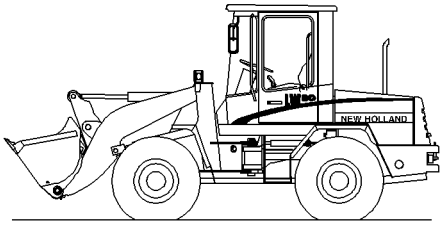
NEW HOLLAND CONSTRUCTION LW 80

TECHNICAL HANDBOOK



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May 1999

NEW HOLLAND

01 GENERAL

FOREWORD

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This **Technical Handbook (THB)** has been written with **the servicing mechanic** in mind and contains important information required to carry out repair and servicing procedures.

Read through the **Technical Handbook**, but also the **Operating Instructions** for the **NEW HOLLAND CONSTRUCTION Wheel Loader** before commencing any servicing or repair work. The **Technical Handbook**, as well as the **Operating Instructions** and **Spare Parts List** should be used as a source of reference and assistance - even when the user is well acquainted with the range of NEW HOLLAND CONSTRUCTION Wheel Loaders.

Using the Technical Handbook allows the experienced mechanic to carry out repair work in a correct manner.

Using the Technical Handbook

The Technical Handbook is divided into main and sub-groups that deal with the machine as actually delivered. Any auxiliary attachments or optional upgrading introduced later are not described.

The main table of contents allows to find the required information quickly.

For the sake of clarity, the illustrations have been simplified and can therefore differ slightly from the actual appearance of the machine.

Servicing and repair

Servicing and repair work should be carried out as soon as possible. This keeps overall servicing & repair costs to a minimum and increases the availabilily of the NEW HOLLAND CONSTRUCTION Wheel Loader.

During servicing and repair work, always follow the instructions contained in the Technical Handbook and Operating instructions.

The **NEW HOLLAND CONSTRUCTION After Sales Service** is always available for assistance and advice.

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⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

Warnings and symbols 2732729

The following signs are used in the manual to designate instructions of particular importance:

⚠ DANGER

Imminent danger involving the risk of death or of severe injuries.

⚠ WARNING

Precautionary rules and measures designed to protect the machine operator and other persons from life-threatening danger or injuries and to prevent extensive damage.

⚠ CAUTION

Information and precautionary measures designed to prevent damage to the machine or other property.

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Danger in the event of non-observance of the safety instructions 96843

⚠ WARNING

This wheel loader has been built in accordance with state-of-the-art standards and the recognized safety rules.

However, operating the machine if a fault is suspected or has occurred, or carrying out repair work inexpertly may

- **endanger the lives of persons in contact with it**
- **damage the machine and other property.**

The wheel loader must be stopped immediately on any damage being suspected or occurring to ensure that the safety of the operator, of other persons at the place of use or of other material property is not compromised.

All components are carefully co-ordinated. Trouble-free operation and a long service life can only be achieved with original spare parts.

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⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

Organizational measures

2800456

The operating instructions must always be at hand at the place of use of the machine, e.g. by stowing them in the tool compartment or tool-box provided for such purpose.

In addition to the operating instructions, observe and instruct the user in all other generally applicable legal and other mandatory regulations relevant to accident prevention and environmental protection.

These compulsory regulations may also deal with the handling of hazardous substances, issuing and/or wearing of personal protective equipment or traffic regulations.

The operating instructions must be supplemented by instructions covering the duties involved in supervising and notifying special organizational features, such as job organization, working sequences or the personnel entrusted with the work.

Personnel entrusted with work on the machine must have read the operating instructions and in particular the chapter on safety before beginning work. Reading the instructions after work has begun is too late. This applies especially to persons working only occasionally on the machine, e.g. during setting up or maintenance.

Check - at least from time to time - whether the personnel is carrying out the work in compliance with the operating instructions and paying attention to risks and safety factors.

For reasons of security, long hair must be tied back or otherwise secured, garments must be close-fitting and no jewellery, such as rings, may be worn. Injury may result from being caught up in the machinery or from rings catching on moving parts.

Use protective equipment wherever required by the circumstances or by law.

Observe all safety instructions and warnings attached to the machine.

See to it that safety instructions and warnings attached to the machine are always complete and perfectly legible.

In the event of safety-relevant modifications or changes in the behaviour of the machine during operation, stop the machine immediately and report the malfunction to the competent authority/person.

Never make any modifications, additions or conversions which might affect safety without the supplier's approval. This also applies to the installation and adjustment of safety devices and valves as well as to welding work on load-bearing elements.

Spare parts must comply with the technical requirements specified by the manufacturer. Spare parts from original equipment manufacturers can be relied to do so.

Replace hydraulic hoses within stipulated and appropriate intervals, even if no safety-relevant defects have been detected.

Adhere to prescribed intervals or those specified in the operating instructions for routine checks and inspections.

For the execution of maintenance work, tools and workshop equipment adapted to the task on hand are absolutely indispensable.

The personnel must be familiar with the location and operation of fire extinguishers.

Observe all fire-warning and fire-fighting procedures.

⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

Selection and qualification of personnel - basic responsibilities

Any work on and with the machine must be executed by reliable personnel only. Statutory minimum age limits must be observed.

Employ only trained or instructed staff and set out clearly the individual responsibilities of the personnel for operation, set-up, maintenance and repair.

Make sure that only authorized personnel works on or with the machine.

Define the machine operator's responsibilities - also with regard to observing traffic regulations - giving the operator the authority to refuse instructions by third parties that are contrary to safety.

Do not allow persons to be trained or instructed or persons taking part in a general training course to work on or with the machine without being permanently supervised by an experienced person.

Work on the electrical system and equipment of the machine must be carried out only by a skilled electrician or by instructed persons under the supervision and guidance of a skilled electrician and in accordance with electrical engineering rules and regulations.

Work on chassis, brake and steering systems must be performed by skilled personnel only, which has been specially trained for such work.

Work on the hydraulic system must be carried out only by personnel with special knowledge and experience of hydraulic equipment.

Safety instructions governing specific operational phases

Standard operation

Avoid any operational mode that might be prejudicial to safety.

Before beginning work, familiarize yourself with the surroundings and circumstances of the site, such as obstacles in the working and travelling area, the soil bearing capacity and any barriers separating the construction site from public roads.

Take the necessary precautions to ensure that the machine is used only when in a safe and reliable state.

Operate the machine only if all protective and safety-oriented devices, such as removable safety devices, emergency shut-off equipment, sound-proofing elements and exhausters, are in place and fully functional.

Check the machine at least once per working shift for obvious damage and defects. Report any changes (incl. changes in the machine's working behaviour) to the competent organization/person immediately. If necessary, stop the machine immediately and lock it.

In the event of malfunctions, stop the machine immediately and lock it. Have any defects rectified immediately.

Start the machine from the driver's seat only.

During start-up and shut-down procedures always watch the indicators in accordance with the operating instructions.

Before setting the machine in motion, make sure that nobody is at risk.

Before starting work or travelling with the machine, check that the braking, steering, signalling and lighting systems are fully functional.

Before setting the machine in motion always check that the accessories have been safely stowed away.

When travelling on public roads, ways and places always observe the valid traffic regulations and, if necessary, make sure beforehand that the machine is in a condition compatible with these regulations.

⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

In conditions of poor visibility and after dark always switch on the lighting system.

Persons accompanying the driver must be seated on the passenger seats provided for this purpose.

When crossing underpasses, bridges and tunnels or when passing under overhead lines always make sure that there is is sufficient clearance.

Always keep at a distance from the edges of building pits and slopes.

Avoid any operation that might be a risk to machine stability.

Never travel across slopes; always keep the working equipment and the load close to the ground, especially when travelling downhill.

On sloping terrain always adapt your travelling speed to the prevailing ground conditions. Never change to a lower gear on a slope but always before reaching it.

Before leaving the driver's seat always secure the machine against inadvertent movement and unauthorized use.

Special work in conjunction with utilization of the machine - maintenance and repairs during operation - disposal of parts and consumables

Observe the adjusting, maintenance and inspection activities and intervals set out in the operating instructions, including information on the replacement of parts and equipment. These activities may be executed by skilled personnel only.

Brief operating personnel before beginning special operations and maintenance work, and appoint a person to supervise the activities.

In any work concerning the operation, conversion or adjustment of the machine and its safety-oriented devices or any work related to maintenance, inspection and repair, always observe the start-up and shut-down procedures set out in the operating instructions and the information on maintenance work.

Ensure that the maintenance area is adequately secured.

If the machine is completely shut down for maintenance and repair work, it must be secured against inadvertent starting by:

- removing the ignition key and
- attaching a warning sign.

Carry out maintenance and repair work only if the machine is positioned on stable and level ground and has been secured against inadvertent movement and buckling.

To avoid the risk of accidents, individual parts and large assemblies being moved for replacement purposes should be carefully attached to lifting tackle and secured. Use only suitable and technically perfect lifting gear and suspension systems with adequate lifting capacity. Never work or stand under suspended loads.

The fastening of loads and the instructing of crane operators should be entrusted to experienced persons only. The marshaller giving the instructions must be within sight or sound of the operator.

⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

For carrying out overhead assembly work always use specially designed or otherwise safety-oriented ladders and working platforms. Never use machine parts as a climbing aid.

Wear a safety harness when carrying out maintenance work at greater heights.

Keep all handles, steps, handrails, platforms, landings and ladders free from dirt, snow and ice.

Clean the machine, especially connections and threaded unions, of any traces of oil, fuel or preservatives before carrying out maintenance/repair. Never use aggressive detergents. Use lint-free cleaning rags.

Before cleaning the machine with water, steam jet (high-pressure cleaning) or detergents, cover or tape up all openings which - for safety and functional reasons - must be protected against water, steam or detergent penetration. Special care must be taken with electric motors and switchgear cabinets.

Ensure during cleaning of the machine that the temperature sensors of the fire-warning and fire-fighting systems do not come into contact with hot cleaning agents as this might activate the fire-fighting system.

After cleaning, remove all covers and tapes applied for that purpose.

After cleaning, examine all fuel, lubricant, and hydraulic fluid lines for leaks, loose connections, chafe marks and damage. Any defects found must be rectified without delay.

Always tighten any screwed connections that have been loosened during maintenance and repair.

Any safety devices removed for set-up, maintenance or repair purposes must be refitted and checked immediately upon completion of the maintenance and repair work.

Ensure that all consumables and replaced parts are disposed of safely and with minimum environmental impact.

Warning of special dangers

Electric energy

Use only original fuses with the specified current rating. Switch off the machine immediately if trouble occurs in the electrical system.

When working with the machine, maintain a safe distance from overhead electric lines. If work is to be carried out close to overhead lines, the working equipment must be kept well away from them. Caution, danger! Check out the prescribed safety distances.

If your machine comes into contact with a live wire

- do not leave the machine
- drive the machine out of the hazard zone
- warn others against approaching and touching the machine
- have the live wire de-energized
- do not leave the machine until the damaged line has been safely de-energized.

The electrical equipment of machines is to be inspected and checked at regular intervals. Defects such as loose connections or scorched cables must be rectified immediately.

Gas, dust, steam and smoke

Operate internal combustion engines and fuel-operated heating systems only on adequately ventilated premises. Before starting the machine on enclosed premises, make sure that there is sufficient ventilation.

Observe the regulations in force at the respective site.

Carry out welding, flame-cutting and grinding work on the machine only if this has been expressly authorized, as there may be a risk of explosion and fire.

Before carrying out welding, flame-cutting and grinding operations, clean the machine and its surroundings from dust and other inflammable substances and make sure that the premises are adequately ventilated (risk of explosion).

⚠ FUNDAMENTAL SAFETY INSTRUCTIONS

Hydraulic and pneumatic equipment

Check all lines, hoses and screwed connections regularly for leaks and obvious damage. Repair damage immediately. Splashed oil may cause injury and fire.

Depressurize all system sections and pressure pipes (hydraulic system, compressed-air system) to be removed in accordance with the specific instructions for the unit concerned before carrying out any repair work.

Hydraulic and compressed-air lines must be laid and fitted properly. Ensure that no connections are interchanged. The fittings, lengths and quality of the hoses must comply with the technical requirements.

Noise

During operation, all sound baffles of the machine must be closed.

Always wear the prescribed ear protectors.

Oil, grease and other chemical substances

When handling oil, grease and other chemical substances, observe the product-related safety regulations.

Be careful when handling hot consumables (risk of burning or scalding).

Transporting and towing - recommissioning

The machine must be towed, loaded and transported only in accordance with the operating instructions.

For towing the machine observe the prescribed transport position, admissible speed and itinerary.

Use only appropriate means of transport and lifting gear of adequate capacity.

The recommissioning procedure must be strictly in accordance with the operating instructions. □

Repair work - safety instructions

2801063

DANGER

Operating instructions

Never carry out repair work without having read and understood the operating instructions.

Pay special attention to:

"Fundamental Safety Instructions", "Inspection and servicing - safety instructions" and all warnings and safety instructions attached to the machine.

The descriptions of job sequences provide only experienced personnel with the necessary instructions.

The operating manual must be kept with the machine at all times.

Repair personnel

Repair personnel must have know-how and experience relevant to repairing this or comparable machines.

Working at greater heights

Always wear safety harnesses when working at greater heights.

Wear an approved safety harness; it must be equipped with stabilizers and safety cables.

DANGER

Pressurized or spring loaded units

Never open defective pressurized or spring loaded units but replace them as an entirety.

In exceptional cases, open only when the system and the operating sequence are precisely known and any special tools required are available.

The technical handbook contains no information on this point.

Never remove lead seals

Never change rated pressure of pressure relief valves without the explicit authorization of NEW HOLLAND CONSTRUCTION.

Never remove lead seals from pressure relief valves and accumulators.

⚠ WARNING

Dismantling components

Never dismantle while the machine is at operating temperature.

Oils, greases, brake fluid or coolants may have a high temperature and result in burning or scalding.

Leave time for the machine to cool down.

Before starting work, depressurize piping and hoses, cylinders, radiator, hydraulic tank, air-brake reservoir and other systems or units.

Replace defective components in good time to prevent major damage.

Clean the defective component carefully before dismantling it.

Mark the dismantled parts in the correct sequence to facilitate assembly.

When dismantling the component, close off exposed hose and piping connections, exposed drill holes and housing carefully to prevent any dust from penetrating.

After the repair work

To prevent corrosion, coat all bright metal machine parts with a grease film.

On completing the work, reassemble all protective devices, covers, and sound- and vibration-insulation material.

Never start up the driving motor while work is being done on the machine.

Check the repaired components and all machine functions with a trial run.

Never release the machine for recommissioning until it is fully functioning.

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ACCUMULATORS
Safety instructions

2800629

⚠ DANGER

Accumulators are installed in the hydraulic system. These accumulators contain nitrogen under high initial pressure.

Even when the hydraulic pressure in the system is reduced, the nitrogen remains in the accumulator.

The accumulators are completely safe in operation. If incorrectly handled, however, there is a risk of explosion.

So:

- **Never handle accumulator mechanically, never weld or solder it.**
- **Testing and servicing work must be carried out by experts only.**
- **Prior to any testing and servicing work, depressurize the hydraulic part of the system.**
- **To dismantle the accumulator, always wear goggles and working gloves.**
- **Fill accumulator with nitrogen only, never with compressed air or oxygen.**
- **Report any defects or damage to the machine owner without delay.**
- **Prior to recommissioning, an inspection by a specialist or expert is essential if the accumulator was damaged or if the admissible operating temperature or operating pressure was exceeded.**

Never remove or paint over warning and information plates, rating plates or type identification markings. Replace illegible or damaged plates immediately.

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ENGINE

2801064

Engine - repair instructions

DANGER

Read and observe: "Repair, safety instructions" and operating instructions for engine before working on the engine.

Risk of injury from rotating or hot engine parts!

Switch off engine and leave to cool down.

Do repair work only if machine is secured as described in section "Securing the machine" of these operating instructions.

Check and change V-belts only when engine is stationary.

Repair work on the engine demands extensive know-how and special tools.

In cases of doubt, have the repair work carried out by your Dealer.

□

Assisted starting (with jumper cables) - safety instructions

2800620

WARNING

Keep any potential ignition sources such as unshielded lights or burning cigarettes away from the batteries. The battery vapours are highly flammable. Explosion hazard.

Never use assisted starting when the batteries are defective or frozen.

Never connect batteries (battery assemblies) unless they have the same voltage.

Use only tested jumper cables with insulated terminal clips and an adequate lead diameter.

Ensure that the bodies of the supplying and receiving machines are not in contact. Otherwise a current flow could result from connecting the positive poles. Risk of short-circuiting.

Never use welding generators or welding transformers as a source of current.

Position the jumper cables in such a way that they cannot be caught by rotating engine components.

Read and observe: "Inspection and servicing, safety instructions", paying particular attention to the section "Handling batteries".

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WELDING OPERATIONS

Welding operations - safety instructions

2801065

⚠ WARNING

Never perform welding operations unless you are qualified to do so.

Observe the accident prevention regulations.

Any work on receptacles that contain or have contained substances which are

- **combustible or which encourage combustion, which**
- **are susceptible to explosion, or which**
- **may develop health-hazardous gases, vapours, mist or dust during welding operations**

must be carried out only under expert supervision and only by experienced persons authorized to do such work.

⚠ WARNING

Prior to any welding operations on the machine:

- **Disconnect the battery, first the negative terminal and then at the positive terminal.**
- **Disconnect the positive terminal at the alternator.**

Protect the disconnected terminals and plugs from short-circuiting and soiling by covering them with foil or adhesive tape.

Apply the welding current terminals very close to the welding point.

The welding current must not flow through gearboxes, bolted or articulated joints or hydraulic cylinders.

On completion of the welding operation, restore all electrical connections.

When connecting the battery, first connect the positive terminal and then the negative terminal.

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Notes

2800145

Service Data General

Service Data LW 80

SERVICE DATEN
SERVICE DATA

Allgemein
General

2 801 850.00 de/us

VORWORT

2801092

⚠ WARNUNG

Jede Person, die mit der Inbetriebnahme, Bedienung, Inspektion und Wartung dieser Baumaschine befaßt ist, muß - bevor sie die ersten Handgriffe ausführt - die "BETRIEBSANLEITUNG" und besonders das Kapitel "GRUNDLEGENDE SICHERHEITSHINWEISE" gelesen und verstanden haben.

Die "Service Daten" enthalten Angaben, die für Kundendienstmitarbeiter wichtig sind. Maschinendaten, die an anderer Stelle der Dokumentation aufgeführt sind, werden hier nicht wiederholt. Zur Dokumentation dieser Baumaschine gehören:

- Betriebsanleitung
- Ersatzteilliste

Zur Dokumentation im weiteren Sinne gehören auch "Technische Handbücher" (THB) und "Service Informationen" (si).

In dieser Broschüre sind die Daten der Hilfsaggregate zum Betrieb von Zusatz- oder Sonderausrüstungen sowie Daten von Einzelgeräten nicht aufgeführt.

Die aufgeführten Füllmengen der Betriebsmittel sind ca.-Angaben, die Dispositionshilfe sein sollen. Jedes Aggregat besitzt geeignete Kontrolleinrichtungen, z. B. Peilstab oder Kontrollschrauben, mit denen die exakte Befüllung geprüft wird.

⚠ VORSICHT

Die in den Kapiteln aufgeführten Sach-Nrn. nicht zum Bestellen von Ersatzteilen verwenden. Sie sollen nur dokumentieren, auf welches Bauteil sich die nachstehenden Daten beziehen. Zur Ersatzteilbestellung die zur Maschine gehörende Ersatzteilliste verwenden.

FOREWORD

⚠ WARNING

Anyone involved with commissioning, operating, inspecting and servicing for this construction machine must read through and acquaint himself with the "OPERATING MANUAL" - and especially the Section "FUNDAMENTAL SAFETY INSTRUCTIONS" - before starting work.

The "Service Data" contains details which are important to the service staff. Data included in other parts of the general documentation have been left aside. The set of documents for this construction machine includes:

- Operating manual
- Spare parts list

"Technical Handbooks" (THB) and "Service Information" bulletins (si) are, furthermore, to be considered as supplements to the general documentation.

Data regarding auxiliary units for operating ancillary or special systems, as well as data on machines produced only in small numbers, have not been included.

Filling quantities are only approximate figures intended to help in stockholding the various fluids and agents. Each unit has appropriate checking systems, e.g. dipstick or checking screws, with which the exact filling level can be checked.

⚠ CAUTION

The Part Nos. given in the sections are not to be used when ordering spare parts. They are only intended to identify the component being referred to. When ordering spare parts, use only the Part Nos. given in the spare parts lists.

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SI - UND WEITERE GRÖSSEN
SI - AND ADDITIONAL UNITS

2801093

Raum - und Massegrößen
Quantities of space and mass

Größe Quantity	Formel zeichen Symbol	Einheit Unit			Umrechnung Conversion		Erläuterungen und Bemerkungen Explanations and Remarks
		alt old	neu new		Für genaue Rechnungen	für über-schlägige Rechnungen	
			SI-Einheit SI-Units	Auswahl weitere Einheiten Selection of additional units	for exact calculation	(2 % Unge-naugikeit) for rough calculation appr. 2 % inexact	
Länge Length	l	m, mm, cm dm, m, km	m	m, mm, km			
Fläche Area	A	mm^2, cm^2, dm^2, m^2	m^2	mm^2, cm^2			
Volumen Volume	V, Vn	mm^3, cm^3, dm^3, m^3, l	m^3	mm^3, cm^3, dm^3, l			
Masse Mass	m	g, mg, g, kg, Mg=t, (kp s^2/m)	kg	g, mg, g Mg, t			
Dichte Density	ρ	g/cm^3, kg/dm^3, kg/m^3, (kp s^2/m^4)	kg/m^3	g/cm^3, kg/dm^3			
Massenträgheitsmoment Inertia moment	J	kp m^2, (kp m s^2)	kg m^2	Mg m^2	1 kp m s^2 = 9,81 kg m^2	1 kp m s^2 = 10 kg m^2	
Spezifisches Volumen Specific volume	v	m^3/kg, m^3/t	m^3/kg	m^3/Mg			

Zeitgrößen
Time-related quantities

Größe Quantity	Formel zeichen Symbol	Einheit Unit			Umrechnung Conversion		Erläuterungen und Bemerkungen Explanations and Remarks
		alt old	neu new		Für genaue Rechnungen	für über-schlägige Rechnungen	
			SI-Einheit SI-Units	Auswahl weitere Einheiten Selection of additional units	for exact calculation	(2 % Unge-naugikeit) for rough calculation appr. 2 % inexact	
Zeitdauer Time	t	s, min, h, d = day	s	ms, min, h, d			
Frequenz Frequency	f	Hz	Hz				1 Hz 1/s
Drehzahl Rate of revolutions	n	U/min	1/s	1/min			s = min/60
Geschwindigkeit Speed	v	m/s, km/h	m/s	km/h			
Beschleunigung Acceleration	a	m/s^2	m/s^2				
Volumenstrom Volume flow	V	m^3/s, m^3/min, m^3/h	m^3/s	m^3/min, l/h			
Massenstrom Mass flow	m	kg/s, kg/min, kg/h	kg/s				
Wärmestrom Heat flow	Φ	(kcal/h)	W	kW, MW	1 kcal/h = 1,163 W	1 kcal/h = 1,2 W	1 W = 1 J/s = 1 Nm/s
Spez. Kraftstoff- oder spez. Ölver-brauch Specific fuel and oil consumption	b, b_s	kg/PSh g/PSh	kg/J	g/(kW h)	1 g/(PS h) = 1,359 g/(kW h)	1 g/(PS h) = 1,36 g/(kW h)	

Kraft-, Energie- und Leistungsgrößen
Quantities of force, energy and power

Größe **Quantity**	**Formel zeichen** **Symbol**	**Einheit Unit**			**Umrechnung Conversion**		**Erläuterungen und Bemerkungen** **Explanations and Remarks**
		alt old	**neu new**		**Für genaue Rechnungen**	**für über-schlägige Rechnungen**	
			SI-Einheit SI-Units	**Auswahl weitere Einheiten Selection of additional units**	**for exact calculation**	**(2 % Unge-naugikeit)** **for rough calculation appr. 2 % inexact**	
Kraft Force	F	(dyn, p)	N (Newton) (njuten)	MN, kN, mN	1 kp = 1 kg x 9,81m/s^2 = 9,81 N	1 kp = 10 N	1 N = 1 kg x 1 m/s^2 = 1 kg m/s^2
Druck (von Fluiden) Pressure (of fluids)	P, Pi, P_e, $P_ü$, P_u	(kp/cm^2,at,atm,) (mWS, Torr,) (mmHg)	N/m^2, Pa (Pascal)	bar, mbar	1 kp/cm^2 = 0,981 bar 1 atm = 1,013 bar 1 mWS = 0,098 bar	1 kp/cm^2=1 bar 1 mWS = 0,1 bar	1 N/m^2=1 Pa 1Pa = 10^{-5} bar 1 bar = 10^5 N/m^2
Mechanische Spannung Mechanical stress	σ,τ	(kp/cm^2, kp/mm^2)	N/m^2, pa	N/mm^2	1 kp/mm^2 = 9,81 N/mm^2 1 kp/cm^2 = 9,81 N/mm^2	1 kp/mm^2 = 10 N/mm^2 1 kp/cm^2 = 10 N/cm^2	1 N/m^2 = 1 Pa
Energie, Arbeit Energy	W	(kpm)	J (Joule) (dschul)	MJ, kJ, kW h	1 kpm = 9,81 J	1 kpm = 10 J	3,6 MJ = 1 kWh 1 J = 1 NM = 1 Ws
Wärmemenge Heat capacity	Q	(cal, erg)	J (Joule) (dschul)	MJ, kJ, kW h	1 kcal = 4,19 kJ		3,6 MJ = 1 kW h 1 J = 1 Nm = 1 Ws
Leistung Power	P	(PS), W	W	kW, MW	1 PS = 0,735499 kW 1 kW = 1,359622 PS	1 PS = 0,74 kW 1 kW = 1,36 PS	1 W =1 J/s = 1 Nm/s
Dreh-Biegemoment Torque, bending moment	M	(kp m)	Nm	N cm	1 kp m = 9,81 N m	1 kp m = 10 N m	

UMRECHNUNGSTABELLEN
CONVERSIONS TABLES

Umrechnung von Längen-Maßen
Conversion for units of length

Länge Length	in	ft	yd	mile	UK n mile	cm	m
1 inch (Zoll)	1	0,0833	0,0278			2,54	0,0254
1 foot (Fuß)	12	1	0,3333	0,00019	0,00016	30,48	0,3048
1 yard	36	3	1	0,00057	0,00049	91,44	0,9144
1 statute mile (Landmeile)	63 360	5 280	1 760	1	0,86842		1609,3
1 UK nautical mile (engl. Seemeile)	72 960	6 080	2 026,7	1,15151	1		1 853,2
1 cm	0,3937	0,0328	0,0109			1	0,01
1 m	39,370	3,2808	1,0936	0,00062	0,00054	100	1

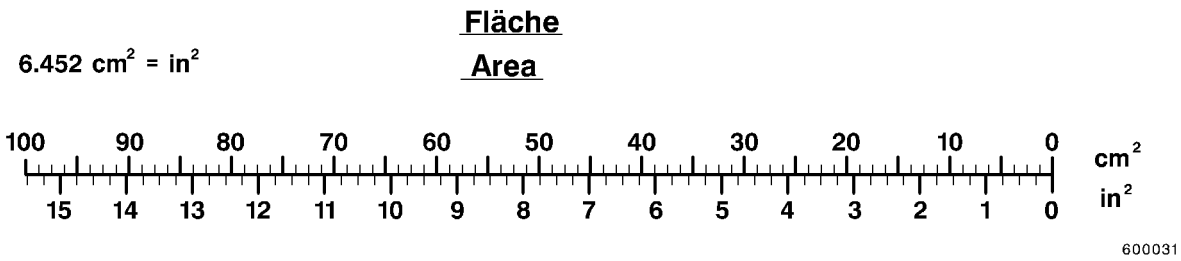
Länge
Length

25,4 mm = 1 in

600030

Umrechnung von Flächenmaßen
Conversion for units of area

Fläche Area	in^2	ft^2	yd^2	sqmile	acre	cm^2	m^2
1 square inch (Quadratzoll)	1	0,0069				6,4516	
1 square foot (Quadratfuß)	144	1	0,111			929,03	0,0929
1 square yard (Quadratyard)	1 296	9	1		0,00021	8361,3	0,8361
1 square mile (Quadratmeile)				1	640		
1 acre		43 560	4 840	0,00156	1		4 046,9
1 cm^2	0,1550					1	0,0001
1 m^2	1 550,0	10,764	1,1960			10 000	1



Umrechnung von foot (Fuss) und inch (Zoll) in Meter
Conversion from foot (Fuss) and inch (Zoll) to metric measures

1 in (inch) = 25,4 mm (genau)
1 in (inch) = 25,4 mm (exact)

1 ft (foot) = 12 in = 304,8 mm

Beispiel: 4 ft 2 in = 1,27 m
Example: 4 ft 2 in = 1,27 m

ft	in											
	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11
	m	m	m	m	m	m	m	m	m	m	m	m
0		0,0254	0,0508	0,0762	0,1016	0,1270	0,1524	0,1778	0, 2032	0,2286	0,2540	0,2794
1	0,3048	0,3302	0,3556	0,3810	0,4064	0,4318	0,4572	0,4826	0,5080	0,5334	0,5588	0,5842
2	0,6096	0,6350	0,6604	0,6858	0,7112	0,7366	0,7620	0,7874	0,8128	0,8382	0,8636	0,8890
3	0,9144	0,9398	0,9652	0,9906	1,0160	1,0414	1,0668	1,0922	1,1176	1,1430	1,1684	1,1938
4	1,2192	1,2446	1,2700	1,2954	1,3208	1,3462	1,3716	1,3970	1,4224	1,4478	1,4732	1,4986
5	1,5240	1,5494	1,5748	1,6002	1,6256	1,6510	1,6764	1,7018	1,7272	1,7526	1,7780	1,8034
6	1,8288	1,8542	1,8796	1,9050	1,9304	1,9558	1,9812	2,0066	2,0320	2,0574	2,0828	2,1082
7	2,1336	2,1590	2,1844	2,2098	2,2352	2,2606	2,2860	2,3114	2,3368	2,3622	2,3876	2,4130
8	2,4384	2,4638	2,4892	2,5146	2,5400	2,5654	2,5908	2,6162	2,6416	2,6670	2,6924	2,7178
9	2,7432	2,7686	2,7940	2,8194	2,8448	2,8702	2,8956	2,9210	2,9464	2,9718	2,9972	3,0226
10	3,0480	3,0734	3,0988	3,1242	3,1496	3,1750	3,2004	3,2258	3,2512	3,2766	3,3020	3,3274
11	3,3528	3,3782	3,4036	3,4290	3,4544	3,4798	3,5052	3,5306	3,5560	3,5814	3,6068	3,6322
12	3,6576	3,6830	3,70	3,7338	3,7592	3,7846	3,8100	3,8354	3,8608	3,8862	3,9116	3,9370

Umrechnung von Newtonmeter "Nm" in Foot Pounds "ft.lb."
Conversion from newtonmeter "Nm" into foot pounds "ft.lb."

Nm	0	1	2	3	4	5	6	7	8	9
10	7.376	8.113	8.851	9.588	10.326	11.063	11.801	12.539	13.276	14.014
20	14.751	15.489	16.226	16.964	17.701	18.439	19.177	19.914	20.652	21.389
30	22.127	22.864	23.602	24.339	25.077	25.815	26.552	27.290	28.027	28.765
40	29.502	30.240	30.978	31.715	32.453	33.190	33.928	34.665	35.403	36.140
50	36.878	37.616	38.353	39.091	39.828	40.566	41.303	42.041	42.778	43.516
60	44.254	44.991	45.729	46.466	47.204	47.941	48.679	49.417	50.154	50.892
70	51.629	52.367	53.104	53.842	54.579	55.317	56.055	56.792	57.530	58.267
80	59.005	59.742	60.480	61.217	61.955	62.693	63.430	64.168	64.905	65.643
90	66.380	67.118	67.856	68.593	69.331	70.068	70.806	71.543	72.281	73.018
100	73.756	74.494	75.231	75.969	76.706	77.444	78.181	78.919	79.656	80.394
110	81.132	81.869	82.607	83.344	84.082	84.819	85.557	86.295	87.032	87.770
120	88.507	89.245	89.982	90.720	91.457	92.195	92.933	93.670	94.408	95.145
130	95.883	96.620	97.358	98.095	98.833	99.571	100.308	101.046	101.783	102.521
140	103.258	103.996	104.734	105.471	106.209	106.946	107.684	108.421	109.159	109.896
150	110.634	111.372	112.109	112.847	113.584	114.322	115.059	115.797	116.534	117.272
160	118.010	118.747	119.485	120.222	120.960	121.697	122.435	123.173	123.910	124.648
170	125.385	126.123	126.860	127.598	128.335	129.073	129.811	130.548	131.286	132.023
180	132.761	133.498	134.236	134.973	135.711	136.449	137.186	137.924	138.661	139.399
190	140.136	140.874	141.612	142.349	143.087	143.824	144.562	145.299	146.037	146.774
200	147.512	148.250	148.987	149.725	150.462	151.200	151.937	152.675	153.412	154.150
210	154.888	155.625	156.363	157.100	157.838	158.575	159.313	160.051	160.788	161.526
220	162.263	163.001	163.738	164.476	165.213	165.951	166.689	167.426	168.164	168.901
230	169.639	170.376	171.114	171.851	172.589	173.327	174.064	174.802	175.539	176.277
240	177.014	177.752	178.490	179.227	179.965	180.702	181.440	182.177	182.915	183.652
250	184.390	185.128	185.865	186.603	187.340	188.078	188.815	189.553	190.290	191.028
260	191.766	192.503	193.241	193.978	194.716	195.453	196.191	196.929	197.666	198.404
270	199.141	199.879	200.616	201.354	202.091	202.829	203.567	204.304	205.042	205.779
280	206.517	207.254	207.992	208.729	209.467	210.205	210.942	211.680	212.417	213.155
290	213.892	214.630	215.368	216.105	216.843	217.580	218.318	219.055	219.793	220.530
300	221.268	222.006	222.743	223.481	224.218	224.956	225.693	226.431	227.168	227.906
310	228.644	229.381	230.119	230.856	231.594	232.331	233.069	233.807	234.544	235.282
320	236.019	236.757	237.494	238.232	238.969	239.707	240.445	241.182	241.920	242.657
330	243.395	244.132	244.870	245.607	246.345	247.083	247.820	248.558	249.295	250.033
340	250.770	251.508	252.245	252.983	253.721	254.458	255.196	255.933	256.671	257.408
350	258.146	258.884	259.621	260.359	261.096	261.834	262.571	263.309	264.046	264.784
360	265.521	266.259	266.997	267.734	268.472	269.209	269.947	270.684	271.422	272.159
370	272.897	273.635	274.372	275.110	275.847	276.585	277.323	278.060	278.798	279.535
380	280.273	281.010	281.748	282.485	283.223	283.960	284.698	285.436	286.173	286.911
390	287.648	288.386	289.123	289.861	290.598	291.336	292.074	292.811	293.549	294.286
400	295.024	295.761	296.499	297.237	297.974	298.712	299.449	300.187	300.924	301.662
410	302.399	303.137	303.875	304.612	305.350	306.087	306.825	307.562	308.300	309.038
420	309.775	310.513	311.250	311.988	312.725	313.463	314.200	314.938	315.676	316.413
430	317.151	317.888	318.626	319.363	320.101	320.838	321.576	322.313	323.051	323.789
440	324.526	325.264	326.001	326.739	327.477	328.214	328.952	329.689	330.427	331.164
450	331.902	332.639	333.377	334.115	334.852	335.590	336.327	337.065	337.802	338.540
460	339.278	340.015	340.753	341.490	342.228	342.965	343.703	344.440	345.178	345.916
470	346.653	347.391	348.128	348.866	349.603	350.341	351.078	351.816	352.553	353.291
480	354.029	354.766	355.504	356.241	356.979	357.717	358.454	359.192	359.929	360.667
490	361.404	362.142	362.879	363.617	364.354	365.092	365.830	366.567	367.305	368.042
500	368.780	369.517	370.255	370.992	371.730	372.468	373.205	373.943	374.680	375.418
510	376.156	376.893	377.631	378.368	379.106	379.843	380.581	381.318	382.056	382.793
520	383.531	384.269	385.006	385.744	386.481	387.219	387.957	388.694	389.432	390.169
530	390.907	391.644	392.382	393.119	393.857	394.594	395.332	396.070	396.807	397.545
540	398.282	399.020	399.757	400.495	401.232	401.970	402.708	403.445	404.183	404.920
550	405.658	406.396	407.133	407.871	408.608	409.346	410.083	410.821	411.558	412.296
560	413.033	413.771	414.509	415.246	415.984	416.721	417.459	418.196	418.934	419.671
570	420.409	421.147	421.884	422.622	423.359	424.097	424.834	425.572	426.310	427.047
580	427.785	428.522	429.260	429.997	430.735	431.472	432.210	432.948	433.685	434.423
590	435.160	435.898	436.635	437.373	438.111	438.848	439.586	440.323	441.061	441.798
600	442.536	443.273	444.011	444.749	445.486	446.224	446.961	447.699	448.436	449.174
610	449.911	450.649	451.386	452.124	452.862	453.599	454.337	455.074	455.812	456.550
620	457.287	458.025	458.762	459.500	460.237	460.975	461.712	462.450	463.187	463.925
630	464.663	465.400	466.138	466.875	467.613	468.350	469.088	469.826	470.563	471.301
640	472.038	472.776	473.513	474.251	474.989	475.726	476.464	477.201	477.939	478.676
650	479.414	480.151	480.889	481.626	482.364	483.102	483.839	484.577	485.314	486.052
660	486.790	487.527	488.265	489.002	489.740	490.477	491.215	491.952	492.690	493.427
670	494.165	494.903	495.640	496.378	497.115	497.853	498.590	499.328	500.065	500.803
680	501.541	502.278	503.016	503.753	504.491	505.229	505.966	506.704	507.441	508.179
690	508.916	509.654	510.391	511.129	511.866	512.604	513.342	514.079	514.817	515.554
700	516.292	517.030	517.767	518.505	519.242	519.980	520.717	521.455	522.192	522.930

