKER	MESX Stecker	
X44:9	006	12	MESX STECKER	MESX Stecker	
X44:14	006	5	MESX STECKER	MESX Stecker	
X44:15	006	5	MESX STECKER	MESX Stecker	
X44:23	006	11	MESX STECKER	MESX Stecker	
X44:26	006	18	MESX STECKER	MESX Stecker	
X44:27	006	17	MESX STECKER	MESX Stecker	
X44:28	006	2	MESX STECKER	MESX Stecker	
X44:29	006	7	MESX STECKER	MESX Stecker	
X44:30	006	9	MESX STECKER	MESX Stecker	
X44:31	006	8	MESX STECKER	MESX Stecker	
X44:32	006	6	MESX STECKER	MESX Stecker	
X44:33	006	18	MESX STECKER	MESX Stecker	
X44:35	006	5	MESX STECKER	MESX Stecker	
X44:36	006	6	MESX STECKER	MESX Stecker	
X44:37	006	7	MESX STECKER	MESX Stecker	

Gez.: 22.03.2005
Name: Seis
Gepr.: 23.03.2005
Name: Werner

Bauteilliste
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Replaces:

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sheet no.: 105

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Name	Bl.	Pf.	Benennung	ms	TYP
X44:38	006	4	MESX STECKER	MESX Stecker	
X44:38	006	7	MESX STECKER	MESX Stecker	
X44:41	006	7	MESX STECKER	MESX Stecker	
X44:46	006	11	MESX STECKER	MESX Stecker	
X44:47	006	10	MESX STECKER	MESX Stecker	
X44:53	006	17	MESX STECKER	MESX Stecker	
X44:54	006	5	MESX STECKER	MESX Stecker	
X44:55	006	13	MESX STECKER	MESX Stecker	
X44:56	006	4	MESX STECKER	MESX Stecker	
X44:57	006	4	MESX STECKER	MESX Stecker	
X44:58	006	4	MESX STECKER	MESX Stecker	
X44:59	006	5	MESX STECKER	MESX Stecker	
X44:60	006	5	MESX STECKER	MESX Stecker	
X44:65	006	13	MESX STECKER	MESX Stecker	
X44:66	006	13	MESX STECKER	MESX Stecker	
X44:67	006	14	MESX STECKER	MESX Stecker	
X44:68	006	14	MESX STECKER	MESX Stecker	
X47:A	006	11	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X47:B	006	12	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X47:C	006	12	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X48:1	006	8	STECKER AUFN. VORNE	conn. sender front	
X48:2	006	7	STECKER AUFN. VORNE	conn. sender front	
X48:3	006	7	STECKER AUFN. VORNE	conn. sender front	
X48:4	006	8	STECKER AUFN. VORNE	conn. sender front	
X49:1	006	10	STECKER AUFN. HINTEN	conn. sender rear	
X49:2	006	9	STECKER AUFN. HINTEN	conn. sender rear	
X49:3	006	9	STECKER AUFN. HINTEN	conn. sender rear	
X49:4	006	10	STECKER AUFN. HINTEN	conn. sender rear	
X53:B	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:C	010	4	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:H	010	4	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:L	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:M	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X54:1	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:2	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:3	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:4	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:6	010	7	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:11	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:12	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X55:1	009	11	STECKER WISCHER HINTE	connector wiper rear	
X55:2	009	10	STECKER WISCHER HINTE	connector wiper rear	
X55:3	009	10	STECKER WISCHER HINTE	connector wiper rear	
X55:4	009	10	STECKER WISCHER HINTE	connector wiper rear	
X56:1	009	14	STECKER WISCHER VORNE	conn. wiper front	
X56:2	009	13	STECKER WISCHER VORNE	conn. wiper front	
X56:3	009	13	STECKER WISCHER VORNE	conn. wiper front	
X56:4	009	13	STECKER WISCHER VORNE	conn. wiper front	
X58:2	008	17	STECKER STVZO VL	Con. STVZO FL	
X58:3	008	7	STECKER STVZO VL	Con. STVZO FL	
X58:5	008	2	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	2	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	7	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	17	STECKER STVZO VL	Con. STVZO FL	
X58:A	006	19	STECKER BOP	Connector BOP	
X58:B	006	18	STECKER BOP	Connector BOP	
X58:D	006	18	STECKER BOP	Connector BOP	
X58:E	006	19	STECKER BOP	Connector BOP	
X58:F	006	18	STECKER BOP	Connector BOP	
X59:2	008	19	STECKER STVZO VR	Con. STVZO FR	
X59:3	008	7	STECKER STVZO VR	Con. STVZO FR	
X59:5	008	2	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	2	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	7	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	19	STECKER STVZO VR	Con. STVZO FR	
X60:1	008	18	STECKER STVZO HL	Con. STVZO BL	
X60:2	008	18	STECKER STVZO HL	Con. STVZO BL	
X60:3	008	6	STECKER STVZO HL	Con. STVZO BL	
X60:4	008	6	STECKER STVZO HL	Con. STVZO BL	
X61:1	008	19	STECKER STVZO HR	Con. STVZO BR	
X61:2	008	19	STECKER STVZO HR	Con. STVZO BR	
X61:3	008	8	STECKER STVZO HR	Con. STVZO BR	
X61:4	008	8	STECKER STVZO HR	Con. STVZO BR	
X74:1	006	14	STECKER DRUCKER	con. printer	
X74:2	006	14	STECKER DRUCKER	con. printer	
X74:3	006	14	STECKER DRUCKER	con. printer	
X74:4	006	15	STECKER DRUCKER	con. printer	
X74:5	006	14	STECKER DRUCKER	con. printer	
X75:2	007	16	SUB–D STECKER BCM INT	con. SUB–D BCM	
X75:7	007	15	SUB–D STECKER BCM INT	con. SUB–D BCM	
X76:1	007	17	STECKER VERS. BCM	con. Power–sup. BCM	
X76:2	007	17	STECKER VERS. BCM	con. Power–sup. BCM	
X77:1	010	13	STECKER PUMPE STANDHE	Conn. pump add. heater	
X77:2	010	13	STECKER PUMPE STANDHE	Conn. pump add. heater	
Y01	002	12	Magnetventil Startmehrmenge	Solenoid valve, start boost fuel	MAX. 3.9A
Y04	004	5	Magnetventil Bremse	Solenoid valve, brake	MAX. 1.8A
Y07	005	14	Magnetventil Vibration vorne gross	Solenoid valve, vibration, front, high	MAX. 2,5A
Y08	005	16	Magnetventil Vibration vorne klein	Solenoid valve, vibration, front, low	MAX. 2,5A
Y13	002	18	Hubmagnet Motor	Shut off solenoid, engine	MAX. 3.8A
Y14	010	13	Kraftstoffpumpe Heizgeraet	Fuel pump, heating unit	
Y15	010	7	Magnetkupplung Klimakompressor	Magnetic clutch, air conditioning compr.	3,5A
Y30	005	6	Magnetventil Stufenumschaltung vorn	Solenoid valve, speed range sel., front	MAX. 1,67A
Y31	005	3	Magnetventil Stufenumschaltung hinten	Solenoid valve, speed range sel., rear	MAX. 1,23A
Y31	005	8	Magnetventil Stufenumschaltung hinten	Solenoid valve, speed range sel., rear	MAX. 1,23A
Y120	002	16	Magnetventil Motordrehzahl hoch	Solenoid valve, rpm engine high	
Y138	010	10	Magnetveentil Heizung	Solenoid valve, heating unit	3,5A
Y140	006	10	Magnetventil Erreger auf	solenoid valve exciter up	
Y141	006	11	Magnetventil Erreger ab	solenoid valve exciter down	

Gez.: 22.03.2005
Name: Seis
Gepr. 23.03.2005
Name: Werner

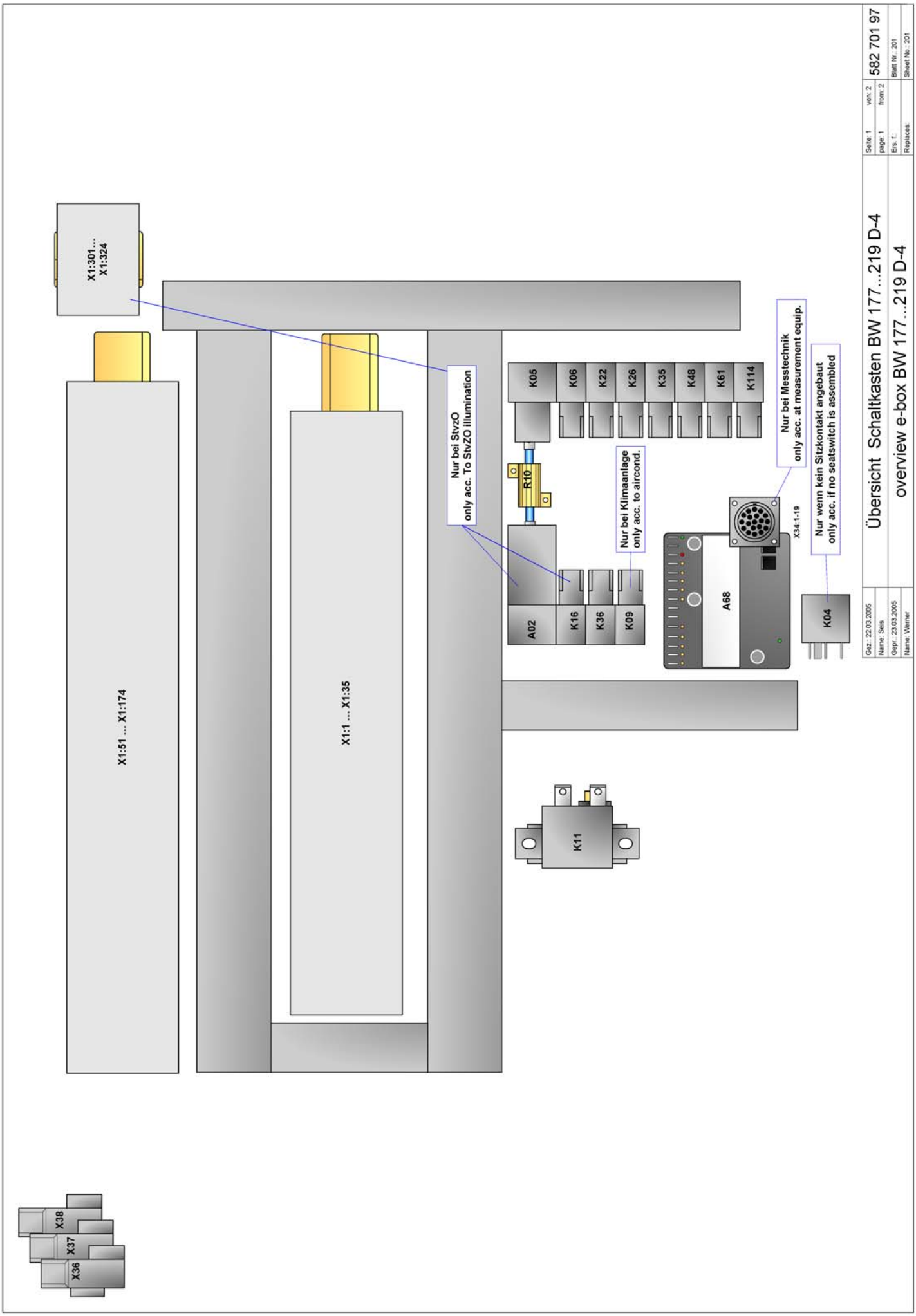
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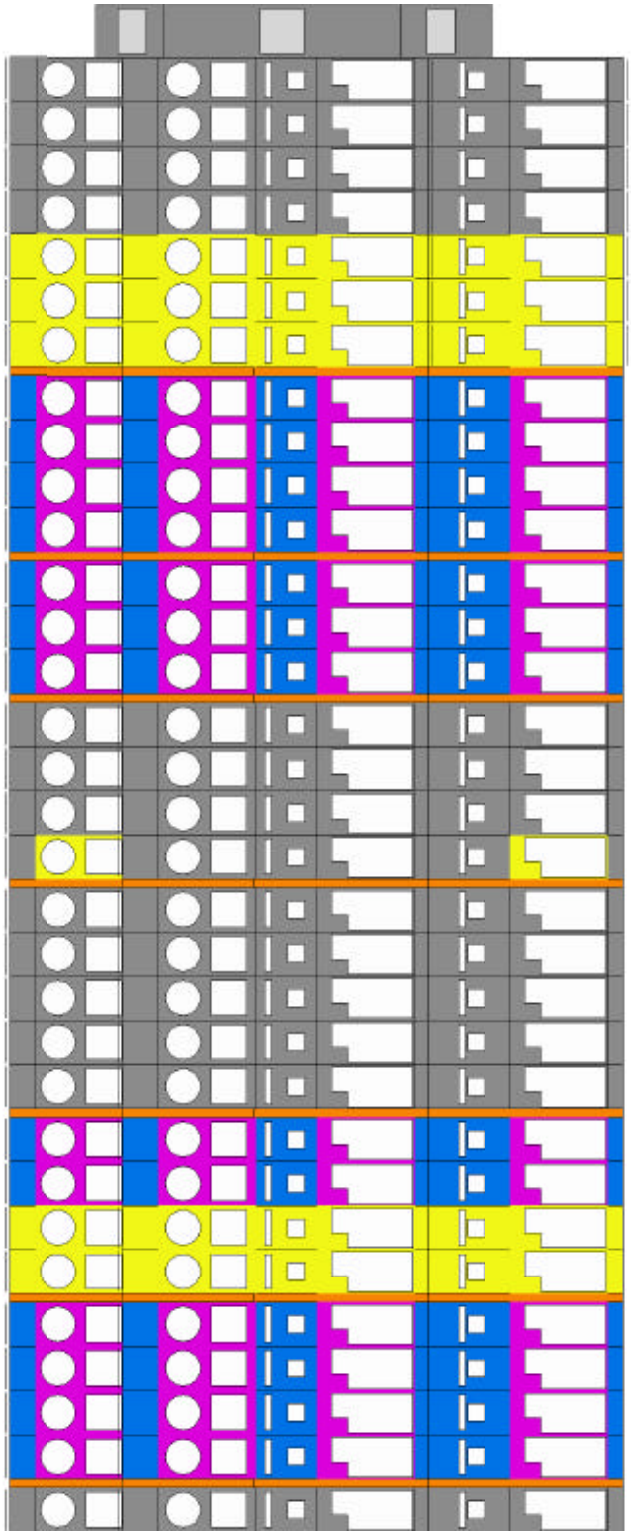
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1	249-116
2	4 x 870-101 "R" + 793-501
6	3 x 870-107 "R" + 793-501
9	870-119
10	4 x 870-109 "R" + 793-501
14	870-119
15	3 x 870-109 "R" + 793-501
18	870-119
19	3 x 870-101 "R" + 793-501
22	870-127 "R" + 793-501
23	870-119
24	5 x 870-101 "R" + 793-501
29	870-119
30	2 x 870-109 "R" + 793-501
32	2 x 870-107 "R" + 793-501
34	870-119
35	4 x 870-109 "R" + 793-501
39	870-119
40	4 x 870-101 "R" + 793-501



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Optional2 :	Projekt :	
Optional3 :	Zeichnung :	
	Plan :	
Optional4 :	Ort :	
	Betriebsmittel :	Kabelbäume D Version
Optional5 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick
Optional6 :	Artikelnummer :	210-112
Optional7 :	Bohrungsabmessungen :	5.20 x 25.00 [mm]

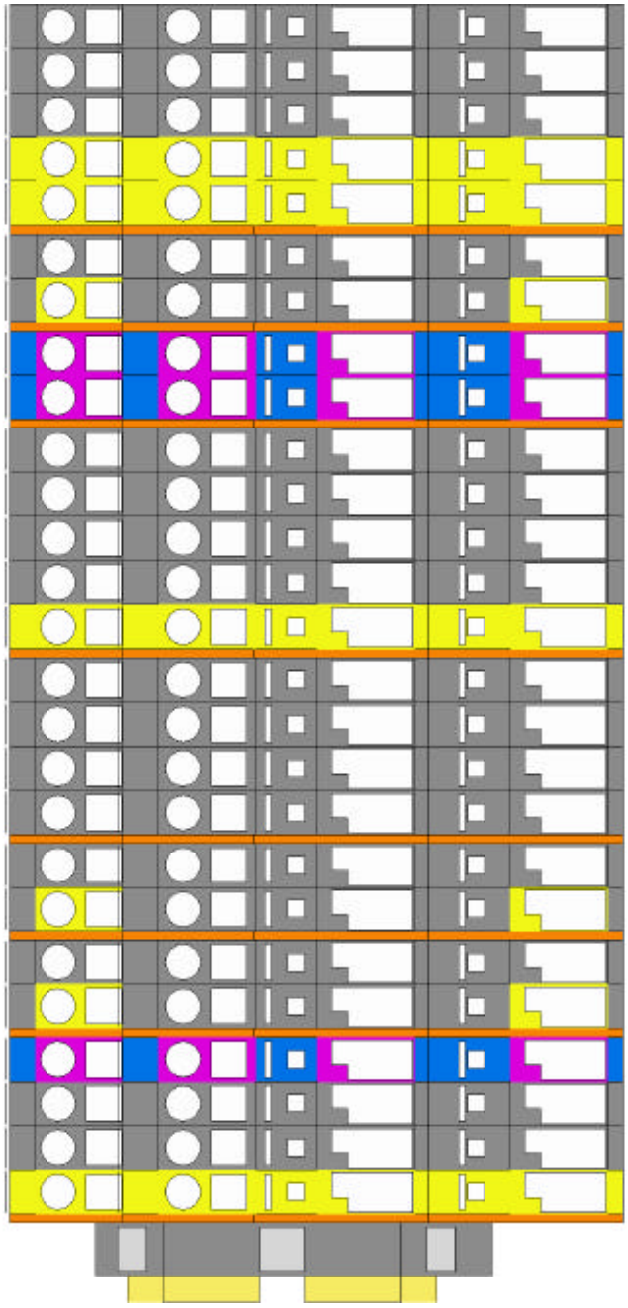
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Artikelnummer lang :
Konstrukteur :
geprüft :

Lieferadresse: :

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44	2 x 870-107 "R" + 793-501
46	870-119
47	870-101 "R" + 793-501
48	870-127 "R" + 793-501
49	870-119
50	2 x 870-109 "R" + 793-501
52	870-119
53	4 x 870-101 "R" + 793-501
57	870-107 "R" + 793-501
58	870-119
59	4 x 870-101 "R" + 793-501
63	870-119
64	870-101 "R" + 793-501
65	870-127 "R" + 793-501
66	870-119
67	870-101 "R" + 793-501
68	870-127 "R" + 793-501
69	870-119
70	870-109 "R" + 793-501
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73	870-107 "R" + 793-501
74	870-119
75	249-116