Nm	0	1	2	3	4	5	6	7	8	9
710	523.667	524.405	525.143	525.880	526.618	527.355	528.093	528.830	529.568	530.305
720	531.043	531.781	532.518	533.256	533.993	534.731	535.469	536.206	536.944	537.681
730	538.419	539.156	539.894	540.631	541.369	542.106	542.844	543.582	544.319	545.057
740	545.794	546.532	547.269	548.007	548.744	549.482	550.220	550.957	551.695	552.432
750	553.170	553.907	554.645	555.383	556.120	556.858	557.595	558.333	559.070	559.808
760	560.545	561.283	562.021	562.758	563.496	564.233	564.971	565.708	566.446	567.184
770	567.921	568.659	569.396	570.134	570.871	571.609	572.346	573.084	573.822	574.559
780	575.297	576.034	576.772	577.509	578.247	578.984	579.722	580.459	581.197	581.935
790	582.672	583.410	584.147	584.885	585.623	586.360	587.098	587.835	588.573	589.310
800	590.048	590.785	591.523	592.260	592.998	593.736	594.473	595.211	595.948	596.686
810	597.423	598.161	598.899	599.636	600.374	601.111	601.849	602.586	603.324	604.062
820	604.799	605.537	606.274	607.012	607.749	608.487	609.224	609.962	610.699	611.437
830	612.175	612.912	613.650	614.387	615.125	615.863	616.600	617.338	618.075	618.813
840	619.550	620.288	621.025	621.763	622.500	623.238	623.976	624.713	625.451	626.188
850	626.926	627.663	628.401	629.138	629.876	630.614	631.351	632.089	632.826	633.564
860	634.302	635.039	635.777	636.514	637.252	637.989	638.727	639.464	640.202	640.939
870	641.677	642.415	643.152	643.890	644.627	645.365	646.102	646.840	647.578	648.315
880	649.053	649.790	650.528	651.265	652.003	652.740	653.478	654.216	654.953	655.691
890	656.428	657.166	657.903	658.641	659.378	660.116	660.854	661.591	662.329	663.066
900	663.804	664.542	665.279	666.017	666.754	667.492	668.229	668.967	669.704	670.442
910	671.179	671.917	672.655	673.392	674.130	674.867	675.605	676.342	677.080	677.817
920	678.555	679.293	680.030	680.768	681.505	682.243	682.980	683.718	684.456	685.193
930	685.931	686.668	687.406	688.143	688.881	689.618	690.356	691.094	691.831	692.569
940	693.306	694.044	694.781	695.519	696.257	696.994	697.732	698.469	699.207	699.944
950	700.682	701.419	702.157	702.895	703.632	704.370	705.107	705.845	706.582	707.320
960	708.057	708.795	709.532	710.270	711.008	711.745	712.483	713.220	713.958	714.696
970	715.433	716.171	716.908	717.646	718.383	719.121	719.858	720.596	721.333	722.071
980	722.809	723.546	724.284	725.021	725.759	726.496	727.234	727.972	728.709	729.447
990	730.184	730.922	731.659	732.397	733.135	733.872	734.610	735.347	736.085	736.822
1000	737.560	738.297	739.035	739.772	740.510	741.248	741.985	742.723	743.460	744.198
1010	744.936	745.673	746.411	747.148	747.886	748.623	749.361	750.098	750.836	751.573
1020	752.311	753.049	753.786	754.524	755.261	755.999	756.736	757.474	758.211	758.949
1030	759.687	760.424	761.162	761.899	762.637	763.375	764.112	764.850	765.587	766.325
1040	767.062	767.800	768.537	769.275	770.012	770.750	771.488	772.225	772.963	773.700
1050	774.438	775.175	775.913	776.651	777.388	778.126	778.863	779.601	780.338	781.076
1060	781.813	782.551	783.289	784.026	784.764	785.501	786.239	786.976	787.714	788.451
1070	789.189	789.927	790.664	791.402	792.139	792.877	793.615	794.352	795.090	795.827
1080	796.565	797.302	798.040	798.777	799.515	800.252	800.990	801.728	802.465	803.203
1090	803.940	804.678	805.415	806.153	806.890	807.628	808.366	809.103	809.841	810.578
1100	811.316	812.053	812.791	813.529	814.266	815.004	815.741	816.479	817.216	817.954
1110	818.691	819.429	820.167	820.904	821.642	822.379	823.117	823.854	824.592	825.330
1120	826.067	826.805	827.542	828.280	829.017	829.755	830.492	831.230	831.968	832.705
1130	833.443	834.180	834.918	835.655	836.393	837.130	837.868	838.605	839.343	840.081
1140	840.818	841.556	842.293	843.031	843.769	844.506	845.244	845.981	846.719	847.456
1150	848.194	848.931	849.669	850.406	851.144	851.882	852.619	853.357	854.094	854.832
1160	855.569	856.307	857.045	857.782	858.520	859.257	859.995	860.732	861.470	862.208
1170	862.945	863.683	864.420	865.158	865.895	866.633	867.370	868.108	868.845	869.583
1180	870.321	871.058	871.796	872.533	873.271	874.009	874.746	875.484	876.221	876.959
1190	877.696	878.434	879.171	879.909	880.646	881.384	882.122	882.859	883.597	884.334
1200	885.072	885.809	886.547	887.284	888.022	888.760	889.497	890.235	890.972	891.710
1210	892.448	893.185	893.923	894.660	895.398	896.135	896.873	897.610	898.348	899.085
1220	899.823	900.561	901.298	902.036	902.773	903.511	904.248	904.986	905.724	906.461
1230	907.199	907.936	908.674	909.411	910.149	910.886	911.624	912.362	913.099	913.837
1240	914.574	915.312	916.049	916.787	917.524	918.262	919.000	919.737	920.475	921.212
1250	921.950	922.687	923.425	924.163	924.900	925.638	926.375	927.113	927.850	928.588
1260	929.325	930.063	930.801	931.538	932.276	933.013	933.751	934.488	935.226	935.963
1270	936.701	937.439	938.176	938.914	939.651	940.389	941.126	941.864	942.602	943.339
1280	944.077	944.814	945.552	946.289	947.027	947.764	948.502	949.240	949.977	950.715
1290	951.452	952.190	952.927	953.665	954.403	955.140	955.878	956.615	957.353	958.090
1300	958.828	959.565	960.303	961.041	961.778	962.516	963.253	963.991	964.728	965.466
1310	966.203	966.941	967.678	968.416	969.154	969.891	970.629	971.366	972.104	972.842
1320	973.579	974.317	975.054	975.792	976.529	977.267	978.004	978.742	979.479	980.217
1330	980.955	981.692	982.430	983.167	983.905	984.642	985.380	986.118	986.855	987.593
1340	988.330	989.068	989.805	990.543	991.281	992.018	992.756	993.493	994.231	994.968
1350	995.706	996.443	997.181	997.918	998.656	999.394	1000.131	1000.869	1001.606	1002.344
1360	1003.082	1003.819	1004.557	1005.294	1006.032	1006.769	1007.507	1008.244	1008.982	1009.719
1370	1010.457	1011.195	1011.932	1012.670	1013.407	1014.145	1014.882	1015.620	1016.357	1017.095
1380	1017.833	1018.570	1019.308	1020.045	1020.783	1021.521	1022.258	1022.996	1023.733	1024.471
1390	1025.208	1025.946	1026.683	1027.421	1028.158	1028.896	1029.634	1030.371	1031.109	1031.846
1400	1032.584	1033.321	1034.059	1034.797	1035.534	1036.272	1037.009	1037.747	1038.484	1039.222

Nm	0	1	2	3	4	5	6	7	8	9
1410	1039.959	1040.697	1041.435	1042.172	1042.910	1043.647	1044.385	1045.122	1045.860	1046.597
1420	1047.335	1048.073	1048.810	1049.548	1050.285	1051.023	1051.760	1052.498	1053.236	1053.973
1430	1054.711	1055.448	1056.186	1056.923	1057.661	1058.398	1059.136	1059.874	1060.611	1061.349
1440	1062.086	1062.824	1063.561	1064.299	1065.036	1065.774	1066.512	1067.249	1067.987	1068.724
1450	1069.462	1070.199	1070.937	1071.675	1072.412	1073.150	1073.887	1074.625	1075.362	1076.100
1460	1076.837	1077.575	1078.312	1079.050	1079.788	1080.525	1081.263	1082.000	1082.738	1083.476
1470	1084.213	1084.951	1085.688	1086.426	1087.163	1087.901	1088.638	1089.376	1090.114	1090.851
1480	1091.589	1092.326	1093.064	1093.801	1094.539	1095.276	1096.014	1096.751	1097.489	1098.227
1490	1098.964	1099.702	1100.439	1101.177	1101.915	1102.652	1103.390	1104.127	1104.865	1105.602
1500	1106.340	1107.077	1107.815	1108.552	1109.290	1110.028	1110.765	1111.503	1112.240	1112.978
1510	1113.715	1114.453	1115.191	1115.928	1116.666	1117.403	1118.141	1118.878	1119.616	1120.354
1520	1121.091	1121.829	1122.566	1123.304	1124.041	1124.779	1125.516	1126.254	1126.991	1127.729
1530	1128.467	1129.204	1129.942	1130.679	1131.417	1132.155	1132.892	1133.630	1134.367	1135.105
1540	1135.842	1136.580	1137.317	1138.055	1138.792	1139.530	1140.268	1141.005	1141.743	1142.480
1550	1143.218	1143.955	1144.693	1145.430	1146.168	1146.906	1147.643	1148.381	1149.118	1149.856
1560	1150.594	1151.331	1152.069	1152.806	1153.544	1154.281	1155.019	1155.756	1156.494	1157.231
1570	1157.969	1158.707	1159.444	1160.182	1160.919	1161.657	1162.394	1163.132	1163.870	1164.607
1580	1165.345	1166.082	1166.820	1167.557	1168.295	1169.032	1169.770	1170.508	1171.245	1171.983
1590	1172.720	1173.458	1174.195	1174.933	1175.670	1176.408	1177.146	1177.883	1178.621	1179.358
1600	1180.096	1180.833	1181.571	1182.309	1183.046	1183.784	1184.521	1185.259	1185.996	1186.734
1610	1187.471	1188.209	1188.947	1189.684	1190.422	1191.159	1191.897	1192.634	1193.372	1194.109
1620	1194.847	1195.585	1196.322	1197.060	1197.797	1198.535	1199.272	1200.010	1200.748	1201.485
1630	1202.223	1202.960	1203.698	1204.435	1205.173	1205.910	1206.648	1207.385	1208.123	1208.861
1640	1209.598	1210.336	1211.073	1211.811	1212.549	1213.286	1214.024	1214.761	1215.499	1216.236
1650	1216.974	1217.711	1218.449	1219.187	1219.924	1220.662	1221.399	1222.137	1222.874	1223.612
1660	1224.349	1225.087	1225.824	1226.562	1227.300	1228.037	1228.775	1229.512	1230.250	1230.988
1670	1231.725	1232.463	1233.200	1233.938	1234.675	1235.413	1236.150	1236.888	1237.625	1238.363
1680	1239.101	1239.838	1240.576	1241.313	1242.051	1242.788	1243.526	1244.264	1245.001	1245.739
1690	1246.476	1247.214	1247.951	1248.689	1249.427	1250.164	1250.902	1251.639	1252.377	1253.114
1700	1253.852	1254.589	1255.327	1256.064	1256.802	1257.540	1258.277	1259.015	1259.752	1260.490
1710	1261.228	1261.965	1262.703	1263.440	1264.178	1264.915	1265.653	1266.390	1267.128	1267.865
1720	1268.603	1269.341	1270.078	1270.816	1271.553	1272.291	1273.028	1273.766	1274.503	1275.241
1730	1275.979	1276.716	1277.454	1278.191	1278.929	1279.667	1280.404	1281.142	1281.879	1282.617
1740	1283.354	1284.092	1284.829	1285.567	1286.304	1287.042	1287.780	1288.517	1289.255	1289.992
1750	1290.730	1291.467	1292.205	1292.943	1293.680	1294.418	1295.155	1295.893	1296.630	1297.368
1760	1298.105	1298.843	1299.581	1300.318	1301.056	1301.793	1302.531	1303.268	1304.006	1304.743
1770	1305.481	1306.219	1306.956	1307.694	1308.431	1309.169	1309.906	1310.644	1311.382	1312.199
1780	1312.857	1313.594	1314.332	1315.069	1315.807	1316.544	1317.282	1318.020	1318.757	1319.495
1790	1320.232	1320.970	1321.707	1322.445	1323.182	1323.920	1324.657	1325.395	1326.133	1326.870
1800	1327.608	1328.345	1329.083	1329.821	1330.558	1331.296	1332.033	1332.771	1333.508	1334.246
1810	1334.983	1335.721	1336.458	1337.196	1337.934	1338.671	1339.409	1340.146	1340.884	1341.622
1820	1342.359	1343.097	1343.834	1344.572	1345.309	1346.047	1346.784	1347.522	1348.260	1348.997
1830	1349.735	1350.472	1351.210	1351.947	1352.685	1353.422	1354.160	1354.897	1355.635	1356.373
1840	1357.110	1357.848	1358.585	1359.323	1360.061	1360.798	1361.536	1362.273	1363.011	1363.748
1850	1364.486	1365.223	1365.961	1366.698	1367.436	1368.174	1368.911	1369.649	1370.386	1371.124
1860	1371.861	1372.599	1373.337	1374.074	1374.812	1375.549	1376.287	1377.024	1377.762	1378.500
1870	1379.237	1379.975	1380.712	1381.450	1382.187	1382.925	1383.662	1384.400	1385.137	1385.875
1880	1386.613	1387.350	1388.088	1388.825	1389.563	1390.301	1391.038	1391.776	1392.513	1393.251
1890	1393.988	1394.726	1395.463	1396.201	1396.938	1397.676	1398.414	1399.151	1399.889	1400.626
1900	1401.364	1402.101	1402.839	1403.576	1404.314	1405.052	1405.789	1406.527	1407.264	1408.002
1910	1408.740	1409.477	1410.215	1410.952	1411.690	1412.427	1413.165	1413.902	1414.640	1415.377
1920	1416.115	1416.853	1417.590	1418.328	1419.065	1419.803	1420.540	1421.278	1422.016	1422.753
1930	1423.491	1424.228	1424.966	1425.703	1426.441	1427.178	1427.916	1428.654	1429.391	1430.129
1940	1430.866	1431.604	1432.341	1433.079	1433.816	1434.554	1435.292	1436.029	1436.767	1437.504
1950	1438.242	1438.979	1439.717	1440.455	1441.192	1441.930	1442.667	1443.405	1444.142	1444.880
1960	1445.617	1446.355	1447.093	1447.830	1448.568	1449.305	1450.043	1450.780	1451.518	1452.255
1970	1452.993	1453.730	1454.468	1455.206	1455.943	1456.681	1457.418	1458.156	1458.894	1459.631
1980	1460.369	1461.106	1461.844	1462.581	1463.319	1464.056	1464.794	1465.531	1466.269	1467.007
1990	1467.744	1468.482	1469.219	1469.957	1470.695	1471.432	1472.170	1472.907	1473.645	1474.382
2000	1475.120	1475.857	1476.595	1477.333	1478.070	1478.808	1479.545	1480.283	1481.020	1481.758
2010	1482.495	1483.233	1483.970	1484.708	1485.446	1486.183	1486.921	1487.658	1488.396	1489.134
2020	1489.871	1490.609	1491.346	1492.084	1492.821	1493.559	1494.296	1495.034	1495.771	1496.509
2030	1497.247	1497.984	1498.722	1499.459	1500.197	1500.934	1501.672	1502.409	1503.147	1503.885
2040	1504.622	1505.360	1506.097	1506.835	1507.573	1508.310	1509.048	1509.785	1510.523	1511.260
2050	1511.998	1512.735	1513.473	1514.210	1514.948	1515.686	1516.423	1517.161	1517.898	1518.636
2060	1519.374	1520.111	1520.849	1521.586	1522.324	1523.061	1523.799	1524.536	1525.274	1526.011
2070	1526.749	1527.487	1528.224	1528.962	1529.699	1530.437	1531.174	1531.912	1532.649	1533.387
2080	1534.125	1534.862	1535.600	1536.337	1537.075	1537.812	1538.550	1539.288	1540.025	1540.763
2090	1541.500	1542.238	1542.975	1543.713	1544.450	1545.188	1545.926	1546.663	1547.401	1548.138
2100	1548.876	1549.613	1550.351	1551.089	1551.826	1552.564	1553.301	1554.039	1554.776	1555.514

Nm	0	1	2	3	4	5	6	7	8	9
2110	1556.251	1556.989	1557.727	1558.464	1559.202	1559.939	1560.677	1561.414	1562.152	1562.889
2120	1563.627	1564.365	1565.102	1565.840	1566.577	1567.315	1568.052	1568.790	1569.528	1570.265
2130	1571.003	1571.740	1572.478	1573.215	1573.953	1574.690	1575.428	1576.166	1576.903	1577.641
2140	1578.378	1579.116	1579.853	1580.591	1581.328	1582.066	1582.803	1583.541	1584.279	1585.016
2150	1585.754	1586.491	1587.229	1587.967	1588.704	1589.442	1590.179	1590.917	1591.654	1592.392
2160	1593.129	1593.867	1594.604	1595.342	1596.080	1596.817	1597.555	1598.292	1599.030	1599.768
2170	1600.505	1601.243	1601.980	1602.718	1603.455	1604.193	1604.930	1605.668	1606.406	1607.143
2180	1607.881	1608.618	1609.356	1610.093	1610.831	1611.568	1612.306	1613.043	1613.781	1614.519
2190	1615.256	1615.994	1616.731	1617.469	1618.207	1618.944	1619.682	1620.419	1621.157	1621.894
2200	1622.632	1623.369	1624.107	1624.844	1625.582	1626.320	1627.057	1627.795	1628.532	1629.270
2210	1630.007	1630.745	1631.482	1632.220	1632.958	1633.695	1634.433	1635.170	1635.908	1636.646
2220	1637.383	1638.121	1638.858	1639.596	1640.333	1641.071	1641.808	1642.546	1643.283	1644.021
2230	1644.759	1645.496	1646.234	1646.971	1647.709	1648.447	1649.184	1649.922	1650.659	1651.397
2240	1652.134	1652.872	1653.609	1654.347	1655.084	1655.822	1656.560	1657.297	1658.035	1658.772
2250	1659.510	1660.247	1660.985	1661.722	1662.460	1663.198	1663.935	1664.673	1665.410	1666.148
2260	1666.885	1667.623	1668.361	1669.098	1669.836	1670.573	1671.311	1672.048	1672.786	1673.523
2270	1674.261	1674.999	1675.736	1676.474	1677.211	1677.949	1678.686	1679.424	1680.162	1680.899
2280	1681.637	1682.374	1683.112	1683.849	1684.587	1685.324	1686.062	1686.800	1687.537	1688.275
2290	1689.012	1689.750	1690.487	1691.225	1691.962	1692.700	1693.437	1694.175	1694.913	1695.650
2300	1696.388	1697.125	1697.863	1698.601	1699.338	1700.076	1700.813	1701.551	1702.288	1703.026
2310	1703.763	1704.501	1705.239	1705.976	1706.714	1707.451	1708.189	1708.926	1709.664	1710.401
2320	1711.139	1711.876	1712.614	1713.352	1714.089	1714.827	1715.564	1716.302	1717.040	1717.777
2330	1718.515	1719.252	1719.990	1720.727	1721.465	1722.202	1722.940	1723.677	1724.415	1725.153
2340	1725.890	1726.628	1727.365	1728.103	1728.841	1729.578	1730.316	1731.053	1731.791	1732.528
2350	1733.266	1734.003	1734.741	1735.479	1736.216	1736.954	1737.691	1738.429	1739.166	1739.904
2360	1740.641	1741.379	1742.116	1742.854	1743.592	1744.329	1745.067	1745.804	1746.542	1747.280
2370	1748.017	1748.755	1749.492	1750.230	1750.967	1751.705	1752.442	1753.180	1753.917	1754.655
2380	1755.393	1756.130	1756.868	1757.605	1758.343	1759.080	1759.818	1760.555	1761.293	1762.031
2390	1762.768	1763.506	1764.243	1764.981	1765.719	1766.456	1767.194	1767.931	1768.669	1769.406
2400	1770.144	1770.881	1771.619	1772.356	1773.094	1773.832	1774.569	1775.307	1776.044	1776.782
2410	1777.520	1778.257	1778.995	1779.732	1780.470	1781.207	1781.945	1782.682	1783.420	1784.157
2420	1784.895	1785.633	1786.370	1787.108	1787.845	1788.583	1789.320	1790.058	1790.795	1791.533
2430	1792.271	1793.008	1793.746	1794.483	1795.221	1795.958	1796.696	1797.434	1798.171	1798.909
2440	1799.646	1800.384	1801.121	1801.859	1802.596	1803.334	1804.072	1804.809	1805.547	1806.284
2450	1807.022	1807.759	1808.497	1809.234	1809.972	1810.710	1811.447	1812.185	1812.922	1813.660
2460	1814.397	1815.135	1815.873	1816.610	1817.348	1818.085	1818.823	1819.560	1820.298	1821.035
2470	1821.773	1822.510	1823.248	1823.986	1824.723	1825.461	1826.198	1826.936	1827.674	1828.411
2480	1829.149	1829.886	1830.624	1831.361	1832.099	1832.836	1833.574	1834.312	1835.049	1835.787
2490	1836.524	1837.262	1837.999	1838.737	1839.474	1840.212	1840.949	1841.687	1842.425	1843.162
2500	1843.900	1844.637	1845.375	1846.113	1846.850	1847.588	1848.325	1849.063	1849.800	1850.538
2510	1851.275	1852.013	1852.750	1853.488	1854.226	1854.963	1855.701	1856.438	1857.176	1857.914
2520	1858.651	1859.389	1860.126	1860.864	1861.601	1862.339	1863.076	1863.814	1864.552	1865.289
2530	1866.027	1866.764	1867.502	1868.239	1868.977	1869.714	1870.452	1871.189	1871.927	1872.665
2540	1873.402	1874.140	1874.877	1875.615	1876.353	1877.090	1877.828	1878.565	1879.303	1880.040
2550	1880.778	1881.515	1882.253	1882.990	1883.728	1884.466	1885.203	1885.941	1886.678	1887.416
2560	1888.153	1888.891	1889.628	1890.366	1891.104	1891.841	1892.579	1893.316	1894.054	1894.792
2570	1895.529	1896.267	1897.004	1897.742	1898.479	1899.217	1899.954	1900.692	1901.429	1902.167
2580	1902.905	1903.642	1904.380	1905.117	1905.855	1906.593	1907.330	1908.068	1908.805	1909.543
2590	1910.280	1911.018	1911.755	1912.493	1913.230	1913.968	1914.706	1915.443	1916.181	1916.918
2600	1917.656	1918.393	1919.131	1919.868	1920.606	1921.344	1922.081	1922.819	1923.556	1924.294
2610	1925.031	1925.769	1926.507	1927.244	1927.982	1928.719	1929.457	1930.194	1930.932	1931.669
2620	1932.407	1933.145	1933.882	1934.620	1935.357	1936.095	1936.832	1937.570	1938.307	1939.045
2630	1939.783	1940.520	1941.258	1941.995	1942.733	1943.470	1944.208	1944.946	1945.683	1946.421
2640	1947.158	1947.896	1948.633	1949.371	1950.108	1950.846	1951.583	1952.321	1953.059	1953.796
2650	1954.534	1955.271	1956.009	1956.747	1957.484	1958.222	1958.959	1959.697	1960.434	1961.172
2660	1961.909	1962.647	1963.385	1964.122	1964.860	1965.597	1966.335	1967.072	1967.810	1968.547
2670	1969.285	1970.022	1970.760	1971.498	1972.235	1972.973	1973.710	1974.448	1975.186	1975.923
2680	1976.661	1977.398	1978.136	1978.873	1979.611	1980.348	1981.086	1981.823	1982.561	1983.299
2690	1984.036	1984.774	1985.511	1986.249	1986.986	1987.724	1988.462	1989.199	1989.937	1990.674
2700	1991.412	1992.149	1992.887	1993.625	1994.362	1995.100	1995.837	1996.575	1997.312	1998.050
2710	1998.787	1999.525	2000.262	2001.000	2001.738	2002.475	2003.213	2003.950	2004.688	2005.426
2720	2006.163	2006.901	2007.638	2008.376	2009.113	2009.851	2010.588	2011.326	2012.063	2012.801
2730	2013.539	2014.276	2015.014	2015.751	2016.489	2017.226	2017.964	2018.701	2019.439	2020.177
2740	2020.914	2021.652	2022.389	2023.127	2023.865	2024.602	2025.340	2026.077	2026.815	2027.552
2750	2028.290	2029.027	2029.765	2030.502	2031.240	2031.978	2032.715	2033.453	2034.190	2034.928
2760	2035.666	2036.403	2037.141	2037.878	2038.616	2039.353	2040.091	2040.828	2041.566	2042.303
2770	2043.041	2043.779	2044.516	2045.254	2045.991	2046.729	2047.466	2048.204	2048.941	2049.679
2780	2050.417	2051.154	2051.892	2052.629	2053.367	2054.104	2054.842	2055.580	2056.317	2057.055
2790	2057.792	2058.530	2059.267	2060.005	2060.742	2061.480	2062.218	2062.955	2063.693	2064.430
2800	2065.168	2065.905	2066.643	2067.380	2068.118	2068.856	2069.593	2070.331	2071.068	2071.806

Nm	0	1	2	3	4	5	6	7	8	9
2810	2072.543	2073.281	2074.019	2074.756	2075.494	2076.231	2076.969	2077.706	2078.444	2079.181
2820	2079.919	2080.656	2081.394	2082.132	2082.869	2083.607	2084.344	2085.082	2085.820	2086.557
2830	2087.295	2088.032	2088.770	2089.507	2090.245	2090.982	2091.720	2092.458	2093.195	2093.933
2840	2094.670	2095.408	2096.145	2096.883	2097.620	2098.358	2099.095	2099.833	2100.571	2101.308
2850	2102.046	2102.783	2103.521	2104.259	2104.996	2105.734	2106.471	2107.209	2107.946	2108.684
2860	2109.421	2110.159	2110.896	2111.634	2112.372	2113.109	2113.847	2114.584	2115.322	2116.059
2870	2116.797	2117.535	2118.272	2119.010	2119.747	2120.485	2121.222	2121.960	2122.698	2123.435
2880	2124.173	2124.910	2125.648	2126.385	2127.123	2127.860	2128.598	2129.335	2130.073	2130.811
2890	2131.548	2132.286	2133.023	2133.761	2134.499	2135.236	2135.974	2136.711	2137.449	2138.186
2900	2138.924	2139.661	2140.399	2141.136	2141.874	2142.612	2143.349	2144.087	2144.824	2145.562
2910	2146.299	2147.037	2147.774	2148.512	2149.250	2149.987	2150.725	2151.462	2152.200	2152.937
2920	2153.675	2154.413	2155.150	2155.888	2156.625	2157.363	2158.100	2158.838	2159.575	2160.313
2930	2161.051	2161.788	2162.526	2163.263	2164.001	2164.738	2165.476	2166.214	2166.951	2167.689
2940	2168.426	2169.164	2169.901	2170.639	2171.376	2172.114	2172.852	2173.589	2174.327	2175.064
2950	2175.802	2176.539	2177.277	2178.014	2178.752	2179.490	2180.227	2180.965	2181.702	2182.440
2960	2183.177	2183.915	2184.653	2185.390	2186.128	2186.865	2187.603	2188.340	2189.078	2189.815
2970	2190.553	2191.291	2192.028	2192.766	2193.503	2194.241	2194.978	2195.716	2196.453	2197.191
2980	2197.929	2198.666	2199.404	2200.141	2200.879	2201.616	2202.354	2203.092	2203.829	2204.567
2990	2205.304	2206.042	2006.779	2207.517	2208.254	2208.992	2209.729	2210.467	2211.205	2211.942
3000	2212.680	2213.417	2214.155	2214.893	2215.630	2216.368	2217.105	2217.843	2218.580	2219.318
3010	2220.055	2220.793	2221.531	2222.268	2223.006	2223.743	2224.481	2225.218	2225.956	2226.693
3020	2227.431	2228.168	2228.906	2229.644	2230.381	2231.119	2231.856	2232.594	2233.332	2234.069
3030	2234.807	2235.544	2236.282	2237.019	2237.757	2238.494	2239.232	2239.969	2240.707	2241.445
3040	2242.182	2242.920	2243.657	2244.395	2245.132	2245.870	2246.608	2247.345	2248.083	2248.820
3050	2249.558	2250.295	2251.033	2251.771	2252.508	2253.246	2253.983	2254.721	2255.458	2256.196
3060	2256.933	2257.671	2258.408	2259.146	2259.884	2260.621	2261.359	2262.096	2262.834	2263.572
3070	2264.309	2265.047	2265.784	2266.522	2267.259	2267.997	2268.734	2269.472	2270.209	2270.947
3080	2271.685	2272.422	2273.160	2273.897	2274.635	2275.372	2276.110	2276.847	2277.585	2278.323
3090	2279.060	2279.798	2280.535	2281.273	2282.010	2282.748	2283.486	2284.223	2284.961	2285.698
3100	2286.436	2287.173	2287.911	2288.648	2289.386	2290.124	2290.861	2291.599	2292.336	2293.074
3110	2293.811	2294.549	2295.287	2296.024	2296.762	2297.499	2298.237	2298.974	2299.712	2300.449
3120	2301.187	2301.925	2302.662	2303.400	2304.137	2304.875	2305.612	2306.350	2307.087	2307.825
3130	2308.562	2309.300	2310.038	2310.775	2311.513	2312.250	2312.988	2313.726	2314.463	2315.201
3140	2315.938	2316.676	2317.413	2318.151	2318.888	2319.626	2320.364	2321.101	2321.839	2322.576
3150	2323.314	2324.051	2324.789	2325.526	2326.264	2327.002	2327.739	2328.477	2329.214	2329.952
3160	2330.689	2331.427	2332.165	2332.902	2333.640	2334.377	2335.115	2335.852	2336.590	2337.327
3170	2338.065	2338.802	2339.540	2340.278	2341.015	2341.753	2342.490	2343.228	2343.966	2344.703
3180	2345.441	2346.178	2346.916	2347.653	2348.391	2349.128	2349.866	2350.604	2351.341	2352.079
3190	2352.816	2353.554	2354.291	2355.029	2355.766	2356.504	2357.241	2357.979	2358.717	2359.454
3200	2360.192	2360.929	2361.667	2362.405	2363.142	2363.880	2364.617	2365.355	2366.092	2366.830
3210	2367.567	2368.305	2369.042	2369.780	2370.518	2371.255	2371.993	2372.730	2373.468	2374.205
3220	2374.943	2375.681	2376.418	2377.156	2377.893	2378.631	2379.368	2380.106	2380.844	2381.581
3230	2382.319	2383.056	2383.794	2384.531	2385.26 9	2386.006	2386.744	2387.481	2388.219	2388.957
3240	2389.694	2390.432	2391.169	2391.907	2392.645	2393.382	2394.120	2394.857	2395.595	2396.332
3250	2397.070	2397.807	2398.545	2399.282	2400.020	2400.758	2401.495	2402.233	2402.970	2403.708
3260	2404.445	2405.183	2405.920	2406.658	2407.396	2408.133	2408.871	2409.608	2410.346	2411.083
3270	2411.821	2412.559	2413.296	2414.034	2414.771	2415.509	2416.246	2416.984	2417.721	2418.459
3280	2419.197	2419.934	2420.672	2421.409	2422.147	2422.884	2423.622	2424.360	2425.097	2425.835
3290	2426.572	2427.310	2428.047	2428.785	2429.522	2430.260	2430.998	2431.735	2432.473	2433.210
3300	2433.948	2434.685	2435.423	2436.160	2436.898	2437.635	2438.373	2439.111	2439.848	2440.586
3310	2441.323	2442.061	2442.799	2443.536	2444.274	2445.011	2445.749	2446.486	2447.224	2447.961
3320	2448.699	2449.437	2450.174	2450.912	2451.649	2452.387	2453.124	2453.862	2454.599	2455.337
3330	2456.075	2456.812	2457.550	2458.287	2459.025	2459.762	2460.500	2461.238	2461.975	2462.713
3340	2463.450	2464.188	2464.925	2465.663	2466.400	2467.138	2467.875	2468.613	2469.351	2470.088
3350	2470.826	2471.563	2472.301	2473.039	2473.776	2474.514	2475.251	2475.989	2476.726	2477.464
3360	2478.201	2478.939	2479.677	2480.414	2481.152	2481.889	2482.627	2483.364	2484.102	2484.839
3370	2485.577	2486.314	2487.052	2487.790	2488.527	2489.265	2490.002	2490.740	2491.478	2492.215
3380	2492.953	2493.690	2494.428	2495.165	2495.903	2496.640	2497.378	2498.115	2498.853	2499.591
3390	2500.328	2501.066	2501.803	2502.541	2503.278	2504.016	2504.754	2505.491	2506.229	2506.966
3400	2507.704	2508.441	2509.179	2509.917	2510.654	2511.392	2512.129	2512.867	2513.604	2514.342
3410	2515.079	2515.817	2516.554	2517.292	2518.030	2518.767	2519.505	2520.242	2520.980	2521.718
3420	2522.455	2523.193	2523.930	2524.668	2525.405	2526.143	2526.880	2527.618	2528.355	2529.093
3430	2529.831	2530.568	2531.306	2532.043	2532.781	2533.518	2534.256	2534.993	2535.731	2536.469
3440	2537.206	2537.944	2538.681	2539.419	2540.156	2540.894	2541.632	2542.369	2543.107	2543.844
3450	2544.582	2545.319	2546.057	2546.794	2547.532	2548.270	2549.007	2549.745	2550.482	2551.220
3460	2551.957	2552.695	2553.433	2554.170	2554.908	2555.645	2556.383	2557.120	2557.858	2558.595
3470	2559.333	2560.071	2560.808	2561.546	2562.283	2563.021	2563.758	2564.496	2565.233	2565.971
3480	2566.708	2567.446	2568.184	2568.921	2569.659	2570.396	2571.134	2571.872	2572.609	2573.347
3490	2574.084	2574.822	2575.559	2576.297	2577.034	2577.772	2578.510	2579.247	2579.985	2580.722
3500	2581.460	2582.197	2582.935	2583.672	2584.410	2585.148	2585.885	2586.623	2587.360	2588.098

Nm	0	1	2	3	4	5	6	7	8	9
3510	2588.835	2589.573	2590.311	2591.048	2591.786	2592.523	2593.261	2593.998	2594.736	2595.473
3520	2596.211	2596.948	2597.686	2598.424	2599.161	2599.899	2600.636	2601.374	2602.112	2602.849
3530	2603.587	2604.324	2605.062	2605.799	2606.537	2607.274	2608.012	2608.750	2609.487	2610.225
3540	2610.962	2611.700	2612.437	2613.175	2613.912	2614.650	2615.387	2616.125	2616.863	2617.600
3550	2618.338	2619.075	2619.813	2620.551	2621.288	2622.026	2622.763	2623.501	2624.238	2624.976
3560	2625.713	2626.451	2627.188	2627.926	2628.664	2629.401	2630.139	2630.876	2631.614	2632.351
3570	2633.089	2633.827	2634.564	2635.302	2636.039	2636.777	2637.514	2638.252	2638.990	2639.727
3580	2640.465	2641.202	2641.940	2642.677	2643.415	2644.152	2644.890	2645.627	2646.365	2647.103
3590	2647.840	2648.578	2649.315	2650.053	2650.791	2651.528	2652.266	2653.003	2653.741	2654.478
3600	2655.216	2655.953	2656.691	2657.428	2658.166	2658.904	2659.641	2660.379	2661.116	2661.854
3610	2662.591	2663.329	2664.066	2664.804	2665.542	2666.279	2667.017	2667.754	2668.492	2669.229
3620	2669.967	2670.705	2671.442	2672.180	2672.917	2673.655	2674.392	2675.130	2675.867	2676.605
3630	2677.343	2678.080	2678.818	2679.555	2680.293	2681.030	2681.768	2682.506	2583.243	2683.981
3640	2684.718	2685.456	2686.193	2686.931	2687.668	2688.406	2689.144	2689.881	2690.619	2691.356
3650	2692.094	2692.831	2693.569	2694.306	2695.044	2695.781	2696.519	2697.257	2697.994	2698.732
3660	2699.469	2700.207	2700.945	2701.682	2702.420	2703.157	2703.895	2704.632	2705.370	2706.107
3670	2706.845	2707.583	2708.320	2709.058	2709.795	2710.533	2711.270	2712.008	2712.745	2713.483
3680	2714.221	2714.958	2715.696	2716.433	2717.171	2717.908	2718.646	2719.384	2720.121	2720.859
3690	2721.596	2722.334	2723.071	2723.809	2724.546	2725.284	2726.021	2726.759	2727.497	2728.234
3700	2728.972	2729.709	2730.447	2731.185	2731.922	2732.660	2733.397	2734.135	2734.872	2735.610
3710	2736.347	2737.085	2737.823	2738.560	2739.298	2740.035	2740.773	2741.510	2742.248	2742.985
3720	2743.723	2744.460	2745.198	2745.936	2746.673	2747.411	2748.148	2748.886	2749.624	2750.361
3730	2751.099	2751.836	2752.574	2753.311	2754.049	2754.786	2755.524	2756.261	2756.999	2757.737
3740	2758.474	2759.212	2759.949	2760.687	2761.424	2762.162	2762.900	2763.637	2764.375	2765.112
3750	2765.850	2766.587	2767.325	2768.062	2768.800	2769.538	2770.275	2771.013	2771.750	2772.488
3760	2773.225	2773.963	2774.700	2775.438	2776.176	2776.913	2777.651	2778.388	2779.126	2779.864
3770	2780.601	2781.339	2782.076	2782.814	2783.551	2784.289	2785.026	2785.764	2786.501	2787.239
3780	2787.977	2788.714	2789.452	2790.189	2790.927	2791.664	2792.402	2793.139	2793.877	2794.615
3790	2795.352	2796.090	2796.827	2797.565	2798.302	2799.040	2799.778	2800.515	2801.253	2801.990
3800	2802.728	2803.465	2804.203	2804.940	2805.678	2806.416	2807.153	2807.891	2808.628	2809.366
3810	2810.103	2810.841	2811.579	2812.316	2813.054	2813.791	2814.529	2815.266	2816.004	2816.741
3820	2817.479	2818.217	2818.954	2819.692	2820.429	2821.167	2821.904	2822.642	2823.379	2824.117
3830	2824.854	2825.592	2826.330	2827.067	2827.805	2828.542	2829.280	2830.018	2830.755	2831.493
3840	2832.230	2832.968	2833.705	2834.443	2835.180	2835.918	2836.656	2837.393	2838.131	2838.868
3850	2839.606	2840.343	2841.081	2841.818	2842.556	2843.293	2844.031	2844.769	2845.506	2846.244
3860	2846.981	2847.719	2848.457	2849.194	2849.932	2850.669	2851.407	2852.144	2852.882	2853.619
3870	2854.357	2855.094	2855.832	2856.570	2857.307	2858.045	2858.782	2859.520	2860.258	2860.995
3880	2861.733	2862.470	2863.208	2863.945	2864.683	2865.420	2866.158	2866.896	2867.633	2868.371
3890	2869.108	2869.846	2870.583	2871.321	2872.058	2872.796	2873.533	2874.271	2875.009	2875.746
3900	2876.484	2877.221	2877.959	2878.697	2879.434	2880.172	2880.909	2881.647	2882.384	2883.122
3910	2883.859	2884.597	2885.334	2886.072	2886.810	2887.547	2888.285	2889.022	2889.760	2890.497
3920	2891.235	2891.973	2892.710	2893.448	2894.185	2894.923	2895.660	2896.398	2897.135	2897.873
3930	2898.611	2899.348	2900.086	2900.823	2901.561	2902.298	2903.036	2903.773	2904.511	2905.249
3940	2905.986	2906.724	2907.461	2908.199	2908.937	2909.674	2910.412	2911.149	2911.887	2912.624
3950	2913.362	2914.099	2914.837	2915.574	2916.312	2917.050	2917.787	2918.525	2919.262	2920.000
3960	2920.737	2921.475	2922.212	2922.950	2923.687	2924.425	2925.163	2925.900	2926.638	2927.375
3970	2928.113	2928.851	2929.588	2930.326	2931.063	2931.801	2932.538	2933.276	2934.013	2934.751
3980	2935.489	2936.226	2936.964	2937.701	2938.439	2939.176	2939.914	2940.652	2941.389	2942.127
3990	2942.864	2943.602	2944.339	2945.077	2945.814	2946.552	2947.290	2948.027	2948.765	2949.502
4000	2950.240	2950.977	2951.715	2952.452	2953.190	2953.927	2954.665	2955.403	2956.140	2956.878
4010	2957.615	2958.353	2959.091	2959.828	2960.566	2961.303	2962.041	2962.778	2963.516	2964.253
4020	2964.991	2965.729	2966.466	2967.204	2967.941	2968.679	2969.416	2970.154	2970.891	2971.629
4030	2972.366	2973.104	2973.842	2974.579	2975.317	2976.054	2976.792	2977.530	2978.267	2979.005
4040	2979.742	2980.480	2981.217	2981.955	2982.692	2983.430	2984.167	2984.905	2985.643	2986.380
4050	2987.118	2987.855	2988.593	2989.331	2990.068	2990.806	2991.543	2992.281	2993.018	2993.756
4060	2994.493	2995.231	2995.969	2996.706	2997.444	2998.181	2998.919	2999.656	3000.394	3001.131
4070	3001.869	3002.606	3003.344	3004.082	3004.819	3005.557	3006.294	3007.032	3007.770	3008.507
4080	3009.245	3009.982	3010.720	3011.457	3012.195	3012.932	3013.670	3014.407	3015.145	3015.883
4090	3016.620	3017.358	3018.095	3018.833	3019.570	3020.308	3021.046	3021.783	3022.521	3023.258
4100	3023.996	3024.733	3025.471	3026.208	3026.946	3027.684	3028.421	3029.159	3029.896	3030.634
4110	3031.371	3032.109	3032.846	3033.584	3034.322	3035.059	3035.797	3036.534	3037.272	3038.010
4120	3038.747	3039.485	3040.222	3040.960	3041.697	3042.435	3043.172	3043.910	3044.647	3045.385
4130	3046.123	3046.860	3047.598	3048.335	3049.073	3049.810	3050.548	3051.285	3052.023	3052.760
4140	3053.498	3054.236	3054.973	3055.711	3056.448	3057.186	3057.924	3058.661	3059.399	3060.136
4150	3060.874	3061.611	3062.349	3063.086	3063.824	3064.562	3065.299	3066.037	3066.774	3067.512
4160	3068.249	3068.987	3069.725	3070.462	3071.200	3071.937	3072.675	3073.412	3074.150	3074.887
4170	3075.625	3076.363	3077.100	3077.838	3078.575	3079.313	3080.050	3080.788	3081.525	3082.263
4180	3083.000	3083.738	3084.476	3085.213	3085.951	3086.688	3087.426	3088.164	3088.901	3089.639
4190	3090.376	3091.114	3091.851	3092.589	3093.326	3094.064	3094.802	3095.539	3096.277	3097.014
4200	3097.752	3098.489	3099.227	3099.964	3100.702	3101.439	3102.177	3102.915	3103.652	3104.390

Nm	0	1	2	3	4	5	6	7	8	9
4210	3105.127	3105.865	3106.603	3107.340	3108.078	3108.815	3109.553	3110.290	3111.028	3111.765
4220	3112.503	3113.240	3113.978	3114.716	3115.453	3116.191	3116.928	3117.666	3118.404	3119.141
4230	3119.879	3120.616	3121.354	3122.091	3122.829	3123.566	3124.304	3125.042	3125.779	3126.517
4240	3127.254	3127.992	3128.729	3129.467	3130.204	3130.942	3131.679	3132.417	3133.155	3133.892
4250	3134.630	3135.367	3136.105	3136.843	3137.580	3138.318	3139.055	3139.793	3140.530	3141.268
4260	3142.005	3142.743	3143.480	3144.218	3144.956	3145.693	3146.431	3147.168	3147.906	3148.643
4270	3149.381	3150.118	3150.856	3151.594	3152.331	3153.069	3153.806	3154.544	3155.281	3156.019
4280	3156.757	3157.494	3158.232	3158.969	3159.707	3160.444	3161.182	3161.919	3162.657	3163.395
4290	3164.132	3164.870	3165.607	3166.345	3167.083	3167.820	3168.558	3169.295	3170.033	3170.770
4300	3171.508	3172.245	3172.983	3173.720	3174.458	3175.196	3175.933	3176.671	3177.408	3178.146
4310	3178.883	3179.621	3180.358	3181.096	3181.833	3182.571	3183.309	3184.046	3184.784	3185.521
4320	3186.259	3186.997	3187.734	3188.472	3189.209	3189.947	3190.684	3191.422	3192.159	3192.897
4330	3193.635	3194.372	3195.110	3195.847	3196.585	3197.322	3198.060	3198.798	3199.535	3200.273
4340	3201.010	3201.748	3202.485	3203.223	3203.960	3204.698	3205.436	3206.173	3206.911	3207.648
4350	3208.386	3209.123	3209.861	3210.598	3211.336	3212.073	3212.811	3213.549	3214.286	3215.024
4360	3215.761	3216.499	3217.237	3217.974	3218.712	3219.449	3220.187	3220.924	3221.662	3222.399
4370	3223.137	3223.875	3224.612	3225.350	3226.087	3226.825	3227.562	3228.300	3229.037	3229.775
4380	3230.512	3231.250	3231.988	3232.725	3233.463	3234.200	3234.938	3235.676	3236.413	3237.151
4390	3237.888	3238.626	3239.363	3240.101	3240.838	3241.576	3242.313	3243.051	3243.789	3244.526
4400	3245.264	3246.001	3246.739	3247.477	3248.214	3248.952	3249.689	3250.427	3251.164	3251.902
4410	3252.639	3253.377	3254.115	3254.852	3255.590	3256.327	3257.065	3257.802	3258.540	3259.277
4420	3260.015	3260.752	3261.490	3262.228	3262.965	3263.703	3264.440	3265.178	3265.916	3266.653
4430	3267.391	3268.128	3268.866	3269.603	3270.341	3271.078	3271.816	3272.553	3273.291	3274.029
4440	3274.766	3275.504	3276.241	3276.979	3277.716	3278.454	3279.191	3279.929	3280.667	3281.404
4450	3282.142	3282.879	3283.617	3284.354	3285.092	3285.830	3286.567	3287.305	3288.042	3288.780
4460	3289.517	3290.255	3290.992	3291.730	3292.468	3293.205	3293.943	3294.680	3295.418	3296.156
4470	3296.893	3297.631	3298.368	3299.106	3299.843	3300.581	3301.318	3302.056	3302.793	3303.531
4480	3304.269	3305.006	3305.744	3306.481	3307.219	3307.956	3308.694	3309.431	3310.169	3310.906
4490	3311.644	3312.382	3313.119	3313.857	3314.594	3315.332	3316.070	3316.807	3317.545	3318.282
4500	3319.020	3319.757	3320.495	3321.232	3321.970	3322.708	3323.445	3324.183	3324.920	3325.658
4510	3326.395	3327.133	3327.870	3328.608	3329.346	3330.083	3330.821	3331.558	3332.296	3333.033
4520	3333.771	3334.509	3335.246	3335.984	3336.721	3337.459	3338.196	3338.934	3339.671	3340.409
4530	3341.146	3341.884	3342.622	3343.359	3344.097	3344.834	3345.572	3346.310	3347.047	3347.785
4540	3348.522	3349.260	3349.997	3350.735	3351.472	3352.210	3352.948	3353.685	3354.423	3355.160
4550	3355.898	3356.635	3357.373	3358.110	3358.848	3359.585	3360.323	3361.061	3361.798	3362.536
4560	3363.273	3364.011	3364.749	3365.486	3366.224	3366.961	3367.699	3368.436	3369.174	3369.911
4570	3370.649	3371.386	3372.124	3372.862	3373.599	3374.337	3375.074	3375.812	3376.550	3377.287
4580	3378.025	3378.762	3379.500	3380.237	3380.975	3381.712	3382.450	3383.187	3383.925	3384.663
4590	3385.400	3386.138	3386.875	3387.613	3388.350	3389.088	3389.825	3390.563	3391.301	3392.038
4600	3392.776	3393.513	3394.251	3394.989	3395.726	3396.464	3397.201	3397.939	3398.676	3399.414
4610	3400.151	3400.889	3401.626	3402.364	3403.102	3403.839	3404.577	3405.314	3406.052	3406.789
4620	3407.527	3408.264	3409.002	3409.740	3410.477	3411.215	3411.952	3412.690	3413.427	3414.165
4630	3414.903	3415.640	3416.378	3417.115	3417.853	3418.590	3419.328	3420.065	3420.803	3421.541
4640	3422.278	3423.016	3423.753	3424.491	3425.229	3425.966	3426.704	3427.441	3428.179	3428.916
4650	3429.654	3430.391	3431.129	3431.866	3432.604	3433.342	3434.079	3434.817	3435.554	3436.292
4660	3437.029	3437.767	3438.504	3439.242	3439.979	3440.717	3441.455	3442.192	3442.930	3443.667
4670	3444.405	3445.143	3445.880	3446.618	3447.355	3448.093	3448.830	3449.568	3450.305	3451.043
4680	3451.781	3452.518	3453.256	3453.993	3454.731	3455.468	3456.206	3456.943	3457.681	3458.419
4690	3459.156	3459.894	3460.631	3461.369	3462.106	3462.844	3463.582	3464.319	3465.057	3465.794
4700	3466.532	3467.269	3468.007	3468.744	3469.482	3470.219	3470.957	3471.695	3472.432	3473.170
4710	3473.907	3474.645	3475.383	3476.120	3476.858	3477.595	3478.333	3479.070	3479.808	3480.545
4720	3481.283	3482.021	3482.758	3483.496	3484.233	3484.971	3485.708	3486.446	3487.183	3487.921
4730	3488.658	3489.396	3490.134	3490.871	3491.609	3492.346	3493.084	3493.822	3494.559	3495.297
4740	3496.034	3496.772	3497.509	3498.247	3498.984	3499.722	3500.459	3501.197	3501.935	3502.672
4750	3503.410	3504.147	3504.885	3505.622	3506.360	3507.098	3507.835	3508.573	3509.310	3510.048
4760	3510.785	3511.523	3512.260	3512.998	3513.736	3514.473	3515.211	3515.948	3516.686	3517.423
4770	3518.161	3518.898	3519.636	3520.374	3521.111	3521.849	3522.586	3523.324	3524.062	3524.799
4780	3525.537	3526.274	3527.012	3527.749	3528.487	3529.224	3529.962	3530.699	3531.437	3532.175
4790	3532.912	3533.650	3534.387	3535.125	3535.862	3536.600	3537.337	3538.075	3538.813	3539.550
4800	3540.288	3541.025	3541.763	3542.500	3543.238	3543.976	3544.713	3545.451	3546.188	3546.926
4810	3547.663	3548.401	3549.138	3549.876	3550.614	3551.351	3552.089	3552.826	3553.564	3554.302
4820	3555.039	3555.777	3556.514	3557.252	3557.989	3558.727	3559.464	3560.202	3560.939	3561.677
4830	3562.415	3463.152	3563.890	3564.627	3565.365	3566.102	3566.840	3567.577	3568.315	3569.052
4840	3569.790	3570.528	3571.265	3572.003	3572.740	3573.478	3574.216	3574.953	3575.691	3576.428
4850	3577.166	3577.903	3578.641	3579.378	3580.116	3580.854	3581.591	3582.329	3583.066	3583.804
4860	3584.541	3585.279	3586.016	3586.754	3587.492	3588.229	3588.967	3589.704	3590.442	3591.179
4870	3591.917	3592.655	3593.392	3594.130	3594.867	3595.605	3596.342	3597.080	3597.817	3598.555
4880	3599.292	3600.030	3600.768	3601.505	3602.243	3602.980	3603.718	3604.456	3605.193	3605.931
4890	3606.668	3607.406	3608.143	3608.881	3609.618	3610.356	3611.094	3611.831	3612.569	3613.306
4900	3614.044	3614.781	3615.519	3616.256	3616.994	3617.731	3618.469	3619.207	3619.944	3620.682

Nm	0	1	2	3	4	5	6	7	8	9
4910	3621.419	3622.157	3622.895	3623.632	3624.370	3625.107	3625.845	3626.582	3627.320	3628.057
4920	3628.795	3629.532	3630.270	3631.008	3631.745	3632.483	3633.220	3633.958	3634.695	3635.433
4930	3636.171	3636.908	3637.646	3638.383	3639.121	3639.858	3640.596	3641.333	3642.071	3642.809
4940	3643.546	3644.284	3645.021	3645.759	3646.496	3647.234	3647.971	3648.709	3649.447	3650.184
4950	3650.922	3651.659	3652.397	3653.135	3653.872	3654.610	3655.347	3656.085	3656.822	3657.560
4960	3658.297	3659.035	3659.772	3660.510	3661.248	3661.985	3662.723	3663.460	3664.198	3664.935
4970	3665.673	3666.410	3667.148	3667.886	3668.623	3669.361	3670.098	3670.836	3671.573	3672.311
4980	3673.049	3673.786	3674.524	3675.261	3675.999	3676.736	3677.474	3678.211	3678.949	3679.687
4990	3680.424	3681.162	3681.899	3682.637	3683.374	3684.112	3684.850	3685.587	3686.325	3687.062
5000	3687.800	3688.537	3689.275	3690.012	3690.750	3691.488	3692.225	3692.963	3693.700	3694.438

Umrechnungstabelle für Druckeinheiten von Gasen, Dämpfen und Flüssigkeiten
Conversion table for units of pressure in gases, steam and fluids

2801094

mit 1 Pa = 1 N/m^2 = $\frac{1}{9{,}81}$ kp/m^2 = 0,102 kp/m^2

	Pa	bar	kp/m^2	at	atm	Torr
1 Pa (= 1 N/m^2) =	1	10^{-5}	0,102	0,102 x 10^{-4}	0,987 x 10^{-5}	0,0075
1 bar (= 0,1 MPa) =	100 000 = 10^5	[1] (= 1000 mbar)	10 200	1,02	0,987	750
1 kp/m^2 =	9,81	9,81 x 10^{-5}	1	10^{-4}	0,968 x 10^{-4}	0,0736
1 at (= 1 kp/cm^2) =	98 100	0,981	10 000	1	0,968	736
1 atm (= 760 Torr) =	101 325	1,013 (= 1013 mbar)	10 330	1,033	1	760
1 Torr (= $\frac{1}{760}$ atm) =	133	0,00133	13,6	0,00136	0,00132	1

Umrechnungstabelle für Einheiten von Energie, Arbeit und Wärmemenge
Conversion table for units of power, ernergy and heat quantity

mit 1 Nm = $\frac{1}{9{,}81}$ kp m = 0,102 kp m

		J	kJ	kW h	kcal	PS h	kp m
1 J (= 1 Nm = 1 Ws)	=	1	0,001	$2{,}78 \times 10^{-7}$	$2{,}39 \times 10^{-4}$	$3{,}77 \times 10^{-7}$	0,102
1 kJ	=	1000	1	$2{,}78 \times 10^{-4}$	0,239	$3{,}77 \times 10^{-4}$	102
1 kW h	=	3 600 000	3 600	1	860	1,36	367 000
1 kcal	=	4 200	4,2	0,00116	1	0,00158	427
1 PS h	=	2 650 000	2 650	0,736	632	1	270 000
1 kp m	=	9,81	0,00981	$2{,}72 \times 10^{-6}$	0,00234	$3{,}7 \times 10^{-6}$	1

Umrechnungstabelle für Einheiten der mechanischen Spannung (Festigkeit)
Conversion table for units of mechanical stress (strength)

mit 1 Pa = 1 N/m^2 = $\frac{1}{9{,}81}$ kp/m^2 = 0,102 kp/m^2

	Pa	N/mm^2	daN/cm^2	daN/mm^2	kp/cm ^{2}	kp/mm^2
1 Pa (= 1 N/m^2) =	1	10^{-6}	10^{-5}	10^{-7}	0,102 x 10^{-4}	0,102 x 10^{-6}
1 N/mm^2 (=1 M Pa) =	1 000 000	1	10	0,1	10,2	0,102
1 daN/cm^2 (= 1 bar) =	100 000	0,1	1	0,01	1,02	0,0102
1 daN/mm^2 (= 1 hbar) =	10 000 000	10	100	1	102	1,02
1 kp/cm^2 (= 1 at) =	98 100	0,0981	0,981	0,00981	1	0,01
1 kp/mm^2 =	9 810 000	9,81	98,1	0,981	100	1

□

Praktisch gleichwertige Einheiten für Druck und mechanische Spannung (Festigkeit)

2801095

Practically equivalent units for pressure and mechanical stress (strength)

mit 1 N = 0,1 kp bzw. 1 kp = 10 N = 1 daN

1 daN/mm²	**1 daN/cm²**	**1 kN/cm²**	**1 kp/mm²**	**1 kp/cm²**
= 1 kp/mm²	≙ 1 kp/cm²	= 1 daN/mm²	≙ 1 daN/mm²	= 1 at
= 1 kN/cm²	≙ 1 at	= 1 hbar	≙ 1 kN/cm²	≙ 1 daN/cm²
= 1 hbar	= 1 bar	≙ 1 kp/mm²	≙ 1 hbar	≙ 1 bar

1 kbar	**1 hbar**	**1 bar**	**1 mbar**	**1 bar**
= 1 hN/mm²	= 1 daN/mm²	= 1 daN/cm²	= 1 cN/cm²	= 1 dN/m²
= 10 kN/cm²	= 1 kN/cm²	≙ 1 kp/cm²	≙ 1 p/cm²	
= 1 Mp/cm²	≙ 1 kp/mm²	≙ 1 at		≙ 1 $\frac{\text{kp/m}^2}{100}$

□

Temperatur - Einheiten und Umrechungsformeln
Units of temperature and conversion formulas

2801096

Einheiten Units		Umrechnung in Conversion into			
Benennung Nomenclature Kurzzeichen Symbol		**K**	**°C**	**°R**	**°F**
Kelvin	K	1	(K-273,16°)	4/5 (K-273,16°)	9/5 (K-273,16°)+32°
Celsius	°C	°C+273,16°	1	4/5 °C	9/5 °C+32°
Réaumur	°R	5/4 °R+273,16°	5/4 °R	1	9/4 °R+32°
Fahrenheit	°F	5/9 (°F-32°)+ 273,16°	5/9 (°F-32°)	4/9 (°F -32°)	1

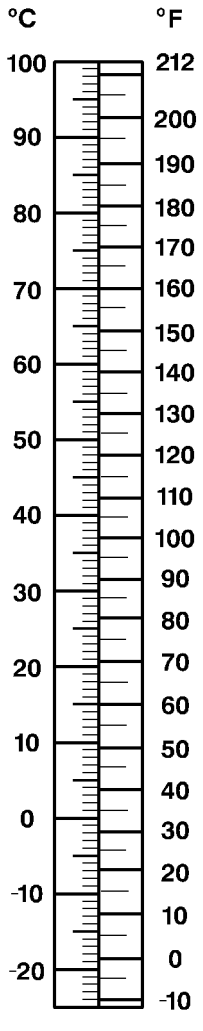
Beispiel: Umrechnung von °R in °C : °C = 5/4 °R
Example: Conversion from

Die Grundeinheit der Temperatur ist Kelvin (K).
The fundamental temperature unit is the Kelvin (K).

Als Formelzeichen wird T verwandt.
The symbol used is the T.

Die ebenfalls benutzte absolute Temperatur degree (Grad) Rankin errechnet sich zu:
The equally used Rankine temperature scale for absolute temperatures is related to K as follows:

°Rank = 9/5 K.

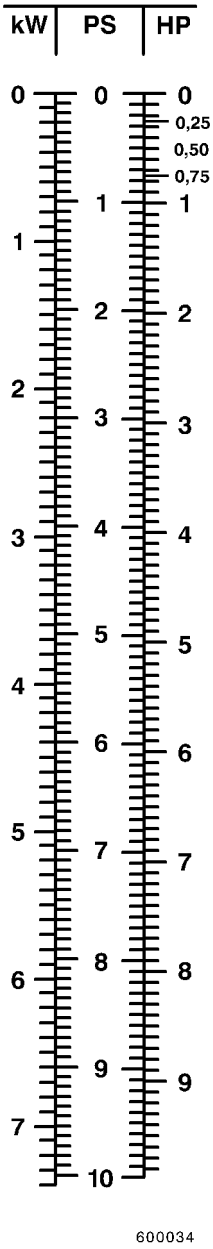


328249

Leistung, Energiestrom, Wärmestrom
Power, energy and heat flow

1 Nm/s = $\frac{1}{9{,}81}$ kp m/s = 0,102 kp m/s

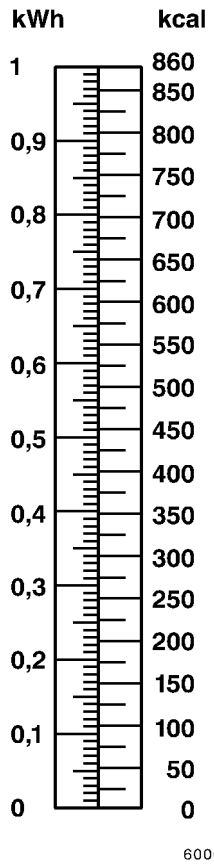
	W	kW	kcal/s	kcal/h	kp m/s	PS	HP
1 W = (= 1 N m/s = 1 J/s)	1	0,001	$2{,}39 \times 10^{-4}$	0,860	0,102	0,00136	0,00134
1 kW =	1 000	1	0,239	860	102	1,36	1,341
1 kcal/s =	4 190	4,19	1	3600	427	5,69	5,61
1 kcal/h =	1,16	0,00116	$\frac{1}{3600}$	1	0,119	0,00158	0,00156
1 kp m/s =	9,81	0,00981	0,00234	8,43	1	0,0133	0,0131
1 PS =	736	0,736	0,176	632	75	1	0,9863
1 HP =	746	0,746	0,178	641,8	76,09	1,0145	1



600034

1 kp m/s = 3600 kp m/h

1 kp m/h = $\frac{1}{3\,600}$ kp m/s



600033

Geschwindigkeiten
Speed

1 km / h	=	0,27778 m / s	1 m / s	=	3,6 km / h
1 mile / h	=	1,60934 km / h	1 km / h	=	0,62137 mile / h
1 kn (Knoten)	=	1,852 km / h	1 km / h	=	0,53996 kn
1 ft / min	=	0,3048 m / min	1 m / min	=	3,28084 ft / min

	Umrechnung von Conversion for								
	km / h	**m / s**	**km / h**	**mile / h (mph)**	**kn**	**ft / min**	**km / h**	**mile / h (mph)**	**km / h**
	in m / s	in km / h	in mile / h	in km / h	in km / h	in m / min	in Zeit / km	in Zeit / km	in Zeit / 100 km
10	2,78	36,0	6,21	16,1	18,52	3,05	6 min	3 min 44 s	10 h
20	5,56	72,0	12,4	32,2	37,04	6,10	3 min	1 min 52 s	5 h
30	8,33	108	18,6	48,3	55,56	9,14	2 min	1 min 15 s	3 h 20 min
40	11,1	144	24,9	64,4	74,08	12,2	1 min 30 s	55,9 s	2 h 30 min
50	13,9	180	31,1	80,5	92,60	15,2	1 min 12 s	44,7 s	2 h
60	16,7	216	37,3	96,6	111	18,3	1 min	37,3 s	1 h 40 min
70	19,4	252	43,5	113	130	21,3	51,4 s	32,0 s	1 h 26 min
80	22,2	288	49,7	129	148	24,4	45 s	28,0 s	1 h 15 min
90	25,0	324	55,9	145	167	27,4	40 s	24,9 s	1 h 6,7 min
100	27,8	360	62,1	161	185	30,5	36 s	22,0 s	1 h
110	30,6	396	68,4	177	---	33,5	32,7 s	20,3 s	54 min 33 s
120	33,4	432	74,6	193	---	36,6	30 s	18,6 s	50 min
130	36,1	468	80,8	209	---	39,6	27,7 s	17,2 s	46 min 9 s
140	38,9	504	87,0	225	---	42,7	25,7 s	16,0 s	42 min 51s
150	41,7	540	93,2	241	---	45,7	24 s	14,9 s	40 min
160	44,4	576	99,4	257	---	48,8	22,5 s	14,0 s	37 min 30 s
170	47,2	612	106	274	---	51,8	21,2 s	13,2 s	35 min 18 s
180	50,0	648	112	290	---	54,9	20,0 s	12,4 s	33 min 20 s
190	52,8	684	118	306	---	57,9	18,9 s	11,8 s	31 min 35 s
200	55,6	720	124	322	---	61,0	18 s	11,2 s	30 min
250	59,4	900	155	402	---	76,2	14,4 s	8,9 s	26 min
300	83,3	1080	186	483	---	91,4	12 s	7,5 s	20 min
400	111	1440	249	644	---	122	9 s	5,8 s	15 min
500	139	1800	311	805	---	152	7,2 s	4,5 s	12 min
600	167	2160	373	966	---	183	6 s	3,7 s	10 min
800	222	2880	497	1287	---	244	4,5 s	2,8 s	7 min 30 s
1000	278	3600	621	1609	---	305	3,6 s	2,2 s	6 min
1200	333 1)	---	746	---	---	366	3 s	---	5 min
1400	389	---	870	---	---	427	2,6 s	---	4 min 17 s

Die Machzahl Ma (keine gesetzliche Einheit) gibt an, wieviel mal schneller ein Körper sich bewegt als der Schall. Ma = 1,3 bedeutet also 1,3fache Schallgeschwindigkeit.

The Mach number "Ma" (no official unit of measurement) gives the factor by which a body is faster, than the speed of sound.
Thus "Ma" = 1.3 means 1.3 times as fast as the speed of sound.

1) Etwa Schallgeschwindigkeit in Luft.
Approximate velocity of sound in the air.

Masseeinheiten (Gewichte)
Units of mass (weight)

	Umrechnung von Conversion for							
	grain	**dram**	**oz**	**lb**	**long cwt**	**sh cwt**	**long tn**	**sh tn**
	in g	in g	in g	in kg	in kg	in kg	in t	in t
1,0	0,0648	1,77	28,3	0,454	50,8	45,4	1,02	0,907
1,1	0,0713	1,95	31,2	0,499	55,9	49,9	1,12	0,998
1,2	0,0778	2,13	34,0	0,544	61,0	54,4	1,22	1,09
1,3	0,0842	2,30	36,9	0,590	66,0	59,0	1,32	1,18
1,4	0,0907	2,48	39,7	0,635	71,1	63,5	1,42	1,27
1,5	0,0972	2,66	42,5	0,680	76,2	68,0	1,52	1,36
1,6	0,104	2,83	45,4	0,726	81,3	72,6	1,63	1,45
1,7	0,110	3,01	48,2	0,771	86,4	77,1	1,73	1,54
1,8	0,117	3,19	51,0	0,816	91,4	81,6	1,83	1,63
1,9	0,123	3,37	53,9	0,862	96,5	82,2	1,93	1,72
2,0	0,130	3,54	56,7	0,907	102	90,7	2,03	1,81
2,1	0,136	3,72	59,5	0,953	107	95,3	2,13	1,91
2,2	0,143	3,90	62,4	0,998	112	99,8	2,24	2,00
2,3	0,149	4,08	65,2	1,04	117	104	2,34	2,09
2,4	0,156	4,25	68,0	1,09	122	109	2,44	2,18
2,5	0,162	4,43	70,9	1,13	127	113	2,54	2,27
2,6	0,168	4,61	73,7	1,18	132	118	2,64	2,36
2,7	0,175	4,78	76,5	1,22	137	122	2,74	2,45
2,8	0,181	4,96	79,4	1,27	142	127	2,84	2,54
2,9	0,188	5,14	82,2	1,32	147	132	2,95	2,63
3,0	0,194	5,32	85,0	1,36	152	136	3,05	2,72
3,2	0,207	5,67	90,7	1,45	163	145	3,25	2,90
3,4	0,220	6,02	96,4	1,54	173	154	3,45	3,08
3,6	0,233	6,38	102	1,63	183	163	3,66	3,27
3,8	0,246	6,73	108	1,72	193	172	3,86	3,45
4,0	0,259	7,09	113	1,81	203	181	4,06	3,63
4,2	0,272	7,44	119	1,91	213	191	4,27	3,81
4,4	0,285	7,80	125	2,00	224	200	4,47	3,99
4,6	0,298	8,15	130	2,09	234	209	4,67	4,17
4,8	0,311	8,50	136	2,18	244	218	4,88	4,35
5,0	0,324	8,86	142	2,27	254	227	5,08	4,54
5,2	0,337	9,21	147	2,36	264	236	5,28	4,72
5,4	0,350	9,57	153	2,45	274	245	5,49	4,90
5,6	0,363	9,92	159	2,54	284	254	5,69	5,08
5,8	0,376	10,3	164	2,63	295	263	5,89	5,26
6,0	0,389	10,6	170	2,72	305	272	6,10	5,44
6,5	0,421	11,5	184	2,95	330	295	6,60	5,90
7,0	0,454	12,4	198	3,18	356	318	7,11	6,35
7,5	0,486	13,3	213	3,40	381	340	7,62	6,80
8,0	0,518	14,2	227	3,63	406	363	8,13	7,26
8,5	0,551	15,1	241	3,86	432	386	8,64	7,71
9,0	0,583	15,9	255	4,08	457	408	9,14	8,16
9,5	0,616	16,8	269	4,31	483	431	9,65	8,62

Die Tabelle gilt auch für dezimale Vielfache und Teile.
The table is also valid for decimal multiples and fractions.

Beispiele: 1 lb = 0,454 kg; 5 long ton = 5,08 t; 42 oz = 1190 g.
Example: 1 lb = 0,454 kg; 5 long ton = 5,08 t; 42 oz = 1190 g.

Volumeneinheiten, Durchflußmenge
Units of volume, flow rates

	Umrechnung von Conversion for							
	in^3	**ft^3**	**yd^3**	**pt (UK)**	**liq pt (US)**	**gal (UK)**	**gal (US)**	**ft^3 / min cfm**
	in cm^3	in l	in m^3	in l	in l	in l	in l	in m^3 / h
1,0	16,4	28,3	0,765	0,568	0,473	4,55	3,79	1,70
1,1	18,0	31,2	0,841	0,625	0,520	5,00	4,16	1,87
1,2	19,7	34,0	0,918	0,682	0,568	5,46	4,54	2,04
1,3	21,3	36,8	0,994	0,739	0,615	5,91	4,92	2,21
1,4	22,9	39,6	1,07	0,796	0,662	6,36	5,30	2,38
1,5	24,6	42,5	1,15	0,852	0,710	6,82	5,68	2,55
1,6	26,2	45,3	1,22	0,909	0,757	7,27	6,06	2,72
1,7	27,9	48,1	1,30	0,966	0,804	7,73	6,44	2,89
1,8	29,5	51,0	1,38	1,02	0,852	8,18	6,81	3,06
1,9	31,1	53,8	1,45	1,08	0,899	8,64	7,19	3,23
2,0	32,8	56,6	1,53	1,14	0,946	9,09	7,57	3,40
2,1	34,4	59,5	1,61	1,19	0,994	9,55	7,95	3,57
2,2	36,1	62,3	1,68	1,25	1,04	10,0	8,33	3,74
2,3	37,7	65,1	1,76	1,31	1,09	10,5	8,71	3,91
2,4	39,3	68,0	1,83	1,36	1,14	10,9	9,09	4,08
2,5	41,0	70,8	1,91	1,42	1,18	11,4	9,46	4,25
2,6	42,6	73,6	1,99	1,48	1,23	11,8	9,84	4,42
2,7	44,3	76,5	2,06	1,53	1,28	12,3	10,2	4,59
2,8	45,9	79,3	2,14	1,59	1,32	12,7	10,6	4,76
2,9	47,5	82,1	2,22	1,65	1,37	13,2	11,0	4,93
3,0	49,2	85,0	2,29	1,70	1,42	13,6	11,4	5,10
3,2	52,4	90,6	2,45	1,82	1,51	14,6	12,1	5,44
3,4	55,7	96,3	2,60	1,93	1,61	15,5	12,9	5,78
3,6	59,0	102	2,75	2,05	1,70	16,4	13,6	6,12
3,8	62,3	108	2,91	2,16	1,80	17,3	14,4	6,46
4,0	65,6	113	3,06	2,27	1,89	18,2	15,1	6,80
4,2	68,8	119	3,21	2,39	1,99	19,1	15,9	7,14
4,4	72,1	125	3,36	2,50	2,08	20,0	16,7	7,48
4,6	75,4	130	3,52	2,61	2,18	20,9	17,4	7,82
4,8	78,7	136	3,67	2,73	2,27	21,8	18,2	8,16
5,0	81,9	142	3,82	2,84	2,37	22,7	18,9	8,50
5,2	85,2	147	3,98	2,96	2,46	23,6	19,7	8,84
5,4	88,5	153	4,13	3,07	2,56	24,6	20,4	9,18
5,6	91,8	159	4,28	3,18	2,65	25,5	21,2	9,52
5,8	95,1	164	4,43	3,30	2,74	26,4	22,0	9,85
6,0	98,3	170	4,59	3,41	2,84	27,3	22,7	10,2
6,2	102	176	4,74	3,52	2,93	28,2	23,5	10,5
6,4	105	181	4,89	3,64	3,03	29,1	24,2	10,9
6,6	108	187	5,05	3,75	3,12	30,0	25,0	11,2
6,8	111	193	5,20	3,86	3,22	30,9	25,7	11,6
7,0	115	198	5,35	3,98	3,31	31,8	26,5	11,9
7,5	123	212	5,73	4,26	3,55	34,1	28,4	12,7
8,0	131	227	6,12	4,55	3,79	36,4	30,3	13,6
8,5	139	241	6,50	4,83	4,02	38,6	32,2	14,4
9,0	148	255	6,88	5,11	4,26	40,9	34,1	15,3
9,5	156	269	7,26	5,40	4,50	43,2	36,0	16,1

Beispiele: 1 in^3 = 16,4 cm^3; 3 gal (UK) = 13,6 l
Example: 1 in^3 = 16,4 cm^3; 3 gal (UK) = 13,6 l

Kraftstoffverbrauch
Fuel consumption

1 g / PS h	=	1,3596 g / kW h	1 g / kW h	=	0,7355 g / PS h
1 lb / HP H	=	608,277 g / kW h	1 g / kW h	=	0,001644 lb / HP H
1 liq pt / HP H	=	634,545 cm^3 / kW h	1 cm^3 / kW h	=	0,001576 liq pt / HP H
1 pt (UK) HP H	=	762,049 cm^3 / kW h	1 cm^3 / kW h	=	0,001312 pt (UK) / HP H