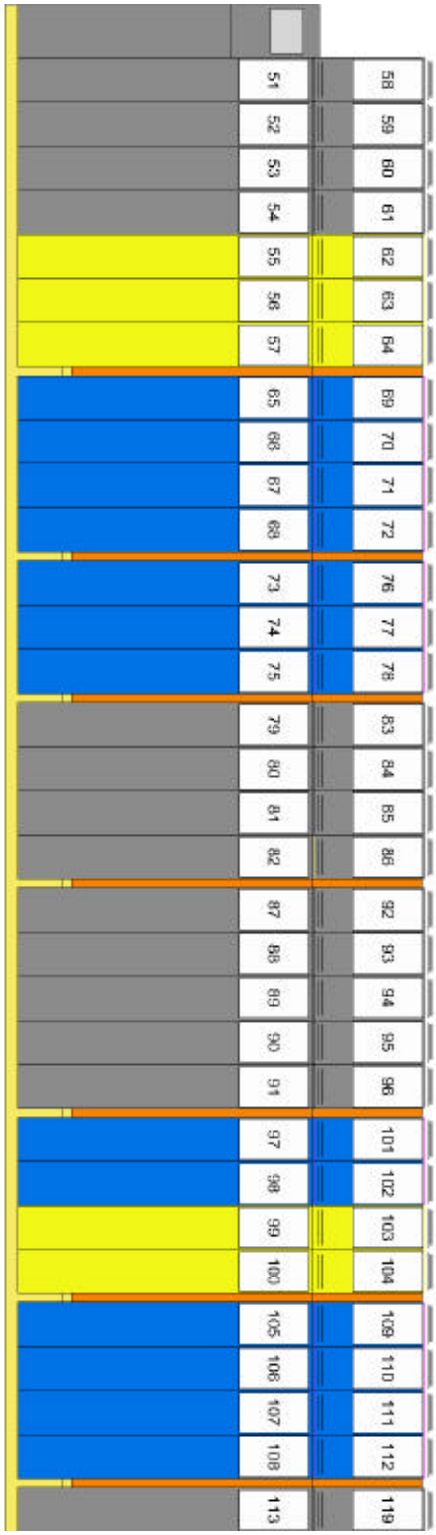
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geprüft :

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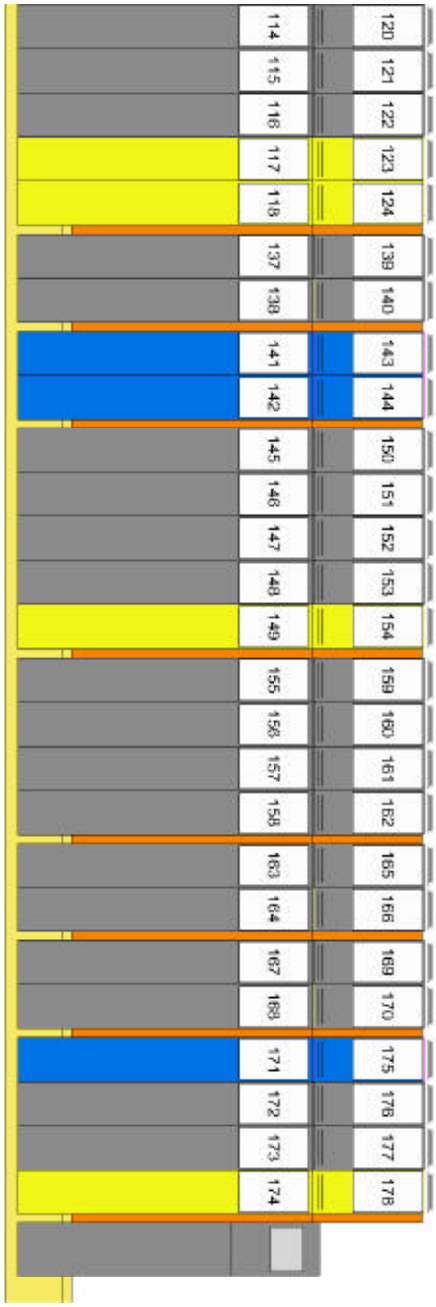
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	Artikelnummer :	210-112	
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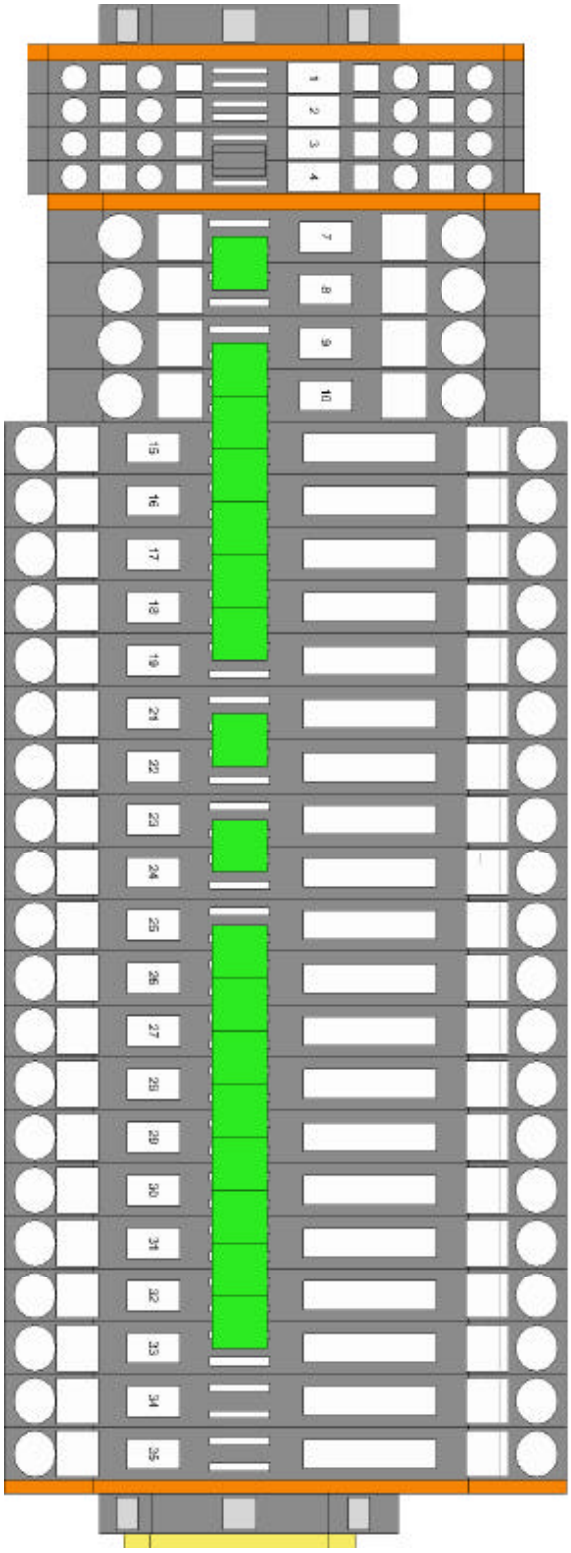
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	Artikelnummer :	210-112	
	Bohrungsabmessungen :	5.20 x 25.00 [mm]	

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7	282-328
8	4 x 282-901 "L" + 793-501
9	282-422
12	282-422
14	282-422
15	20 x 282-696 "R" + 793-501
16	282-422
18	282-422
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49	282-333
50	249-116



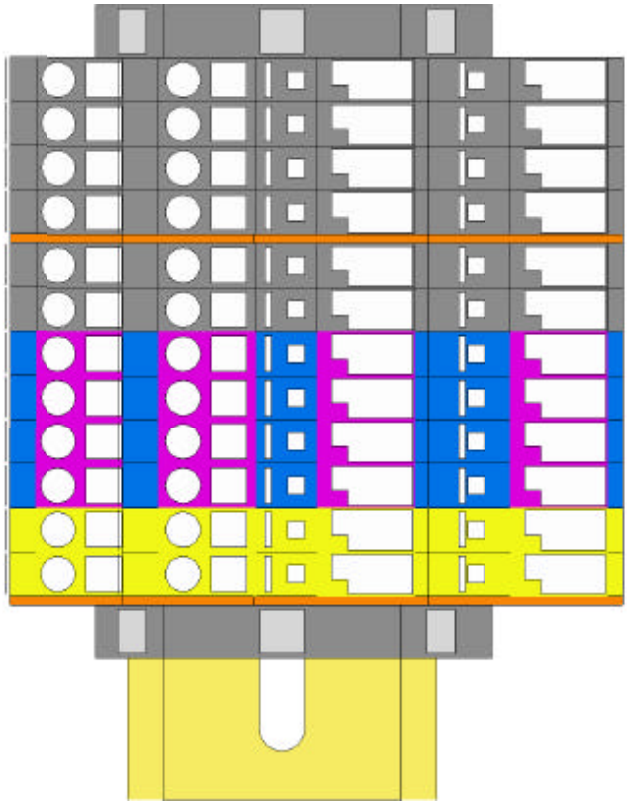
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Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
	Artikelnummer :	210-112	
	Bohrungsabmessungen :	5.20 x 25.00 [mm]	

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1	249-116
2	4 x 870-101 "R" + 793-501
6	870-119
7	2 x 870-101 "R" + 793-501
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13	2 x 870-107 "R" + 793-501
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16	249-116



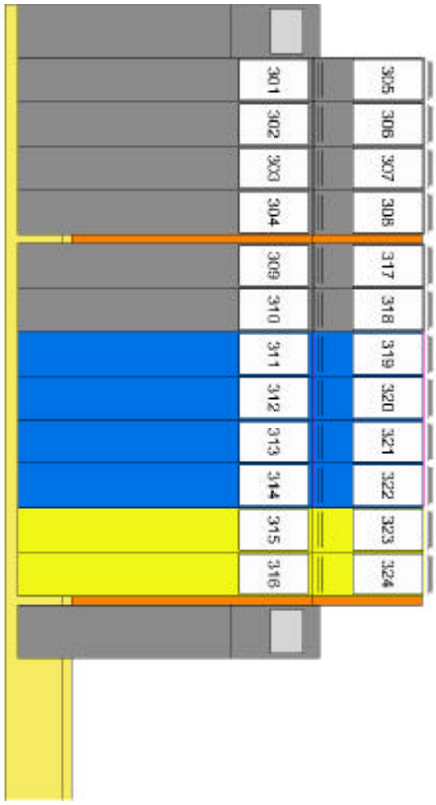
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Optional5 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick
Optional6 :	Artikelnummer :	210-112
Optional7 :	Bohrungsabmessungen :	5.20 x 25.00 [mm]

Zeichnungsnummer :
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geprüft :

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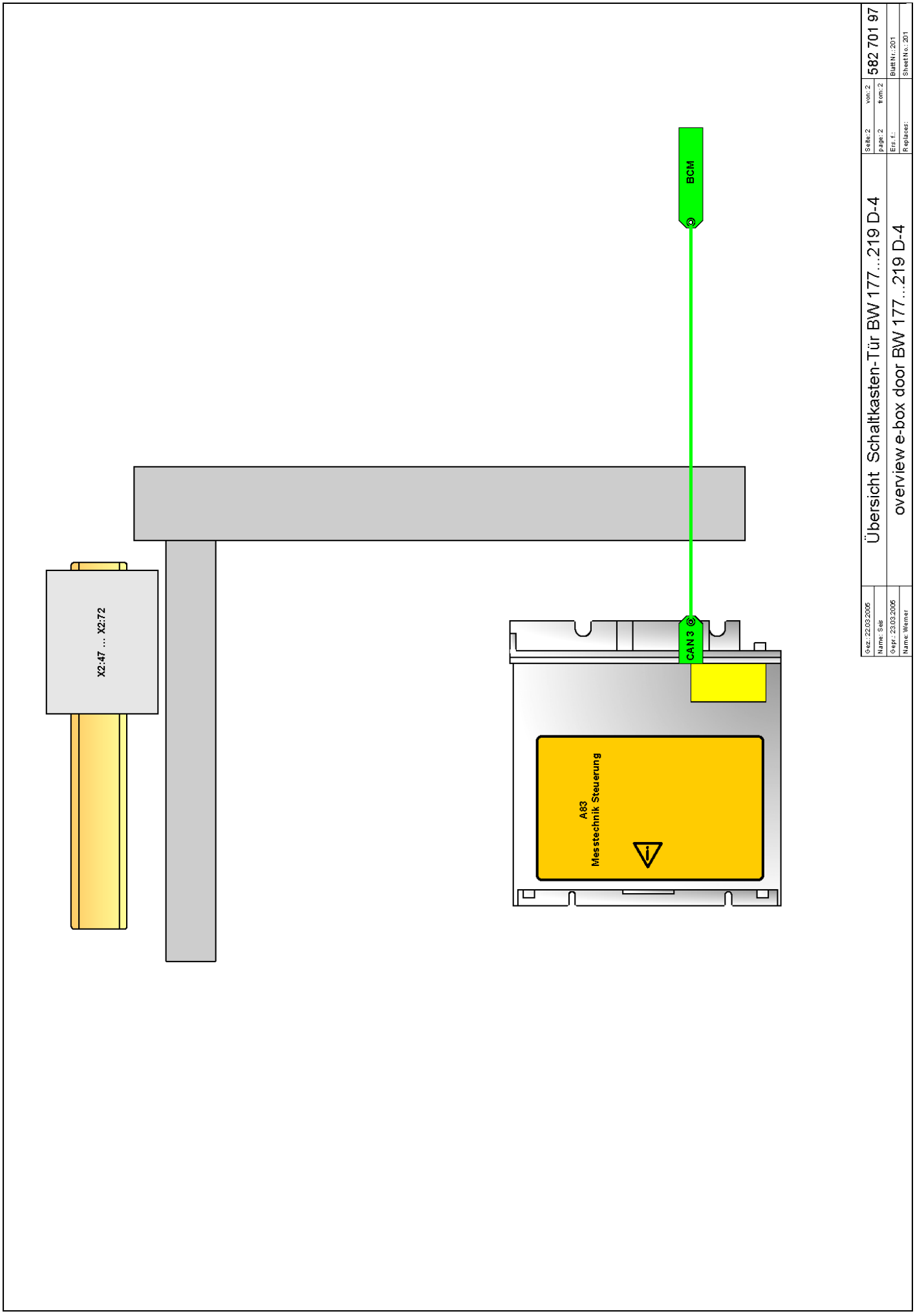
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Optional3 :	Zeichnung :		Artikelnummer lang :
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Optional5 :	Ort :		geprüft :
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	Artikelnummer :	210-112	
	Bohrungsabmessungen :	5.20 x 25.00 [mm]	

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overview e-box door BW 177...219 D-4

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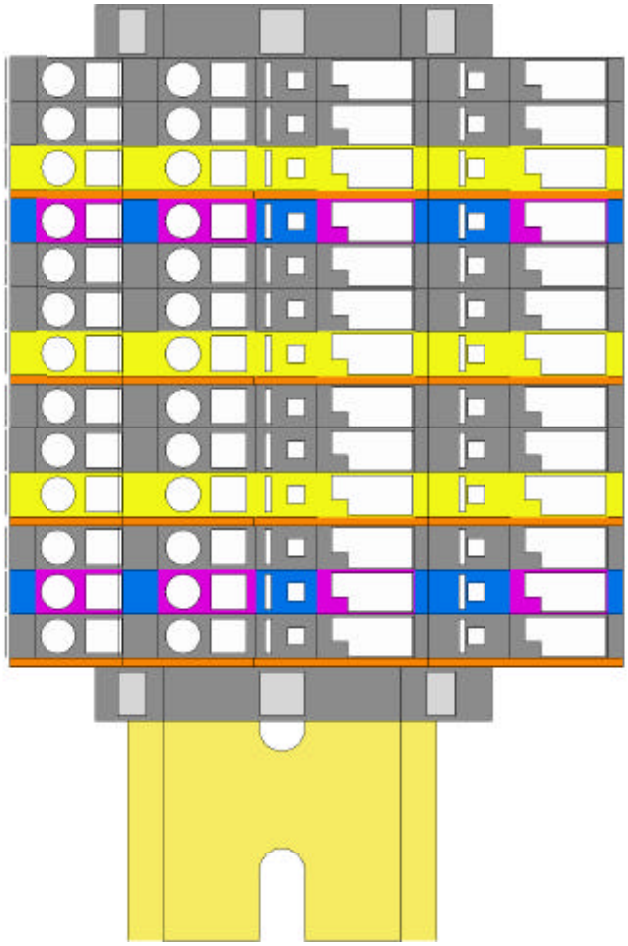
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Name: Seis
Gepr.: 23.03.2005
Name: Werner

Seite: 2 von: 2
page: 2 from: 2
Ers. f.:
Replaces:
Blatt Nr.: 201
Sheet No.: 201

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4	870-107 "R" + 793-501
5	870-119
6	870-109 "R" + 793-501
7	2 x 870-101 "R" + 793-501
9	870-107 "R" + 793-501
10	870-119
11	2 x 870-101 "R" + 793-501
13	870-107 "R" + 793-501
14	870-119
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19	249-116



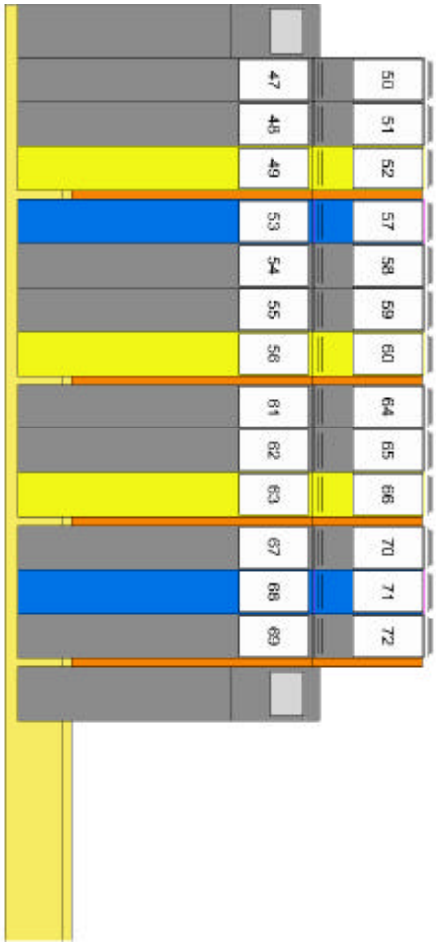
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Optional6 :	Artikelnummer :	210-112
Optional7 :	Bohrungsabmessungen :	5.20 x 25.00 [mm]