Umrechnung von Conversion for			Umrechnung von Conversion for				Umrechnung von Conversion for		
	g/PS h	g/kW h		lb HP H	liq pt HP H	pt (UK) HP H		miles gal (US)	miles gal (UK)
	in g / kW h	in g / PS h		in g / kW h	in cm^3 / kW h	in cm^3 / kW h		in l / 100 km	in l / 100 km
100	136,0	73,55	0,10	60,83	63,45	76,20	10	23,5	28,2
120	163,2	88,26	0,15	91,24	95,18	114,3	11	21,4	25,7
140	190,3	103,0					12	19,6	23,5
160	217,5	117,7	0,20	121,7	126,9	152,4	13	18,1	21,7
180	244,7	132,4	0,25	152,1	158,6	190,5	14	16,8	20,2
200	271,9	147,1	0,30	182,5	190,4	228,6	15	15,7	18,8
220	299,1	161,8	0,32	194,6	203,1	243,9	16	14,7	17,7
240	326,3	176,5	0,34	206,8	215,7	259,1	17	13,8	16,6
260	353,5	191,2	0,36	219,0	228,4	274,3	18	13,1	15,7
280	380,7	205,9	0,38	231,1	241,1	289,6	19	12,4	14,9
300	407,9	220,6	0,40	243,3	253,8	304,8	20	11,8	14,1
320	435,1	235,4	0,42	255,5	266,5	320,1	22	10,7	12,8
340	462,3	250,1	0,44	276,6	279,2	335,3	24	9,80	11,8
360	489,5	264,8	0,46	279,8	291,9	350,5	26	9,05	10,9
380	516,6	279,5	0,48	292,0	304,6	365,8	28	8,40	10,1
400	543,8	294,2	0,50	304,1	317,3	381,0	30	7,84	9,42
420	571,0	308,9	0,52	316,3	330,0	396,3	32	7,35	8,83
440	598,2	323,6	0,54	328,5	342,7	411,5	34	6,92	8,31
460	625,4	338,3	0,56	340,6	355,3	426,7	36	6,53	7,85
480	652,6	353,0	0,58	352,8	368,0	442,0	38	6,19	7,43
500	679,8	367,7	0,60	365,0	380,7	457,2	40	5,89	7,06
520	707,0	382,5	0,62	377,1	393,4	472,5	42	5,60	6,73
540	734,2	397,2	0,64	389,3	406,1	487,7	44	5,35	6,42
560	761,4	411,9	0,66	401,5	418,8	503,0	46	5,11	6,14
580	788,6	426,6	0,68	413,6	431,5	518,2	48	4,90	5,88
600	815,8	441,3	0,70	425,8	444,2	533,4	50	4,70	5,65
650	883,7	478,1	0,75	456,2	475,9	571,5	55	4,28	5,14
700	951,7	514,8	0,80	486,6	507,6	609,6	60	3,92	4,71
750	1020	551,6	0,85	517,0	539,4	647,7	70	3,36	4,04
800	1088	588,4	0,90	547,4	571,1	685,8	80	2,94	3,53
900	1224	661,9	0,95	577,9	602,8	723,9	90	2,61	3,14

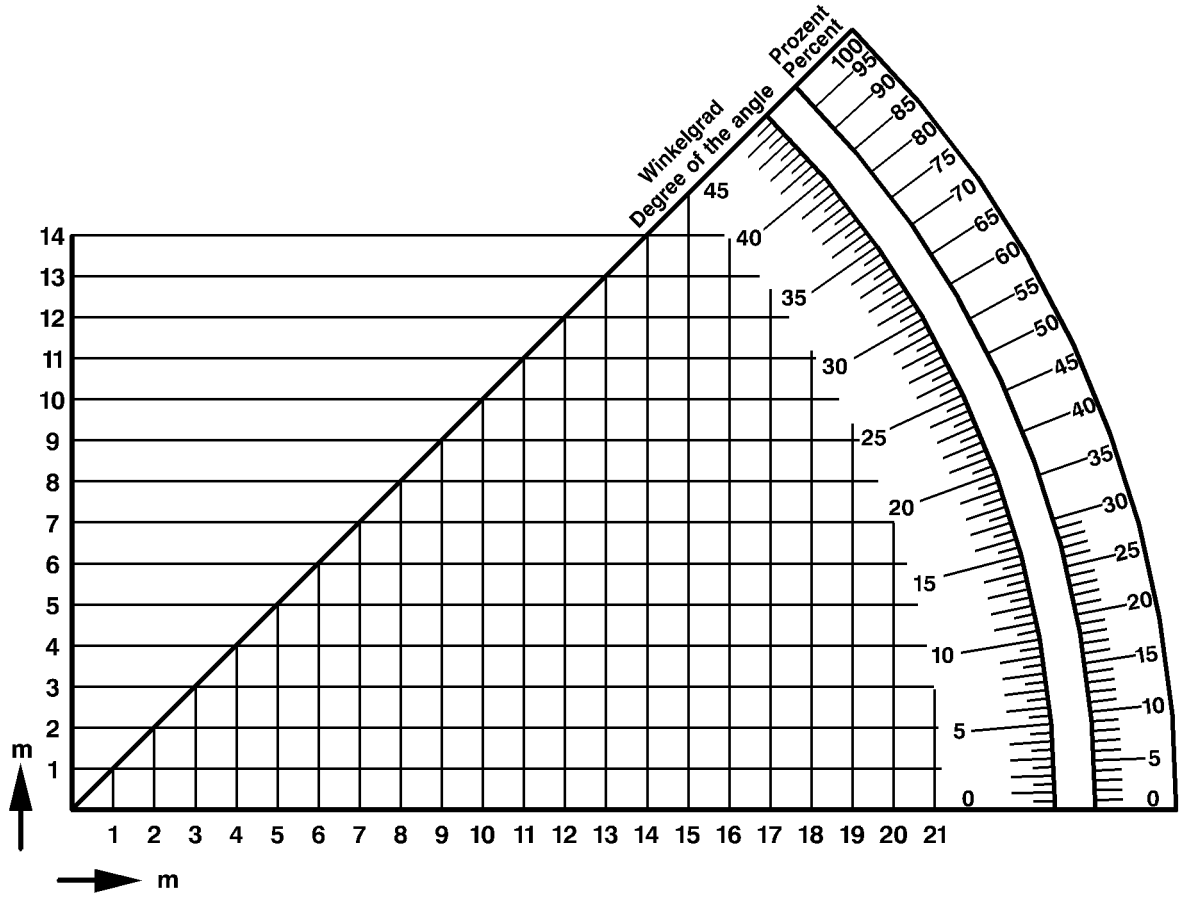
Beispiel:
Example:
240 g / PS h = 326,3 g / kW h

Beispiel:
Example:
0,68 liq pt / HP H = 431,5 cm^3 / kW h

Beispiel:
Example:
18 miles / gal (US) = 13,1 l / 100 km

BERECHNUNGSBEISPIELE
CALCULATION EXAMPLES

Steigungswinkel
Angles of slope



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Fahrgeschwindigkeiten
Travel speeds

$$V = \frac{360}{t}$$

V= km/h
t= Sekunden auf 100 m
Seconds needed for 100 m

Beispiel: Bei einer konstanten Geschwindigkeit werden für eine Strecke von 100 m 18 Sekunden benötigt.
Example: At a constant speed, a travel time of 18 seconds is needed for a distance of 100 meters.

$$V_{(km/h)} = \frac{360}{18} = 20 \text{ km/h}$$

Hydraulische Leistungen (Pumpen/Motoren) Hydraulic outputs (pumps/motors)

$$P = \frac{p \cdot Q}{600}$$

P= kW
p= bar
Q= l/min

Beispiel: Von einer Pumpe mit einer effektiven Fördermenge von Q = 80 l/min soll bei einem Pumpendruck von p = 300 bar die Leistung berechnet werden.

Example: For a pump with an effective discharge rate of Q = 80 l/min, at a pressure of p = 300 bar the output is to be calculated.

$$P_{(kW)} = \frac{300 \cdot 80}{600} = 40 \text{ kW}$$

Zylinder-Hubzeiten Stroking times of cylinders

$$t = \frac{V_{Zyl.} \cdot 60}{Qp}$$

t = Sekunden/Seconds
$V_{Zyl.}$= Volumen des(r) Zylinder in dm^3
Volume of the cylinder(s) in dm^3
Qp = theoretische Fördermenge der Pumpe(n) in l/min
theoretical discharge rate of the pump(s) in l/min

Beispiel: Gegeben sind Pumpenfördermenge Qp = 80 l/min und Zylindervolumen $V_{Zyl.}$ = 10 dm^3

Example: For a given pump discharge rate of Qp = 80 l/min and a cylinder volume of $V_{Zyl.}$ = 10 dm^3 we obtain

$$t_{(Sek.)} = \frac{10 \cdot 60}{80} = 7{,}5$$ Sekunden / Seconds

Drehzahlen von Hydraulikmotoren Speeds of hydraulic motors

$$n = \frac{Vp \cdot np}{VM}$$

n = Drehzahl in U/min (min^{-1})
motor speed in rpm
Vp = Geometrisches Fördervolumen der Pumpe in cm^3/U
geometrical displacement of the pump in cm^3/revolution
np = Drehzahl der Pumpen in U/min (min^{-1})
turning speed of the pump in rpm
VM= Geometrisches Schluckvolumen des Motors in cm^3/U
geometrical displacement of the motor in cm^3/rpm

Beispiel: Gegeben sind Pumpendrehzahl np = 2150 min^{-1}, geometrisches Fördervolumen Pumpe Vp = 11 cm^3/U und das geometrische Schluckvolumen des Motors VM = 8 cm^3/U

Example: For a given pump speed np = 2,150 rpm, a geometrical displacement of the pump Vp = 11 cm^3/rpm and a geometrical displacement of the motor of VM = 8 cm^3/rpm we obtain

$$n = \frac{11 \cdot 2150}{8} = 2956 \text{ min}^{-1}$$

ANZIEHDREHMOMENTE

Allgemeine Hinweise

In den nachfolgenden Tabellen sind die Anziehdrehmomente für Schrauben mit metrischem Gewinde DIN 13 - 13.

Die Konstruktion kann von Fall zu Fall von der Norm abweichende Anziehdrehmomente festlegen. **Deshalb sind die in den Tabellen genannten Werte nur dann anzuwenden, wenn in der Betriebsanleitung Kapitel "Inspektion und Wartung", im Technischen Handbuch oder in der Zeichnung keine anderen Werte angegeben sind.**

Die Festlegung der Anziehdrehmomente richtet sich nicht nur nach der Schraubenqualität, sie ist auch von der Reibung im Gewinde und von der Auflage des Schraubenkopfes abhängig. Deshalb sind bei der Berechnung von Anziehdrehmomenten je nach Schraubenausführung und Zustand unterschiedliche Reibungszahlen (gesamt) zu verwenden.

1. Reibungszahl gesamt = 0,10:
   Schraube und/oder Mutter galvanisch verzinkt (Oberflächenschutz A3B).

2. Reibungszahl gesamt = 0,12:
   Schraube schwarzvergütet oder phoshatiert.
   Mutter blank.
   Gewinde geölt.

3. Reibungszahl gesamt = 0,16:
   Schrauben mit flüssiger Schraubensicherung z.B. Loctite 242, 243, entsprechend der Verarbeitungsvorschrift.
   Die entsprechenden Zeilen sind in den Tabellen zusätzlich mit einem "L" gekennzeichnet.

Die drei Zahlen sind mittlere Reibungswerte.
Die errechneten Anziehdrehmomente M_A gelten für das Anziehen der Schrauben von Hand.

Maßeinheiten

Die in den Tabellen angegebenen Anziehdrehmomente sind in Nm (Newtonmeter) angegeben. Werden Drehmomentschlüssel älterer Bauart verwendet, müssen die Nm in die früher verwendete Einheit kpm (Kilopondmeter) umgerechnet werden. Diese Umrechnung ist problemlos, da 1 kpm fast genau 10 Nm entsprechen (genauer Umrechnungsfaktor 1 kpm = 9,81 Nm). Diese geringfügige Differenz kann vernachlässigt werden, so daß bei einer Umrechnung der in Nm angegebene Wert lediglich durch 10 dividiert werden muß.

Beispiel: $1840\ \text{Nm} = \frac{1840}{10} = 184\ \text{kpm}$

TIGHTENING TORQUES

General information

The following tables contain the tightening torques for screws with a DIN 13 - 13 metric thread.

The construction dept. may specify in certain cases tightening torques other than those set out in the standard. **The values set out in the tables are therefore applicable unless otherwise specified in the "Inspection and servicing" chapter of the operating instructions, the Technical Handbook or the drawings.**

The tightening torques specified do not only depend on the screw grade, but also on the friction at the thread and the bearing face of the screw head. Therefore, different friction coefficients (total) depending on the type and condition of the screws used must be applied when calculating tightening torques.

1. Friction coefficient total = 0.10:
   screw and/or nut electro-galvanized (surface protection A3B).

2. Friction coefficient total = 0.12:
   screw black-plated or phosphatized
   nut bright
   thread oiled

3. Friction coefficient total = 0.16:
   screws with liquid screw fixer, e.g. Loctite 242, 243, in acc. with application instructions.
   The corresponding column is marked in the tables with an "L".

The three figures given are mean friction coefficients.
The calculated tightening torques M_A are valid for tightening of the screws by hand

Units of measurement

The tightening torques specified in the tables are expressed in Nm (newtonmeter). If older torque wrenches are used for tightening, the Nm values must be converted to the formerly used kpm (kilopondmeter) unit. The conversion is simple since 1 kpm is almost exactly the same as 10 Nm (exact coversion factor: 1 kpm = 9.81 Nm). The small difference can be ignored so that for conversion purposes the Nm value must only be divided by 10.

Example:

$$1840\ \text{Nm} = \frac{1840}{10} = 184\ \text{kpm}$$

Schrauben mit Regelgewinde nach DIN 13 - 13
Bolts with standard thread DIN 13 - 13

Gewinde-Nenn Ø Thread nominal Ø	Festigkeits-klasse Material quality	Anziehdrehmomente M_A in Nm Tightening torques M_A in Nm		
		gesamt total 0,10[1]	gesamt total 0,12[2]	gesamt total 0,16 (L)[3]
M 5	8.8 10.9 12.9	4,9 7,3 8,5	5,5 8,1 9,5	6,5 9,5 11,2
M 6	8.8 10.9 12.9	8,5 12,5 14,5	9,5 14 16,5	11,2 16,5 19,5
M 8	8.8 10.9 12.9	20,5 30 35	23 34 40	27 40 47
M 10	8.8 10.9 12.9	41 60 71	46 68 79	55 80 94
M 12	8.8 10.9 12.9	71 104 195	79 117 215	94 140 260
M 16	8.8 10.9 12.9	170 250 300	195 280 330	230 340 400
M 20	8.8 10.9 12.9	350 490 580	390 560 650	470 670 780
M 24	8.8 10.9 12.9	600 850 1000	670 960 1120	800 1140 1350
M 30	8.8 10.9 12.9	1190 1700 2000	1350 1900 2250	1600 2300 2700
M 36	8.8 10.9 12.9	2100 3000 3500	2350 3300 3900	2800 4000 4700

[1] Schraube und/oder Mutter galvanisch verzinkt (A3B).
Screw and/or nut electro-galvanized.

[2] Schraube schwarz vergütet oder phosphatiert, Gewinde geölt.
Screw black-plated or phosphatized, thread oiled.

[3] Schrauben mit flüssiger Schraubensicherung z.B. Loctite 242, 243.
Screws with liquid screw fixer, e.g. Loctite 242, 243.

Schrauben mit metrischem Feingewinde DIN 13 - 13
Bolts with metric fine thread DIN 13 - 13

Gewinde-Nenn Ø Thread nominal Ø	Festigkeits-klasse Material quality	Anziehdrehmomente M_A in Nm Tightening torques M_A in Nm gesamt total 0,10[1]	gesamt total 0,12[2]	gesamt total 0,16 (L)[3]
M 8x1	8.8 10.9 12.9	22 32 38	24,5 36 43	30 43 51
M 10x1	8.8 10.9 12.9	45 67 78	52 76 89	62 91 107
M 10x1,25	8.8 10.9 12.9	43 64 74	49 72 84	58 86 100
M 12x1,25	8.8 10.9 12.9	77 112 130	87 125 150	104 150 180
M 14x1,5	8.8 10.9 12.9	121 175 205	135 200 235	165 240 280
M 16x1,5	8.8 10.9 12.9	180 270 310	205 300 360	250 370 430
M 20x1,5	8.8 10.9 12.9	380 540 630	430 620 720	530 750 880
M 22x1,5	8.8 10.9 12.9	510 720 840	580 820 960	700 1000 1170
M 24x2	8.8 10.9 12.9	640 920 1070	730 1040 1220	890 1250 1500
M 27x2	8.8 10.9 12.9	940 1350 1550	1070 1500 1800	1300 1850 2150
M 30x2	8.8 10.9 12.9	1370 1940 2270	1490 2120 2480	1740 2480 2900

[1] Schraube und/oder Mutter galvanisch verzinkt (A3B).
Screw and/or nut electro-galvanized.

[2] Schraube schwarz vergütet oder phosphatiert, Gewinde geölt.
Screw black-plated or phosphatized, thread oiled.

[3] Schrauben mit flüssiger Schraubensicherung z.B. Loctite 242, 243.
Screws with liquid screw fixer, e.g. Loctite 242, 243. □

Anziehdrehmomente für SAE Flanschsystem
Tightening torques for SAE flange-system

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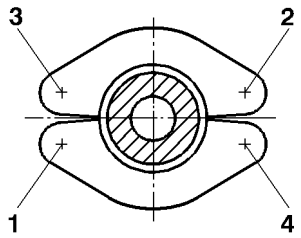


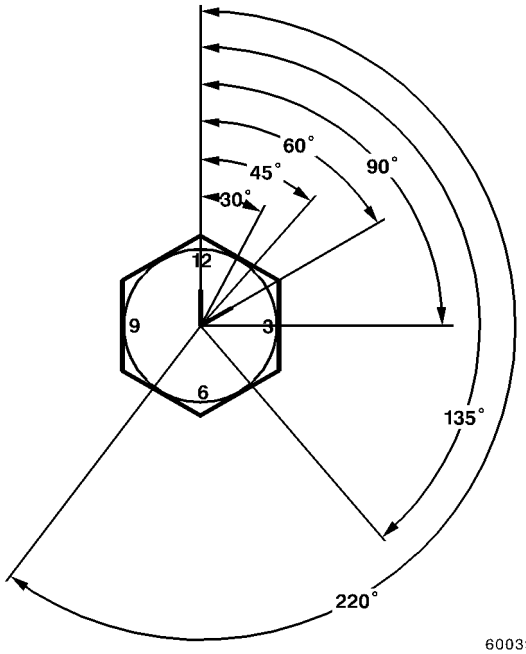
Schrauben in mehreren Durchgängen anziehen. * *
Reihenfolge: 1, 2, 3, 4

Tighten bolts in several stages. * *
Sequence: 1, 2, 3, 4

Gewinde Thread	SW Wrench size	Anziehdrehmoment Tightening
M 10 M 12 M 14 M 16	11 mm 13 mm 15 mm 19 mm	60 Nm 100 Nm 160 Nm 250 Nm

* * Siehe THB "Armaturen, Rohr- und Schlauchleitungen".
See THB "Fittings, pipes and hoses".

Anzugswinkel
Tightening angles



6°	=	1	min.
30°	=	5	min.
45°	=	7,5	min.
60°	=	10	min.
90°	=	15	min.
135°	=	22,5	min.
220°	=	36,7	min.

□

Notizen / Notes

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SERVICE DATA

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DANGER

Anyone involved with commissioning, operating, inspecting and servicing the construction machine must read through and acquaint himself with the "OPERATING MANUAL" - and especially the Section "FUNDAMENTAL SAFETY INSTRUCTIONS" - before starting work.

The "Service Data" contains details which are important to the service staff. Data included in other parts of the general documentation have been left aside.

Data regarding auxiliary units for operating ancillary or special systems, as well as data on machines produced only in small numbers, have not been included.

Filling quantities are only approximate figures intended to help in stockholding the various fluids and agents. Each unit has appropriate checking systems, e.g. dipstick or checking screws, with which the exact filling level can be checked.

CAUTION

The Part Nos. given in the sections are not to be used when ordering spare parts. They are only intended to identify the component being referred to. When ordering spare parts, use only the Part Nos. given in the spare parts lists.

□

Engine

2800844

	Unit	LW 80 No. 560 501 -
Manufacturer and model		Perkins 1004.42
Rated output DIN 70 020 (at rated speed)	kW	56
Rated speed (at full load)	rpm	2200
Idling speed	rpm	860
High idling speed	rpm	2350
Firing sequence		1,3,4,2
Direction of rotation		Anti-clockwise when looking at flywheel
Valve clearance: inlet and exhaust (engine cold)	mm / mm inch / inch	0.20 / 0.45 0.008 : 0.018
Compression pressure	bar psi	17.25 : 1 250 : 1
Oil pressure	bar psi	2.8 40.6

Axles and transmission gears

Front axle

	LW 80 No. 560 501 -
Type	Planetary axle (with self-locking differential)
Model	ASP 50
Ratio	i = 23,25

Rear axle with transfer box gearing

	LW 80 No. 560 001 -	
Type	Planetary axle (without self locking differential)	Planetary axle (with self-locking differential)[1)]
Model	ASPPV 50	ASPPV 50
Ratio	i = 43,66	

[1)] Optional

Travel speeds

	Unit	**LW 80** No. 560 501 -
Travel range 1 (working gear)	km / h	0 - 6[2)]
Travel range 2 (travel gear)	km / h	0 - 20[2)]

[2)] at tyre-dimension 14.5-20

Hydraulic system

Checking and setting data

	Unit	LW 80 No. 560 501 -
Hydr. oil temp. (oil reservoir) for checking and adjustments	˚C ˚F	approx. 60 - 70 approx. 140 - 160
Working hydraulic		
- primary pressure relief	bar / psi	230^{+5}_{-10} / 3340^{+70}_{-145}
- secondary pressure relief tip cylinder piston side	bar / psi	240 ± 5 / 3480 ± 70
- secondary pressure relief tip cylinder rod side	bar / psi	280 ± 5 / 4065 ± 70
Steering		
- primary pressure relief	bar / psi	175^{+20}_{-5} / 2540^{+290}_{-70}
- secondary pressure relief	bar / psi	240^{+20} / 3480^{+290}
Drive unit		
- charge pressure (at speed 2200 min^{-1})	bar / psi	25 ± 2 / 360 ± 30
- beginning of control action (at speed 1100 min^{-1} ± 100)	bar / psi	50 / 725
- end of control action (at speed 2000 min^{-1}) ± 100)	bar / psi	400 / 5800
- pressure cut-off	bar / psi	430 ± 10 / 6240 ± 145
- opening pressure high-pressure valves	bar / psi	465^{+20}_{-10} / 6750^{+290}_{-145}
- inch valve		
- brake pressure at inch begin	bar / psi	5 / 73
- brake pressure at inch end	bar / psi	13 / 190
- control begin variable motor	bar / psi	210 ± 10 / 3050 ± 145
Hydraulic cylinder lifting times (bucket empty)		
- lifting		6,3
- lowering	Sec.	3,8
- tipping	Sec.	1,1

Hydraulic system

Checking and setting data

	Unit	LW 80 No. 560 501 -
Pump store brake		
- store load valve		
pressure on-point	bar / psi	130 $^{+10}$ / 1890 $^{+145}$
pressure off-point	bar / psi	150 $_{-10}$ / 2180 $_{-145}$
permissible pressure	bar / psi	150 $^{+10}$ / 2180 $^{+145}$
- store		
pressurization	bar / psi	50 $\pm$ 5 / 725 $\pm$ 70
- pedal valve		
permissible operating pressure	bar / psi	150 $^{+10}$ / 2180 $^{+145}$
pre pressure	bar / psi	60 $\pm$ 3 / 870 $\pm$ 40
- switch on valve		
pre pressure	bar / psi	14$_{-4}$ / 200$_{-60}$

Variable pump (PAG = Primary unit)

	Unit	**LW 80** No. 560 501 -
Modele		Swashplate pump with over speed control
Model		A4VG71DA1D8/32R (with hydr. inch valve)
Displacement	cc / rev.	71
Power requirement max.	kW	56
Drive		Direct from engine, i = 1.0
Operating speed (= rated speed of engine)	rpm	2200
Oil flow (at operating speed)	l / min. gal / min	152 40
Displacement of the feed pump	cc / rev.	19

Triple hydraulic pump

	Unit	LW 80 No. 560 501 -		
Function		**Working hydraulic and steering**	**Service brake**	**Cooling system**
Bauart		Gear-type pump		
Displacement	cm^3/U	33	14	8
Drive		Direct drive from variable pump, i = 1,0		
Operating speed (= rated speed of engine	min^{-1}	2200		
Oil flow (at operating speed)	l/min gal / min	72.5 19	31 8	17.5 4.5

Variable motor (SAG = Secondary unit)

	Unit	LW 80 No. 560 501 -
Modele		**Variable-displacement motor with high pressure control**
Model		A6VM107HA1U1/63W
Displacement	cc / rev.	107 / 38.5
Operating speed	rpm	1396 - 3788
Oil flow max.	l / min gal / min	152 40

Hydraulic cylinders

	Unit	LW 80 No. 560 501 -		
Function		**Lifting cylinder**	**Tipping cylinder**	
Number of hydraulic cylinders		2	1	
Rod- / piston-Ø	mm / mm inch / inch	50 / 85 1.97 / 3.35	50 / 100 1.97 / 3.94	
Stroke	mm inch	675 26.6	430 16.9	

	Unit	LW 80 No. 560 501 -	
Function		**Steering cylinder**	**Cylinder for quick-hitch**
Number of hydraulic cylinders		2	1
Rod-/piston-Ø	mm / mm inch / inch	28 / 60 1.10 / 2.36	25 / 50 0.98 / 1.97
Stroke	mm inch	310 12.20	75 2.95

Service fluids

	LW 80 No. 560 501 -		
	Approx. quantity litres (gal)	**Operating hours between changes**	**Grade[2)]**
Engine (including filter)	9,0[1)] (2.4)	500[2)]	CD SE 15W-40
Fuel tank	100 (25.5)	See Engine Oper. Instruction	
Cooling system	18.5 (5)	2000[7)]	See Engine Oper. Instruction
Hydraulic system	75[1)] (20)	3000[3)]	O&K Multigrade Hydraulic-Oil
Transfer box gearing	1,0[1)] (0.3)	1000[4)]	LS 5-90
Front axle	3,7[1)] (1.0)	1000[4)]	LS 5-90
Rear axle	3,7[1)] (1.0)	1000[4)]	LS 5-90
Axle-planetary gears	4 x 0,6[1)] (4 x 0.16)	1000[4)]	LS 5-90
Lubricating points	2 x for all lube points[6)]	weekly	NLGI-Nr.2[5)]

1) Filling quantities are valid for oil changes and **not** for first filling

2) See Operating Instructions

3) After 3 years at the latest

4) After 1 year at the latest

5) At ambient temperatures below 0˚C (32˚F) use grease NLGI-No. 1 or 0.

6) 0,4 kg (0.9 lbft) - cartridge

7) After 2 years at the latest

Tightening torques

		LW 80 No. 560 501 -
Wheel nut	Thread size **Tightening torque**	A 20 - 8 (M 20 x 1,5 / SW 27) **450 Nm (332 lbft)**
Cardan shaft	Thread size **Tightening torque**	M 8[1)] / 10.9 / SW 1 **34 Nm (25 lbft)**
Front axle mounting (bow screw)	Thread size **Tightening torque**	M 24 / 8 / SW 36 (Nut) **670 Nm (495 lbft)**
Rear axle mounting (Cover-bolt-axle box connection)	Thread size **Tightening torque**	M 10[1)] / 10.9 / SW 17 **68 Nm (50 lbft)**
Variable pump-engine mounting	Thread size **Tightening torque**	M 16 [2)] / 8.8 / SW 14 **195 Nm (144 lbft)**
Variable motor-transfer box	Thread size **Tightening torque**	M 16 [2)] / 8.8 / SW 14 **195 Nm (144 lbft)**
Counter weight	Thread size **Tightening torque**	M 10 [1)] / 8.8 / SW 17 **46 Nm (34 lbft)**
Engine bracket	Thread size **Tightening torque**	M 12[1)] / 8.8 / SW 19 **79 Nm (58 lbft)**

[1)] Hex. hd. screw, lightly oiled

[2)] Cyl. hd. screw, lightly oiled

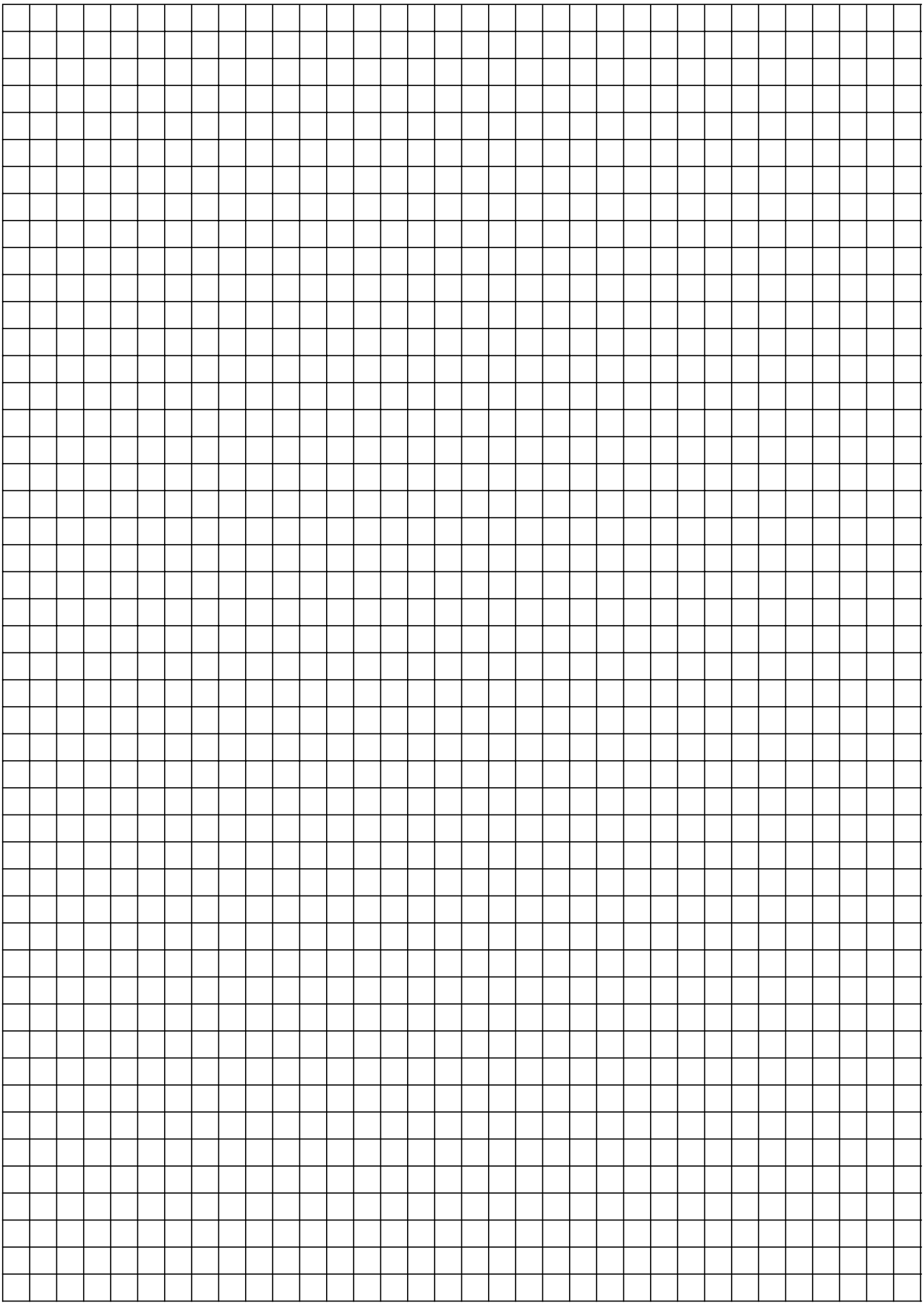
Approx. weights

	Unit	**LW 80** No. 560 501 -
Engine	kg / lb	380 / 840
Front axle	kg / lb	185 / 420
Rear axle (including transfer box gearing)	kg / lb	270 / 600
Variable pump	kg / lb	55 / 120
Variable motor	kg / lb	45 / 100
Triple hydraulic pump	kg / lb	20 / 45
Cab	kg / lb	470 / 1050
Lift frame	kg / lb	485 / 1070
Lifting cylinder	kg / lb	30 / 66
Tipping cylinder	kg / lb	30 / 66
Steering cylinder	kg / lb	10 / 22
Cylinder for quick-hitch	kg / lb	10 / 22

Further weights see "Technical Data LW 80".

Notes

2800145



Diesel engine

if required, engine manuals can be orederd.

Hydraulic System, Safety Instructions

2800476

DANGER

Read and observe the operating instruction: "Inspection and Servicing, Safety Instructions".

Before working on the hydraulic system, ensure that the system is depressurized and that any residual pressure is discharged.

Engine off.

Secure the machine as described in the operating instruction: "Securing the machine".

Avoid skin contact with hydraulic oils. Wear gloves and firm working gear. Skin contact with hydraulic oils is a health risk.

□

Explanations of circuit diagrams and illustrations

2800487

All circuit diagrams and illustrations in this Workshop Manual form one coherent system.

Each component has its own unique part number. In some cases a letter indicating the use is assigned to the digit for improved clarity.

Meanings:

A =	transmission drive,	z. B. **A7** =	servo-valve
B =	braking system,	z. B. **B1** =	brake fluid pump
L =	steering system,	z. B. **L1** =	steering cylinder
H =	working hydraulics,	z. B. **H8** =	primary valve
T =	tank, filter, cooling system	z. B. **T1** =	hydraulic tank

Part numbers without letters designate general components, e.g. Part **1** = diesel engine.

Encircled parts, e.g. (2), designate connections. They indicate the destination or the origin of the connection lines. Example (2) indicates that the connection designated in this way is connected with the dual pump.

Measuring connections are specified with rectangular boxes.

X1 designates, for example, the measuring point for control pressure. □

Depressurizing the hydraulic system

2800488

Before starting work, depressurize the hydraulic system:

- Secure the machine as described under "Securing the machine".
- Move control lever for operating equipment and 3rd function in all directions until the operating equipment makes no further movement.

The residual pressure in the operating equipment is then discharged. □

Principle: hydrostatic travel drive

2800924

To meet the demands of customers for optimum performance with simple operation and low-maintenance units in small to medium wheel loaders, they are equipped with hydrostatic drives.

In the LW 80 this is a self-contained system, comprising primarily a variable displacement pump (A3) driven direct by the diesel engine (1) and a hydraulic motor (A15) on the rear axle.

In neutral position (i.e. neither forward or reverse gear engaged) the driving pump (A3) is not swivelled out and pumps no pressure oil to the hydraulic motor (A15). The machine is stationary.

When the forward or reverse gear is engaged, the variable displacement pump (A3) swivels out in the corresponding direction and the hydraulic motor (A15) is provided with pressure oil on the required side. The machine moves forward or in reverse.

The control pressure which makes the driving pump (A3) swivel out is generated by the feed pump (A2). At the same time, oil gets from the feed circuit via the replenishing valves (A5) to the respective intake side of the variable displacement pump (A3) and thus compensates the leakages occurring in the high-pressure circuit.

Fig. 1 shows a simplified schematic diagram of a hydrostatic drive in a self-contained system.

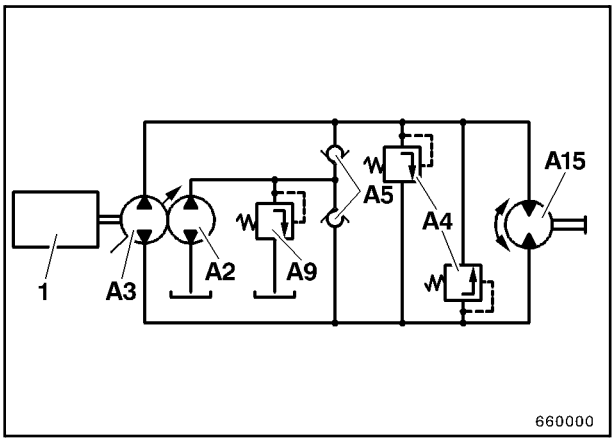


Fig. 1

Parts

1	-	Diesel engine - drives the system
A2	-	Feed pump - feeds the system with control and feed oil
A3	-	Travel pump, variable displacement pump provides the pressure oil for the hydraulic motor
A4	-	Pressure relief valves - limit the high pressure in the system
A5	-	Replenishing valves - allow for follow-up feeding
A9	-	Feed pressure relief valve - limits the feed pressure
A15	-	Reversible hydraulic motor - drives the machine

N.B.:

The diagram in Fig. 1 is highly simplified and serves only to explain the functioning principle.

Explanation of terms

High pressure: Pressure generated by the travel pump to drive the hydraulic motor.

Feed pressure: Pressure generated by the feed pump.

Control pressure: Pressure needed to swivel out the travel pump.

Hydraulic circuit diagram - travel drive

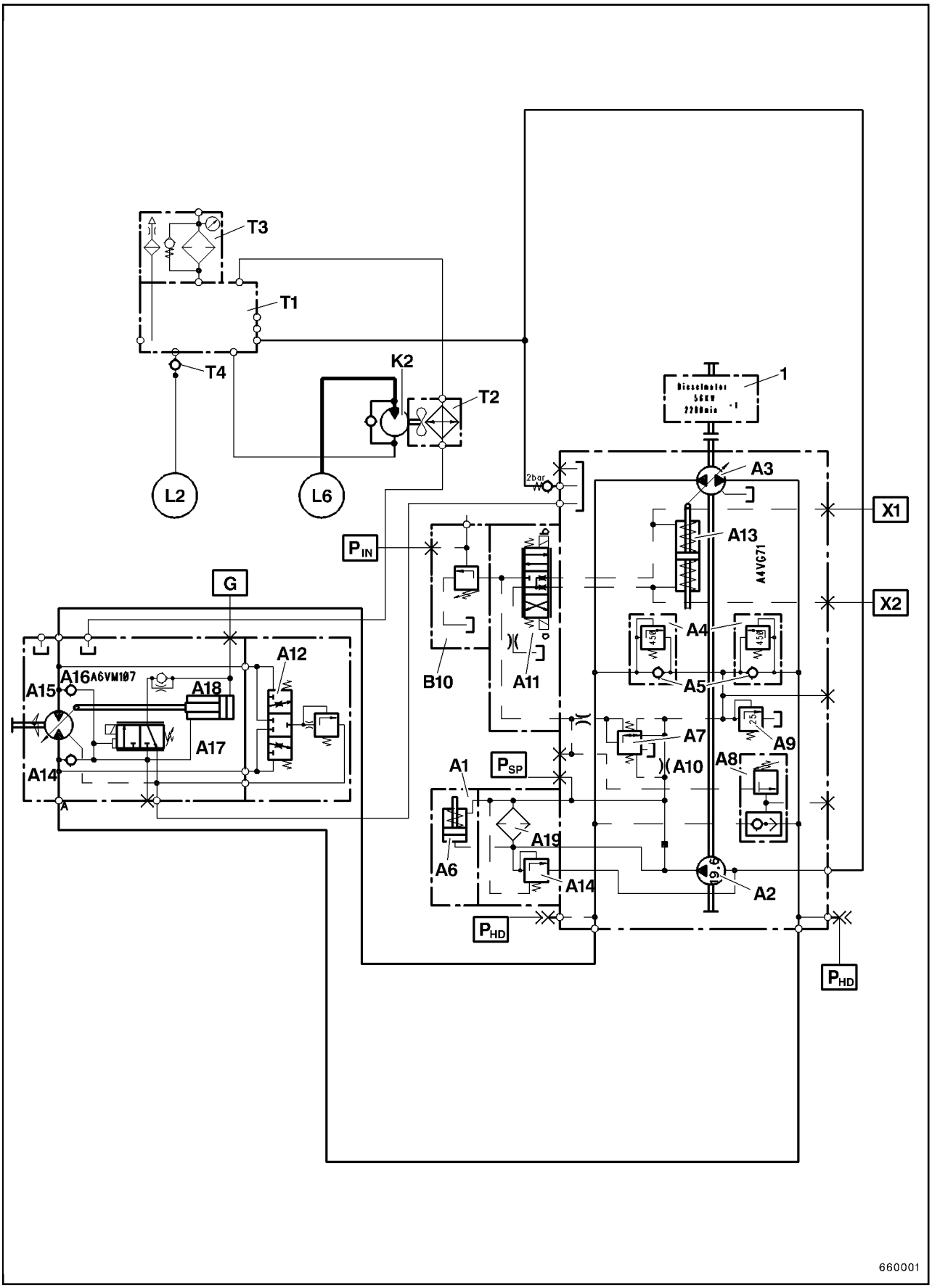


Fig. 2

Hydraulic circuit diagram, legend

1 - Diesel engine
2 - Triple pump, steering system / working hydraulics / braking system / fan drive
9 - Front axle
10 - Rear axle

T1 - Hydraulic tank
T2 - Hydraulic oil cooler
T3 - Hydraulic oil return-flow filter with bypass
T4 - Check valve
T5 - Distributor

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve, steering system
L4 - Primary valve, steering
L5 - Check valve
L6 - Priority valve

H1 - Lifting cylinder
H2 - Dumping cylinder
H3 - Quick-change locking cylinder
H4 - Hydraulic cylinder, 3rd function
H5 - Quick-change locking mechanism (multiway cock)
H6 - Control block, working hydraulics
H7 - Secondary valve "Rearward tilting" with replenishing valve
H8 - Secondary valve "Dumping" with replenishing valve
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve "Lifting/lowering"
H12 - Pressure-maintaining valve "Tilting"
H13 - Pressure-maintaining valve "3rd function "
H14 - Control piston "Lifting-lowering-floating" position
H15 - Control piston "Rearward tilting" dumping
H16 - Control piston "3rd function"
H17 - Hydraulic pump, steering and working hydraulics

B1 - Brake fluid pump
B2 - Accumulator charging valve
B4 - Brake accumulator
B5 - Pedal operated brake valve
B6 - Pressure switch, braking light
B7 - Pressure switch, accumulator warning
B8 - Sequence valve
B9 - Multiple-disc brake
B10 - Inching valve

A1 - Feed circuit filter
A2 - Feed pump
A3 - Variable displacement axial-piston pump A4VG-Da
A4 - High-pressure relief valves, deblockable
A5 - Replenishing valves
A6 - Soiling indicator, feed circuit filter
A7 - Servo-valve
A8 - Pressure cutout
A9 - Feed pressure relief valve
A10 - Restrictor
A11 - Electromagnetically activated switchover valve for forward and reverse travel
A12 - Scavenging needle
A13 - Adjusting cylinder forward/reverse/neutral
A14 - Bypass valve (feed circuit filter)
A15 - Axial-piston oil motor A6VM - HA 1U
A16 - Check valve
A17 - Electromagnetically activated switchover valve for slow travel (high displacement)
A18 - Adjusting cylinder for displacement change
A19 - Feed circuit filter

Pressure measuring points

P_H - Pump pressure for working and steering hydraulics

P_{SP} - Feed pressure

P_{HD} - High pressure at travelling

P_{HD*} - High pressure at travelling (at travel motor)

P_{BS} - Accumulator pressure

P_{in} - Actual braking pressure

P_{BL} - Braking pressure (for the multiple-disc brakes)

X_1 - Control pressure

X_2 - Control pressure

G - Regulation threshold (travel motor) □

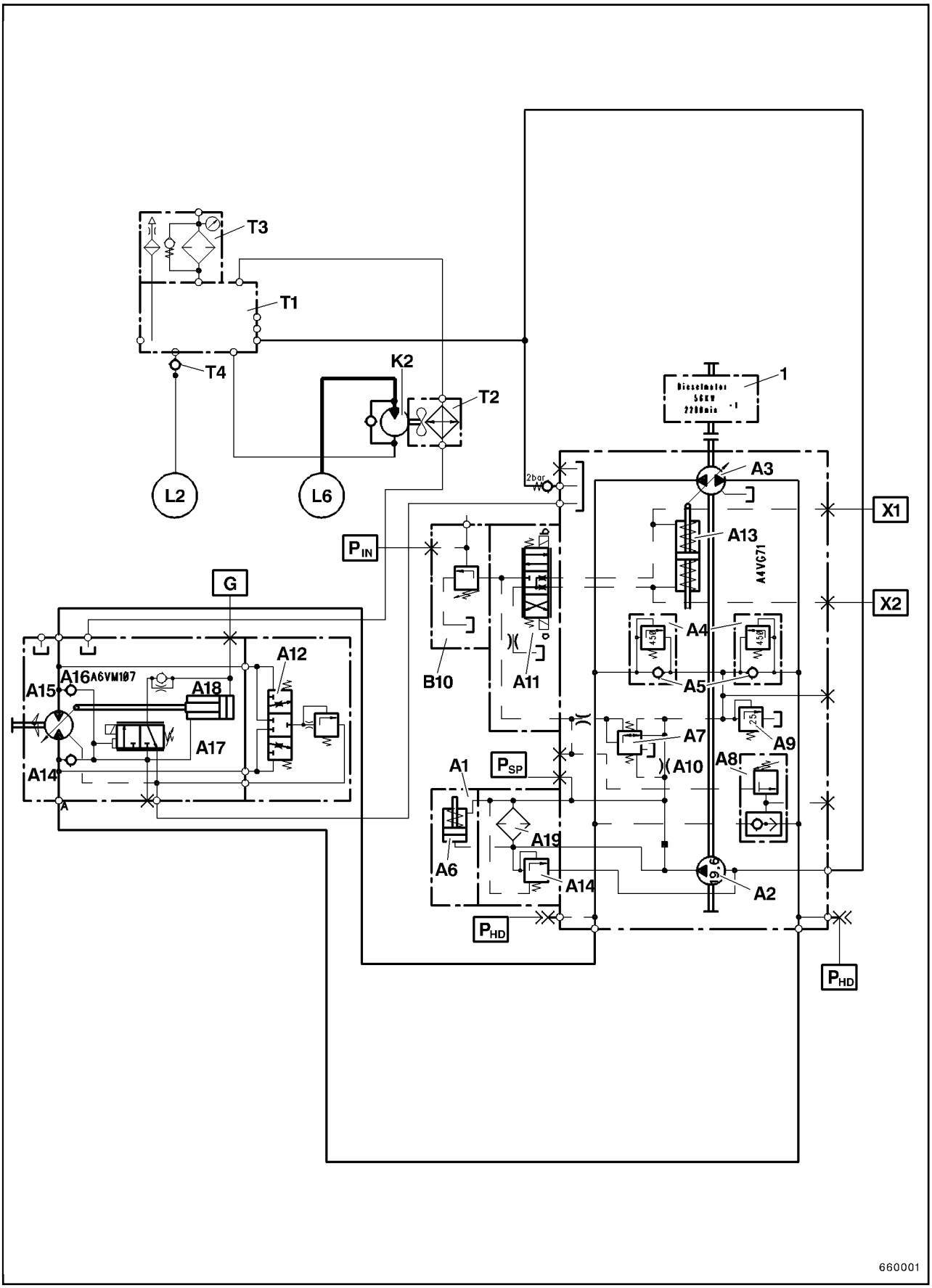

T3
T1
T4
K2
T2
L2
L6
1
A3
X1
A13
A4VG71
X2
A4
A5
A7
A9
A8
A10
A1
PSP
A19
A6
A14
A2
PHD
PIN
G
A12
A16A6VM107
A15
A18
A17
A14
B10
A11
2bar
PHD
660001

Fig. 3

Functional description: hydrostatic travel drive of wheel loader LW 80

(Figs. 3 - 5)

The variable displacement pump (A3) and the feed pump (A2) are driven by the diesel engine (1).

The feed pump (A2) pumps oil through the feed circuit filter (A19). If the filter cartridge is excessively soiled, the soiling indicator (A6) responds.
If counterpressure is too high in front of a soiled filter cartridge, the feed circuit bypass valve (A14) opens and directs part of the pressure oil back to the suction side of the feed pump (A2).

The feed pressure is limited to ca. 25 bars (360 psi) by the feed pressure relief valve (A9) and can be checked at the measuring point (P_{SP}).
Feed oil is directed to the respective suction side (dependent on travel direction) of the variable displacement pump via the replenishing valves (A5) integrated in the high-pressure relief valves (A4) to compensate for leakages.

Depending on the speed of the diesel engine (1), the feed pump (A2) generates a variable flow. The variation of flow is determined by sensing the dynamic pressure at restrictor (A10) . The higher the dynamic pressure the higher the speed of the drive engine (1). Depending on the dynamic pressure at restrictor (A10), control valve (A7) derives a higher or lower amount of control pressure from the feed pressure.

N.B.:
The control valve (A7) is set in such a way that ca. 50 bars (725 psi) travelling pressure (P_{HD}) are built up at an engine speed of ca. 1100 rpm. In the technical data, this is referred to as regulation threshold.

The control pressure is applied to the electromagnetically activated switching valve (A11). When the operator activates the travel direction switch, the switching valve (A11) is electrically activated and directs the control pressure to the required side of the adjusting cylinder (A13). The pump swivels out and pumps pressure oil to the hydraulic motor (A15).

On activation of the pedal-operated brake valve (B5), the generated braking pressure acts on the inching valve (B10).

Depending on the height of the actual braking pressure, the inching valve (B10) opens a larger or smaller connection between the control pressure and the tank, so that light application of the brake pedal reduces the control pressure only slightly, and the control pressure is directed completely into the hydraulic tank at a braking pressure (P_{in}) of ca. 14 bars (200 psi). As a consequence, the travelling machine is braked by means of the travel drive.

N.B.:
Inching means reducing travelling speed (= braking) by reducing the control pressure of the travel pump. The inching is the auxiliary brake of the machine.

When the machine is travelling, the pressure oil is pumped to the hydraulic motor (A15) by the travel pump (A3).
In the event of high pressure at travelling exceeding a value of ca. 420 bars (6095 psi), the pressure cutout (A8) reduces the control pressure until the high pressure remains constant at the set value.
In addition to the pressure cutout, the high pressure at travelling is secured with two pressure relief valves (A4) which respond, however, only at ca. 450 bars (6530 psi). Depending on travel direction (forward or reverse), one or the other of the pressure relief valves responds.

The switching valve (A17) can direct the high pressure at travelling to the adjusting cylinder (A18). This increases the displacement of the hydraulic motor (A15), resulting in the drive turning more slowly but strongly (= creep speed).
The switching valve (A17) is activated either electrically (with the travel direction switch) or by the high pressure at travelling.

In the case of high-pressure dependent switchover, the oil pressure goes via one of the check valves (A16) onto the switching valve (A17).
If the hydraulic motor (A15) is under pressure in excess of ca. 140 bars (2030 psi), the valve (A17) switches over even if it is not electrically activated. This results in the high pressure at travelling being directed onto the piston base side of the adjusting cylinder (A18).

In practice, this means that the machine switches automatically to the slower gear from a certain travelling resistance onwards. It also means that the so-called creep speed (= transmission range 1) has to be engaged only if a lower travelling speed is required. In all other situations, transmission range 2 is preferable.

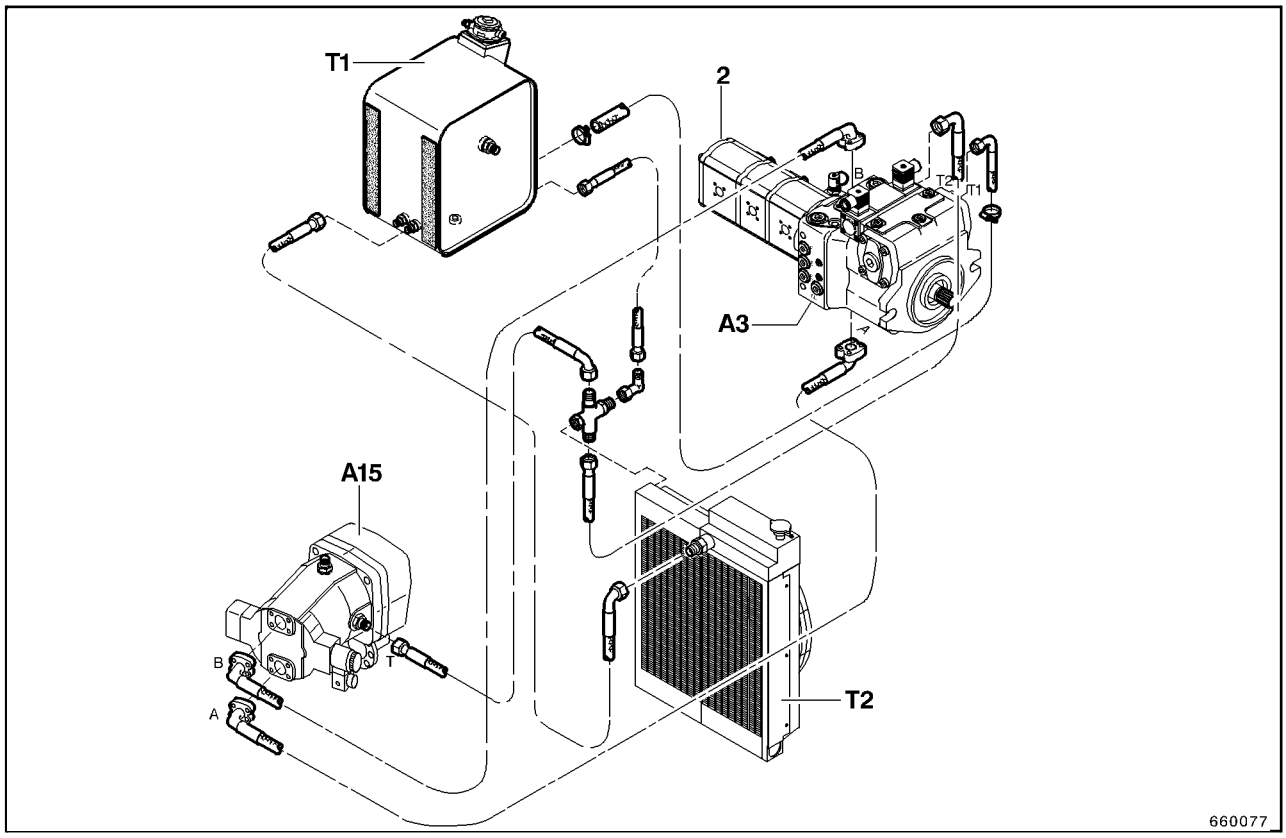

T1
2
B
T2
T1
A3
A15
B
T
A
T2
660077

Fig. 4

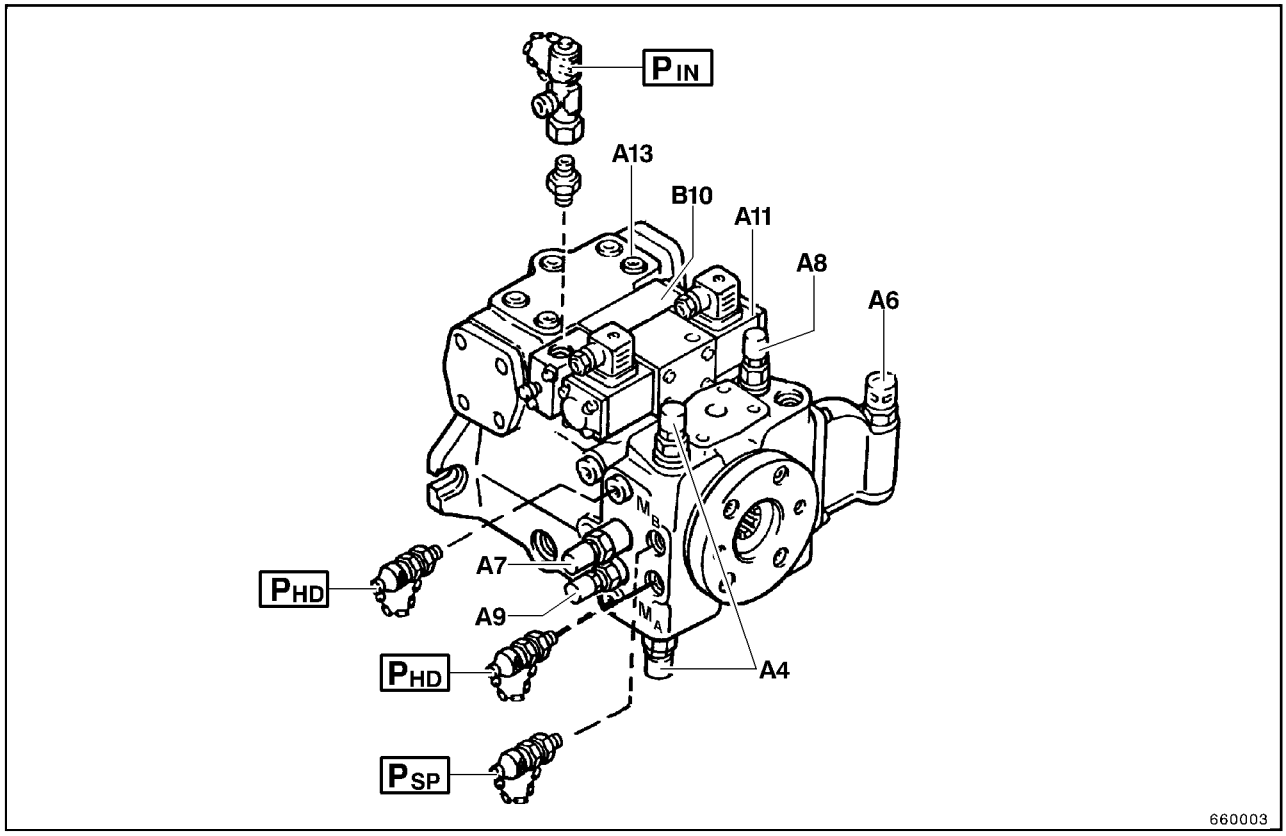

PIN
A13
B10
A11
A8
A6
A7
PHD
A9
PHD
A4
PSP
660003

Fig. 5

Travel drive installation

2	-	Triple pump steering / working hydraulics / braking system / fan drive
T1	-	Hydraulic tank
T2	-	Hydraulic oil cooler
T5	-	Distributor
L2	-	Steering valve
H6	-	Control block, working hydraulics
B5	-	Pedal-operated brake valve
B10	-	Inching valve
A3	-	Variable displacement axial-piston pump A4VG-Da
A4	-	High-pressure relief valve, deblockable
A6	-	Soiling indicator, feed circuit filter
A7	-	Control valve
A8	-	Pressure cutout
A9	-	Feed pressure relief valve
A11	-	Electromagnetically activated switching valve for forward and reverse travel
A13	-	Adjusting cylinder, forward/reverse/neutral
A15	-	Axial-piston oil motor A6VM - HA 1U

Pressure measuring points

P_{SP}	-	Feed pressure
P_{HD}	-	High pressure at travelling
P_{HD*}	-	High pressure at travelling (at travel motor)
P_{in}	-	Actual braking pressure

□

Adjusting work at the hydrostatic travel drive

2800479

For all testing and adjusting work on the travel drive, the hydraulic oil temperatur must be ca. 60 - 70˚C (140 - 160˚F).

Mechanical zero position

The mechanical zero position is not normally self-adjusting. Control or adjustment is therefore necessary only when:

- the pump has been dismantled and reassembled,
- the operator complains that the loader, despite the travel direction switch being set to neutral position, is moving in one direction. In this case, however, the functioning of the travel direction switch and the electromagnetically activated switching valve (A11) should **first** be checked.

To check the mechanical zero position, a pressure gauge (measuring range 600 bars / 8700 psi) must be connected to both measuring points for the high pressure at travelling (P_{HD}).

N.B.:

The machine must now be secured with appropriate measures against forward or reverse movement. The safety instructions must be observed.

The engine is started up, the travel direction switch is set to neutral.

After slackening the lock nut (A13, Part 9) the centering rod (A13, Part 5) is turned with a socket wrench 5 mm (0.2 inch) until the same pressure (in this case feed pressure) is read off at both measuring points (P_{HD}).

After adjustment, the centering rod (A13, Part 5) must be secured with the lock nut (A13, Part 9).

The mechanical zero position is set.

Checking and adjusting high pressure at travelling

The high pressure at travelling (P_{HD}) is limited both by the high-pressure relief valves (A4) and by the pressure cutout (A8).

N.B.:

The maximum high pressure is attained only if the displacement switchover at the hydraulic motor (A15) is prevented. For this purpose the regulation threshold adjusting screw (A15, Part 2) must be **unturned** by ca. 3 turns. On completion of work, the regulation threshold of the hydraulic motor must be reset. For all high-pressure measurements, transmission range 2 (driving) must be selected at the travel direction lever.

If resetting of the regulation threshold of the engine is to be avoided, a pressure drop due to spinning wheels can generally also be avoided by applying the parking brake as far as the limit stop and preventing the travel drive from being switched off with the handbrake switch.

Adjusting cylinder (A13)

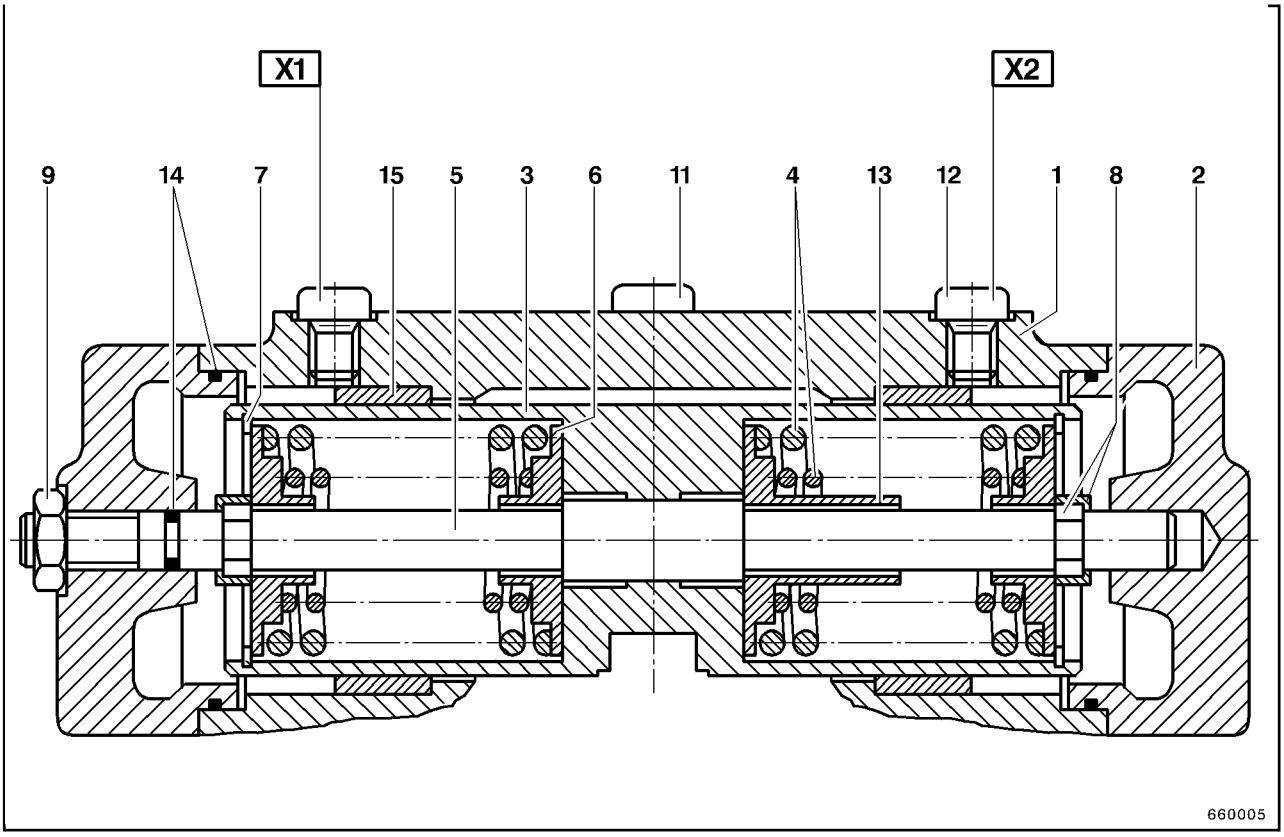


Fig. 6

Parts Fig. 6

1	-	Cylinder bore in pump housing
.2	-	Cap
3	-	Adjusting piston
4	-	Compression spring
5	-	Centering rod
6	-	Spring plate
7	-	Circlip
8	-	Check nut or ring and sleeve
.9	-	Lock nut
11	-	Vent screw
12	-	Dummy screw for control pressure testing connection (M 12 x 1.5)
13	-	Spacer sleeve
14	-	O-ring
15	-	Bearing bushing

□

High-pressure relief valve (A4)

2800926

To check the high-pressure relief valves (A4), the adjusting screw for pressure cutout (A8, Part 1) must first be tightened to the limit stop and a pressure gauge (measuring range 600 bars / 8700 psi) connected at the corresponding measuring point (P_{HD}).

It is advisable first to measure the dimension "X" (Fig. 8) at the adjusting screw (A8, Part 1) and to make a note of the measurement for later resetting.

The wheel loader is then driven in transmission range 2 against a wall or a mound of earth, with the pressure gauge being observed. The maximum attainable pressure in forward and reverse direction is ca. 450 bars (6530 psi).

N.B.:

The machine must not be driven for more than 5 seconds against the high-pressure relief valves (A4), as they are otherwise damaged by the high temperature.

The high-pressure relief valves (A4) normally need virtually no adjustment.
If the high pressure has to be adjusted, however, the cap (A4, Part 2) is removed and the lock nut (A4, Part 3) slackened.
The pressure can then be set at the adjustment screw (A4, Part 1).

When adjustment is completed, the lock nut (A4, Part 3) is retightened and the cap (A4, Part 2) refitted.

N.B.:

When the lock nut (A4, Part 3) has been tightened, the pressure is checked again. The high-pressure setting must be secured with a lead seal on completion of work.

High-pressure relief valve (A4), deblockable

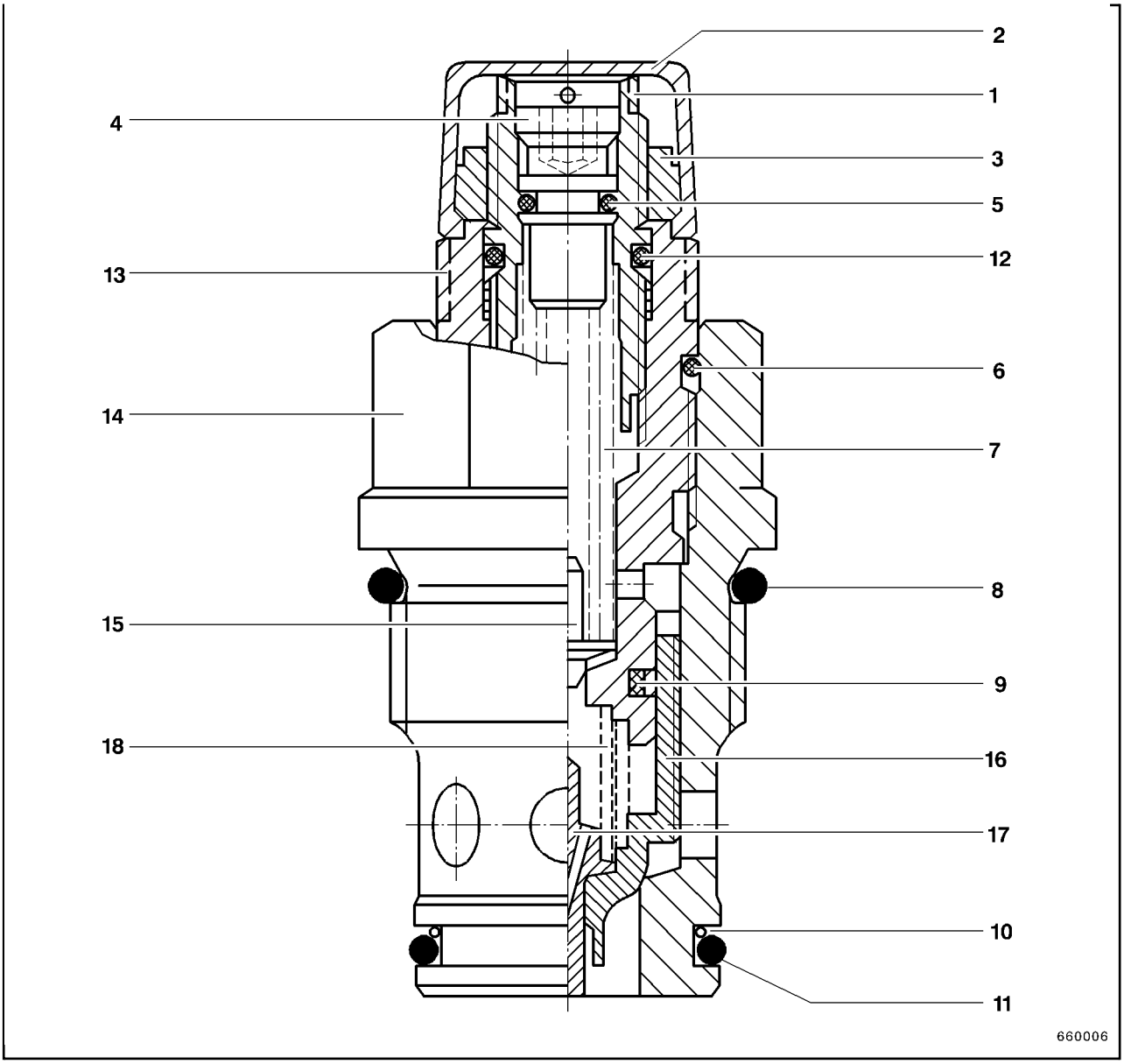


Fig. 7

Parts Fig. 7

1 - Adjusting screw SW 11
2 - Cap
3 - Lock nut SW 19 / 20 Nm (15 lbft)
4 - Bypass set screw loosen by 3 turns with tool size SW 4 / 10 Nm (7.5 lbft)
5 - O-ring
6 - Sealing ring
7 - Spring
8 - O-ring
9 - Piston seal
10 - Retaining ring
11 - O-ring
12 - O-Ring
13 - Screw plug SW 22 / 100 Nm (74 lbft)
14 - Valve housing SW 32 / 150 Nm (111 lbft)
15 - Pilot piston
16 - Piston
17 - Restrictor needle
18 - Spring

□

Pressure cutout (A8)

2800481

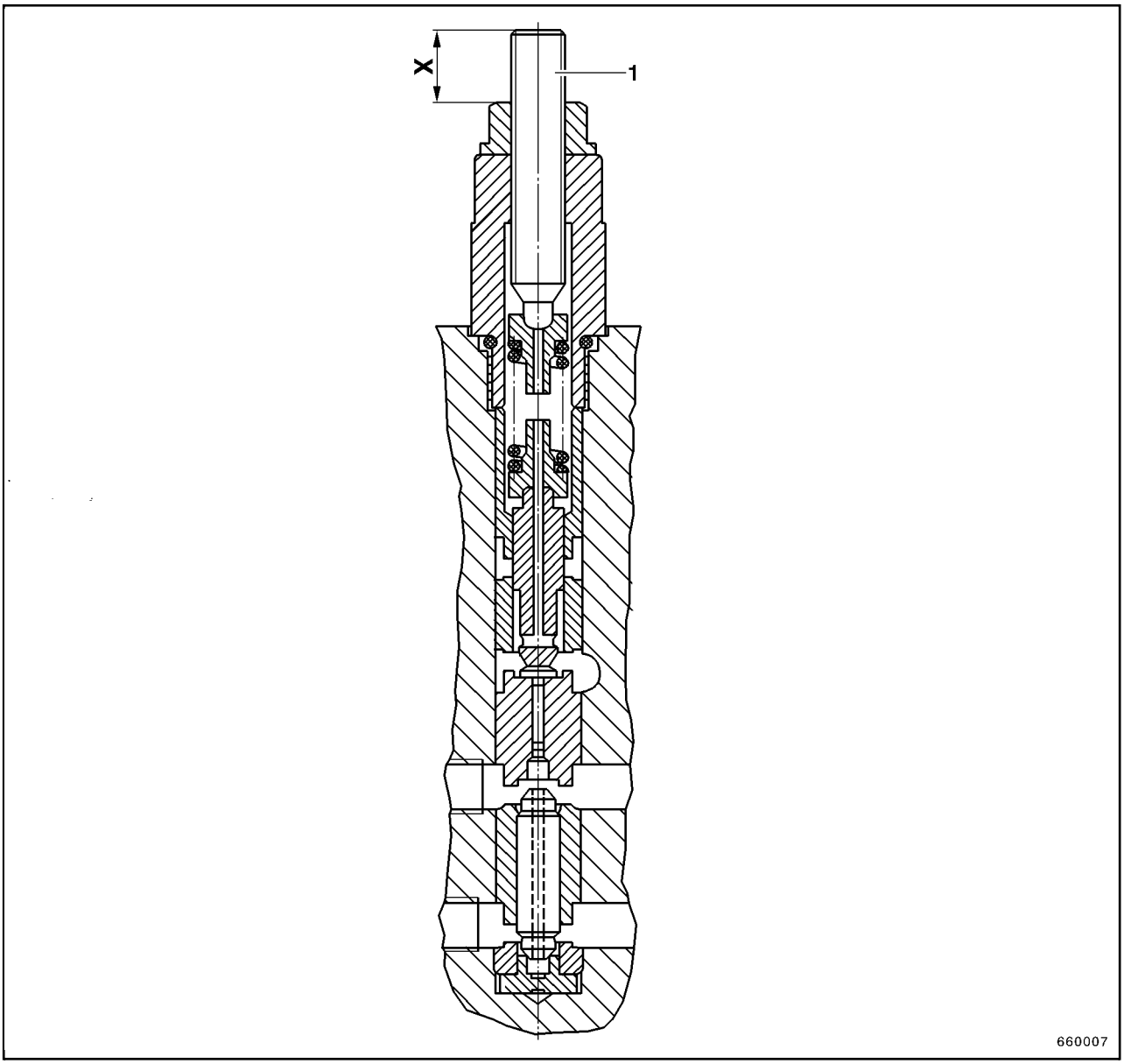


Fig. 8

As the pressure cutout acts both forwards and in reverse, it is sufficient to check the high pressure in forward direction. For this purpose a pressure gauge (measuring range 600 bars / 8700 psi) is connected to the forward-travel pressure measuring connection (P_{HD}) and the wheel loader driven against a wall or mound of earth.

The pressure cutout can be adjusted in built-in state at the adjusting screw for pressure relief (A8.1). The adjustment value of the pressure cutout is 420 $\pm$ 10 bars (6095 $\pm$ 145 psi) .

N.B.:

Prior to dismantling the pressure cutout (A8), it is advisable to measure dimension X and to make a note of it for later resetting.