Zeichnungsnummer :
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Konstrukteur :
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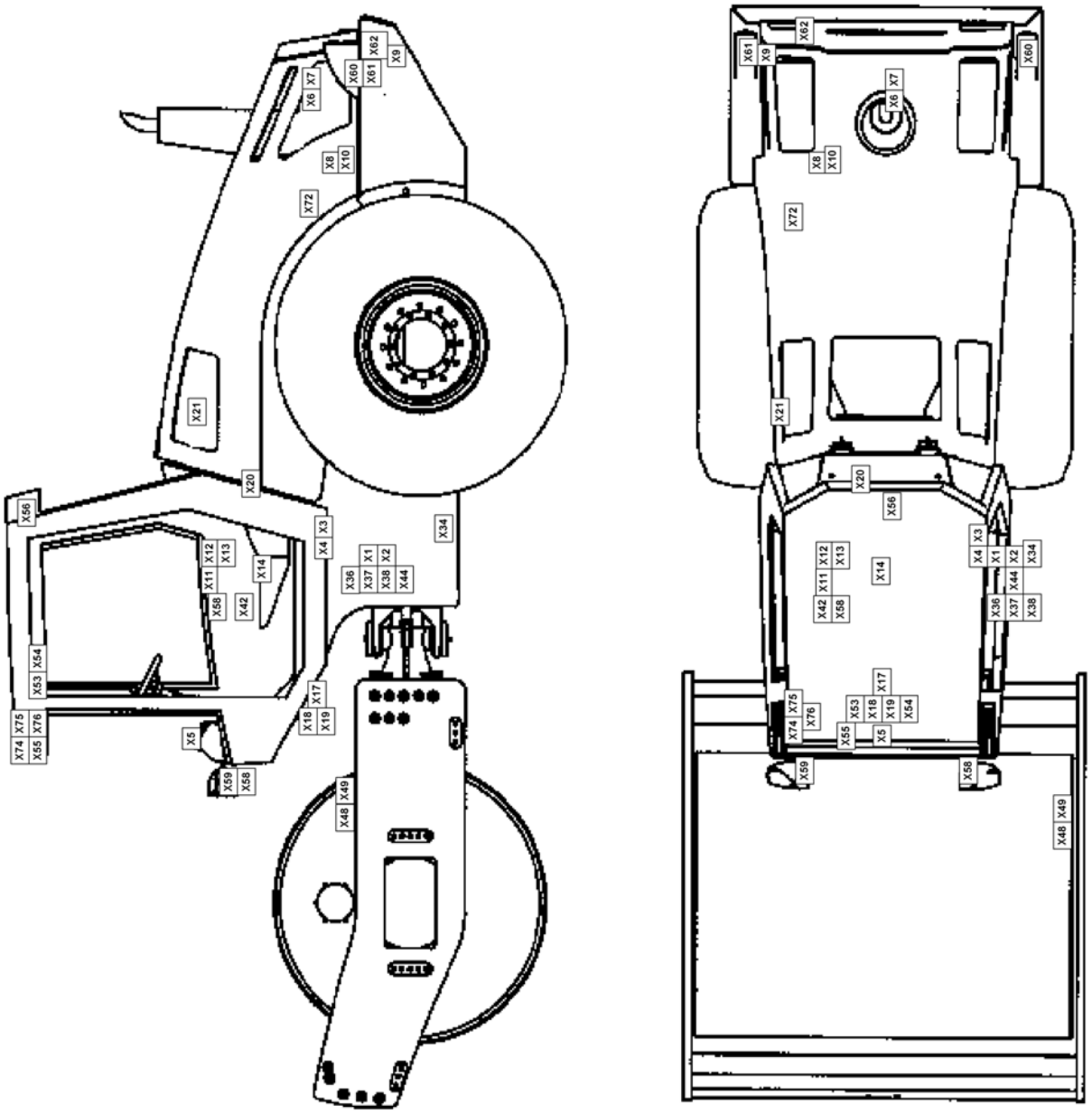
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Optional5 :	Ort :		geprüft :
Optional6 :	Betriebsmittel :	Klemmenleiste X2 /	Lieferadresse: :
Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
	Artikelnummer :	210-112	
	Bohrungsabmessungen :	5.20 x 25.00 [mm]	

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Ersatz: 22.03.2005	Steckerübersicht BW 177...219 D-4	Seite: 1 von: 1	582 701 97
Name: Seis		page: 1 from: 1	
Gepr.: 23.03.2005	Connector overview BW 177...219 D-4	Ers. f.:	Blatt Nr.: 301
Name: Werner		Replaces:	Sheet No.: 301

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17.2 Wiring diagram

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Wiring diagram 582 702 06 from serial number

101 582 721 113 BW 219 D-4
101 582 731 101 BW 219 PD-4

Standardverkabelung: standard wireing:	dicke Linien thick lines	Platinenverdrahtung: connection on printed circuit board:	dünne Linien thin lines

Inhaltsverzeichnis: BW 177..219 D–4/D–40
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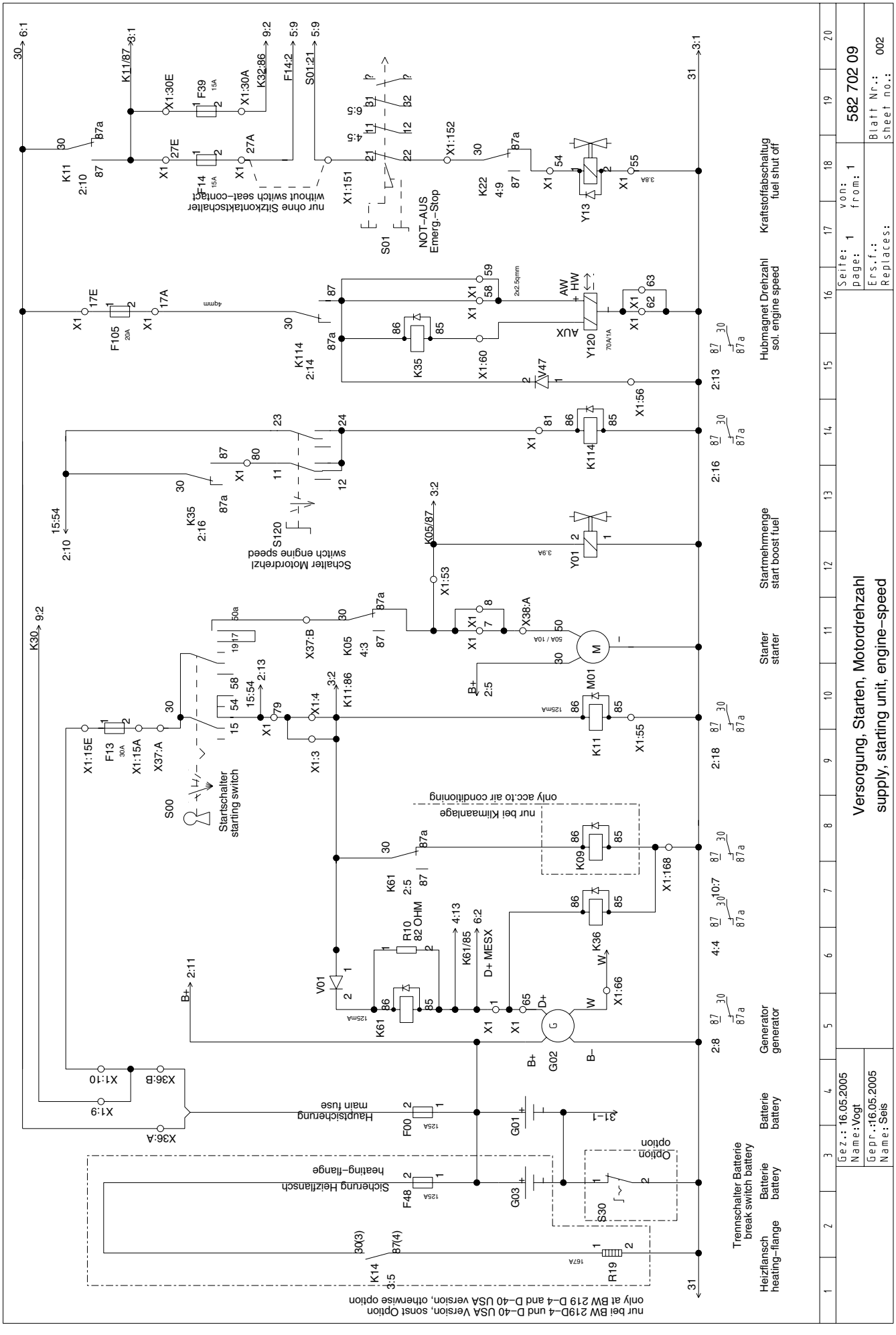
Blatt Nr.: sheet no.:	Zeichnungsnummer drawing – no.	Funktionsgruppe	function unit
001	582 702 09	Stromlaufplan	Circuit Diagram
002	582 702 09	Versorgung, Starten, Motordrehzahl	supply, starting unit, engine–speed
003	582 702 09	Motor–Heizflansch, Signalhorn, Geschwindigkeit–Anz.	engine heating–flange cont., warning horn, speedometer
004	582 702 09	Bremse, Rückfahrwarneinr., Anzeige	brake, back up alarm, indicator
005	582 702 09	Fahrstufen, Sitzkontaktsch., Vibration	speed–ranges, seat–switch, vibr.
006	582 702 09	ZA Messtechnik	option measurement equipm.
007	582 702 09	BOMAG Compaction Management BCM	BOMAG Compaction Management BCM
008	582 702 09	ZA Beleuchtung und StvZO	opt. illumination and StvZO
009	582 702 09	ZA Kabine, Beleuchtung, Radio, Tachograph	opt. cabin, headlights, radio, tachograph
010	582 702 09	ZA Kabinenheizung, Klimaanlage, Zusatzheizung	opt. cabin–heater, air conditioning, add. heater
101	582 702 09	Bauteilliste	component listing

1	2	3	4	5	6	7	8	9	10

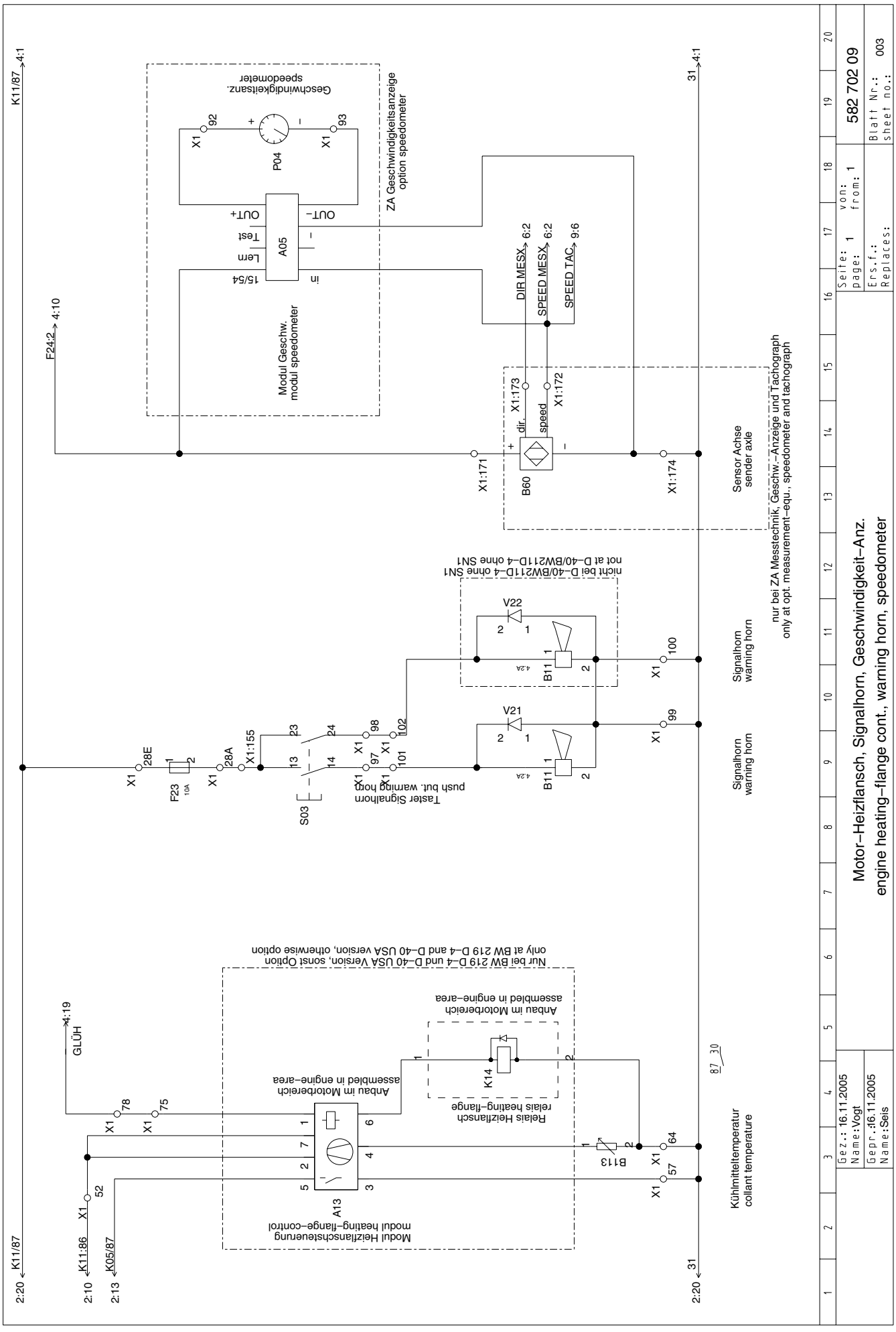
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	Gepr.: 16.11.2005 Name: Seis		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 001