Parts Fig. 8

1 - Adjusting screw

Switching valve (A11), electromagnetically activated

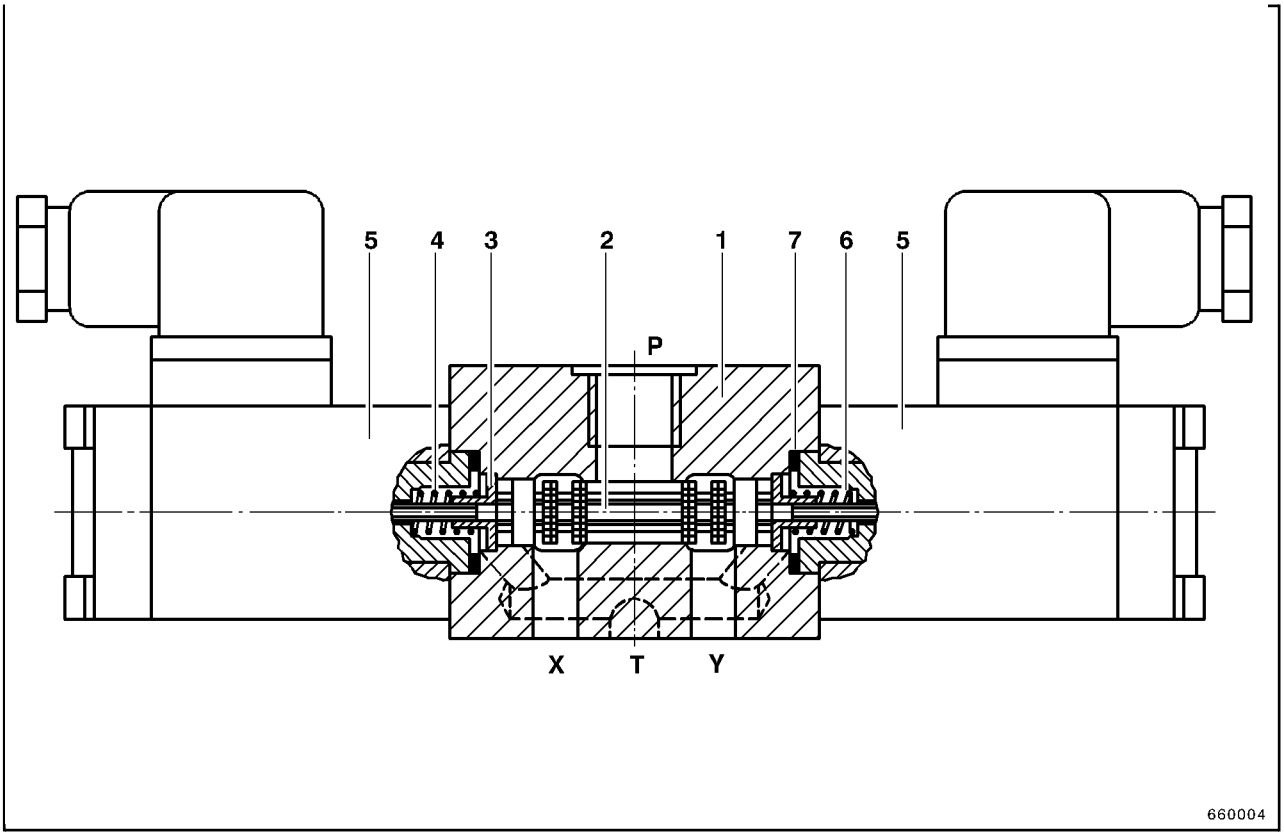


Fig. 9

Parts Fig. 9

1 - Housing
2 - Control piston
3 - Spring plate
4 - Spring
5 - Magnet
6 - Tappet
7 - Gasket

□

Feed pressure relief valve (A9)

2800927

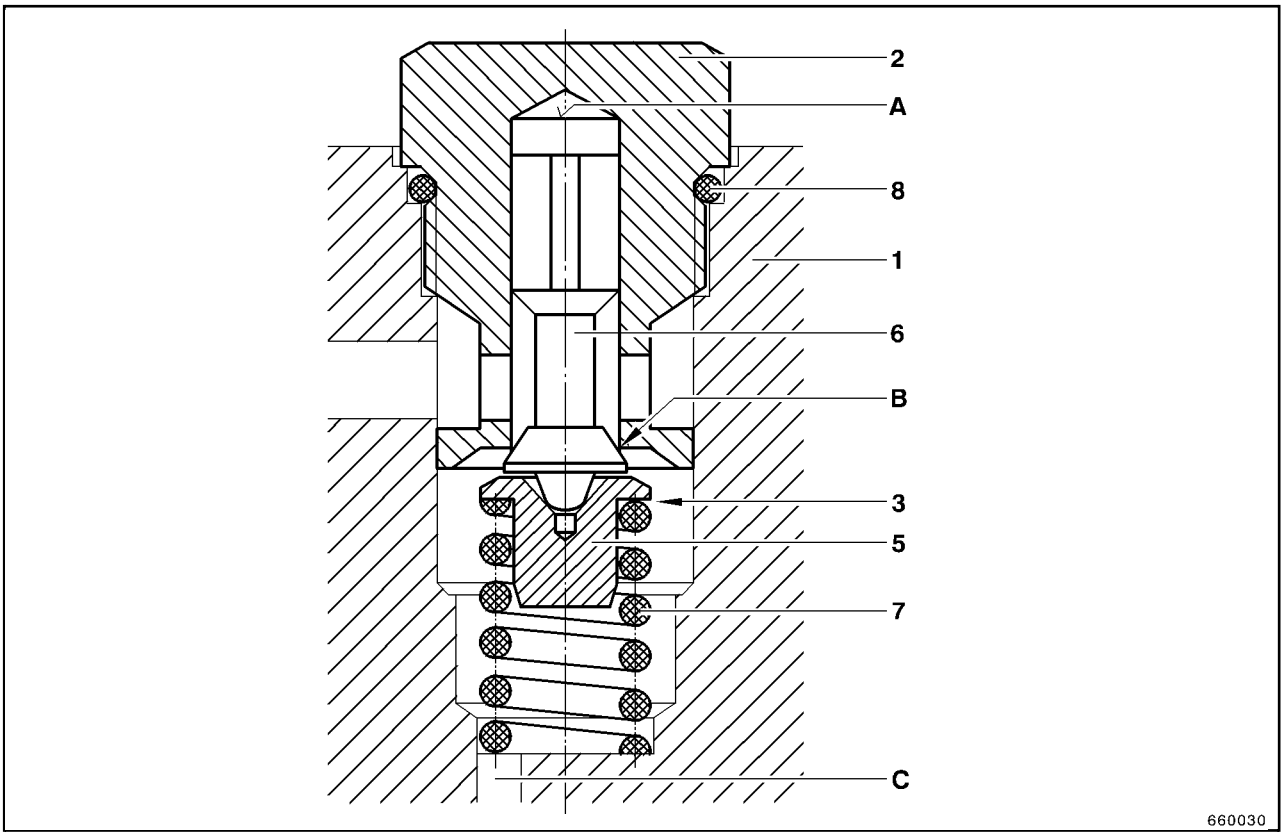


Fig. 10

Parts Fig. 10

1 - Valve housing or bore in valve plate
2 - Screw plug
3 - Shim (s)
4 - Lock nut
5 - Spring plate
6 - Valve piston
7 - Compression spring
8 - O-ring or sealing ring
9 - Spring pin
A - Piston surface
B - Sealing edge or control edge
C - Tank channel (into pump housing)

Checking and adjusting feed pressure

The feed pressure is checked at the measuring point (P_{SP}) and adjusted at the feed pressure relief valve (A9).

The feed pressure setpoint is 25 $\pm$ 2 bars (360 $\pm$ 30 psi) at n_{mof} = 2300 min^{-1}.

If the pressure value has to be corrected, it can be adjusted at the adjusting screw (A9, Part 3) of the feed pressure relief valve (A9).
The feed pressure is reduced by CCW turning and increased by CW turning.

N.B.:

At basic setting (e.g. after replacing or dismantling the valve), the valve spring must first be relaxed by removing all shims (A9, Pos. 3) and a pressure gauge (measuring range 60 bars / 870 psi) connected at the measuring point (P_{SP}).
The diesel engine is then started up and the feed pressure measured at the corresponding engine speed.
If the feed pressure is too low, the value must be adjusted by adding the required shims (1 mm = 3.9 bar / 1 mm = 56.6 psi). □

Control valve (A7)

2800483

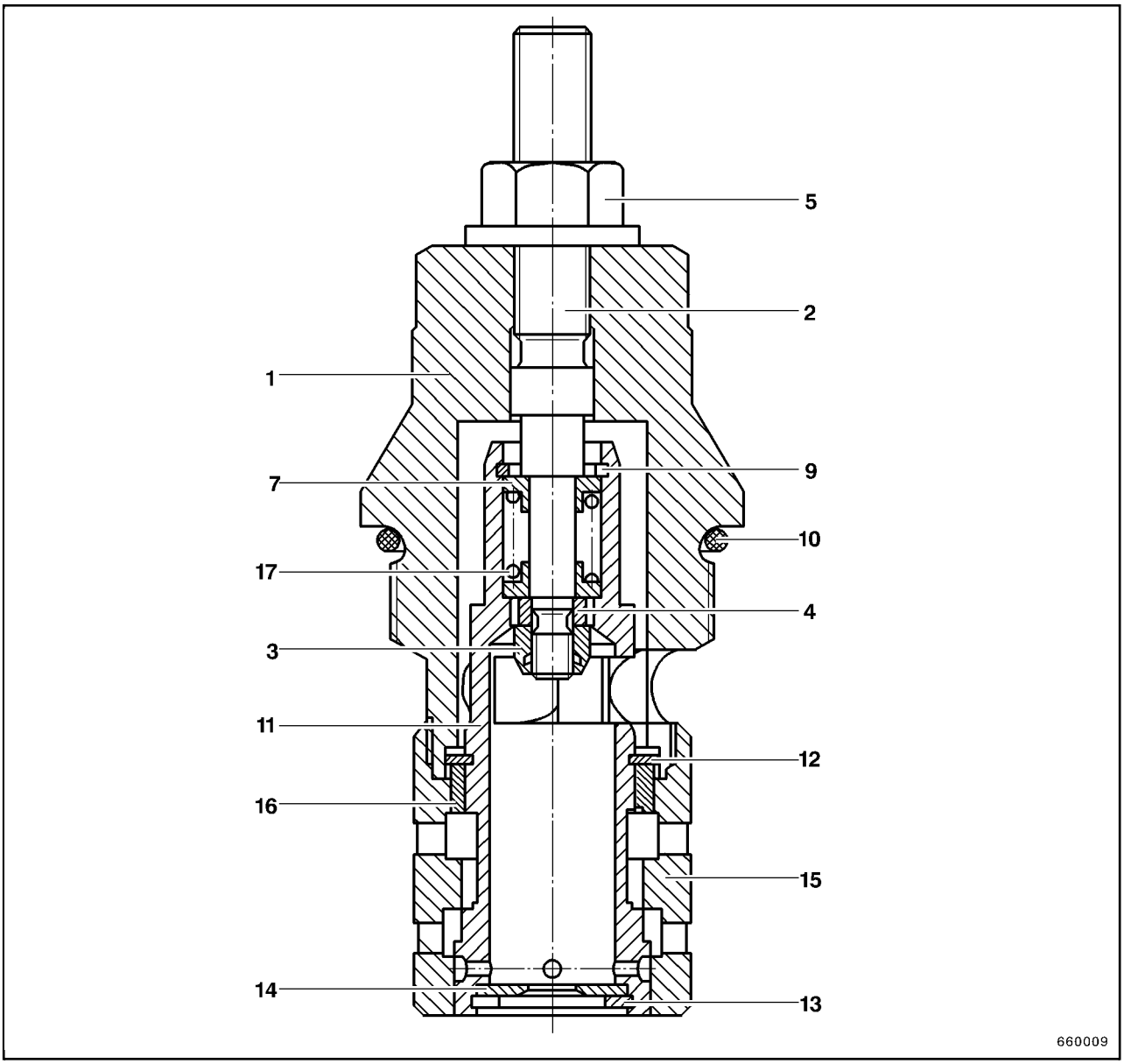


Fig. 11

Parts Fig. 11

1 - Valve housing
2 - Adjusting screw
3 - Lock nut
4 - Spacer ring
5 - Lock nut
7 - Spring plate
9 - Ring
10 - O-ring
11 - Piston
12 - Circlip
13 - Circlip
14 - Shield
15 - Piston housing
16 - Cylindrical piston
17 - Spring

Checking and adjusting the regulation threshold (driving start)

A pressure gauge must be connected at the measuring point (P_{HD}) for forward travel (measuring range 600 bars / 8700 psi). To measure the engine speed, an appropriate tachometer (preferably a digital tachometer for clamping to the fuel-injection lines) is also connected.

The wheel loader is then driven against a wall or a mound of earth. The engine speed is now kept at 1100 $\pm$ 100 min^{-1}. This must yield a high pressure at travelling (P_{HD}) of 50 bars (725 psi).

Adjustment is done by turning the adjusting screw (A7, Part 2) after slackening the lock nut (A7, Part 5). If the adjusting screw (A7, Part 2) is turned in CCW direction, the regulation threshold is changed towards earlier; if it is turned in CW direction, it is changed towards later.

When 50 bars (725 psi) high pressure has been set at 1100 $\pm$ 100 min^{-1}, the lock nut (A7, Part 5) is tightened again.

Checking regulation end

If the regulation threshold (driving start) is correctly set, the regulation end is yielded automatically. As for checking and adjusting the regulation threshold, a high-pressure gauge and a tachometer must be connected.

At an engine speed of (see Technical Data) the high pressure at travelling (P_{HD}) is 400 bars (5800 psi).

N.B.:

This measurement must also be performed in highway gear, as the wheels spin prematurely in cross-country gear. To prevent a displacement switchover at the engine (A15), the regulation threshold adjusting screw (A15, Part 2) must be **unscrewed** by ca. 3 turns in CCW direction. On completion of the work, the regulation threshold of the hydraulic motor must be reset. □

Axial-piston oil motor (A15)

2800484

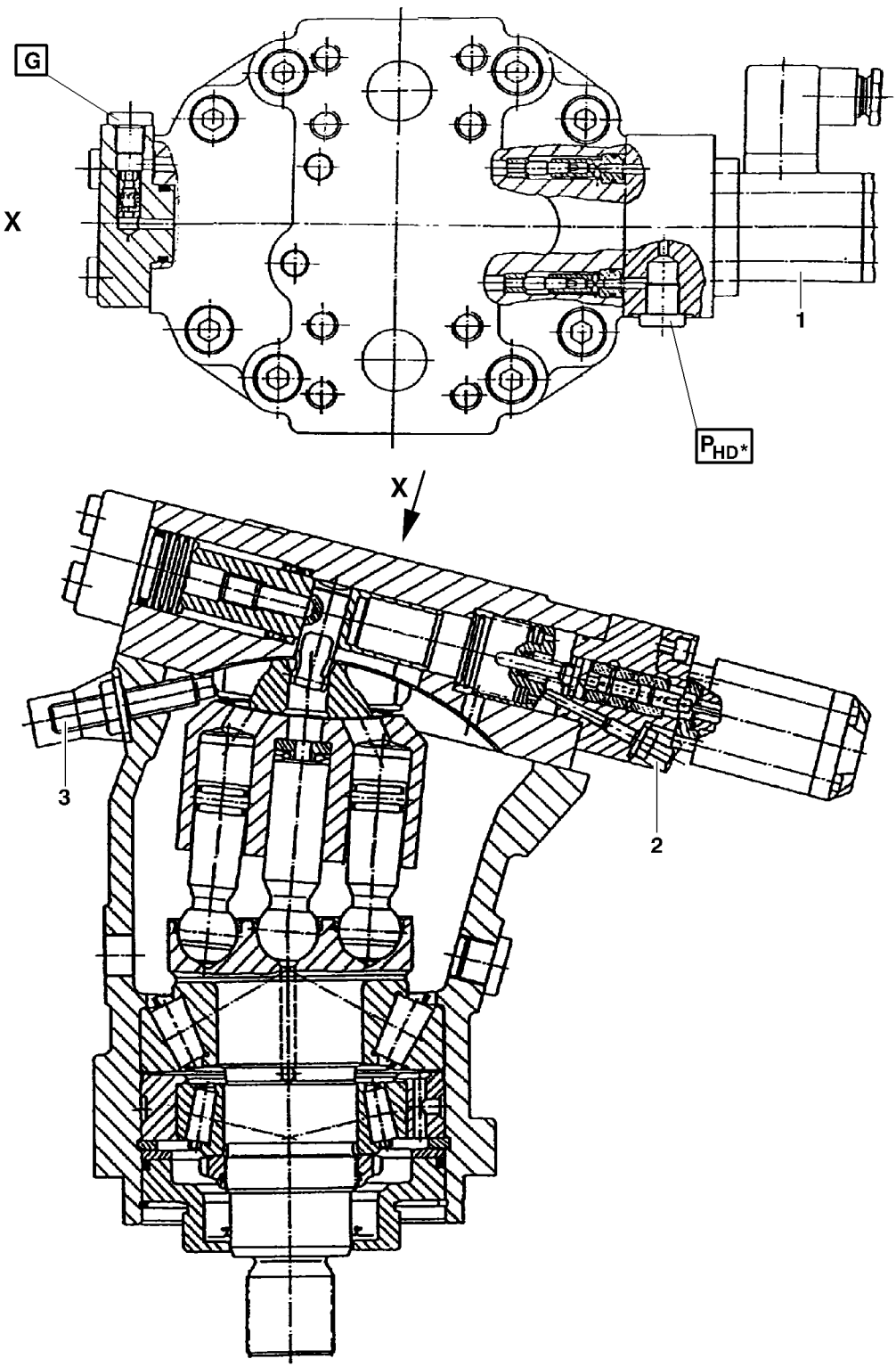


Fig. 12

Checking and adjusting the regulation threshold of the hydraulic motor (displacement switch-over)

Pressure gauges with a measuring range of 600 bars (8700 psi) must be connected at measuring points (G) and (P_{HD}) in forward direction. The wheel loader is then driven in highway gear against a wall or a mound of earth. The speed of the diesel engine must then be gradually increased, with the two pressure gauges being observed at the same time.

The regulation threshold is reached when a first pressure rise is observed at the measuring point (G). The high pressure at travelling (P_{HD}) read off simultaneously at the other pressure gauge is the set value for the regulation threshold (regulation threshold see Technical Data).
If it is too low (regulation threshold too early), the adjusting screw (A15, Part 2) must be **unscrewed** in CCW direction. This tightens the spring for the regulation theshold.
If the measured value is too high (regulation threshold too late), the adjusting screw must be **turned** in clockwise direction.
Adjustment of the hydraulic motor is completed when both pressure gauges indicate virtually the same pressure. This is the case at ca. 10 - 20 bars (145 - 290 psi) above regulation threshold.

N.B.:
For adjustment of the regulation threshold of the hydraulic motor, the high pressure at travelling can also be measured at measuring point (P_{HD}*).

Parts Fig. 12

1 - Solenoid for displacement switchover
2 - Adjusting screw for regulation threshold
3 - Adjusting screw for swivel angle limitation
Do not re-adjust

G - Measuring point for regulation threshold
P_{HD} - Measuring point for high pressure at travelling

□

Inching valve (B10)

2800485

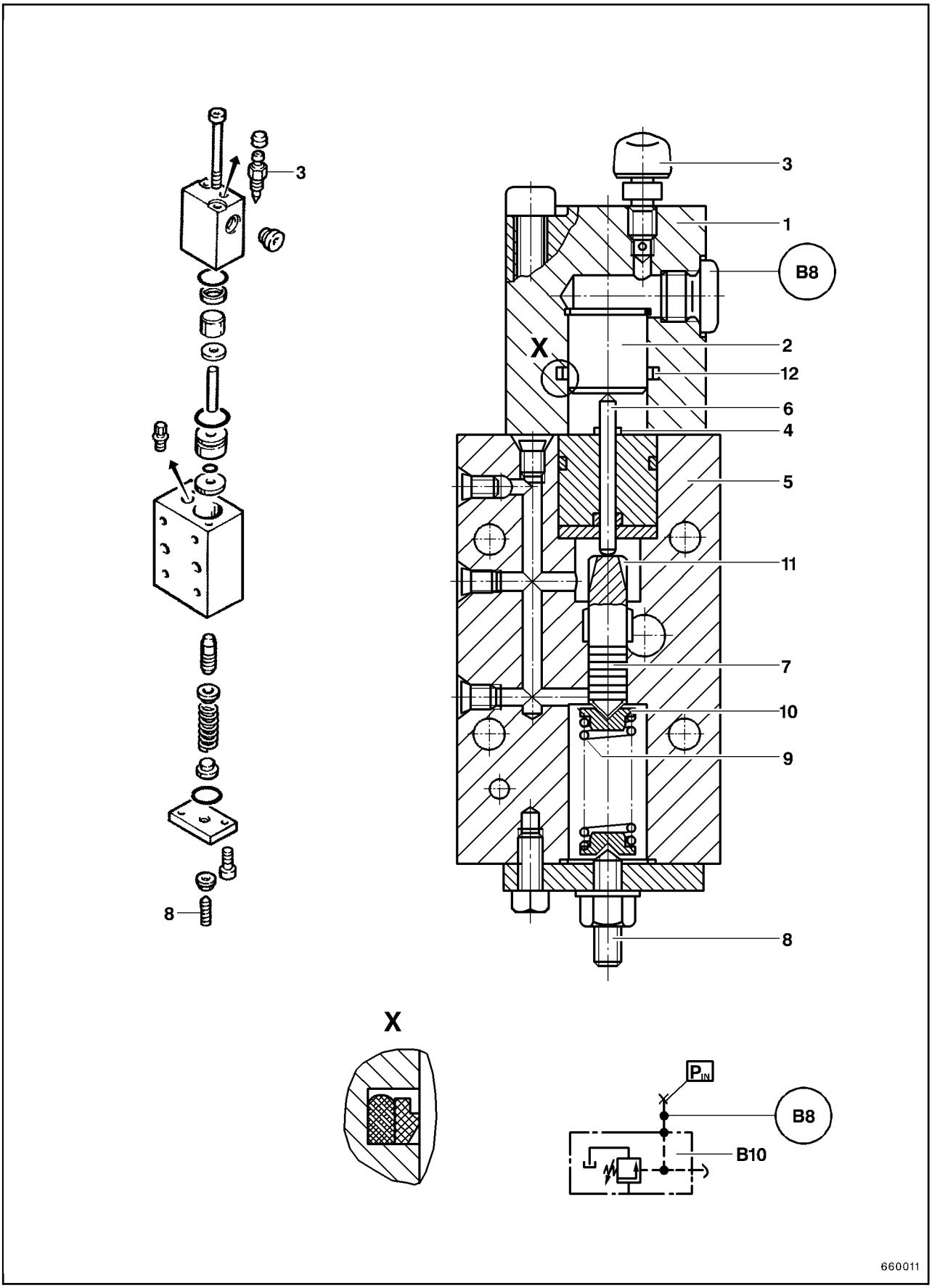


Fig. 13

Adjusting the inching threshold

A pressure gauge with a measuring range of 600 bars (8700 psi) is connected at the measuring point for the high pressure at travelling (P_{HD}). A further pressure gauge with a measuring range of 60 bars (870 psi) must be connected at measuring point (P_{in}).

The wheel loader is then driven in highway gear against a wall or a mound of earth. The engine speed is kept constant so that the measured high pressure at travelling (P_{HD}) also remains constant. A braking pressure (P_{in}) of 5 bars (73 psi) is now set. The inching valve (B10) is set at the adjusting screw (B10, Part 8) in such a way that the high pressure at travelling (P_{HD}) starts to drop at a braking pressure (P_{in}) of 5 bars (73 psi).

If the inching threshold has been correctly set, the inching end is yielded at an actual braking pressure (P_{in}) of 13 bars (190 psi), i.e. at this pressure, it is only the feed pressure that is measured at the measuring point for the high pressure at travelling (P_{HD}).

Parts Fig. 13

1 - Slave cylinder
2 - Piston
3 - Venting valve
4 - Relief channels
5 - Valve housing
6 - Tappet
7 - Control piston
8 - Adjusting screw
9 - Spring
10 - Spring plate
11 - Notch
12 - Gasket

□

Notes

2800145

Repair instructions, hydraulic pump

2800486

A 4V G 71DA1D8/32R
Baureihe / Series 32

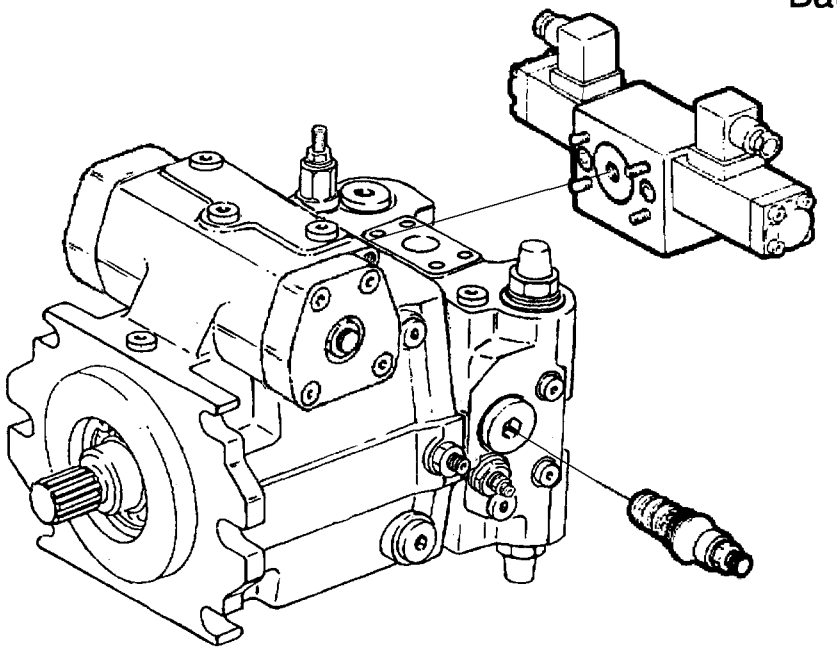
Repair instructions, hydraulic motor

A6VM107HA1U1/63W
Baureihe / Series 63 □

Reparaturanleitung
Repair Instructions

A4VG 71

Baureihe / Series 32



HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

BRUENINGHAUS HYDROMATIK- Baugruppen, mit Angabe der Fabrik-Nr. bestellt, sind die Basis guter Reparaturen.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Servicearbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

BRUENINGHAUS HYDROMATIK reserves the right to discontinue models or options at any time or to change speci-fications, materials, or design without notice and with-out incurring obligation.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

For the available combinations refer to the relevant data sheet for the basic unit and the desired option.

Adjustment and tests have to be carried out on the test bench under operating temperatures.

Protection of personnel and property has to be guaranteed by appropriate measures.

Expert knowledge, the precondition of any service work, can be obtained in our training courses.

INHALT

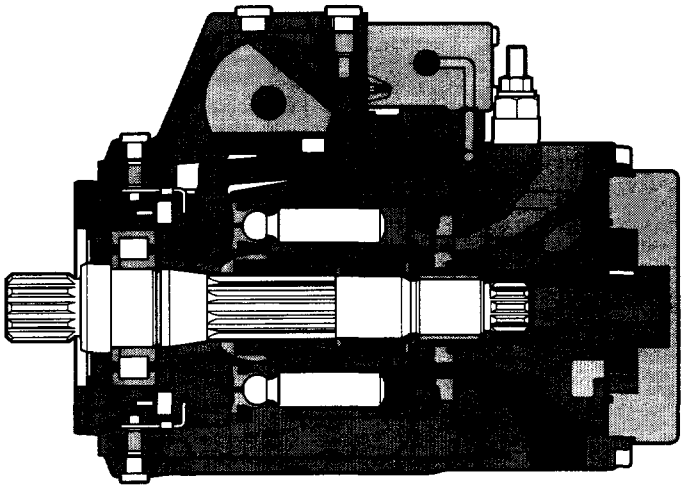
Seite/ Page

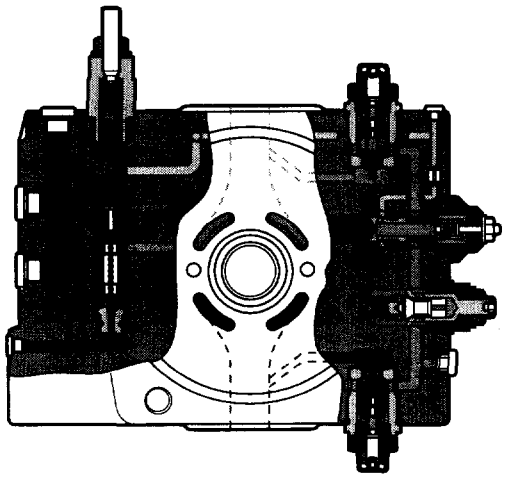
CONTENTS

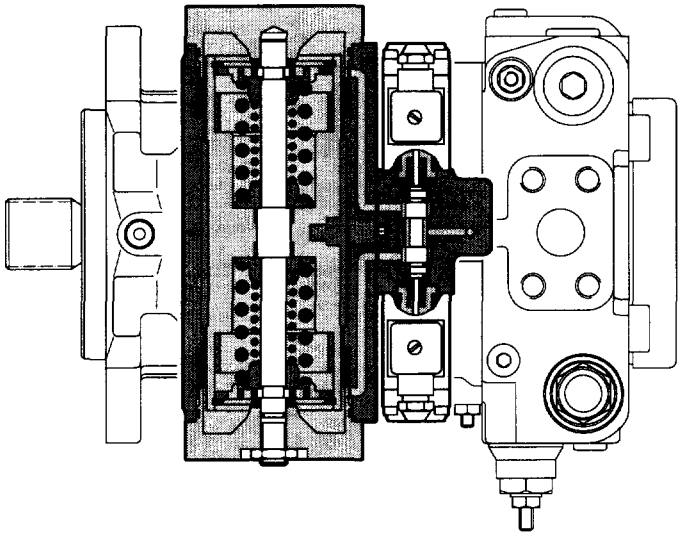
A4VG

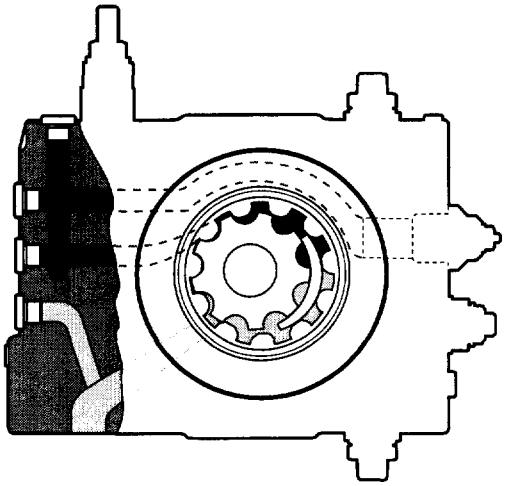
A4VG

DA/D



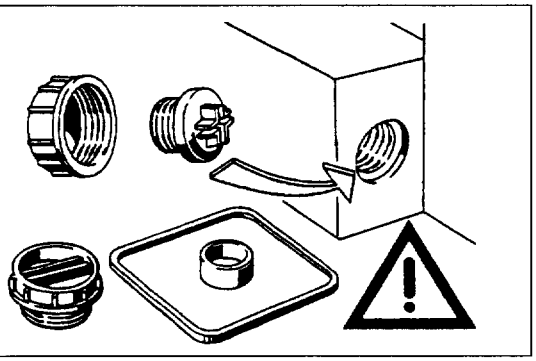






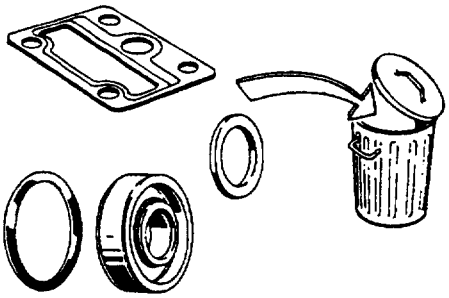
Achtung!
Nachfolgend Hinweise bei allen Reparaturarbeiten an Hydraulikaggregaten beachten!

Attention!
Observe the following notices when carrying out repair work at hydraulic aggregates!



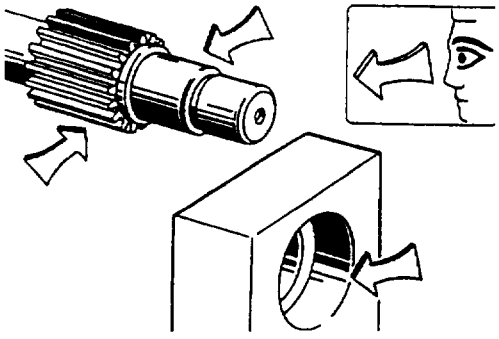
Alle Öffnungen der Hydraulikaggregate verschließen.

Close all ports of the hydraulic aggregates.



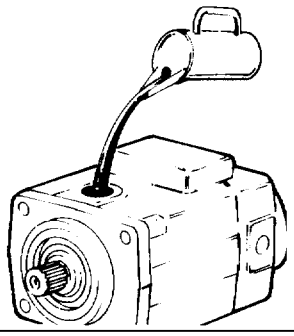
Alle Dichtungen erneuern.

Replace all seals.



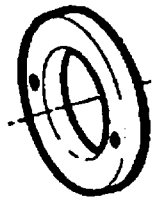
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch Schleifpapier kann die Oberfläche beschädigen.

Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive paper can damage surface.



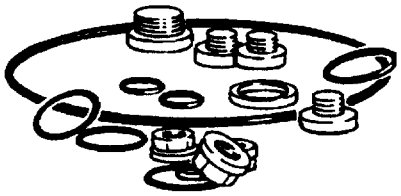
Hydraulikaggregate vor Inbetriebnahme mit Betriebsmedium befüllen.

Fill up hydraulic aggregates with medium before start- up.



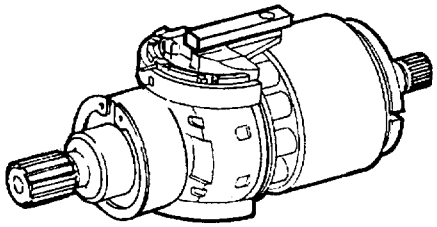
1 Dichtsatz für Triebwelle.

Seal kit for drive shaft.



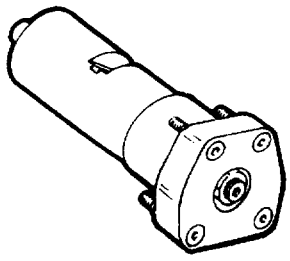
2 Äußerer Dichtsatz.

External seal kit.



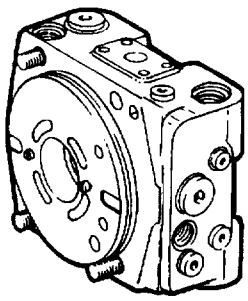
3 Triebwerk komplett.

Complete rotary group.



4 Stellkolben

Positioning piston

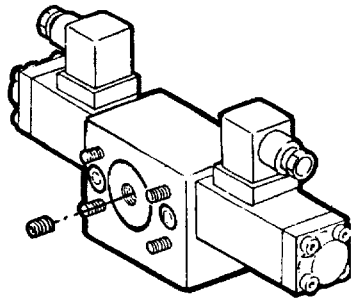


5 Anschlußplatte

Valve plate

6

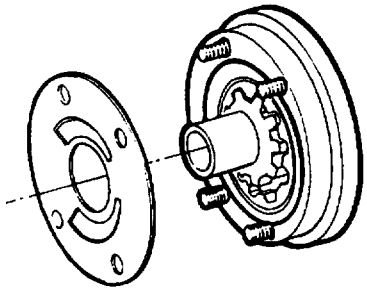
7



Ansteuergerät **DA**
Hinweis:
NG 71 wie NG 40 - 56 mit Flachdichtung.

Control device **DA**
Note:
Size 71 control device as size 40 - 56 with flat seal.

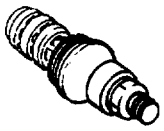
8



Hilfspumpe

Boost pump

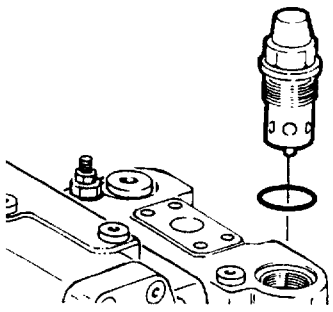
9



Regelventil

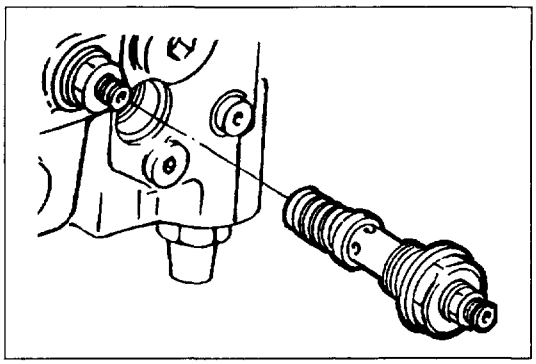
Control valve

10



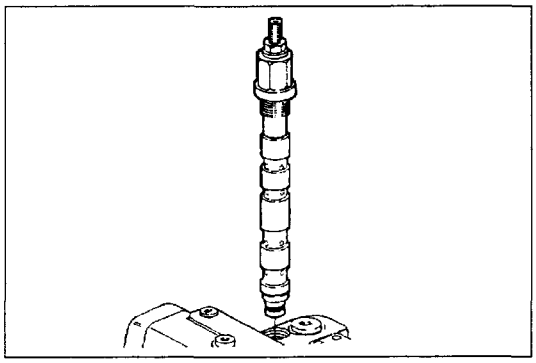
HD - Ventil

High pressure valve



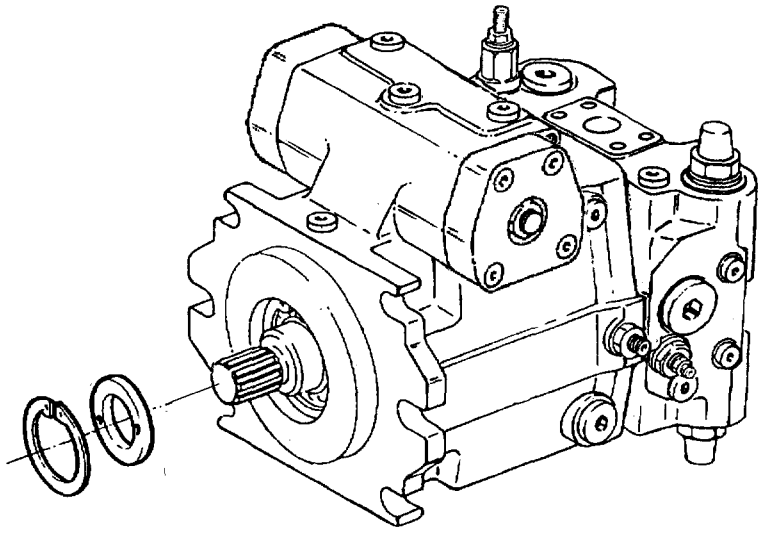
11 ND - Ventil

Low pressure valve



12 Druckabschneidung

Pressure cut-off



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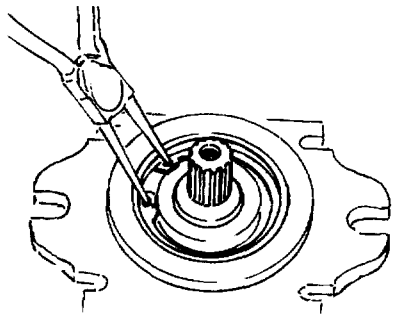
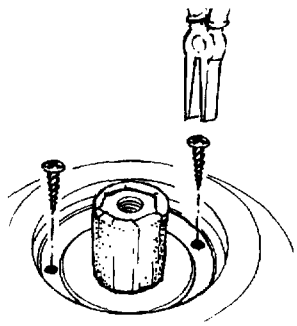


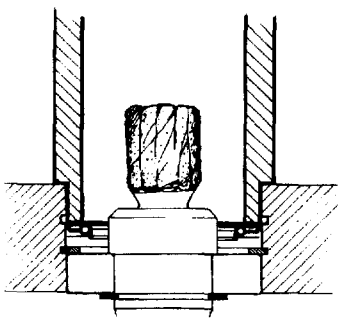
14 Triebwelle abkleben.
Sicherungsring ausbauen.

Protecting the drive shaft.
Remove retaining ring.



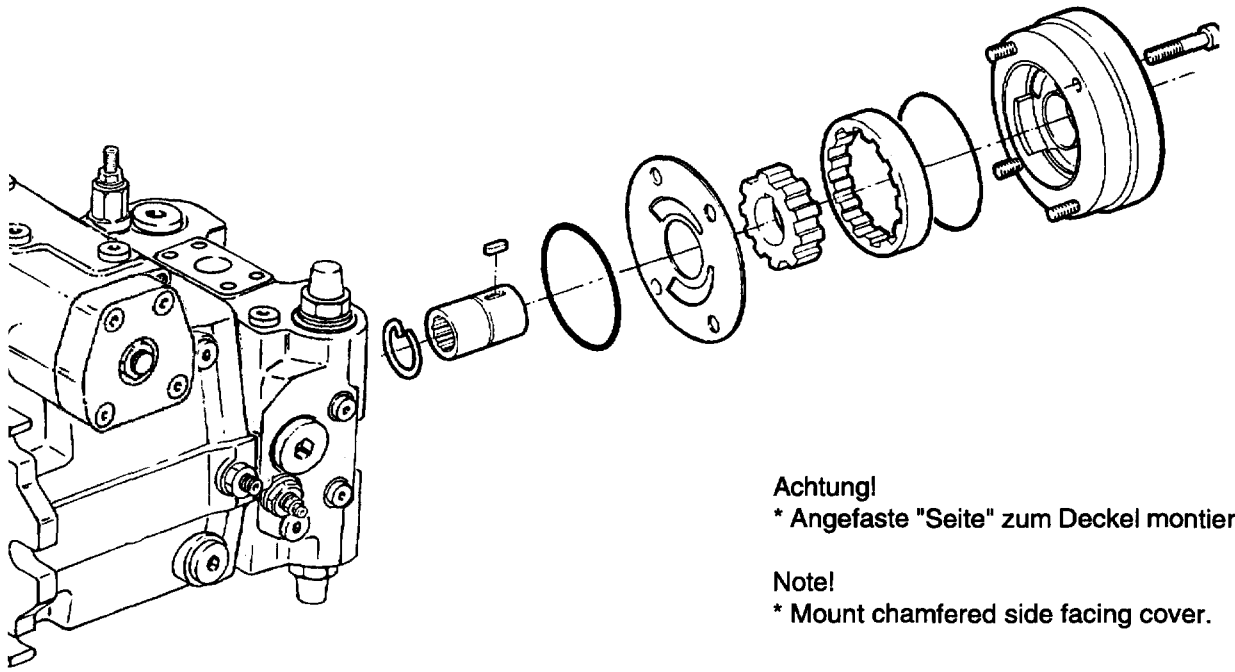
15 Blechschraube in die mit Gummi gefüllten Löcher eindrehen.
Mit Zange WDR herausziehen.

Screw in sheet metal screw into the holes fitted with rubber.
Pull out shaft seal with pliers.



16 Wellendichtring mit Buchse auf Anschlag einpressen.
Sicherungsring einbauen.

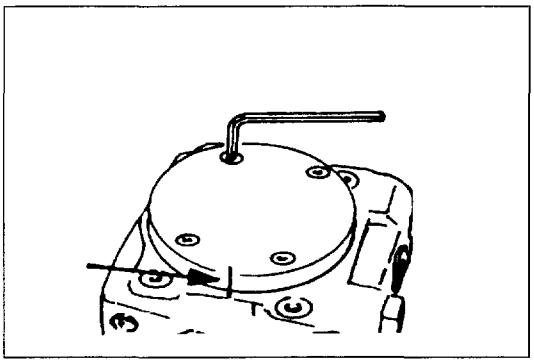
Press-in shaft seal with bush to stop.
Assemble retaining ring.



Achtung!
* Angefaste "Seite" zum Deckel montieren.

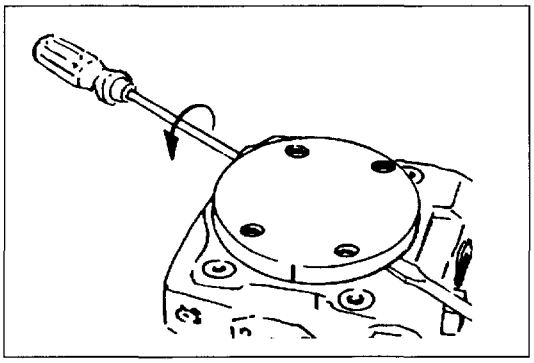
Note!
* Mount chamfered side facing cover.

17



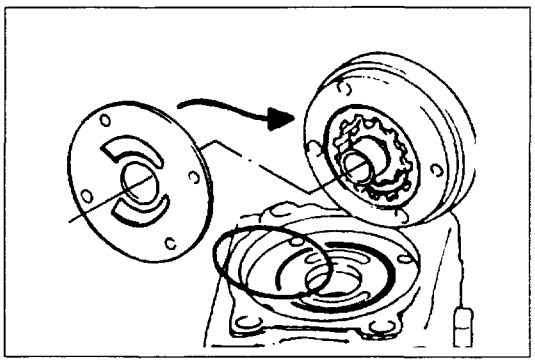
18 Lage kennzeichnen,
Befestigungsschrauben ausbauen.

Mark position,
remove fixing screws.



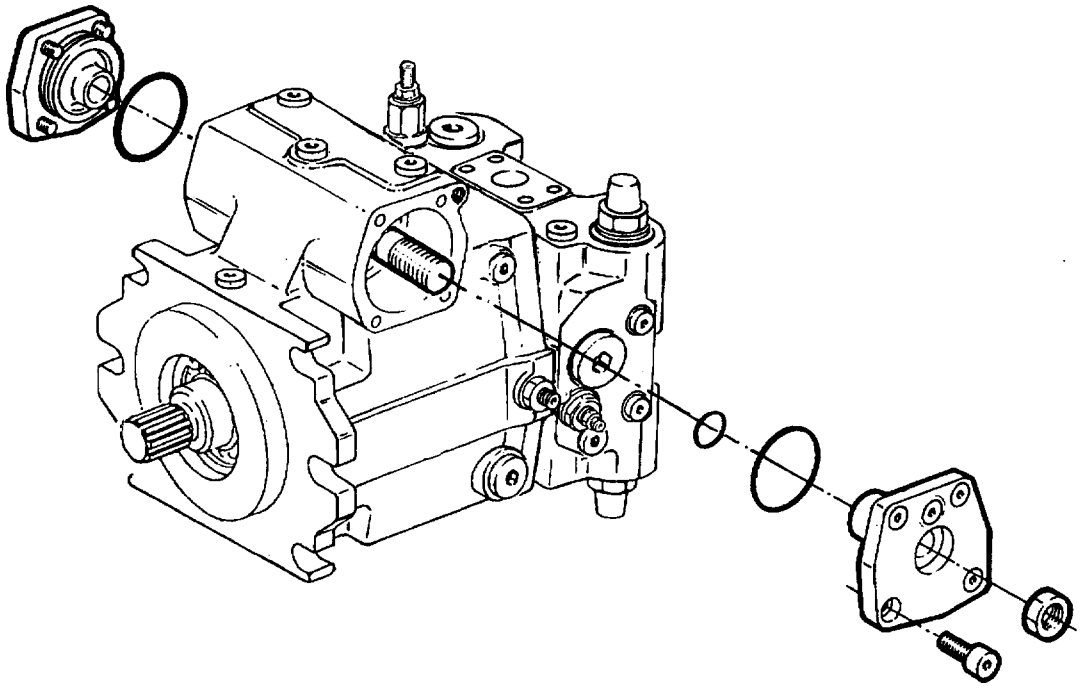
19 Deckel abdrücken.

Pry-off cover.



20 Kontrolle:
O-Ring, Nut,
Lauffläche, Anschlußplatte.

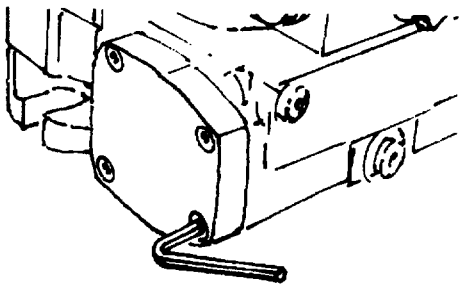
Check:
O-ring, groove,
gliding surface, connection plate.



Achtung!
Korrekt mechanische 0-Lageneinstellung überprüfen

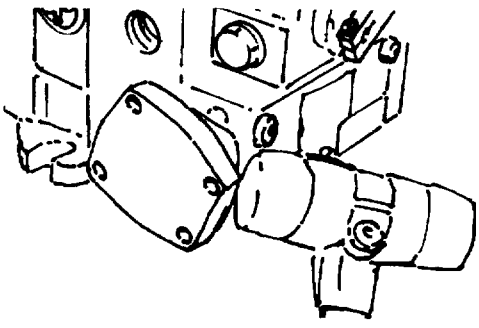
Attention!
Check correct mechanical 0-position.

21



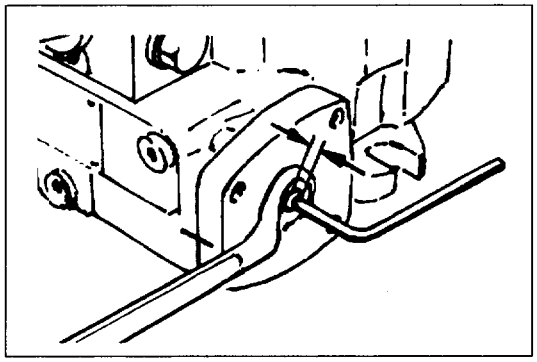
22 Lage kennzeichnen.

Mark position.



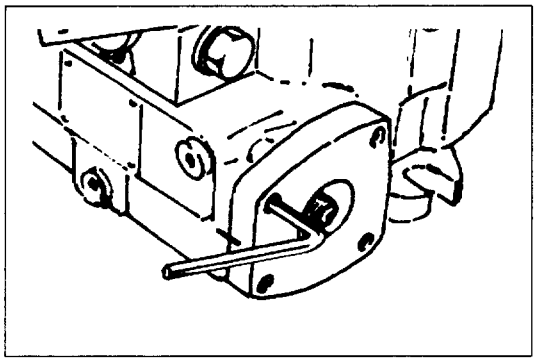
23 Deckel verdrehen und mit leichten Hammerschlägen lösen.

Rotate cover and release by tapping gently with hammer.



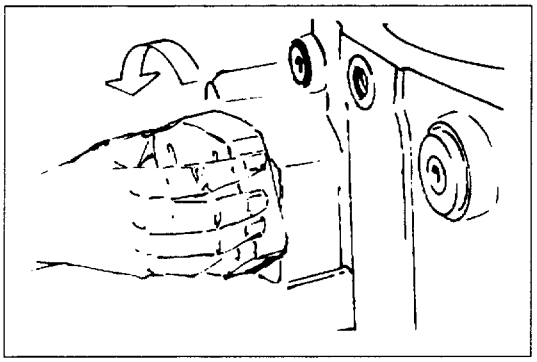
24 Deckel kennzeichnen. Maß festhalten, Kontermutter lösen, Stellschraube gegenhalten.

Mark cover. Must be fixed, loosen counter nut, hold adjustment screw.



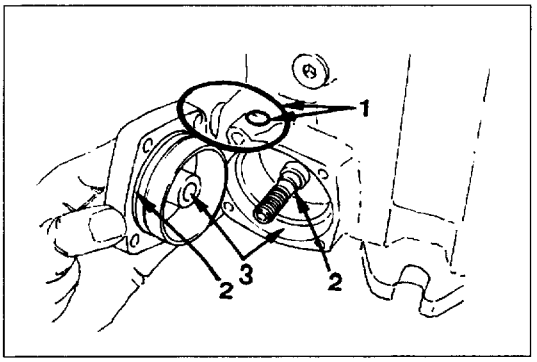
25 Deckel demontieren.

Remove cover.



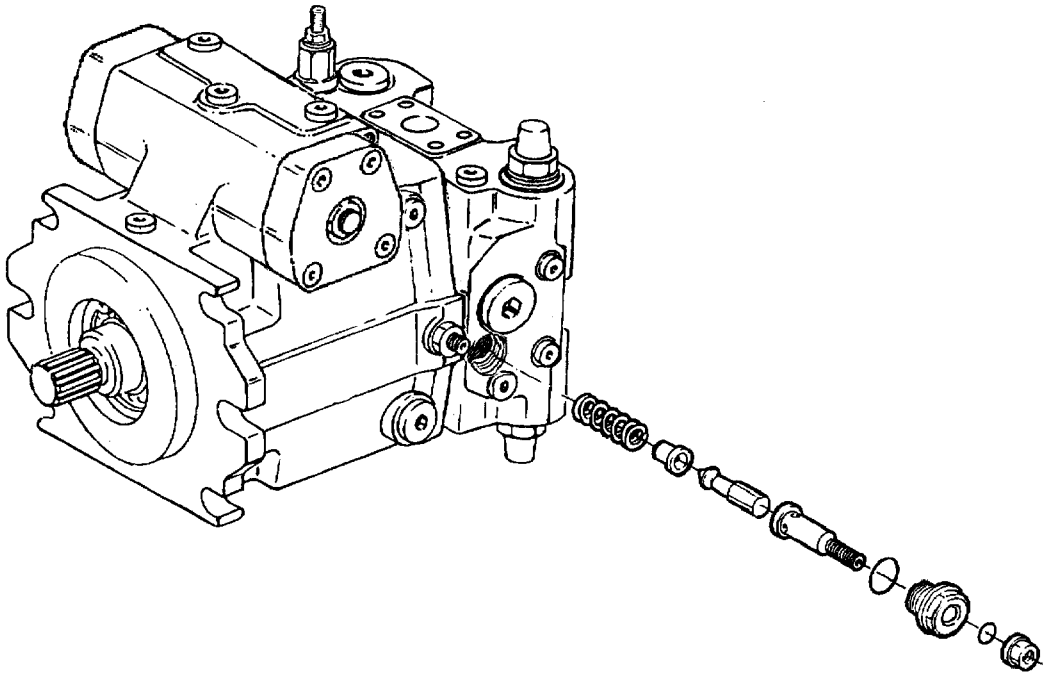
26 Deckel von Stellschraube "abschrauben".

Lift off by turning the setting screw.

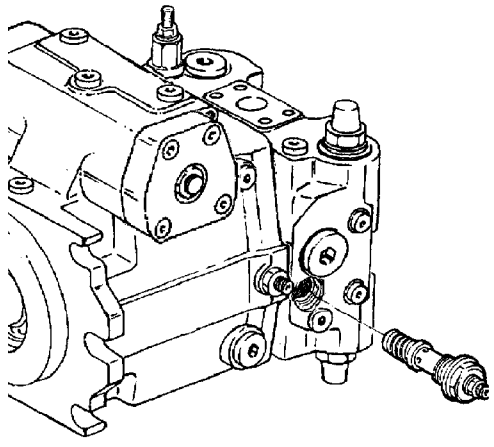


27 Kontrolle!
O-Ring (1), Nut (2), Gehäuse (3).

Check!
O-ring (1), groove (2), housing (3).



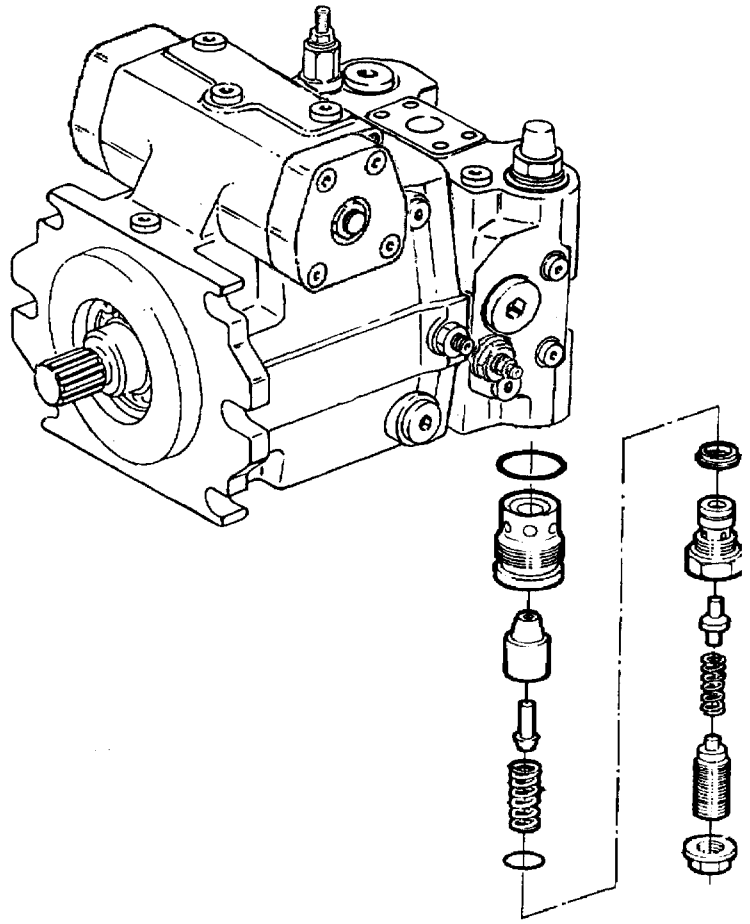
28



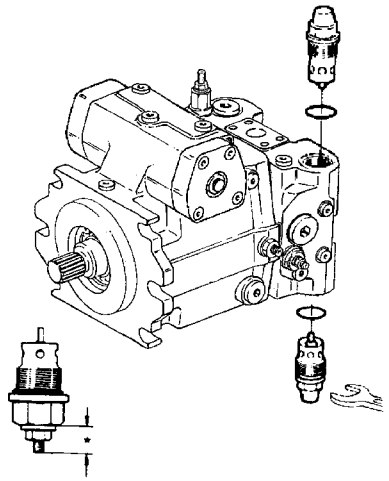
29

Ventil komplett ausbauen.
Hinweis:
Einstellschraube nicht verändern.
Achtung!
Nach Einbau Ventileinstellung überprüfen!

Remove valve completely:
Note:
Do not change adjustment screw.
Attention!
Check valve setting after installation.

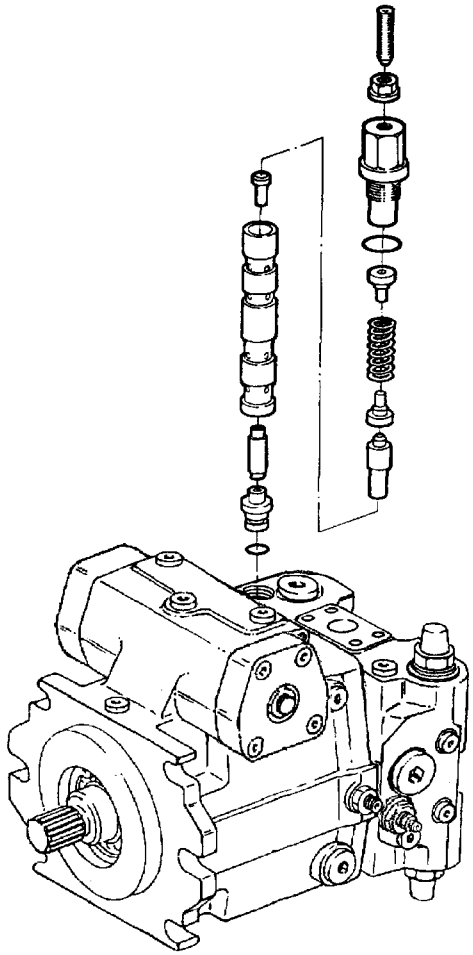


30

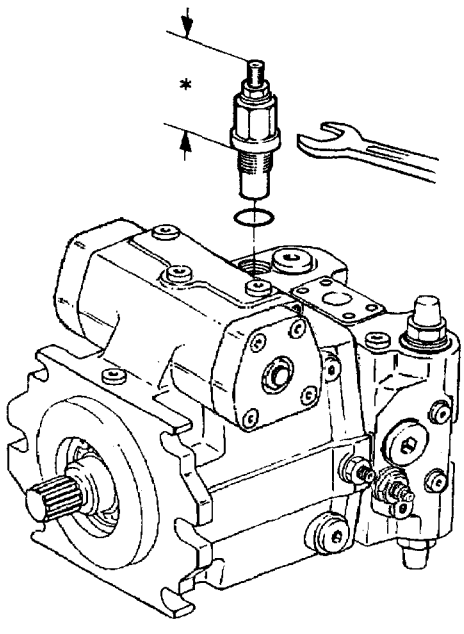


31 Ventil komplett ausbauen.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter - Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

Remove valve completely.
Control: O-ring, housing.
Replacement of the tightening nut, record measure (*).
Attention!
After assembly check "valve setting".



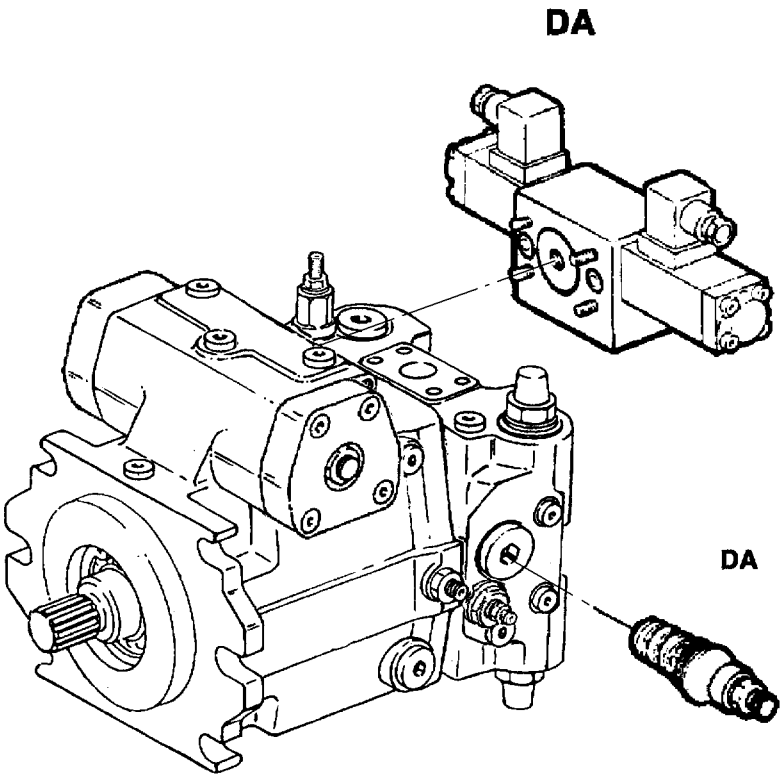
32



33

Einstellteil komplett ausschrauben.
Kontrolle: O-Ring, Gehäuse.
Wechsel der Dichtmutter - Einstellmaß (*) festhalten.
Achtung!
Nach Einbau "Ventileinstellung" überprüfen.

Unscrew setting cartridge completely.
Control: O-ring, housing.
Replacement of the tightening nut, record measure (*).
Attention!
After assembly check "valve setting".

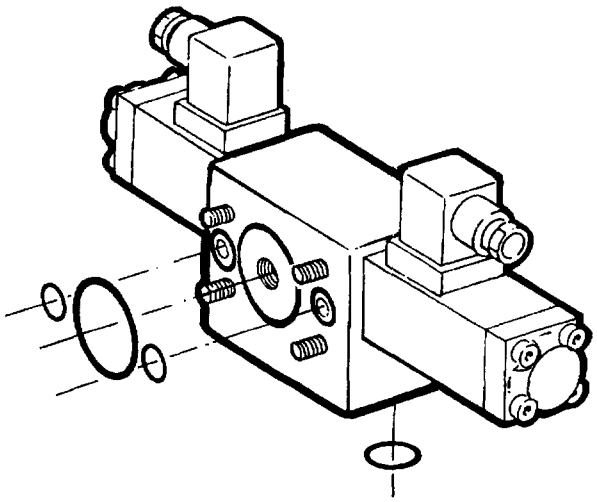


Ansteuergerät abbauen.

Remove control device.

Hinweis:
NG 71: Abdichtung der Ansteuergeräte wie NG 40 - 56 mit Flachdichtung.
Achtung!
Korrekte hydraulische Nullageneinstellung überprüfen.

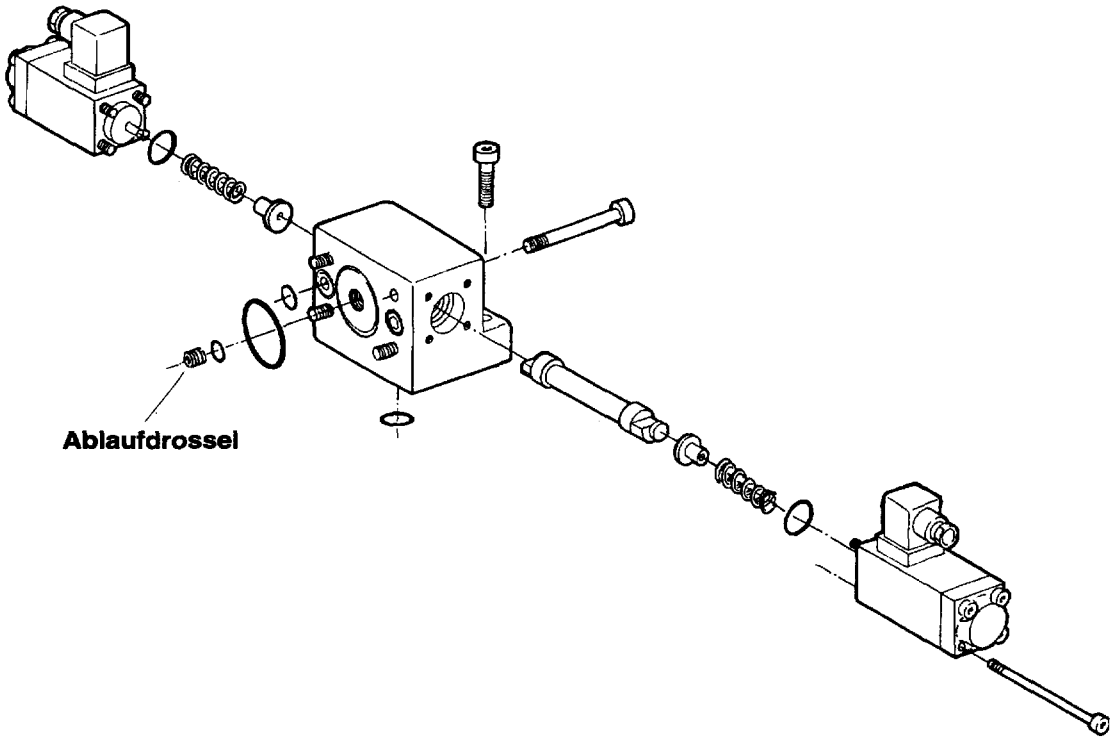
Note:
Size 71: Sealing of control device as size 40 - 56 with flat seal.
Attention!
Check correct hydraulic 0-position.



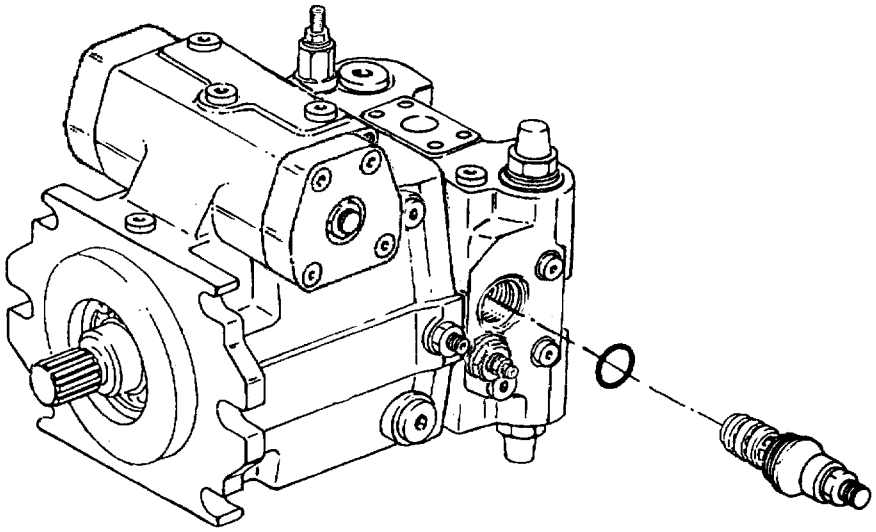
Kontrolle:
O-Ringe

Check:
O-rings

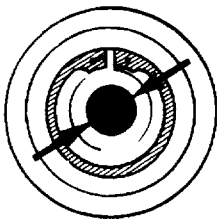
41



42

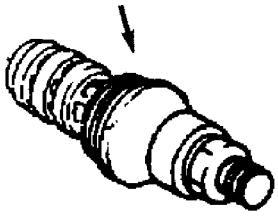


43



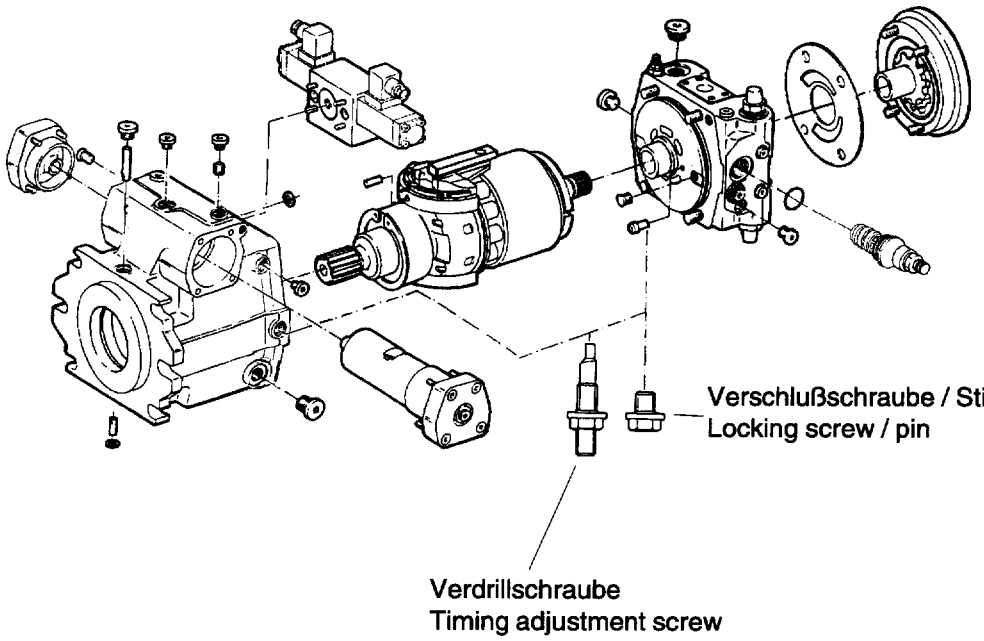
44 Blende überprüfen.
Keine Beschädigung.

Inspect orifice.
No damage.

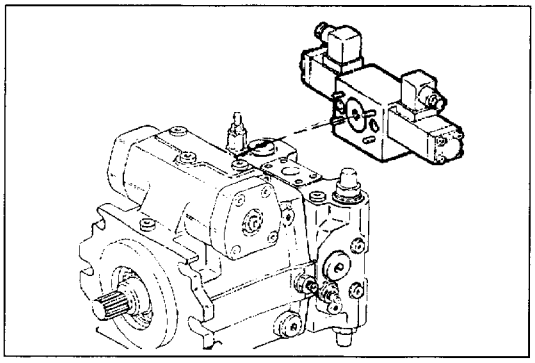


45 Gewinde abkleben.
O-Ring einsetzen.

Cover threads.
Insert O-ring.

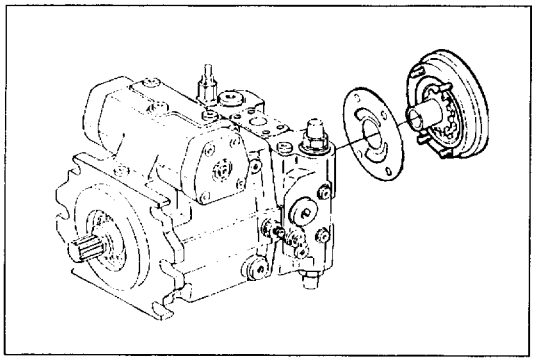


46



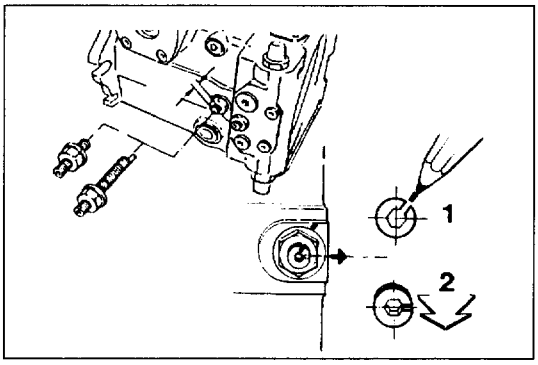
47 Ansteuergerät abbauen.

Remove control device.



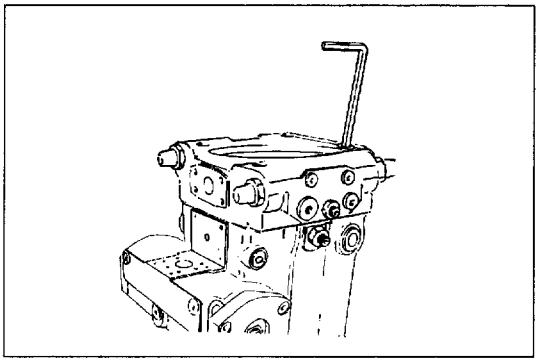
48 Hilfspumpe ausbauen.
Hinweis:
Einbaulage kennzeichnen.

Remove auxiliary pump.
Note:
Mark assembly position previously.



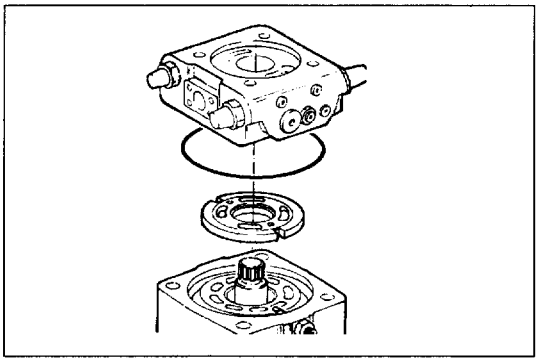
49 Lage der Verdrillschraube markieren (1).
Einstellmaß festhalten.
Verdrillschraube auf Demontageposition stellen (2).

Mark the position of the indexing screw (1).
Record setting measure.
Set the indexing screw to disassembly position (2).



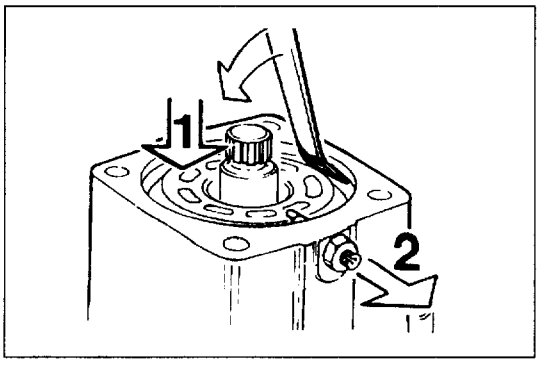
50 Lage der Hilfspumpe und Anschlußplatte markieren.
Anschlußplattenbefestigung lösen.

Mark position of the connection plate.
Loosen connection plate fixation.



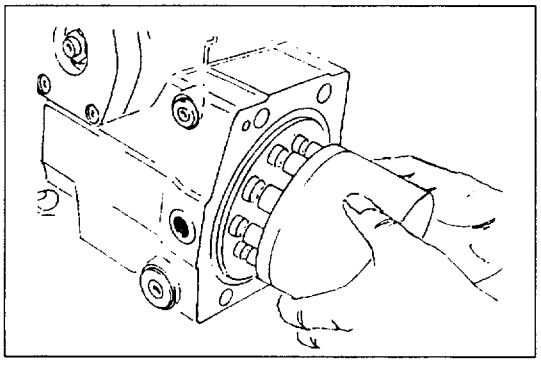
51 Anschlußplatte und Steuerplatte abheben.

Lift off port plate and control plate.



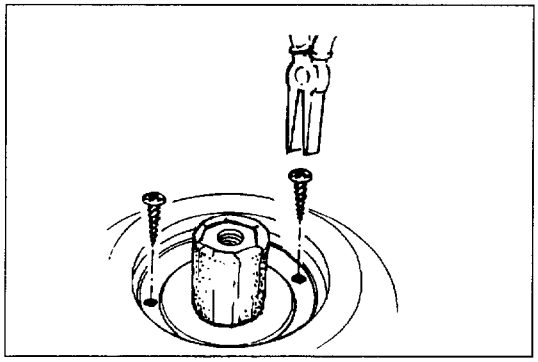
52 1. Zylinder nach unten drücken.
2. Verdrillschraube herausdrehen.

1. Press the cylinder to the bottom.
2. Remove fixing indexing screw.



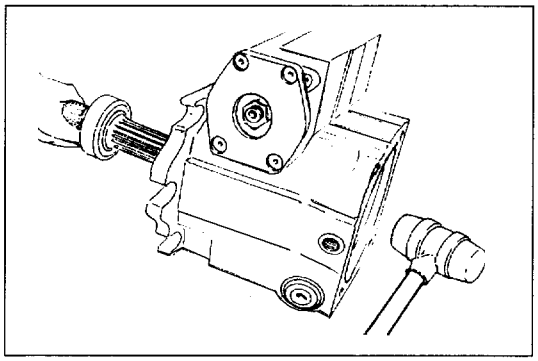
53 Zylinder komplett mit Kolben und
Rückzugeinrichtung ausbauen.