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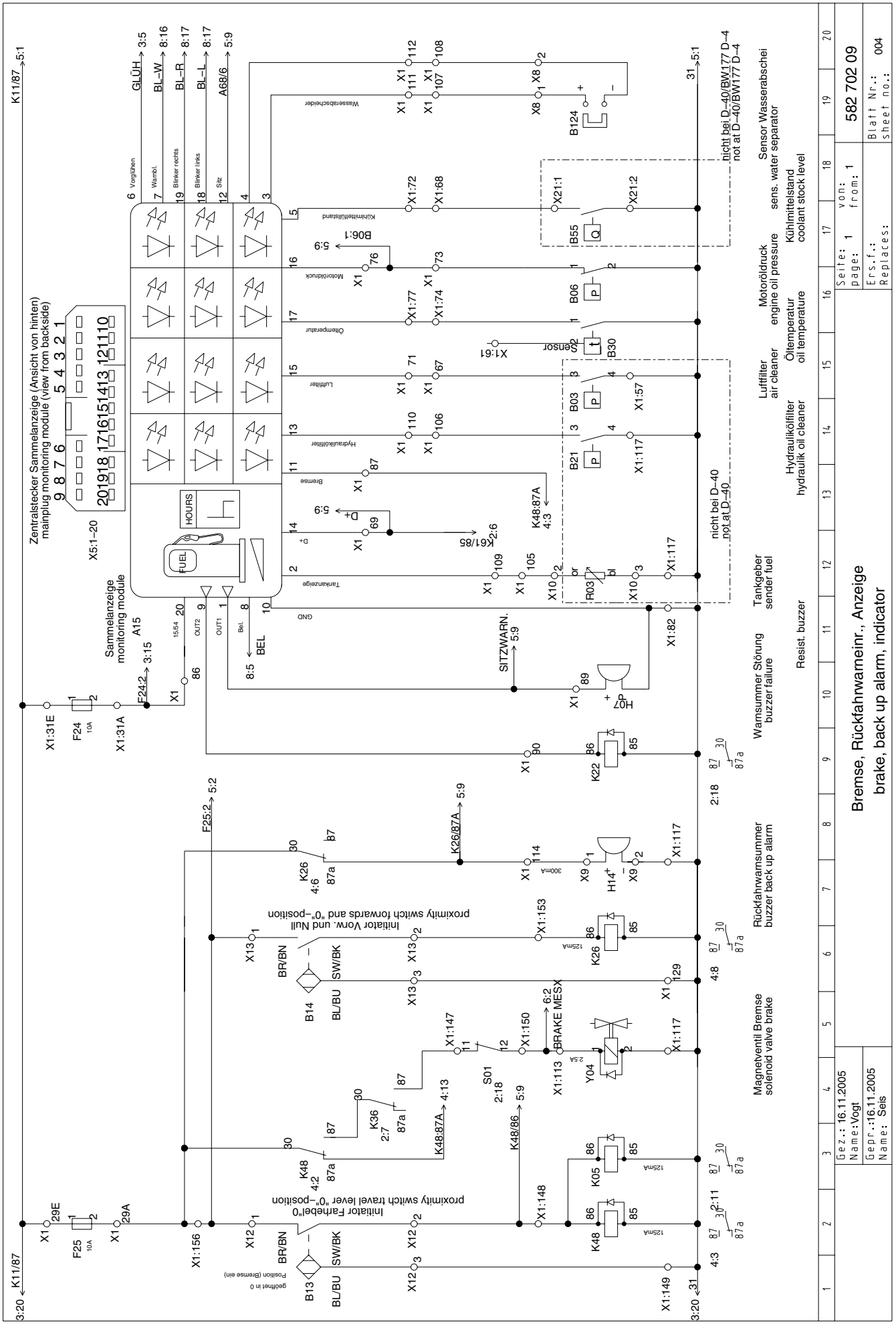
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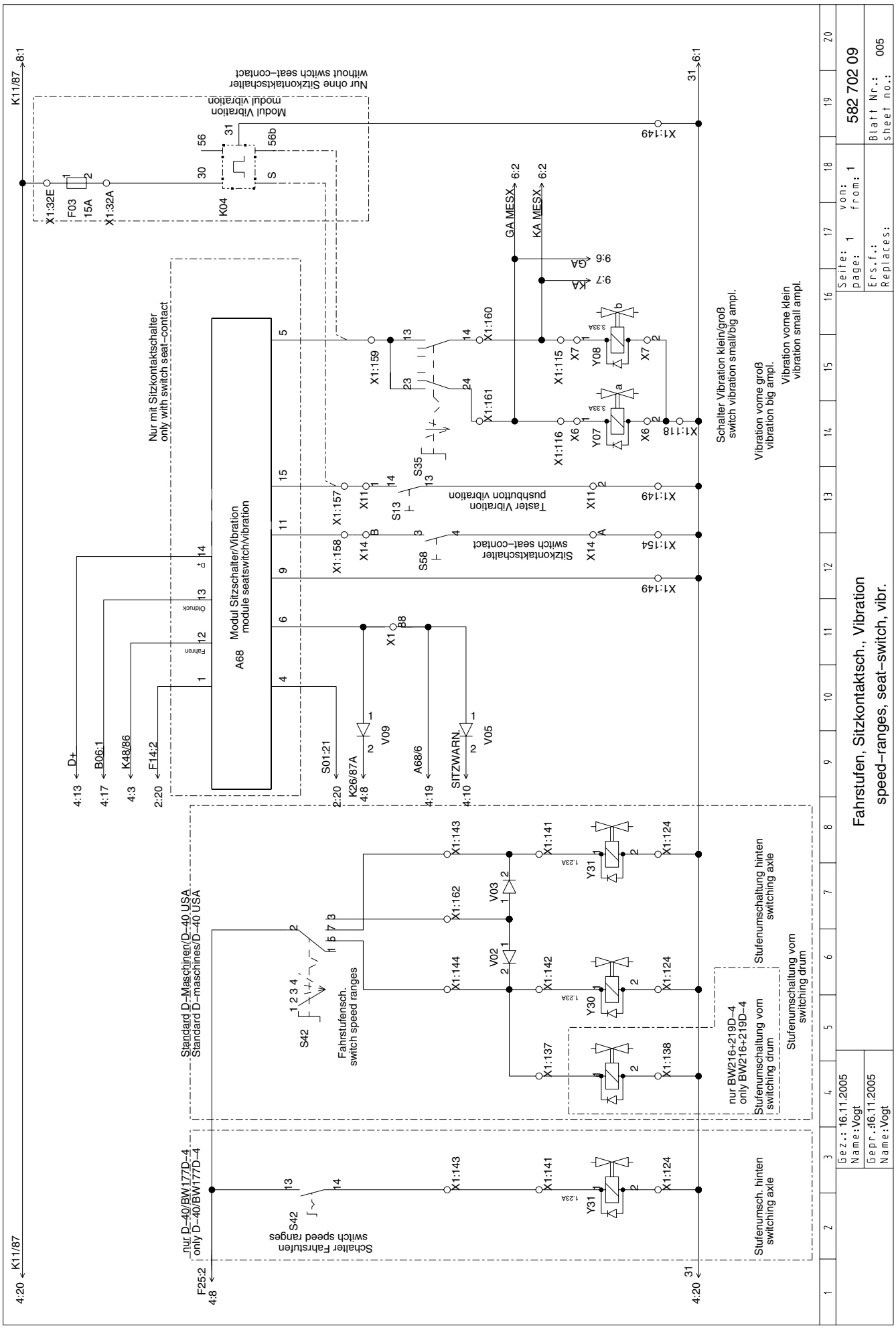
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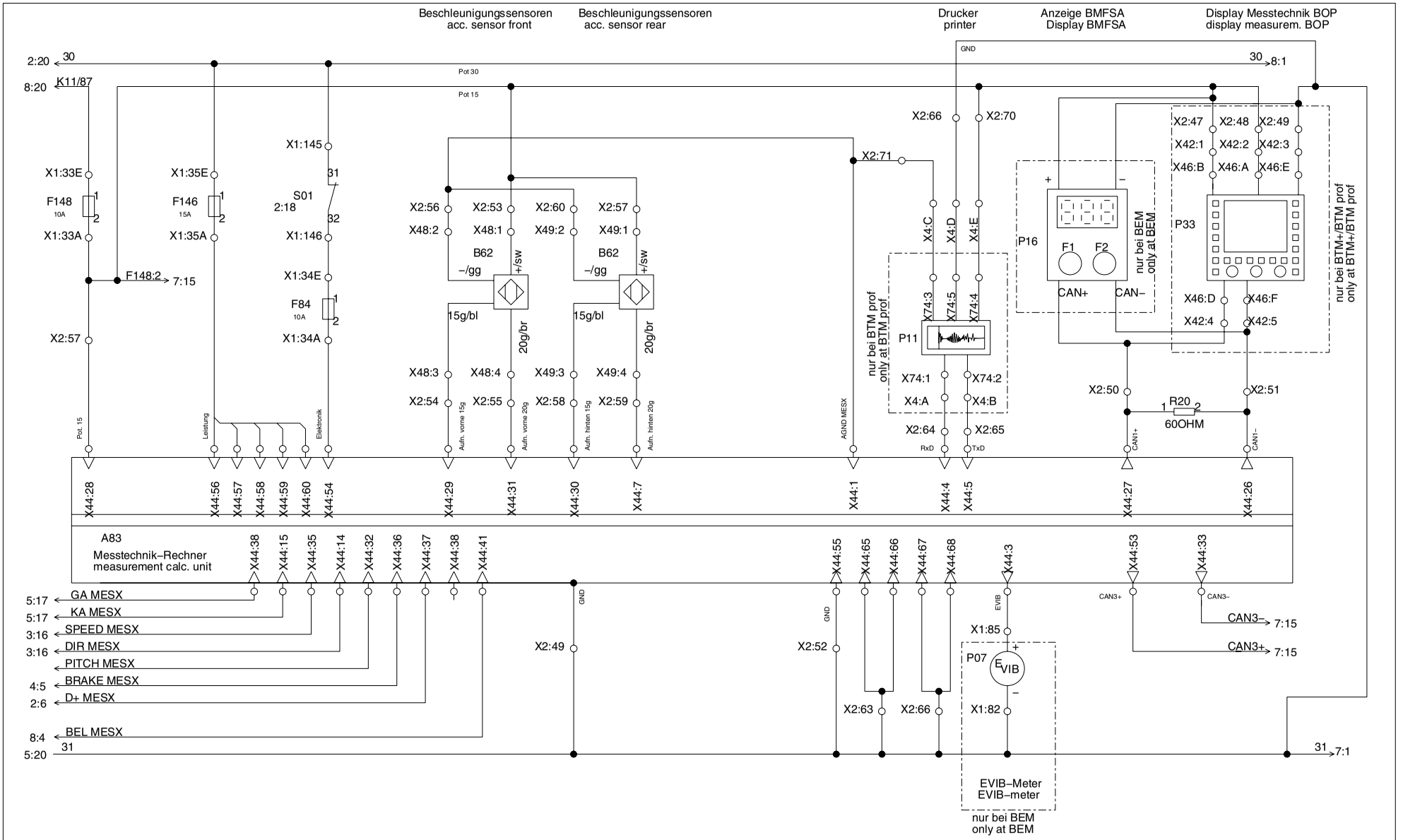
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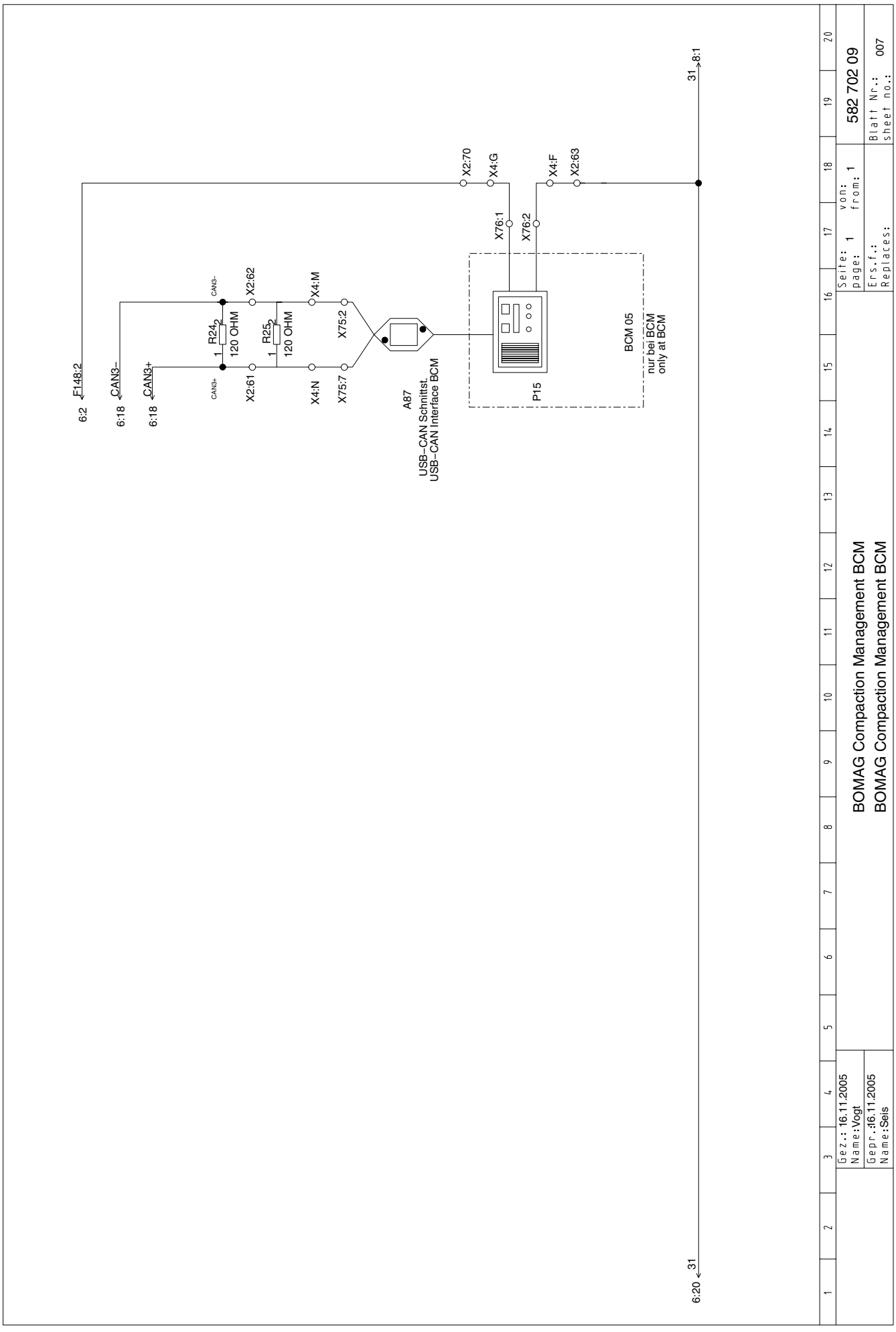


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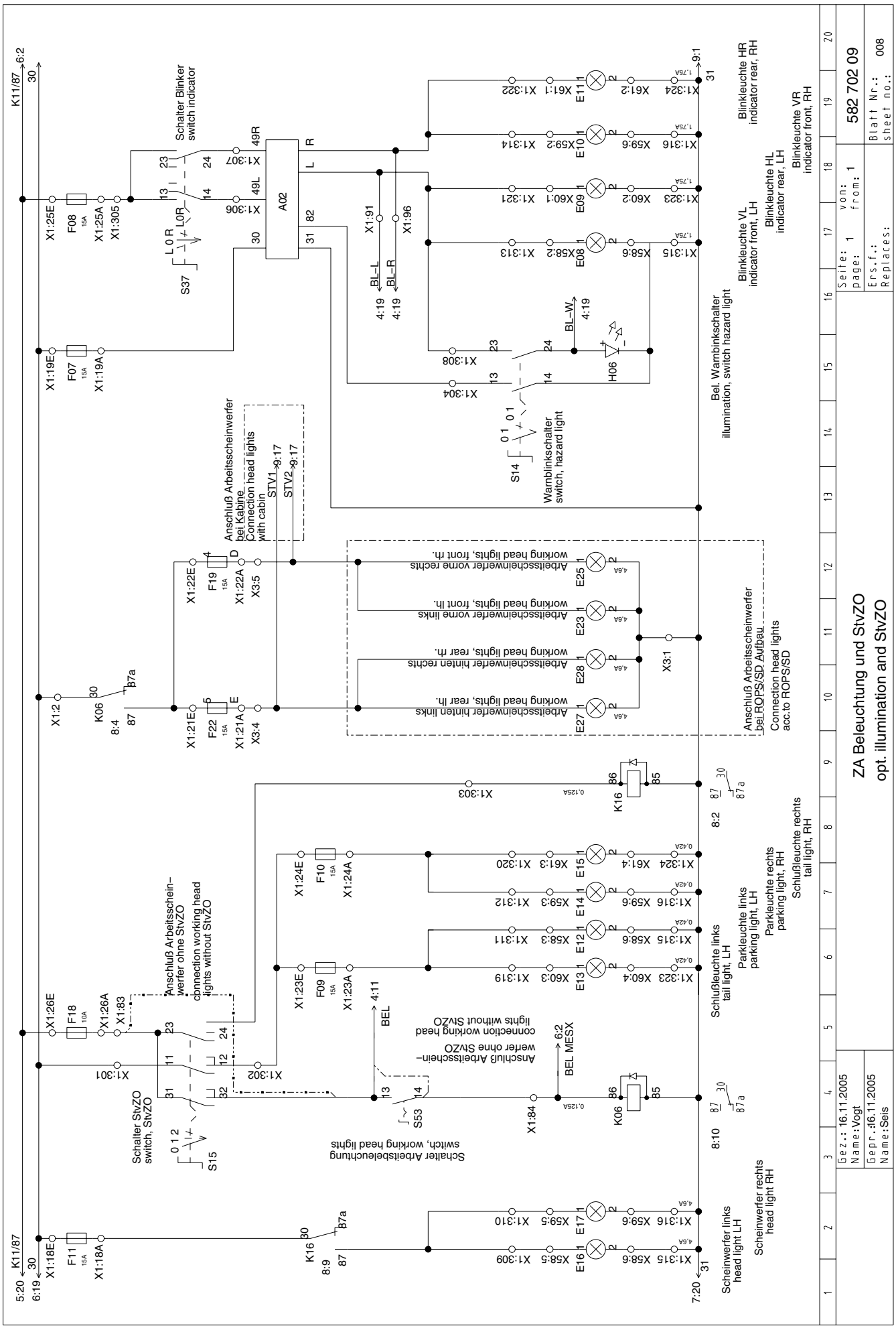
	Gez.: 16.11.2005 Name: Vogt	ZA Messtechnik option measurement equipm.	Seite: page: 1 von: from: 1	582 702 09
	Gepr.: 16.11.2005 Name: Seis		Ers.f.: Replaces:	Blatt Nr.: sheet no.: 006

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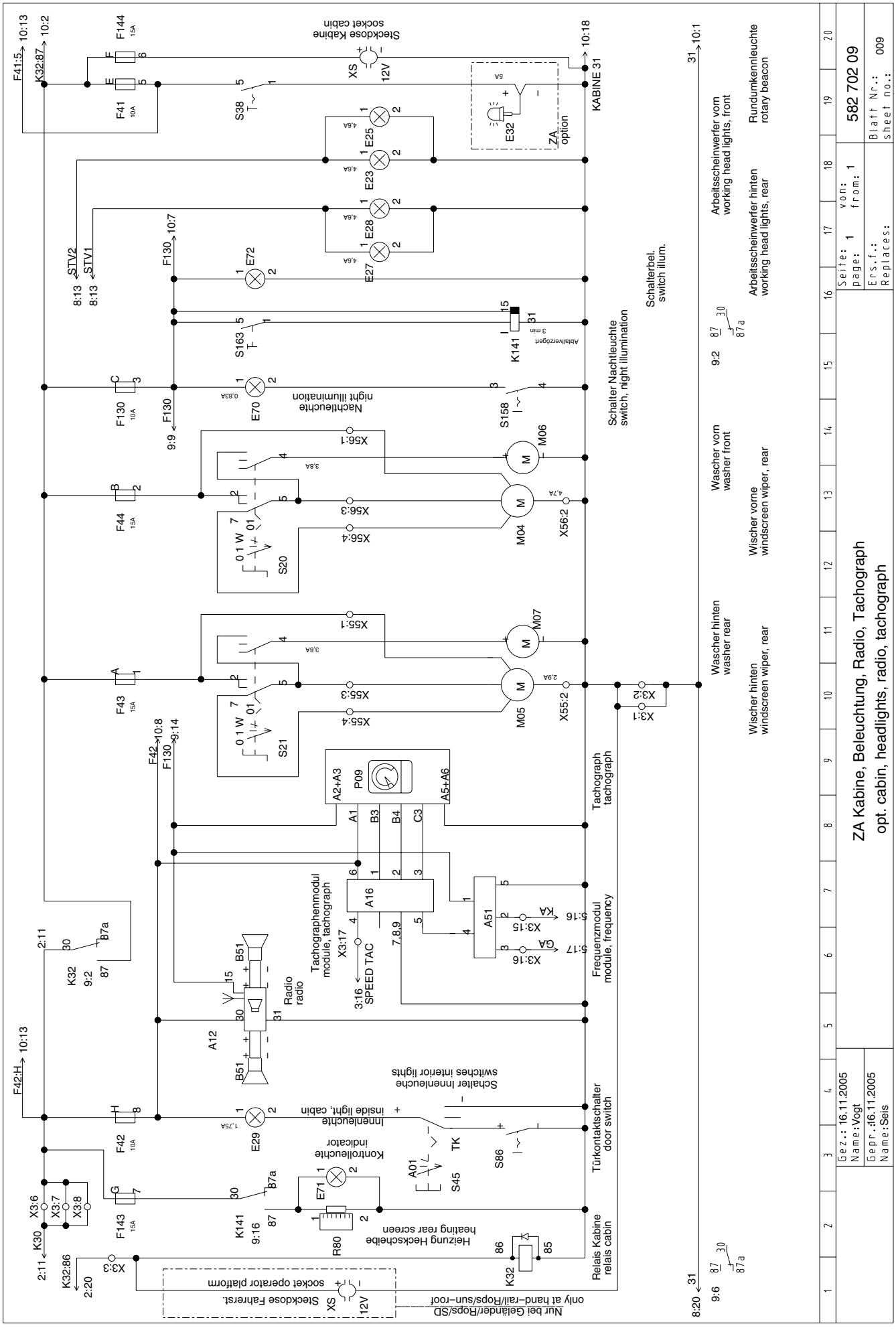
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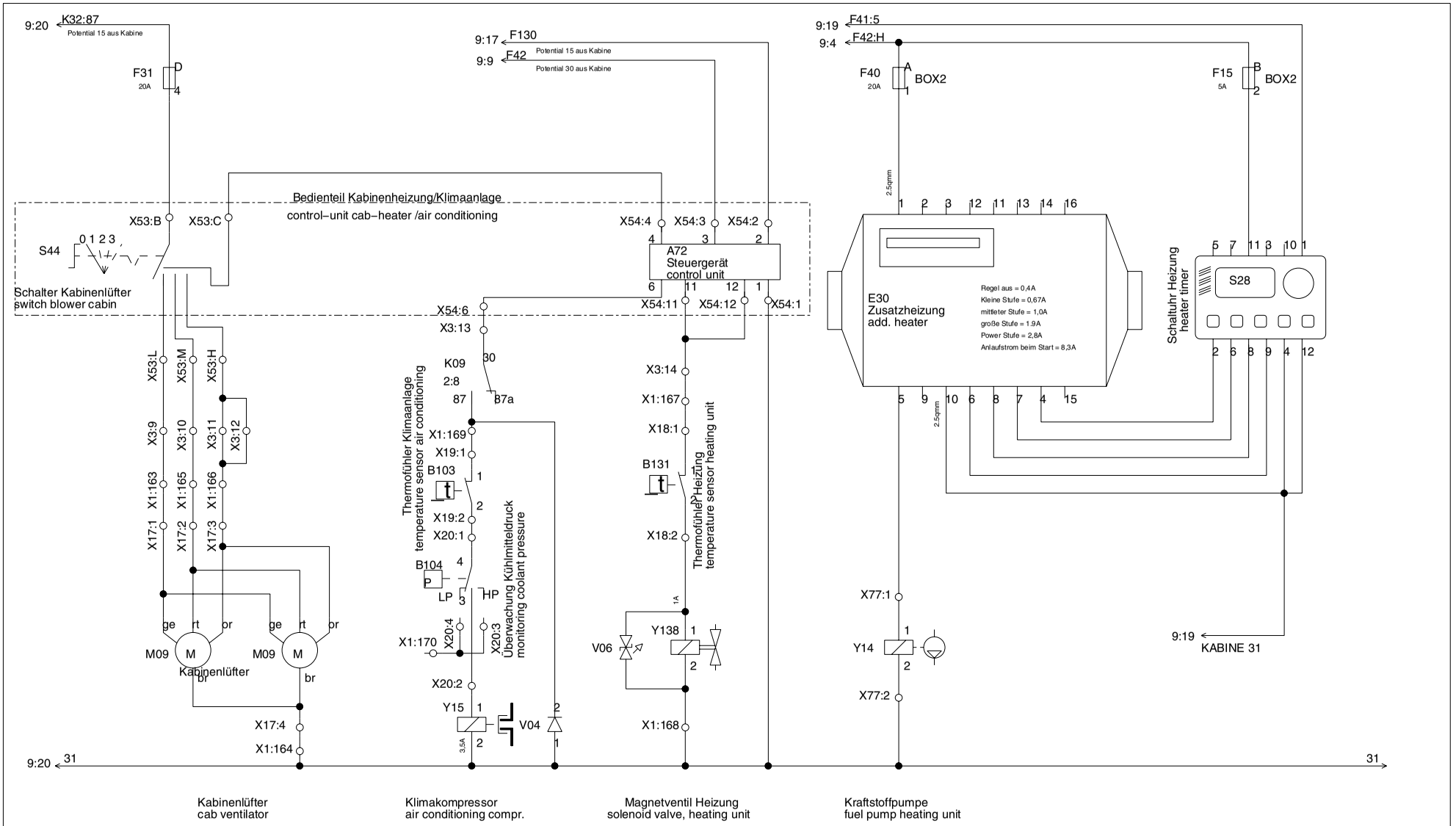


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	Gez.: Vogt Name: Seis	ZA Kabinenheizung, Klimaanlage, Zusatzheizung opt. cabin–heater, air conditioning, add. heater	Seite: 1 von: 1 page:	582 702 09
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Gez.: 16.11.2005
Name: Vogt
Gepr.: 16.11.2005
Name: Seis

Bauteilliste
component listing

Name	Bl.	Pf.	Benennung	title	TYP
	005	4			MAX. 1,67A
A02	008	17	Blinkrelais	indicator relay	
A05	003	17	Elektronik Geschwindigkeitsanzeige	Electronic system, speedometer	MODUL
A12	009	5	Radio	Radio	
A13	003	3	Steuergeraet Heizung	Control unit, heating	
A15	004	16	Ueberwachungsmodul	monitoring module	
A16	009	7	Elektronik Tachograph	Electronic system, tachograph	
A51	009	6	Platine Frequenzanzeige	Circuit board,frequenzy meter	
A68	005	10	Modul Sitzkontakt	Modul seat contact	MAX. 0,12A
A72	010	11	Steuergeraet Klimaanlage, Heizung	Control unit,air conditioning,heating	
A83	006	6	Elektronik Messtechnik	electronic measurement–equipment	
A87	007	15	USB–CAN Schnittstelle BCM	USB–CAN Interface BCM	
B03	004	15	Unterdruckschalter Luftfilter	Vacuum switch, air cleaner	
B06	004	17	Druckschalter Motoroel	Pressure switch, engine oil	
B11	003	9	Signalhorn	Warning horn	MAX.5A
B11	003	11	Signalhorn	Warning horn	MAX.5A
B13	004	2	Naeherungsinitiator Fahrhebel links	Proximity switch, travel lever, lh.	
B14	004	6	Naeherungsinitiator Fahrhebel rechts	Proximity switch, travel lever, rh.	
B21	004	14	Differenzdruckschalter Hydr.–Oelfilter	Pressure diff. switch, hydr. oil filter	
B30	004	16	Temperaturschalter Motoroel	Temperature switch, engine oil	
B51	009	5	Lautsprecher Radio	Speaker radio	
B51	009	6	Lautsprecher Radio	Speaker radio	
B55	004	17	Kuehlmittelstand Ausgleichsbehaelter	Coolant charge expansion tank	
B60	003	14	Aufnehmer Achsgeschwindigkeit	Sensor, axle speed	
B61	006	12	Aufnehmer Verstellzylinder	Sensor, ajustable zylinder	
B62	006	8	Beschleunigungsaufnehmer	Acceleration sensor	
B62	006	10	Beschleunigungsaufnehmer	Acceleration sensor	
B103	010	7	Temperaturschalter Klimaanlage	Temperature switch, air conditioning	
B104	010	7	Druckschalter Klimaanlage	Pressure switch, air conditioning	
B113	003	3	EMR Temperaturgeber Kuehlmittel	EMR Temperature switch, collant	
B124	004	19	Geber Wasserstandsabscheider Diesel	Sender, water separator fuel	
B131	010	10	Temperaturschalter Heizung	Temperature switch, heating	
E08	008	17	Blinkleuchte vorne links	Indicator, front, lh.	MAX. 1,75A
E09	008	18	Blinkleuchte hinten links	Indicator, rear, lh.	MAX. 1,75A
E10	008	19	Blinkleuchte vorne rechts	Indicator, front, rh.	MAX. 1,75A
E11	008	19	Blinkleuchte hinten rechts	Indicator, rear, rh.	MAX. 1,75A
E12	008	7	Parkleuchte links	Parking light, lh.	MAX. 0,42A
E13	008	6	Schlussleuchte links	Tail light, lh.	MAX. 0,42A
E14	008	7	Parkleuchte rechts	Parking light, rh.	MAX. 0,42A
E15	008	8	Schlussleuchte rechts	Tail light, rh.	MAX. 0,42A
E16	008	2	Scheinwerfer links	Head light, lh.	MAX. 4,6A
E17	008	2	Scheinwerfer rechts	Head light, rh.	MAX. 4,6A
E23	008	11	Arbeitsscheinwerfer vorne links	Working head light, front, lh.	MAX. 4,6A
E23	009	18	Arbeitsscheinwerfer vorne links	Working head light, front, lh.	4,6A
E25	008	12	Arbeitsscheinwerfer vorne rechts	Working head light, front, rh.	MAX. 4,6A
E25	009	19	Arbeitsscheinwerfer vorne rechts	Working head light, front, rh.	4,6A
E27	008	10	Arbeitsscheinwerfer hinten links	Working head light, rear, lh.	MAX. 4,6A
E27	009	17	Arbeitsscheinwerfer hinten links	Working head light, rear, lh.	4,6A
E28	008	11	Arbeitsscheinwerfer hinten rechts	Working head light, rear, rh.	MAX. 4,6A
E28	009	17	Arbeitsscheinwerfer hinten rechts	Working head light, rear, rh.	4,6A
E29	009	4	Innenleuchte Kabine	Inside light, cabin	1,75A
E30	010	13	Heizgeraet	Heating unit	
E32	009	19	Kennleuchte	Warning light	5A
E70	009	15	Nachtleuchte	Night lamp	0,83A
E71	009	3	Kontrolleuchte Schalter Heckscheibenheizung	indicator light switch rear screen	1,75A
E72	009	16	Beleuchtung Bedienschalter	illum. Switches	
F00	002	4	Hauptsicherung Batterie	Fuse, main, battery	125A
F03	005	18	Sicherung Vibration	Fuse, vibration	MAX. 1,23A
F07	008	15	Sicherung Warnblinker	Fuse, hazard light	15A
F08	008	18	Sicherung Blinker u. Arbeitsscheinw.	Fuse, indicators a. work. head light	15A
F09	008	6	Sicherung Park– u. Schlussl. links	Fuse, parking and tail light, lh.	10A
F10	008	8	Sicherung Park– u. Schlussl. rechts	Fuse, parking and tail light, rh.	10A
F11	008	2	Sicherung Scheinwerfer links	Fuse, head light, lh.	15A
F13	002	10	Sicherung Startschalter	Fuse, starter switch	30A
F14	002	18	Sicherung Hubmagnet Motor	Fuse, shut off solenoid, engine	15A
F15	010	18	Sicherung Heizgeraet	Fuse, heating unit	BOX2
F18	008	5	Vorsicherung Arbeitsscheinw. vorne	Primary fuse, work. head light, fr.	30A
F19	008	12	Sicherung Arbeitsscheinw. vorne li.	Fuse, working head light, front, lh.	30A
F22	008	10	Sicherung Arbeitsscheinwerfer hinten	Fuse, working head lights, rear	30A
F23	003	9	Sicherung Signalhorn	Fuse, warning horn	10A
F24	004	10	Sicherung Ueberwachungsmodul	Fuse, monitoring module	10A
F25	004	2	Sicherung Magnetv. Fahren u. Bremse	Fuse, sol. valve, travel and brake	10A
F31	010	3	Sicherung Kabinenluefter	Fuse, cabin ventilator	
F39	002	19	Hauptsicherung Kabine	Main fuse, cab	15A
F40	010	13	Sicherung Kabinenheizung	Fuse, heating unit cab	BOX2
F41	009	19	Sicherung Rundumkennleuchte	Fuse, rotary beacon	
F42	009	4	Sicherung Kabineninnenleuchte	Fuse, inside light cab	
F43	009	10	Sicherung Wischermotor hinten	Fuse, wipermotor rear	
F44	009	13	Sicherung Wischermotor vorn	Fuse, wipermotor front	
F48	002	3	Sicherung Gluehanlage	Fuse, glow plug system	125A
F84	006	5	Sicherung Steuerung (Klemme 54)	Fuse, controller (Pin 54)	10A
FM4	006	11	Platinensicherung	Multifuse	
F105	002	16	Sicherung Motordrehzahl	Fuse, motor speed	20A
F130	009	15	Sicherung Nachtleuchte	Fuse, night lamp	
F143	009	2	Sicherung Heckscheibenheizung	fuse rear screen heating unit	
F144	009	20	Sicherung Kabinensteckdose	Fuse cabin–socket	
F146	006	4	Sicherung Steuerung MESX (Potential 30)	Fuse Controller (Pot. 30)	
F148	006	2	Sicherung Steuerung MESX (Potential 15)	Fuse Controller (Pot. 15)	
G01	002	4	Batterie	Battery	103A
G02	002	5	Generator	Generator	
G03	002	3	Batterie	Battery	103A
H06	008	15	Meldeleuchte Warnblinker	Indicator light, hazard light	
H07	004	10	Warnsummer Betriebsstoerung	Warning buzzer, breakdown	MAX. 0,12A

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Name	Bl.	Pf.	Benennung	title	TYP
H14	004	8	Warnsummer Rueckwaertsfahrt	Back–up alarm buzzer	MAX. 0,12A
K04	005	18	Schrittrelais Vibration	Toggle relay, vibration	MAX. 1,23A
K05	004	3	Relais Startstrom	Relay, starting current	BOSCHW
K06	008	4	Relais Scheinwerfer hinten	Relay, head lights, rear	BOSCHW
K09	002	8	Relais Klimageraet	Relay, air conditioning	BOSCHW
K11	002	10	Relais Klemme 30 auf 15	Relay, terminal 30 to 15	BOSCHW
K14	003	5	Relais Vorgluehen	Relay, glow plug system	BOSCHL
K16	008	9	Relais Scheinwerfer vorne	Relay, head lights, front	BOSCHW
K22	004	9	Relais Hubmagnet Motor	Relay, shut off solenoid, engine	BOSCHW
K26	004	6	Relais Rueckfahrwarneinrichtung	Relay, back up alarm	BOSCHW
K32	009	2	Relais Kabine	Relay, cabin	BOSCHW
K35	002	16	Relais Selbsthaltung	Relay, holding contact	BOSCHW
K36	002	7	Relais Bremskontrolle	Relay, brake control	BOSCHW
K48	004	2	Relais Fahrhebel 0–Stellung	Relay, travel lever 0–position	BOSCHW
K61	002	5	Relais Ladekontrolle	Relay, charge control	BOSCHW
K114	002	14	Relais Motordrehzahl	Relay, engine rpm	BOSCHW
K141	009	16	Relais Heckscheibenheizung	relay, heating rear screen	BOSCHW
M01	002	11	Starter	Starter	2.3 KW
M04	009	13	Scheibenwischermotor vorne	Windscreen wiper motor, front	4,7A
M05	009	10	Scheibenwischermotor hinten	Windscreen wiper motor, rear	2,9A
M06	009	14	Scheibenwaschermotor vorne	Windscreen washer motor, front	MAX. 3,8A
M07	009	11	Scheibenwaschermotor hinten	Windscreen washer motor, rear	MAX. 3,8A
M09	010	3	Kabinenluefter	Cabin ventilator	
M09	010	4	Kabinenluefter	Cabin ventilator	
P04	003	19	Geschwindigkeitsanzeige	Speedometer	
P07	006	15	Omegameter	Omegameter	
P09	009	8	Frequenz– und Geschwindigkeitsanzeige	Frequency– and Speedometer	
P11	006	14	Drucker	Printer	
P15	007	16	BCM 03 Bildschirm	BCM 03 terminal	
P16	006	16	Diagnose, Variomatic	Diagnostics, varimatic	
P33	006	18	Opus 21	Opus 21	
R03	004	12	Geber Tankanzeige	Sender, level gauge	
R10	002	6	Parallelwiderstand	Parallel resistor	82 OHM
R19	002	2	Heizflansch	heater flange	167A
R20	006	17	Widerstand	Resistor	60OHM
R24	007	15	Widerstand	Resistor	120 OHM
R25	007	15	Widerstand	Resistor	120 OHM
R80	009	2	Heizung Heckscheibe	heating rear screen	
S00	002	10	Startschalter	Starter switch	
S01	002	18	Schalter NOT AUS	Switch, emergency off	
S03	003	9	Taster Signalhorn	Push button, warning horn	
S13	005	13	Vibrationsschalter Fahrhebel rechts	Switch, vibration, travel lever, rh.	
S14	008	15	Warnblinkschalter	Switch, hazard light	
S15	008	4	Beleuchtungsschalter StVZO	Switch, lighting StVZO	
S20	009	13	Schalter Scheibenwischer vorne	Switch, windscreen wiper, front	
S21	009	10	Schalter Scheibenwischer hinten	Switch, windscreen wiper, rear	
S28	010	17	Schalter Kabinenheizung	Switch, cabin heating	
S30	002	3	Batterietrennschalter	Switch, battery disconnect	
S35	005	15	Vibrationsschalter klein/gross	Switch, vibration low/high	
S37	008	18	Schalter Blinker	Switch, indicator	
S38	009	19	Schalter Kennleuchte	Switch, warning light	
S42	005	3	Stufenumschalter schnell–langsam	Speed range selector, fast–slow	
S42	005	7	Stufenumschalter schnell–langsam	Speed range selector, fast–slow	
S44	010	3	Schalter Kabinenluefter	Switch, cabin ventilator	
S45	009	4	Schalter Kabineninnenleuchte	Switch, cabin inside light	
S53	008	4	Schalter Arbeitsbeleuchtung	Switch, working lights	
S58	005	13	Schalter Aetherstartanlage	Push button, ether starting unit	
S86	009	4	Schalter Tuer, links	Switch door, lh.	
S120	002	14	Schalter Motordrehzahl	Switch, engine speed	
S158	009	15	Schalter Nachtbeleuchtung	Switch, cabin night lamp	
S163	009	16	Schalter Heckscheibenheizung	switch rear screen heating unit	
V01	002	6	Diode	Diode	4UF004
V02	005	6	Diode	Diode	MAX. 1,23A
V03	005	7	Diode	Diode	MAX. 1,23A
V04	010	8	Diode	Diode	FE5B
V05	005	10	Diode	Diode	MAX. 0,12A
V06	010	9	Diode	Diode	
V09	005	10	Diode	Diode	MAX. 0,12A
V21	003	10	Diode	Diode	
V22	003	11	Diode	Diode	
V47	002	15	Diode (A7)	Diode (A7)	FE5B
X1:1	002	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:2	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:3	002	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:4	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:7	002	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:8	002	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:9	002	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:10	002	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:52	003	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:53	002	12	WAGO,E–Kasten	WAGO,E–BOX	
X1:54	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:55	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:55	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:56	002	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:57	003	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:57	004	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:58	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:59	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:60	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:61	004	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:62	002	16	WAGO,E–Kasten	WAGO,E–BOX	

Gez.: 16.11.2005
Name: Vogt
Gepr.: 16.11.2005
Name: Seis

Bauteilliste
component listing

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Blatt Nr.: 102
sheet no.: 102

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Name	Bl.	Pf.	Benennung	title	TYP
X1:63	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:64	003	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:65	002	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:66	002	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:67	004	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:68	004	17	WAGO,E–Kasten	WAGO,E–BOX	
X1:69	004	13	WAGO,E–KASTEN	WAGO, E–box	
X1:71	004	15	WAGO,E–KASTEN	WAGO, E–box	
X1:72	004	17	WAGO,E–Kasten	WAGO,E–BOX	
X1:73	004	17	WAGO,E–Kasten	WAGO,E–BOX	
X1:74	004	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:75	003	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:76	004	17	WAGO,E–KASTEN	WAGO, E–box	
X1:77	004	16	WAGO,E–KASTEN	WAGO, E–box	
X1:78	003	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:79	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:80	002	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:81	002	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:82	004	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:82	006	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:83	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:84	008	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:85	006	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:86	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:87	004	13	WAGO,E–KASTEN	WAGO, E–box	
X1:88	005	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:89	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:90	004	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:91	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:92	003	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:93	003	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:96	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:97	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:98	003	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:99	003	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:100	003	11	WAGO,E–Kasten	WAGO,E–BOX	
X1:101	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:102	003	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:105	004	12	WAGO,E–Kasten	WAGO,E–BOX	
X1:106	004	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:107	004	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:108	004	20	WAGO,E–Kasten	WAGO,E–BOX	
X1:109	004	12	WAGO,E–KASTEN	WAGO, E–box	
X1:110	004	14	WAGO,E–KASTEN	WAGO, E–box	
X1:111	004	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:112	004	20	WAGO,E–Kasten	WAGO,E–BOX	
X1:113	004	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:114	004	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:115	005	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:116	005	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:117	004	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:117	004	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:117	004	12	WAGO,E–Kasten	WAGO,E–BOX	
X1:117	004	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:118	005	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:124	005	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:124	005	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:124	005	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:129	004	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:137	005	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:138	005	4	WAGO,E–Kasten	WAGO,E–BOX	
X1:141	005	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:141	005	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:142	005	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:143	005	3	WAGO,E–Kasten	WAGO,E–BOX	
X1:143	005	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:144	005	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:145	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:146	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:147	004	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:148	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:149	004	1	WAGO,E–Kasten	WAGO,E–BOX	
X1:149	005	12	WAGO,E–Kasten	WAGO,E–BOX	
X1:149	005	13	WAGO,E–Kasten	WAGO,E–BOX	
X1:149	005	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:150	004	5	WAGO,E–Kasten	WAGO,E–BOX	
X1:151	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:152	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:153	004	6	WAGO,E–Kasten	WAGO,E–BOX	
X1:154	005	13	WAGO,E–Kasten	WAGO,E–BOX	
X1:155	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:156	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:157	005	13	WAGO,E–Kasten	WAGO,E–BOX	
X1:158	005	13	WAGO,E–Kasten	WAGO,E–BOX	
X1:159	005	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:15A	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:15E	002	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:160	005	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:161	005	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:162	005	7	WAGO,E–Kasten	WAGO,E–BOX	
X1:163	010	3	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:164	010	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:165	010	3	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:166	010	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:167	010	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:168	002	8	WAGO,E–Kasten	WAGO,E–BOX	
X1:168	010	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:169	010	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:170	010	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	

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Name	Bl.	Pf.	Benennung	title	TYP
X1:171	003	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:172	003	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:173	003	15	WAGO,E–Kasten	WAGO,E–BOX	
X1:174	003	14	WAGO,E–Kasten	WAGO,E–BOX	
X1:17A	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:17E	002	16	WAGO,E–Kasten	WAGO,E–BOX	
X1:18A	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:18E	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:19A	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:19E	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:21A	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:21E	008	10	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:22A	008	12	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:22E	008	12	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:23A	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:23E	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:24A	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:24E	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:25A	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:25E	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:26A	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:26E	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:27A	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:27E	002	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:28A	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:28E	003	9	WAGO,E–Kasten	WAGO,E–BOX	
X1:29A	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:29E	004	2	WAGO,E–Kasten	WAGO,E–BOX	
X1:301	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:302	008	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:303	008	9	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:304	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:305	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:306	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:307	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:308	008	15	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:309	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:30A	002	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:30E	002	19	WAGO,E–Kasten	WAGO,E–BOX	
X1:310	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:311	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:312	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:313	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:314	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:315	008	17	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	7	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:316	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:319	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:31A	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:31E	004	10	WAGO,E–Kasten	WAGO,E–BOX	
X1:320	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:321	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:322	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:323	008	6	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:323	008	18	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:324	008	8	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:324	008	19	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:32A	005	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:32E	005	18	WAGO,E–Kasten	WAGO,E–BOX	
X1:33A	006	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:33E	006	2	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:34A	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:34E	006	5	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:35A	006	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X1:35E	006	4	WAGO ZENTRALELEKTRIK	WAGO E–BOX	
X2:47	006	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:48	006	19	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:49	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:49	006	19	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:50	006	17	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:51	006	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:52	006	13	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:53	006	8	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:54	006	7	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:55	006	8	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:56	006	7	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:57	006	2	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:57	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:58	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:59	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:60	006	9	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:61	007	15	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:62	007	16	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:63	006	13	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:63	007	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:64	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:65	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:66	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:66	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:67	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:68	006	12	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:69	006	12	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:70	006	15	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:70	007	18	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:71	006	14	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:73	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	

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X2:74	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:75	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:76	006	10	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:77	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X2:78	006	11	WAGO–MESSTECHNIK	Wago–measurement equip.	
X3:1	008	11	STECKER ROPS/SD	conn. ROPS/SR	
X3:1	009	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:2	009	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:3	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:4	008	10	STECKER ROPS/SD	conn. ROPS/SR	
X3:5	008	12	STECKER ROPS/SD	conn. ROPS/SR	
X3:6	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:7	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:8	009	2	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:9	010	3	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:10	010	3	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:11	010	4	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:12	010	4	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:13	010	7	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:14	010	10	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:15	009	7	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:16	009	6	STECKER KABINE/ROPS	conn. cabin/ROPS	
X3:17	009	6	STECKER KABINE/ROPS	conn. cabin/ROPS	
X4:A	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:B	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:C	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:D	006	14	KABINENST. MESST.	con. measurem.equipm.	
X4:E	006	15	KABINENST. MESST.	con. measurem.equipm.	
X4:F	007	18	KABINENST. MESST.	con. measurem.equipm.	
X4:G	007	18	KABINENST. MESST.	con. measurem.equipm.	
X4:M	007	16	KABINENST. MESST.	con. measurem.equipm.	
X4:N	007	15	KABINENST. MESST.	con. measurem.equipm.	
X6:1	005	14	DEUTSCH	DEUTSCH connector	
X6:2	005	14	DEUTSCH	DEUTSCH connector	
X7:1	005	16	DEUTSCH	DEUTSCH connector	
X7:2	005	16	DEUTSCH	DEUTSCH connector	
X8:1	004	19	DEUTSCH	DEUTSCH connector	
X8:2	004	20	DEUTSCH	DEUTSCH connector	
X9:1	004	8	DEUTSCH	DEUTSCH connector	
X9:2	004	8	DEUTSCH	DEUTSCH connector	
XS	009	1	Steckdose	Socket	
XS	009	20	Steckdose	Socket	
X10:2	004	12	AMP SUPERSEAL	AMP connector	
X10:3	004	12	AMP SUPERSEAL	AMP connector	
X11:1	005	13	DEUTSCH	DEUTSCH connector	
X11:2	005	13	DEUTSCH	DEUTSCH connector	
X12:1	004	2	DEUTSCH	DEUTSCH connector	
X12:2	004	2	DEUTSCH	DEUTSCH connector	
X12:3	004	1	DEUTSCH	DEUTSCH connector	
X13:1	004	6	DEUTSCH	DEUTSCH connector	
X13:2	004	6	DEUTSCH	DEUTSCH connector	
X13:3	004	6	DEUTSCH	DEUTSCH connector	
X14:A	005	13	DEUTSCH	DEUTSCH connector	
X14:B	005	13	DEUTSCH	DEUTSCH connector	
X17:1	010	3	STECKER LÜFTER HKL	conn. blower	
X17:2	010	3	STECKER LÜFTER HKL	conn. blower	
X17:3	010	4	STECKER LÜFTER HKL	conn. blower	
X17:4	010	5	STECKER LÜFTER HKL	conn. blower	
X18:1	010	10	STECKER THERMOFÜHLER	conn. sender temp.	
X18:2	010	10	STECKER THERMOFÜHLER	conn. sender temp.	
X19:1	010	7	STECKER EISSCHUTZ HKL	conn. anti–ice air–cond.	
X19:2	010	7	STECKER EISSCHUTZ HKL	conn. anti–ice air–cond.	
X20:1	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:2	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:3	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X20:4	010	7	STECKER DRUCKSCH. KLI	conn. pressuresitch air–cond.	
X21:1	004	17	STECKER KÜHLMITTEL	connector coolant sensor	
X21:2	004	17	STECKER KÜHLMITTEL	connector coolant sensor	
X36:A	002	4	EINSPEISUNG SCHALTKAS	supply e–box	
X36:B	002	4	EINSPEISUNG SCHALTKAS	supply e–box	
X37:A	002	10	ST. ZÜNDSCHLOß E–KAST	connector ignition switch	
X37:B	002	11	ST. ZÜNDSCHLOSS E–KAS	connector ignition switch, e–box	
X38:A	002	11	ST.STARTER E–KASTEN	connector starter e–box	
X42:1	006	18	STECKER ADAPTER BOP	conector adapter BOP	
X42:2	006	19	STECKER ADAPTER BOP	conector adapter BOP	
X42:3	006	19	STECKER ADAPTER BOP	conector adapter BOP	
X42:4	006	18	STECKER ADAPTER BOP	conector adapter BOP	
X42:5	006	18	STECKER ADAPTER BOP	conector adapter BOP	
X44:1	006	13	MESX STECKER	MESX Stecker	
X44:3	006	15	MESX STECKER	MESX Stecker	
X44:4	006	14	MESX STECKER	MESX Stecker	
X44:5	006	14	MESX STECKER	MESX Stecker	
X44:7	006	10	MESX STECKER	MESX Stecker	
X44:9	006	12	MESX STECKER	MESX Stecker	
X44:14	006	5	MESX STECKER	MESX Stecker	
X44:15	006	5	MESX STECKER	MESX Stecker	
X44:23	006	11	MESX STECKER	MESX Stecker	
X44:26	006	18	MESX STECKER	MESX Stecker	
X44:27	006	17	MESX STECKER	MESX Stecker	
X44:28	006	2	MESX STECKER	MESX Stecker	
X44:29	006	7	MESX STECKER	MESX Stecker	
X44:30	006	9	MESX STECKER	MESX Stecker	
X44:31	006	8	MESX STECKER	MESX Stecker	
X44:32	006	6	MESX STECKER	MESX Stecker	
X44:33	006	18	MESX STECKER	MESX Stecker	
X44:35	006	5	MESX STECKER	MESX Stecker	
X44:36	006	6	MESX STECKER	MESX Stecker	
X44:37	006	7	MESX STECKER	MESX Stecker	
X44:38	006	4	MESX STECKER	MESX Stecker	

Gez.: 16.11.2005
Name: Vogt
Gepr.: 16.11.2005
Name: Seis

Bauteilliste
component listing

Seite: page: 5 von: from: 6
Ers.f.: Replaces:

Blatt Nr.: sheet no.: 105

582 702 09

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Gez.: 16.11.2005
Name: Vogt
Gepr.: 16.11.2005
Name: Seis

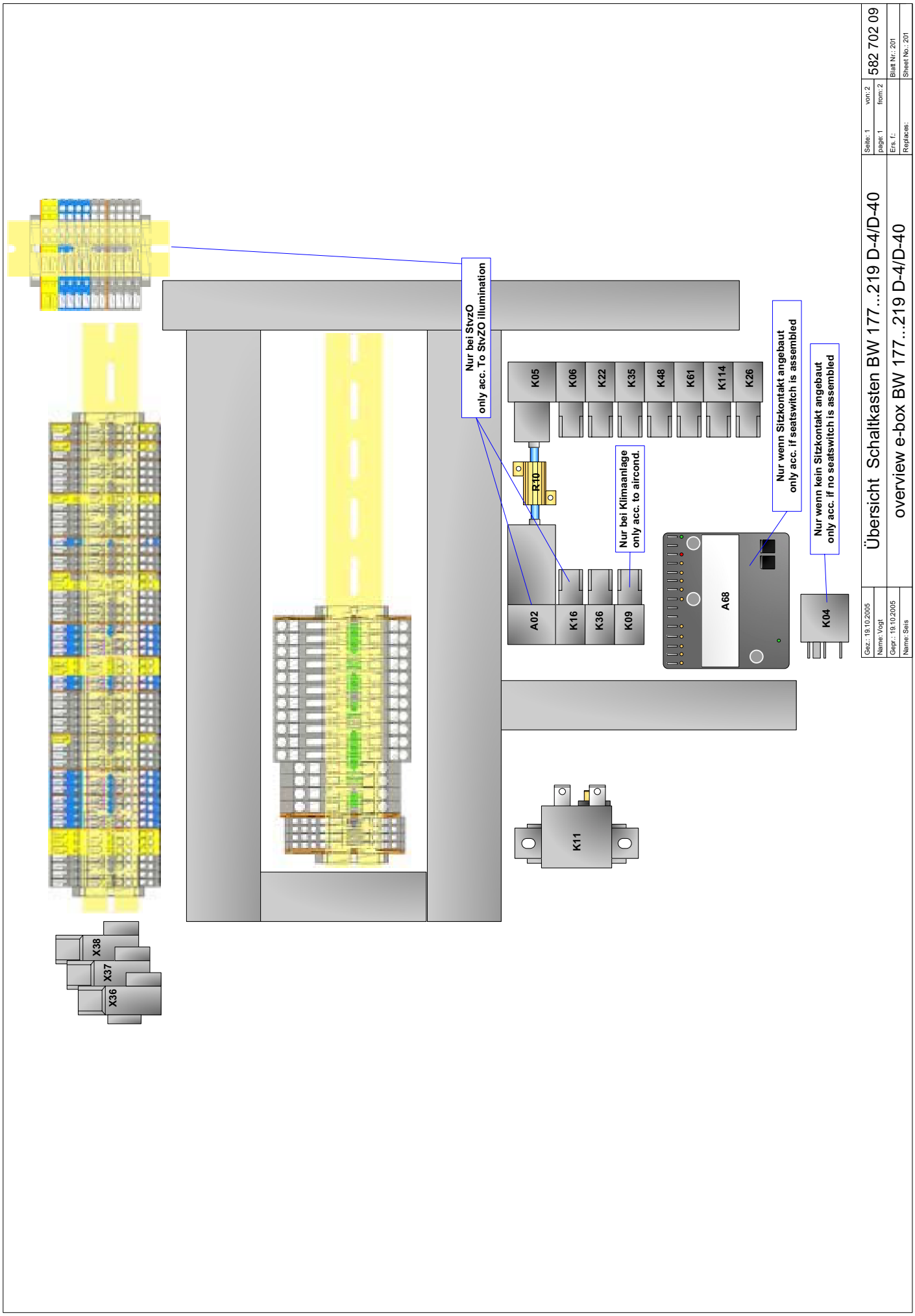
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Seite: 6 von:
page: 6 from: 6
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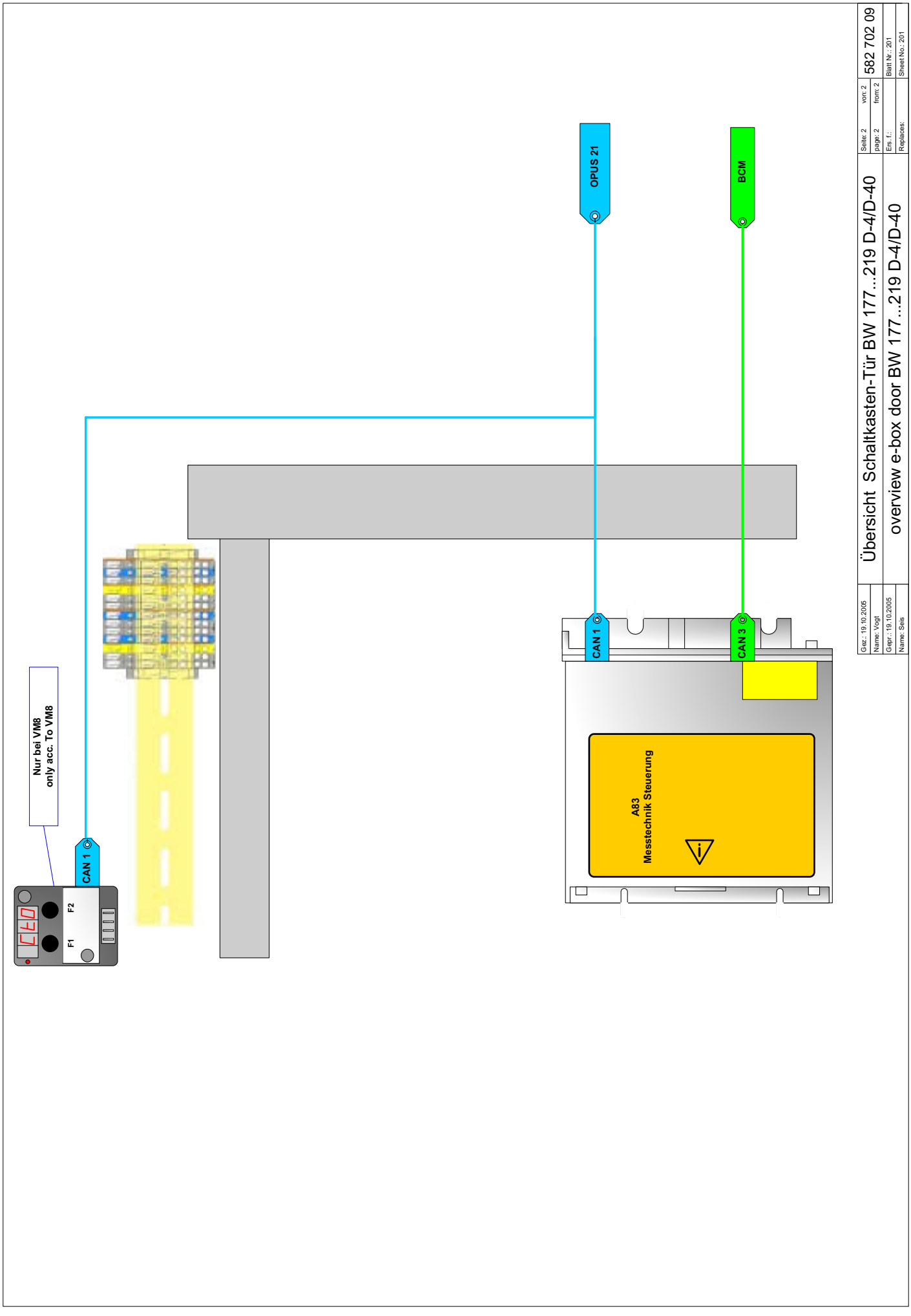
582 702 09
Blatt Nr.:
sheet no.: 106

Name	Bl.	Pf.	Benennung	title	TYP
X44:38	006	7	MESX STECKER	MESX Stecker	
X44:41	006	7	MESX STECKER	MESX Stecker	
X44:46	006	11	MESX STECKER	MESX Stecker	
X44:47	006	10	MESX STECKER	MESX Stecker	
X44:53	006	17	MESX STECKER	MESX Stecker	
X44:54	006	5	MESX STECKER	MESX Stecker	
X44:55	006	13	MESX STECKER	MESX Stecker	
X44:56	006	4	MESX STECKER	MESX Stecker	
X44:57	006	4	MESX STECKER	MESX Stecker	
X44:58	006	4	MESX STECKER	MESX Stecker	
X44:59	006	5	MESX STECKER	MESX Stecker	
X44:60	006	5	MESX STECKER	MESX Stecker	
X44:65	006	13	MESX STECKER	MESX Stecker	
X44:66	006	13	MESX STECKER	MESX Stecker	
X44:67	006	14	MESX STECKER	MESX Stecker	
X44:68	006	14	MESX STECKER	MESX Stecker	
X46:A	006	19	STECKER BOP	Connector BOP	
X46:B	006	18	STECKER BOP	Connector BOP	
X46:D	006	18	STECKER BOP	Connector BOP	
X46:E	006	19	STECKER BOP	Connector BOP	
X46:F	006	18	STECKER BOP	Connector BOP	
X47:A	006	11	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X47:B	006	12	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X47:C	006	12	STECKER AUFN. PLEIGER	conn. sender PLEIGER	
X48:1	006	8	STECKER AUFN. VORNE	conn. sender front	
X48:2	006	7	STECKER AUFN. VORNE	conn. sender front	
X48:3	006	7	STECKER AUFN. VORNE	conn. sender front	
X48:4	006	8	STECKER AUFN. VORNE	conn. sender front	
X49:1	006	10	STECKER AUFN. HINTEN	conn. sender rear	
X49:2	006	9	STECKER AUFN. HINTEN	conn. sender rear	
X49:3	006	9	STECKER AUFN. HINTEN	conn. sender rear	
X49:4	006	10	STECKER AUFN. HINTEN	conn. sender rear	
X53:B	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:C	010	4	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:H	010	4	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:L	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X53:M	010	3	STECKER LÜFTERSCHALTE	conn. blowerswitch	
X54:1	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:2	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:3	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:4	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:6	010	7	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:11	010	10	STECKER HEIZSTEUERUNG	conn. heating controller	
X54:12	010	11	STECKER HEIZSTEUERUNG	conn. heating controller	
X55:1	009	11	STECKER WISCHER HINTE	connector wiper rear	
X55:2	009	10	STECKER WISCHER HINTE	connector wiper rear	
X55:3	009	10	STECKER WISCHER HINTE	connector wiper rear	
X55:4	009	10	STECKER WISCHER HINTE	connector wiper rear	
X56:1	009	14	STECKER WISCHER VORNE	conn. wiper front	
X56:2	009	13	STECKER WISCHER VORNE	conn. wiper front	
X56:3	009	13	STECKER WISCHER VORNE	conn. wiper front	
X56:4	009	13	STECKER WISCHER VORNE	conn. wiper front	
X58:2	008	17	STECKER STVZO VL	Con. STVZO FL	
X58:3	008	7	STECKER STVZO VL	Con. STVZO FL	
X58:5	008	2	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	2	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	7	STECKER STVZO VL	Con. STVZO FL	
X58:6	008	17	STECKER STVZO VL	Con. STVZO FL	
X59:2	008	19	STECKER STVZO VR	Con. STVZO FR	
X59:3	008	7	STECKER STVZO VR	Con. STVZO FR	
X59:5	008	2	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	2	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	7	STECKER STVZO VR	Con. STVZO FR	
X59:6	008	19	STECKER STVZO VR	Con. STVZO FR	
X60:1	008	18	STECKER STVZO HL	Con. STVZO BL	
X60:2	008	18	STECKER STVZO HL	Con. STVZO BL	
X60:3	008	6	STECKER STVZO HL	Con. STVZO BL	
X60:4	008	6	STECKER STVZO HL	Con. STVZO BL	
X61:1	008	19	STECKER STVZO HR	Con. STVZO BR	
X61:2	008	19	STECKER STVZO HR	Con. STVZO BR	
X61:3	008	8	STECKER STVZO HR	Con. STVZO BR	
X61:4	008	8	STECKER STVZO HR	Con. STVZO BR	
X74:1	006	14	STECKER DRUCKER	con. printer	
X74:2	006	14	STECKER DRUCKER	con. printer	
X74:3	006	14	STECKER DRUCKER	con. printer	
X74:4	006	15	STECKER DRUCKER	con. printer	
X74:5	006	14	STECKER DRUCKER	con. printer	
X75:2	007	16	SUB–D STECKER BCM INT	con. SUB–D BCM	
X75:7	007	15	SUB–D STECKER BCM INT	con. SUB–D BCM	
X76:1	007	17	STECKER VERS. BCM	con. Power–sup. BCM	
X76:2	007	17	STECKER VERS. BCM	con. Power–sup. BCM	
X77:1	010	13	STECKER PUMPE STANDHE	Conn. pump add. heater	
X77:2	010	13	STECKER PUMPE STANDHE	Conn. pump add. heater	
Y01	002	12	Magnetventil Startmehrmenge	Solenoid valve, start boost fuel	MAX. 3.9A
Y04	004	5	Magnetventil Bremse	Solenoid valve, brake	MAX. 1,8A
Y07	005	14	Magnetventil Vibration vorne gross	Solenoid valve, vibration, front, high	MAX. 2,5A
Y08	005	16	Magnetventil Vibration vorne klein	Solenoid valve, vibration, front, low	MAX. 2,5A
Y13	002	18	Hubmagnet Motor	Shut off solenoid, engine	MAX. 3.8A
Y14	010	13	Kraftstoffpumpe Heizgeraet	Fuel pump, heating unit	
Y15	010	7	Magnetkupplung Klimakompressor	Magnetic clutch, air conditioning compr.	3,5A
Y30	005	6	Magnetventil Stufenumschaltung vorn	Solenoid valve, speed range sel., front	MAX. 1,67A
Y31	005	3	Magnetventil Stufenumschaltung hinten	Solenoid valve, speed range sel., rear	MAX. 1,23A
Y31	005	8	Magnetventil Stufenumschaltung hinten	Solenoid valve, speed range sel., rear	MAX. 1,23A
Y120	002	16	Magnetventil Motordrehzahl hoch	Solenoid valve, rpm engine high	
Y138	010	10	Magnetveentil Heizung	Solenoid valve, heating unit	3,5A
Y140	006	10	Magnetventil Erreger auf	solenoid valve exciter up	
Y141	006	11	Magnetventil Erreger ab	solenoid valve exciter down	

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Übersicht Schaltkasten-Tür BW 177...219 D-4/D-40

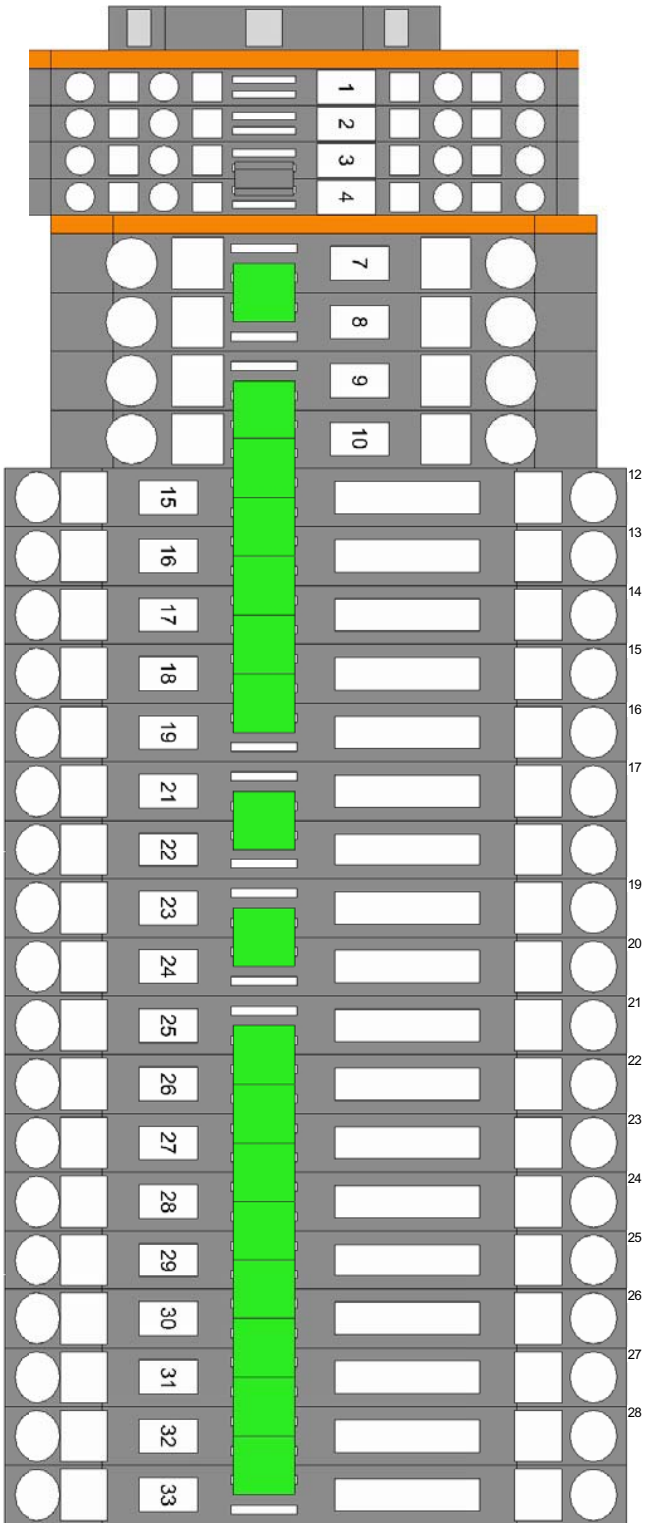
overview e-box door BW 177...219 D-4/D-40

Gez.: 19.10.2005	Seite: 2	von: 2	582 702 09
Name: Vogt	page: 2	from: 2	
Gepr.: 19.10.2005	Ers. f.:		Blatt Nr.: 201
Name: Seis	Replaces:		Sheet No.: 201

WAGO smart DESIGNER 4.1

BOMAG FAYAT GROUP

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3	2 x 05756425 "L" + 793-501
5	2 x 05756425 "L" + 05756420 + 793-501
7	05756422
8	4 x 05756423 "L" + 05756419 + 793-501
12	18 x 05756436 "R" + 05756419 + 793-501



12	Flachsicherung DIN 72581-C30 / 057 510 99
13	Flachsicherung DIN 72581-C15 / 057 510 98
14	Flachsicherung DIN 72581-C20 / 057 511 00
15	Flachsicherung DIN 72581-C15 / 057 510 98
16	Flachsicherung DIN 72581-C15 / 057 510 98
17	Flachsicherung DIN 72581-C15 / 057 510 98
19	Flachsicherung DIN 72581-C10 / 057 510 97
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21	Flachsicherung DIN 72581-C15 / 057 510 98
22	Flachsicherung DIN 72581-C10 / 057 510 97
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24	Flachsicherung DIN 72581-C10 / 057 510 97
25	Flachsicherung DIN 72581-C10 / 057 510 97
26	Flachsicherung DIN 72581-C15 / 057 510 98
27	Flachsicherung DIN 72581-C10 / 057 510 97
28	Flachsicherung DIN 72581-C15 / 057 510 98

Optional1 :	Projektgruppe : Walzenzüge-4 Klemmenleisten	Zeichnungsnummer :
Optional2 :	Projekt :	Artikelnummer :
Optional3 :	Zeichnung :	Artikelnummer lang :
Optional4 :	Obere Ebenen :	gezeichnet: :
Optional5 :	Ort :	geprüft: :
Optional6 :	Tragschiene : Absicherung D-4 Version	Lieferadresse :
Optional7 :	ausgewählte Tragschiene : Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
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	Größe der Bohrung : 5.20 x 25.00 [mm]	

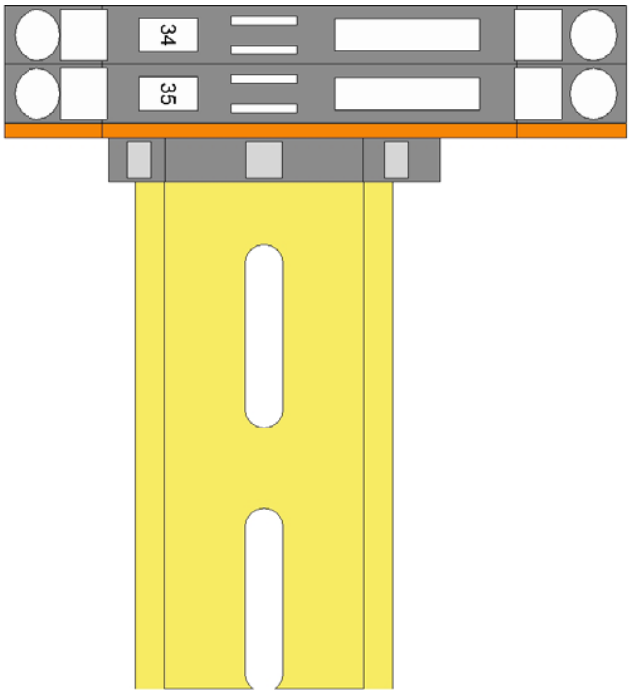
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32 05756435

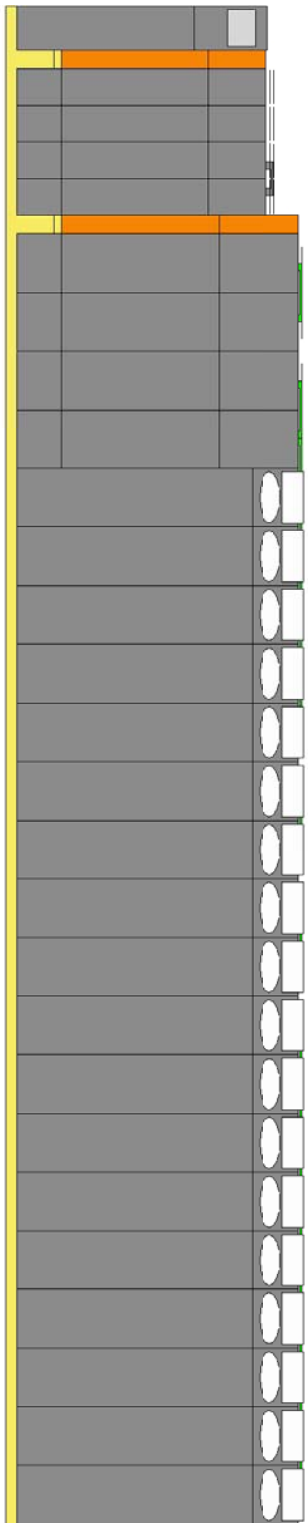
33 05756417



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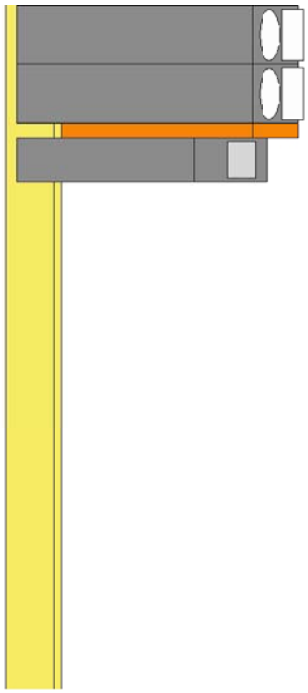
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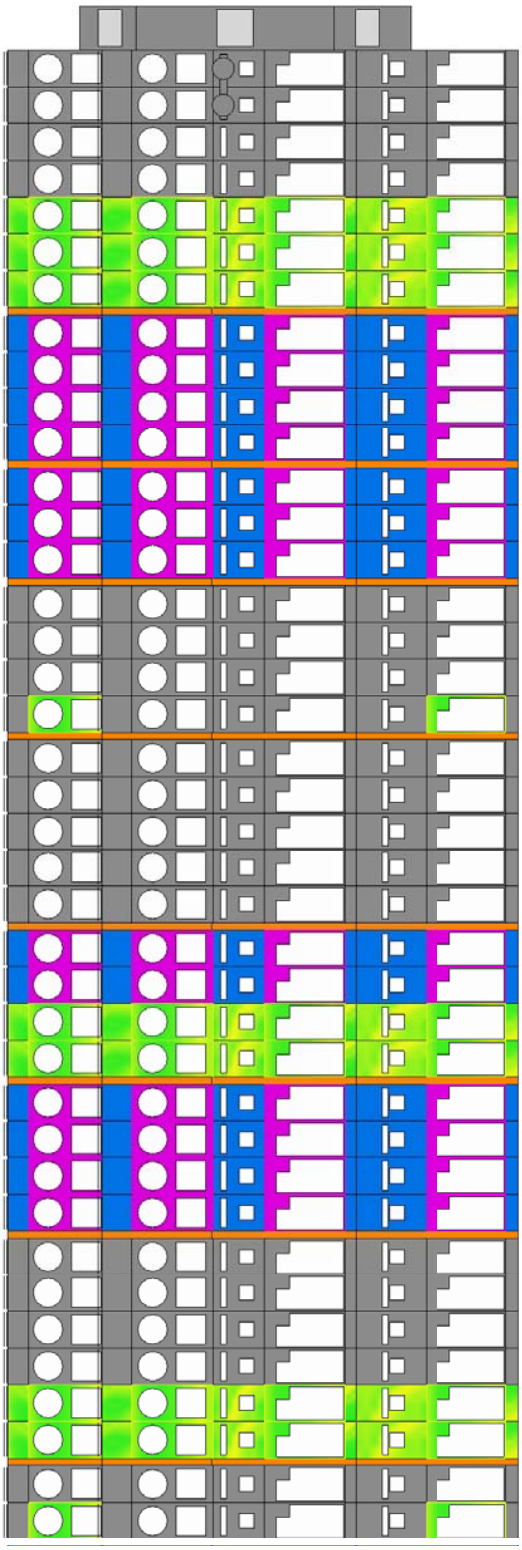
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BOMAG FAYAT GROUP

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6	3 x 05756539 "R" + 793-501
9	05756537
10	4 x 05756538 "R" + 793-501
14	05756537
15	3 x 05756538 "R" + 793-501
18	05756537
19	3 x 05756540 "R" + 793-501
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24	5 x 05756540 "R" + 793-501
29	05756537
30	2 x 05756538 "R" + 793-501
32	2 x 05756539 "R" + 793-501
34	05756537
35	4 x 05756538 "R" + 793-501
39	05756537
40	4 x 05756540 "R" + 793-501
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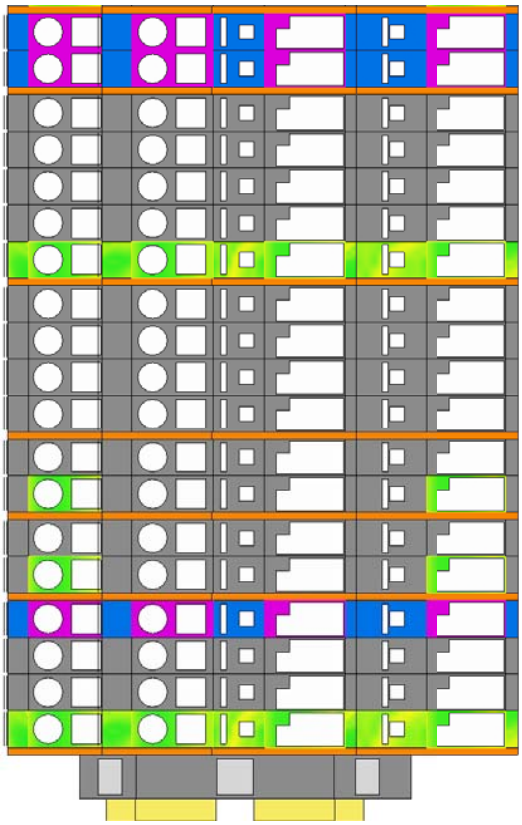
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Optional4 :	Obere Ebenen :		gezeichnet: :
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Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
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	Größe der Bohrung :	5.20 x 25.00 [mm]	

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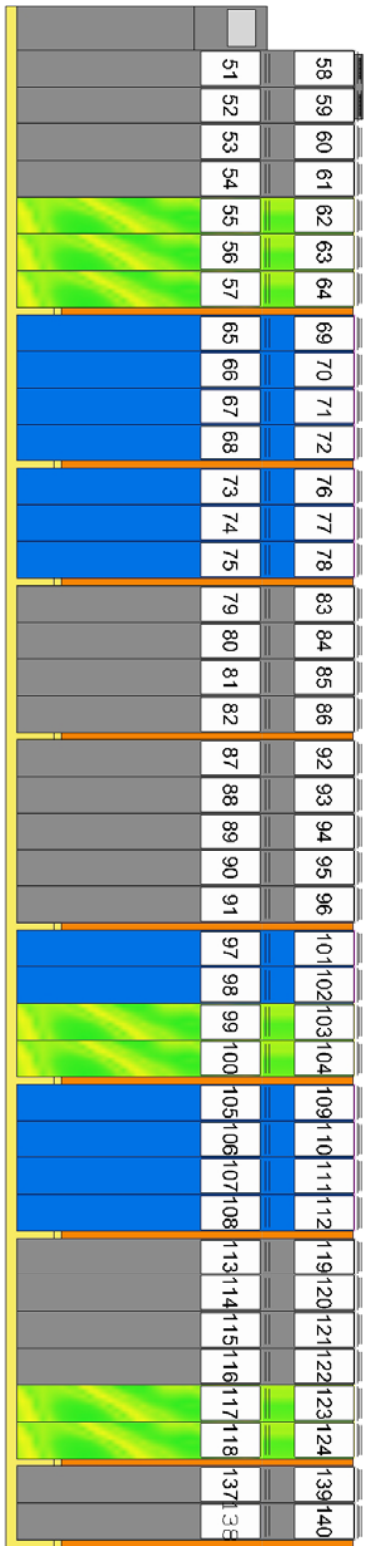
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58	05756537
59	4 x 05756540 "R" + 793-501
63	05756537
64	05756540 "R" + 793-501
65	05756535 "R" + 793-501
66	05756537
67	05756540 "R" + 793-501
68	05756535 "R" + 793-501
69	05756537
70	05756538 "R" + 793-501
71	2 x 05756540 "R" + 793-501
73	05756539 "R" + 793-501
74	05756537
75	05756417



Optional1 :	Projektgruppe :	Walzenzüge-4 Klemmenleisten	Zeichnungsnummer :
Optional2 :	Projekt :		Artikelnummer :
Optional3 :	Zeichnung :		Artikelnummer lang :
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Optional6 :	Tragschiene :	Kabelbäume D Version	Lieferadresse :
Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
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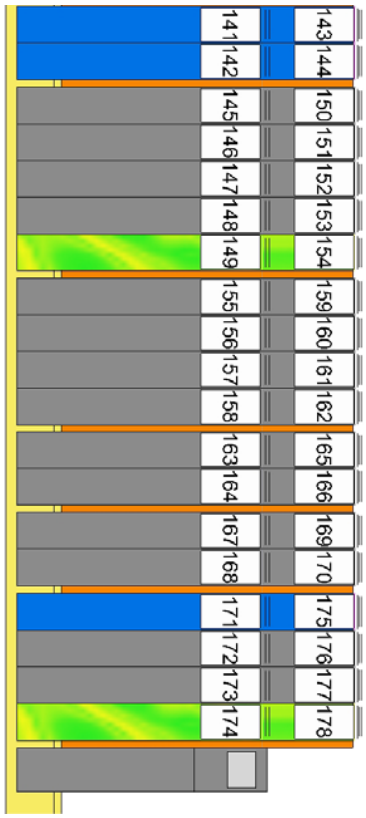
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Optional3 :	Zeichnung :		Artikelnummer lang :
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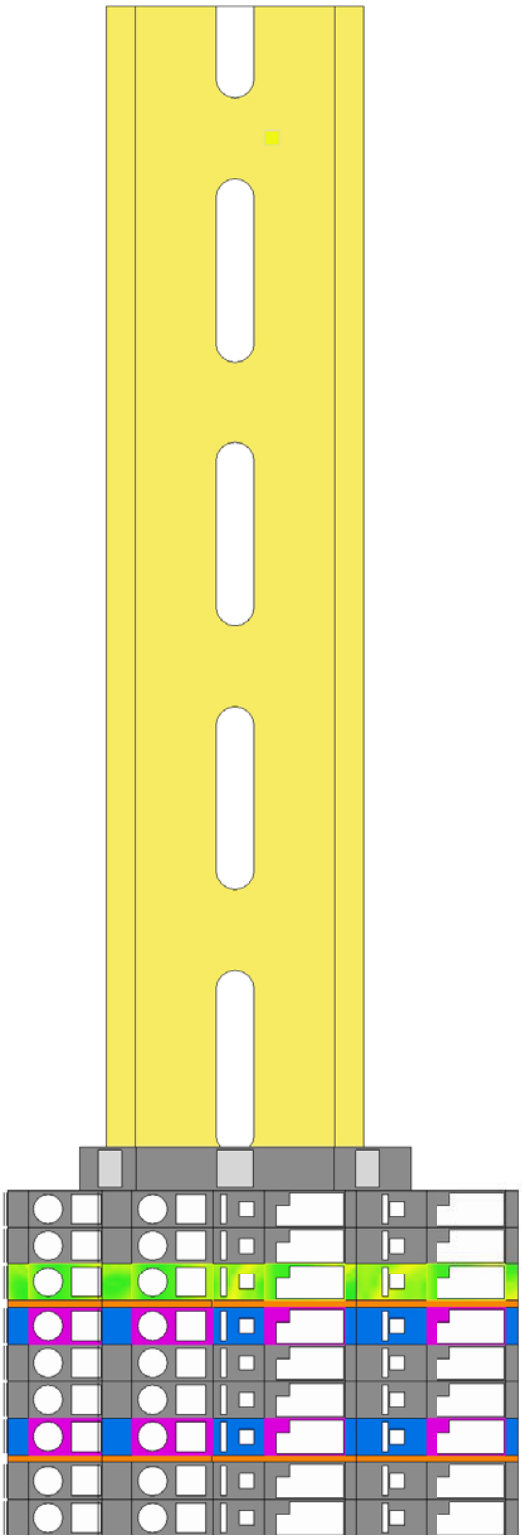


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	Artikelnummer :	210-112	
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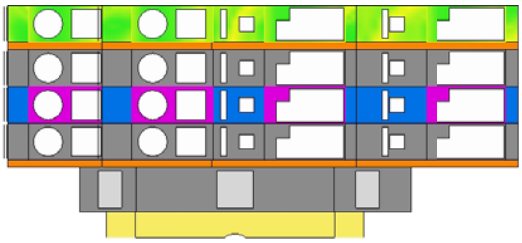
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11	2 x 05756540 "R" + 793-501

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Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
	Artikelnummer :	210-112	
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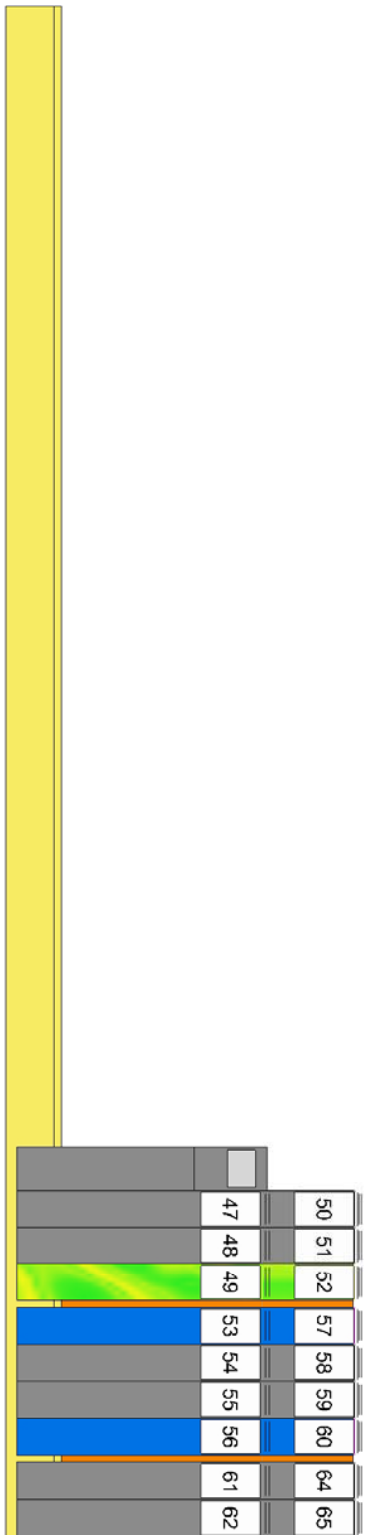
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14	05756537	
15	05756540	"R" + 793-501
16	05756538	"R" + 793-501
17	05756540	"R" + 793-501
18	05756537	
19	05756417	



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Optional2 :	Projekt :	Messtechnik D	Artikelnummer :
Optional3 :	Zeichnung :		Artikelnummer lang :
Optional4 :	Obere Ebenen :		gezeichnet: :
Optional5 :	Ort :		geprüft: :
Optional6 :	Tragschiene :	Klemmenleiste X2	Lieferadresse :
Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
	Artikelnummer :	210-112	
	Größe der Bohrung :	5.20 x 25.00 [mm]	

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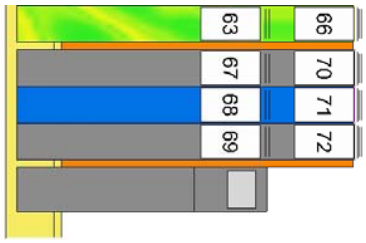
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Optional6 :	Tragschiene :	Klemmenleiste X2	Lieferadresse :
Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
	Artikelnummer :	210-112	
	Größe der Bohrung :	5.20 x 25.00 [mm]	

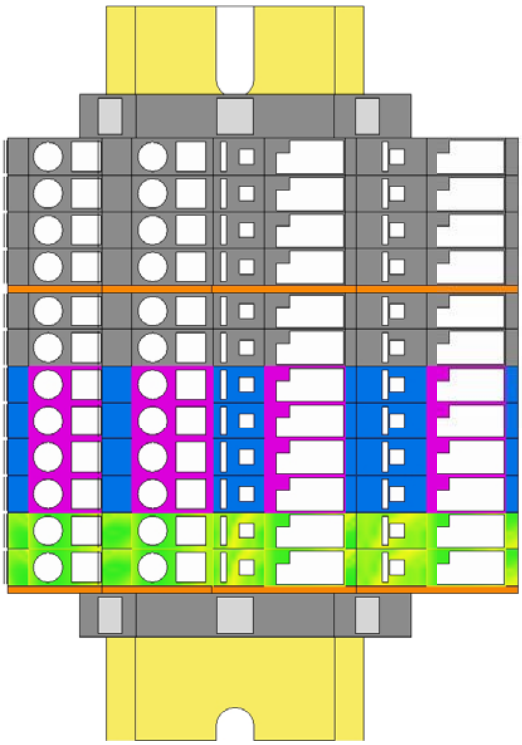
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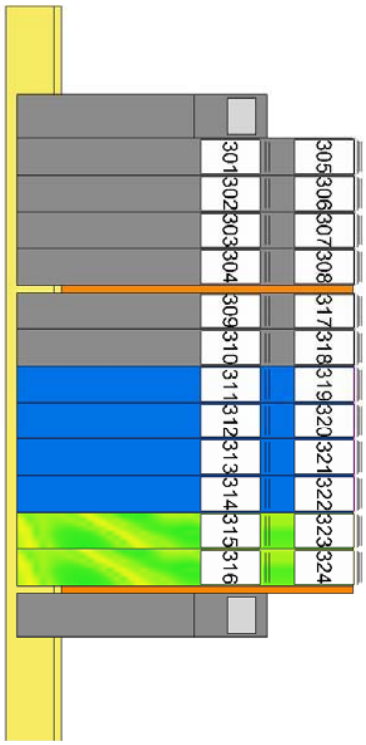
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		14	Nur bei ZA E2 StvZO Beleuchtung
15	05756537	15	Nur bei ZA E2 StvZO Beleuchtung
16	05756417	16	Nur bei ZA E2 StvZO Beleuchtung



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Optional3 :	Zeichnung :		Artikelnummer lang :
Optional4 :	Obere Ebenen :		gezeichnet: :
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Optional6 :	Tragschiene :	Option E2 StvZO Beleuchtung	Lieferadresse :
Optional7 :	ausgewählte Tragschiene :	Stahl-Tragschiene 35x7,5 mm, 1 mm dick	
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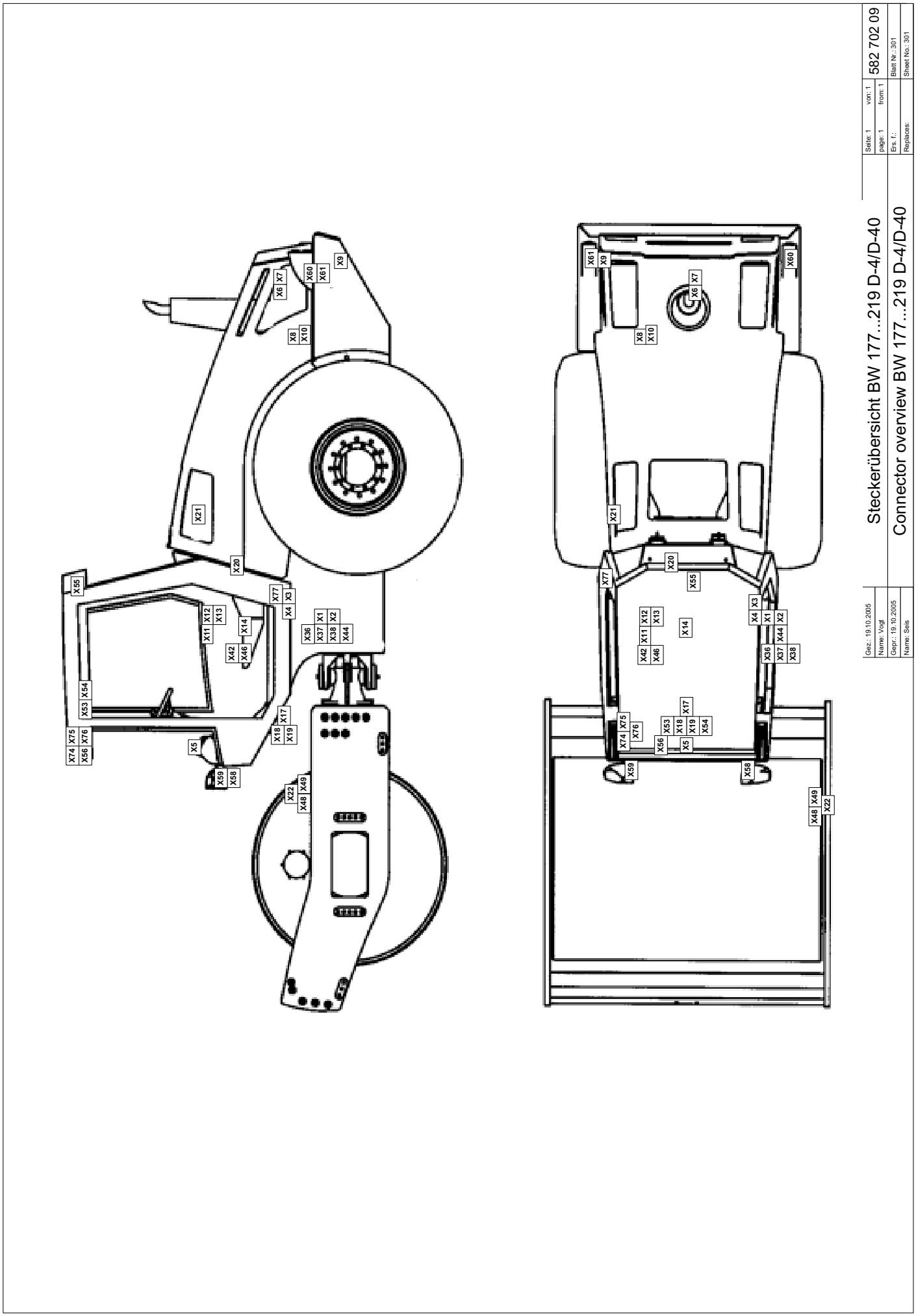
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Steckerübersicht BW 177...219 D-4/D-40

Connector overview BW 177...219 D-4/D-40

Seite: 1	von: 1	582 702 09	
page: 1	from: 1		
Ers. f.:		Blatt Nr.: 301	
Replaces:		Sheet No.: 301	

Gez.: 19.10.2005	
Name: Vogt	
Gepr.: 19.10.2005	
Name: Seis	

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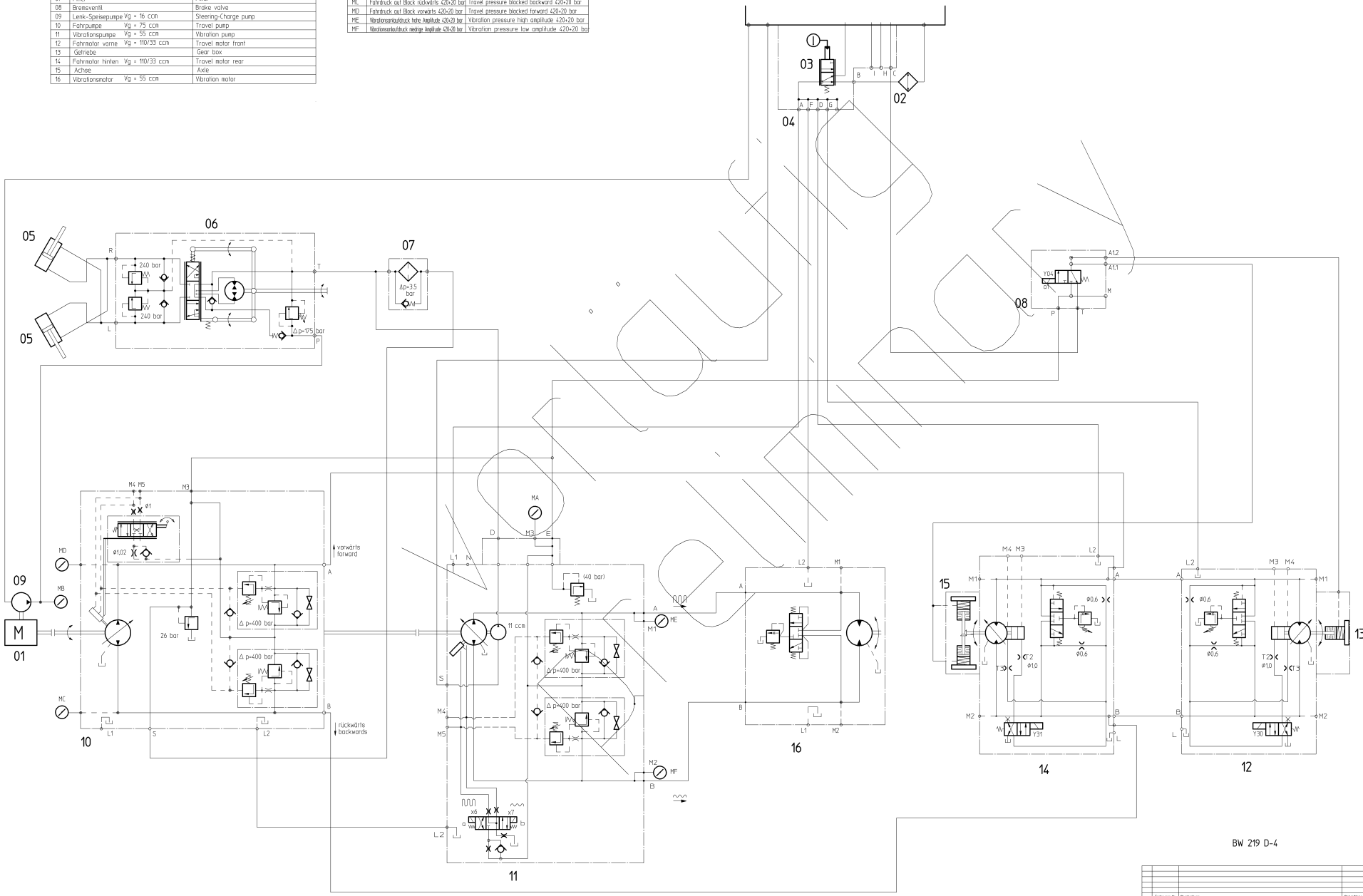
17.3 Hydraulic diagram

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Pos.	Benennung	Description
01	Verbrennungsmotor n=2300 1/min	Engine
02	Ölkühler	Oil cooler
03	Öltemperaturregler	Oiltemperature regulator
04	Anschlußblock	Connecting block
05	Lenkzylinder	Steering cylinder
06	Lenkeinheit	Steering unit
07	Filter	Filter
08	Bremsventil	Brake valve
09	Lenk-Speisepumpe Vg = 16 ccm	Steering-Charge pump
10	Fahrpumpe Vg = 75 ccm	Travel pump
11	Vibrationspumpe Vg = 55 ccm	Vibration pump
12	Fahrmotor vorne Vg = 110/33 ccm	Travel motor front
13	Getriebe	Gear box
14	Fahrmotor hinten Vg = 110/33 ccm	Travel motor rear
15	Achse	Axle
16	Vibrationsmotor Vg = 55 ccm	Vibration motor

alle Drücke gemessen bei einer Öltemperatur von ca.50°C
Verbrennungsmotor im hohen Leerlauf n=2300 1/min
all pressures measured by an oiltemperature of ca.50°C
Engine at high idling speed n=2300 1/min

Pos.	Beschreibung	Description
MA	Speisedruck 26+3 bar	Charge pressure 26+3 bar
MB	Lenkdruck bei Volleinschlag 200+20 bar	Steering pressure at max. steering angle 200+20 bar
MC	Fahrdruck auf Block rückwärts 420+20 bar	Travel pressure blocked backward 420+20 bar
MD	Fahrdruck auf Block vorwärts 420+20 bar	Travel pressure blocked forward 420+20 bar
ME	Vibrationsantriebsdruck hohe Amplitude 420+20 bar	Vibration pressure high amplitude 420+20 bar
MF	Vibrationsantriebsdruck niedrige Amplitude 420+20 bar	Vibration pressure low amplitude 420+20 bar



Hydraulikschema
Hydraulic schematic

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