Push off hydraulic section of rotary group.



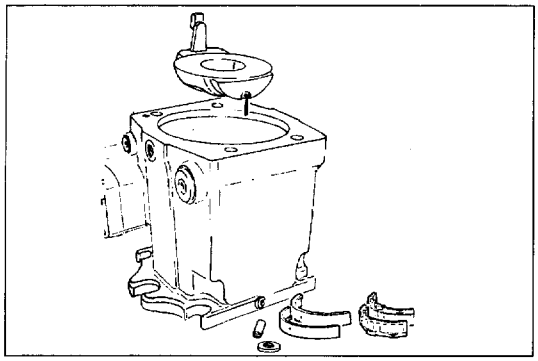
54 Seegerring / WDR ausbauen.

Remove retaining ring and radial seal ring.



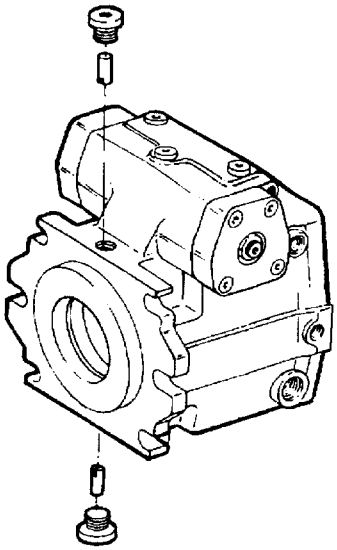
55 Triebwelle mit leichten Hammerschlägen austreiben.

Remove drive shaft with slide hammer strokes.



56 Schwenkwiege / Lager komplett ausbauen.

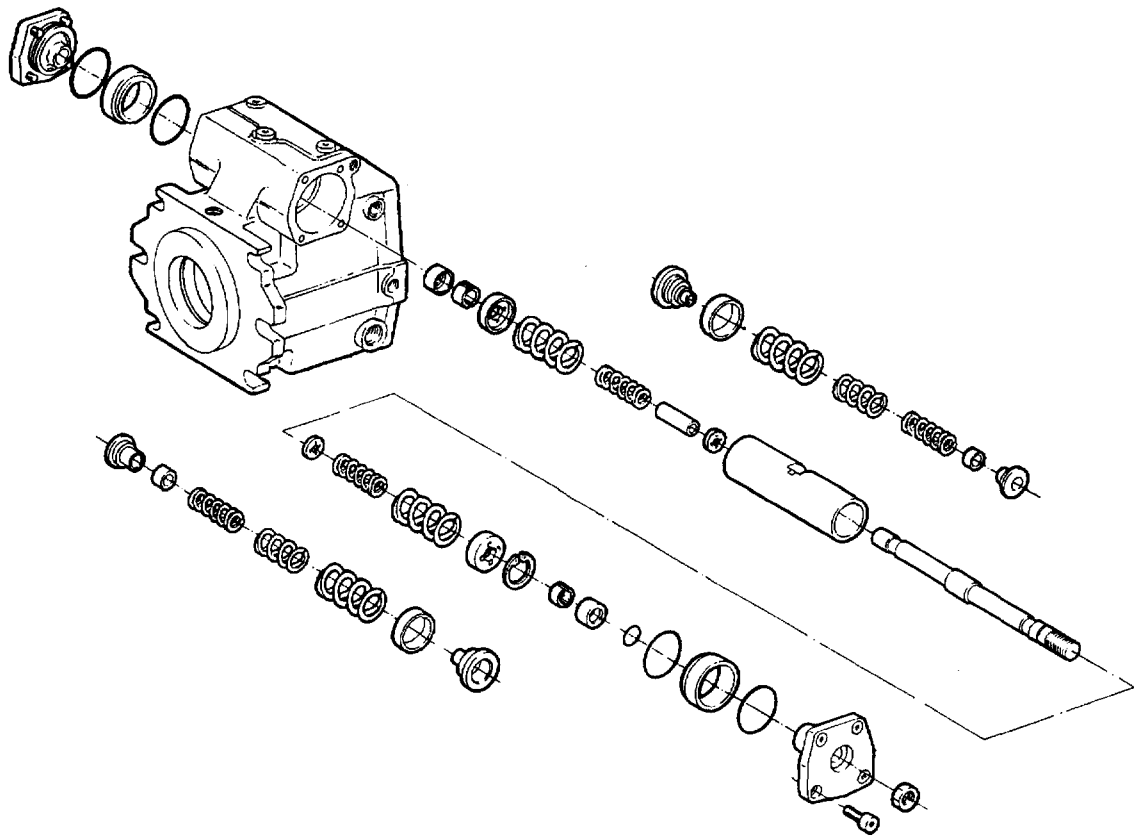
Remove swash plate / bearing cups.



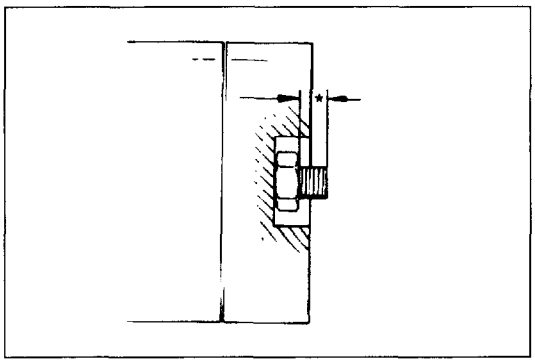
Gelenkstift ausbauen.

Remove joint pin.

57

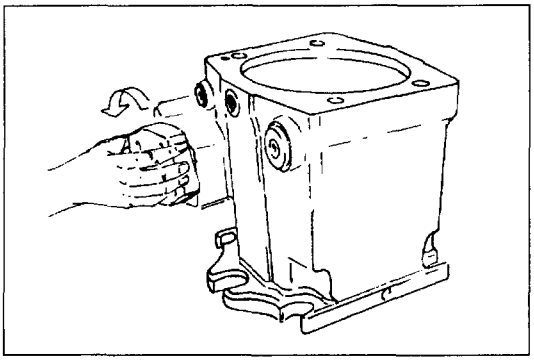


58



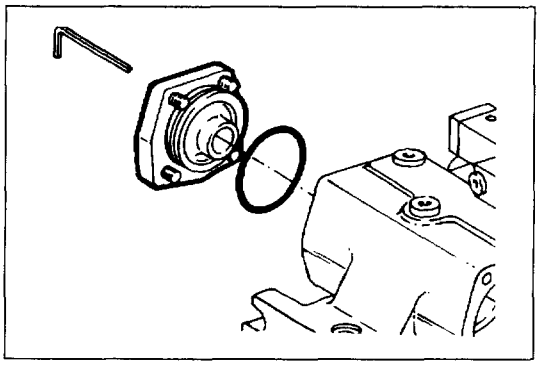
59 Lage vom Deckel markieren, Maß "Nullage" festhalten, Mutter lösen.

Mark position of the cover, note measure of "zero position". Loosen nut.



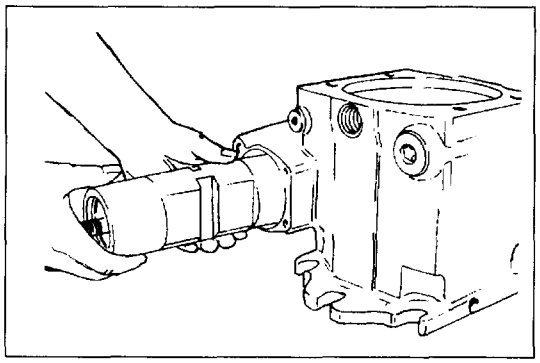
60 Deckel abdrehen.

Remove cover.



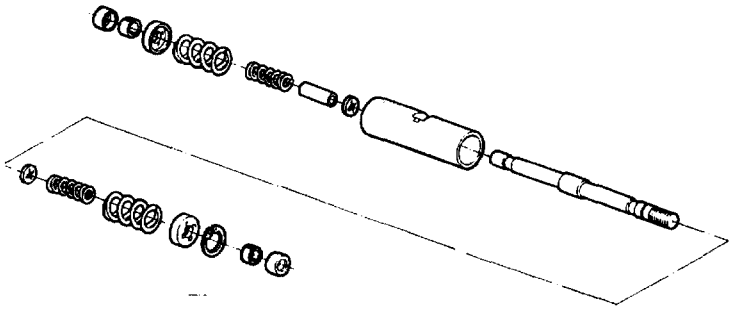
61 Lage des Deckels markieren.
Befestigungsschrauben lösen, abbauen.

Mark position of the cover.
Loosen locking screw, remove cover.

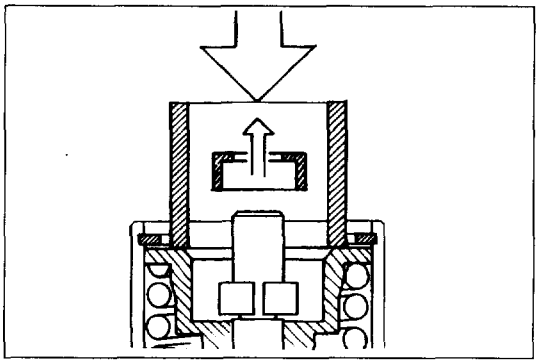


62 Stellzylinder ausbauen.

Remove positioning ring.

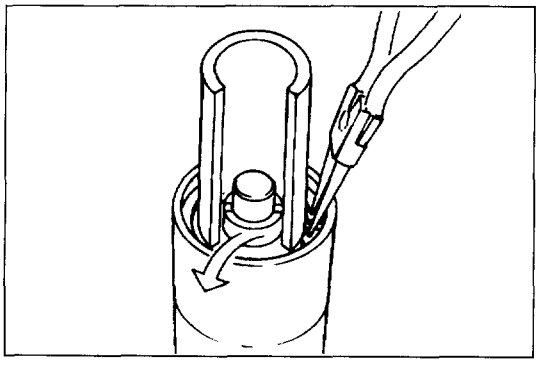


63



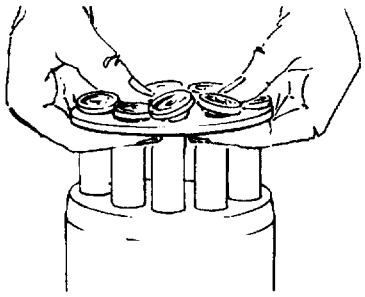
64 Vorrichtung aufsetzen und Feder vorspannen.
Aufnahmering ausbauen.

Fit tool device and preload spring.
Remove take-off ring.



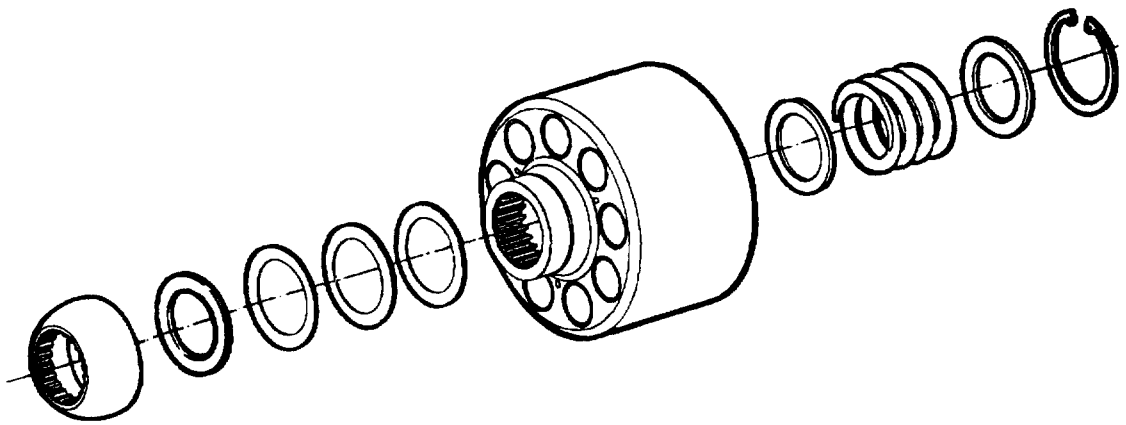
65 Ringe ausbauen.
Sicherungsring ausbauen.
Achtung: Teile stehen unter Federvorspannung.

Remove rings.
Remove safety ring.
Attention: Parts are under spring load.

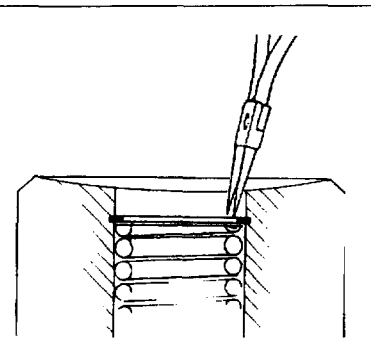


66 Kolben mit Rückzugeinrichtung ausbauen.
Tragkugel mit Tellerfedersäule abheben.

Remove piston with retaining plate.
Remove retaining ball with spring cup assembly.

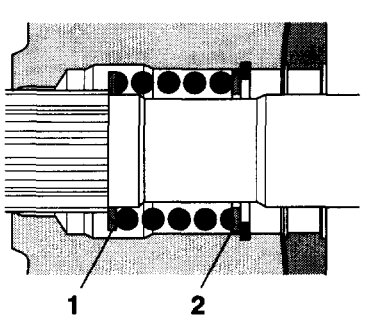


67



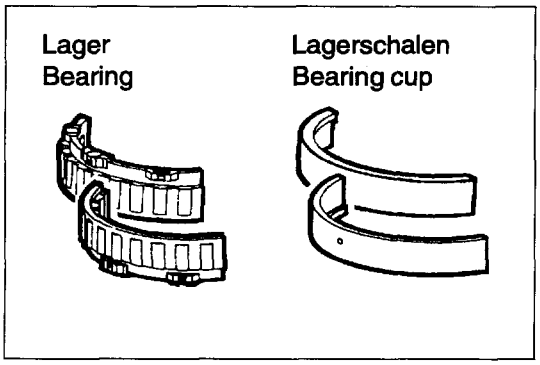
68 Sicherungsring ausbauen.

Remove safety ring.



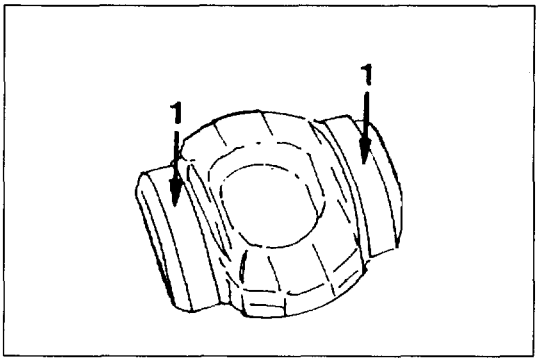
69 Scheibe 1, 2

Disc 1, 2



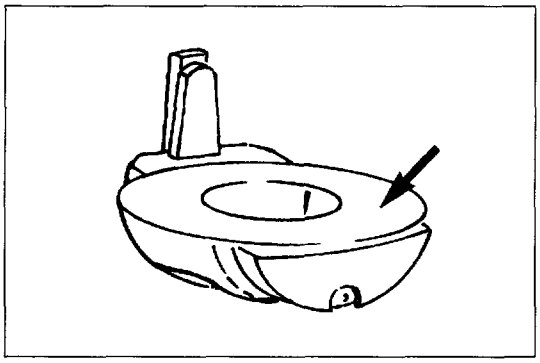
70 Kontrolle!
Käfig-Paar (1),
Lagerschalenpaar (2).

Check!
Cage set (1),
Bearing cup set (2).



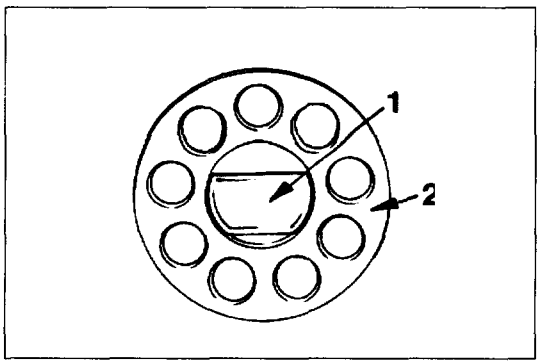
71 Kontrolle!
Lagerbahnen (1)

Check!
Bearing surfaces (1)



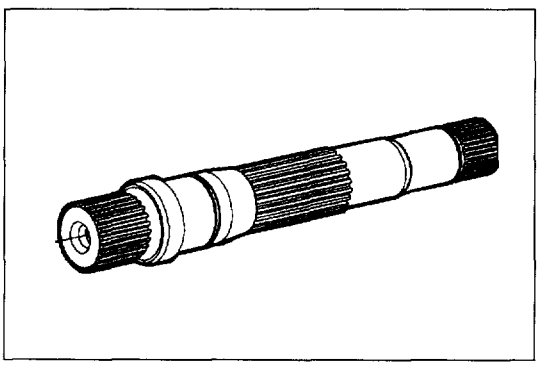
72 Kontrolle!
Gleitfläche riefenfrei.

Check!
Sliding surface free from scoring.



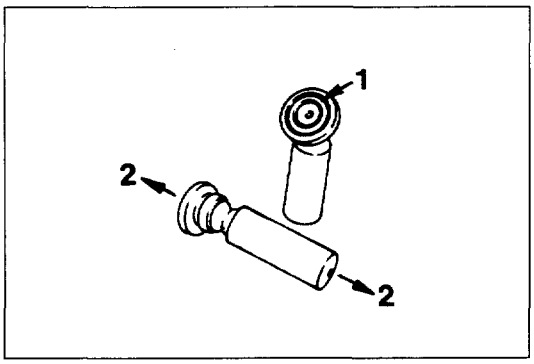
73 Kontrolle!
Rückzugeinrichtung riefenfrei.

Check!
Check that return device is free of scoring.



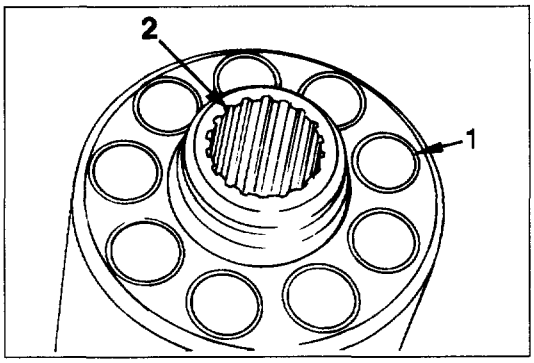
74 Kontrolle!
1. Verzahnung "ausgeschlagen", Passungsrost.
2. Laufflächen.
3. Lauffläche - Wellendichtring.

Check!
1. Splines for damage or fretting.
2. Running surfaces.
3. Groove cut by shaft seal.



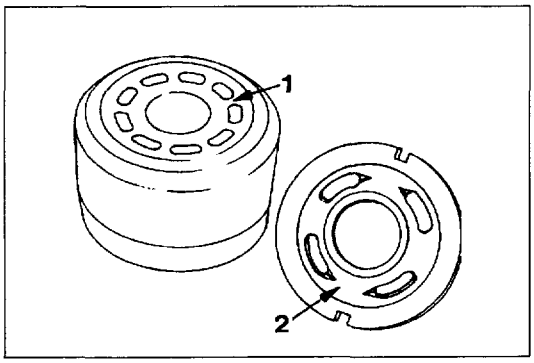
75 Kontrolle!
Lauffläche (1) keine Kratzer, keine Metalleinlagerungen, kein Axialspiel (2), (Kolben nur satzweise tauschen).

Check!
Check that there are no scratches or metal deposits on sliding surface (1), and there is no axial play (2), (otherwise: pistons must be replaced in sets).



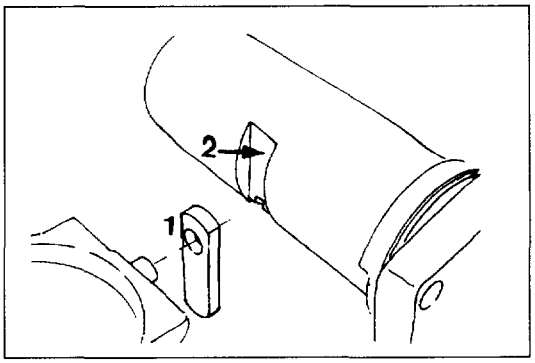
76 Kontrolle!
Zylinderbohrungen (1), Verzahnungen (2).

Check!
Cylinder bores (1), splines (2).



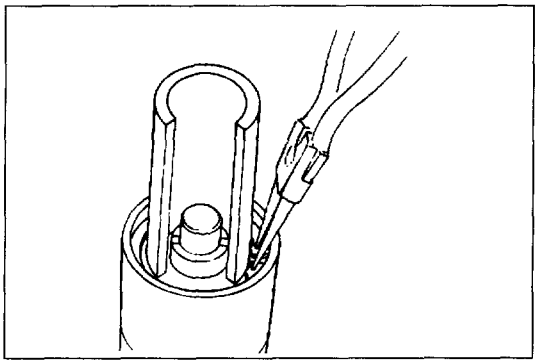
77 Kontrolle!
Zylindergleitfläche (1) riefenfrei.
Steuerplatte (2) nicht riefig.

Check!
Cylinder surface (1) free of scoring.
Control plate (2) without scoring.



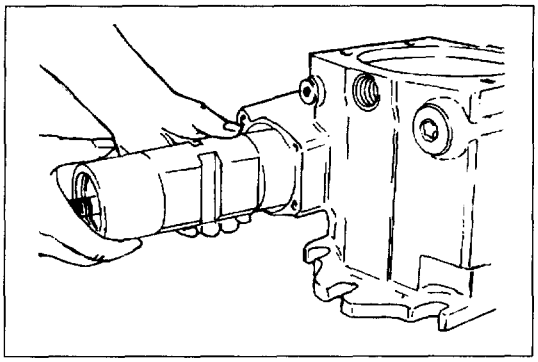
78 Kontrolle!
Stellkolben - Schwenkwiegenverbindung
Gleitstein (1), Nut im Stellkolben (2), Stellkolben.

Check!
Positioning piston - cradle linkage
Gliding stone (1), groove at the positioning piston (2).
Positioning piston.



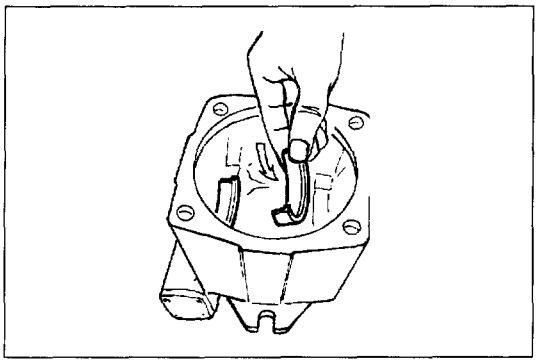
79 Stellkolben montieren.
Hinweis:
Auf korrekten Sitz der geteilten Ringe "achten".

Assemble positioning piston.
Instruction:
Observe correct fit of the divided rings.



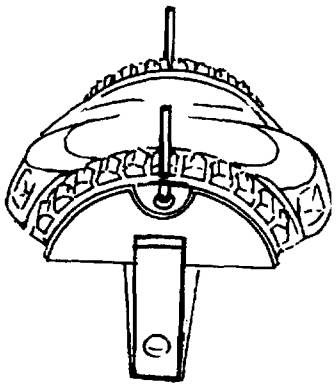
80 Stellkolben ins Gehäuse einsetzen.
Hinweis:
Stellkolben vor Einbau einölen.

Insert positioning piston into the housing.
Instruction:
Oil positioning piston before assembly.



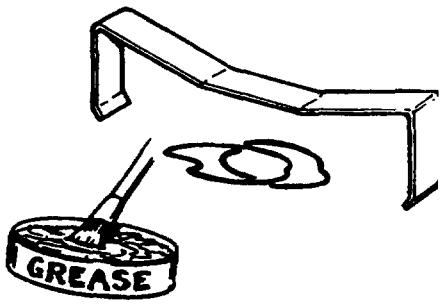
81 Lagerschalenpaar einsetzen.

Insert bearing cup set.

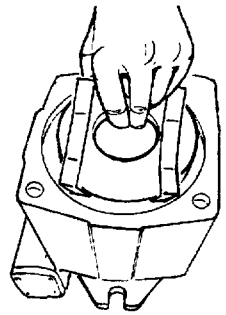


Lager, Draht, Gleitstein und Gelenkstift
montieren.
Montagehilfe: z.B. - Klammer / Gummiringe / Fett

Assemble bearing, wire, gliding stone
and articulating pin.
Assistance: Devices e.g. - Clamp / rubber rings / grease



82

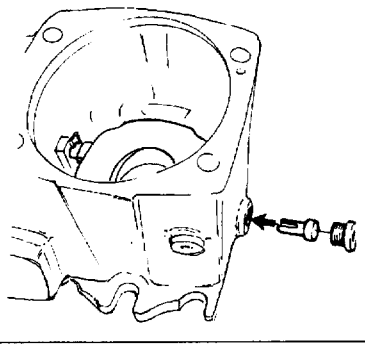


83 Schwenkwiege komplett ins Gehäuse einsetzen.
Auf korrekten Sitz der Schwenklager im Gehäuse "achten".

⚠ Montagehilfe ausbauen.

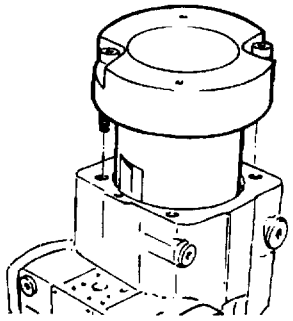
Insert completely swivel cradle into the housing.
Pay attention for correct seat of the swivel cradle in the housing.

⚠ Remove auxiliary device.



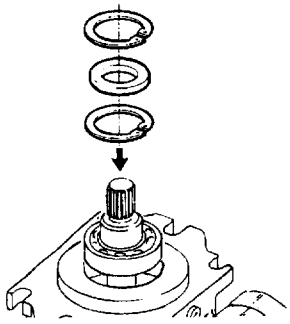
84 Gelenkstifte montieren.

Assemble articulating pins.



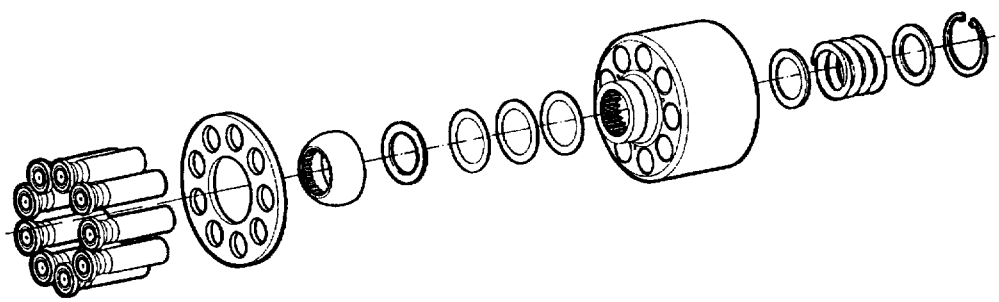
85 Vorrichtung zum Fixieren der Schwenkwiege montieren.

Assemble device for fixation of the swivel cradle.

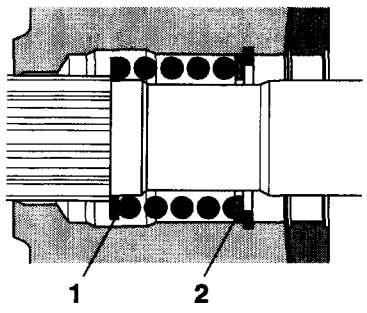


86 Neue Montageposition!
Triebwelle mit Lager und Wellendichtring einbauen.

Assemble drive shaft with bearings and radial seal rings.

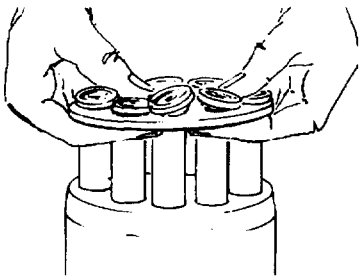


87



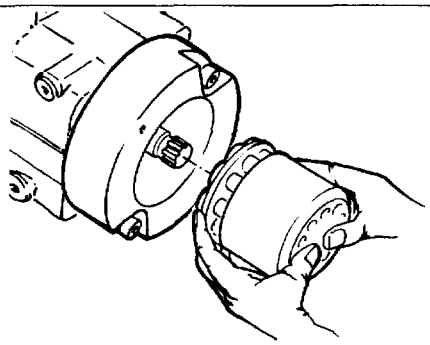
88 Scheibe 1, 2

Disc 1, 2



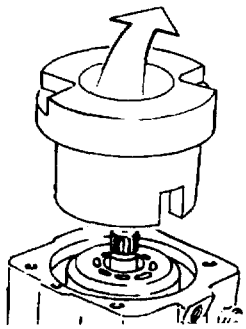
89 Kolben mit Rückzugeinrichtung montieren.
Hinweis:
Kolben, Gleitschuhe einölen.

Assemble piston with retaining plate.
Note:
Oil piston and piston pad.



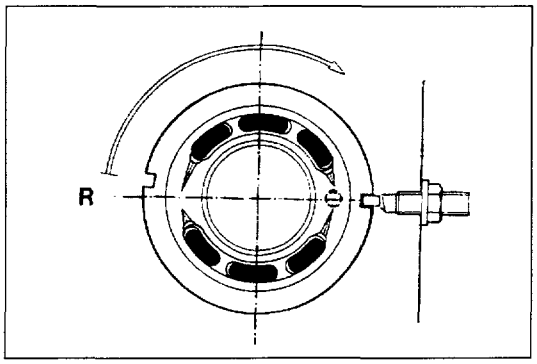
90 Zylinder komplett einbauen.

Assemble cylinder completely.



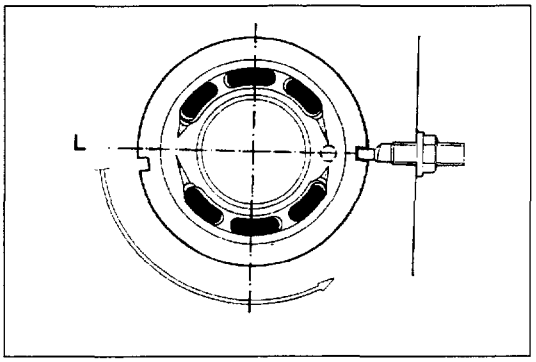
91 Vorrichtung ausbauen.

Remove assembly device.



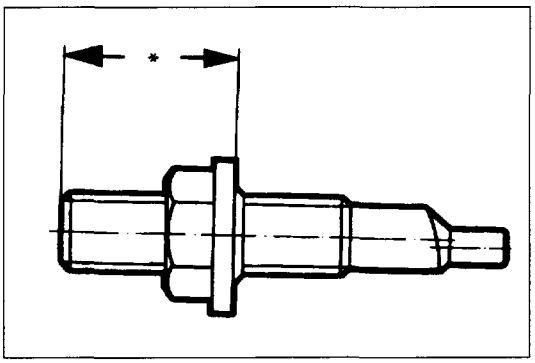
92 Steuerplatte Rechtslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - in based on direction of rotation.



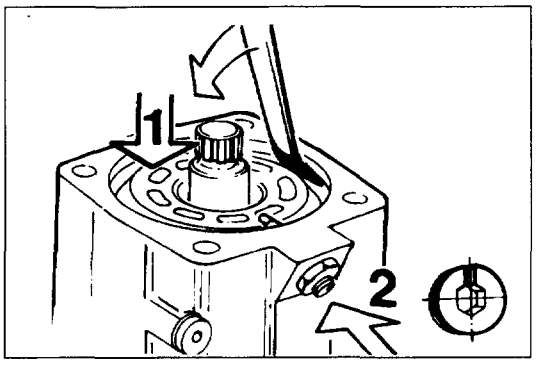
93 Steuerplatte Linkslauf - in Drehrichtung verdreht.
Achtung!
Geräuschkerben sind drehrichtungsbezogen eingeschliffen.

Control plate counter clockwise rotation - indexed in the direction of rotation.
Note!
Noise grooves are machined - in based on direction of rotation.



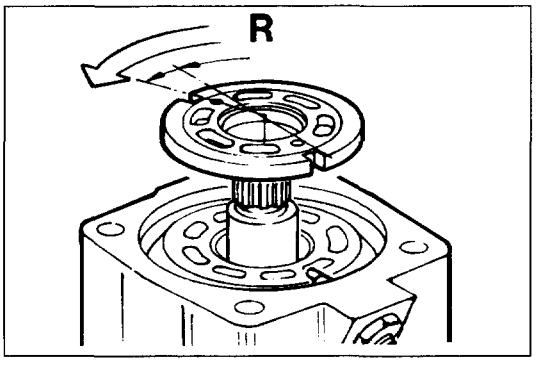
94 Grundeinstellung - Verdrillschraube
A4VG...71 * = 28 ± 0,75 mm A4VG...90 * = 29 ± 0,75 mm
A4VG...125 * = 20 ± 0,75 mm A4VG...180 * = 22 ± 0,75 mm.

Basic setting - indexing screw
A4VG...71 * = 28 ± 0,75 mm A4VG...90 * = 29 ± 0,75 mm
A4VG...125 * = 20 ± 0,75 mm A4VG...180 * = 22 ± 0,75 mm.



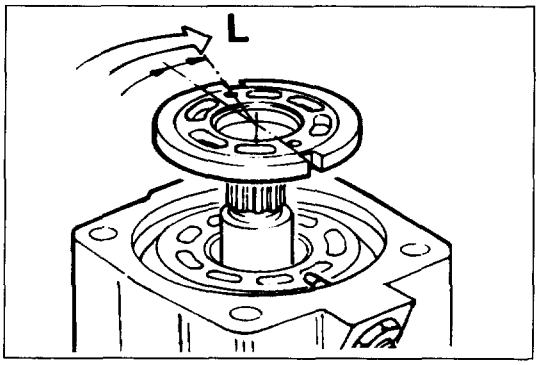
95 Steuerplatte einsetzen - Rechtslauf.

Insert the control plate - clockwise rotation.



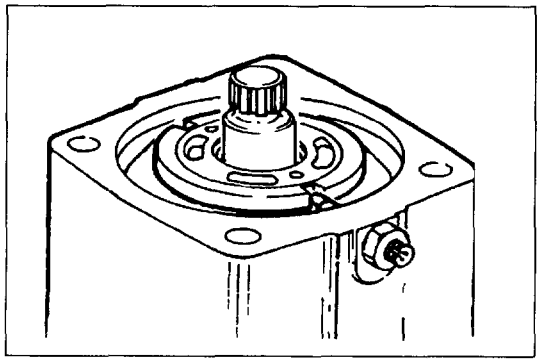
96 Zylinder nach unten drücken (1).
Verdrillschraube einbauen (2).
Kerbe in Montageposition.

Press the cylinder to the bottom (1).
Screw in the indexing screw (2).
Groove in mounting position.

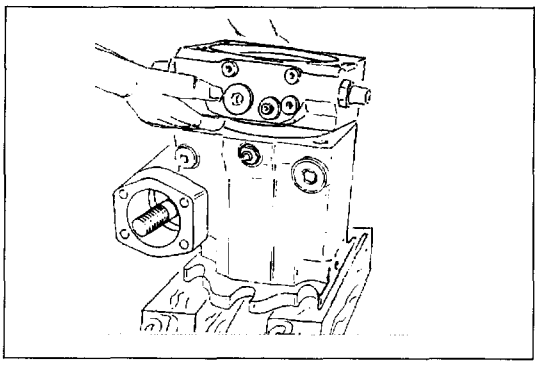


97 Steuerplatte einsetzen - Linkslauf.

Insert the control plate - Counter- clockwise rotation.

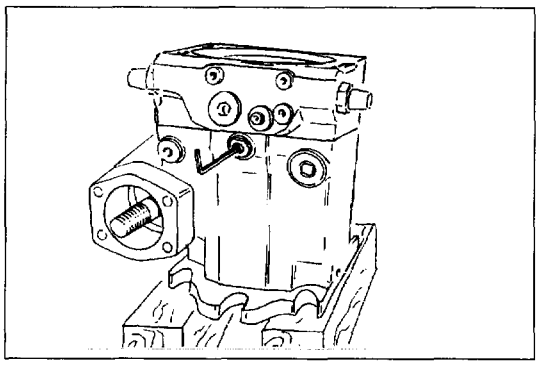


98



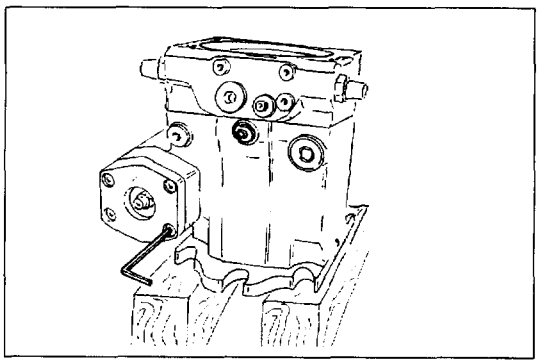
99 Anschlußplatte aufbauen.
Achtung! Federvorspannung!
Mit zwei Befestigungsschrauben überkreuz Anschlußplatte in Gehäuseführung einsetzen - Fertigmontage!

Assemble connection plate.
Attention! Spring preloaded!
Insert control plate into housing, guidance with two locking screws crossing over -Finish assembly!



100 Verdrillschraube - Nach Markierung ausrichten.

Locking screw - Observe adjusting measure.

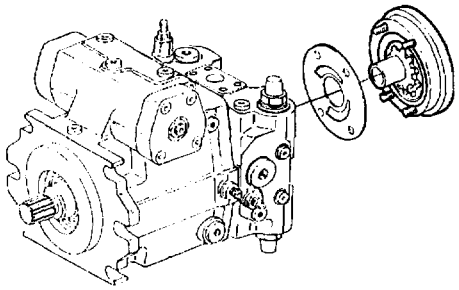


101 1. Deckel montieren.
2. Nullage nach Maß einstellen.

1. Assemble cover
2. Adjust zero position according to measure.

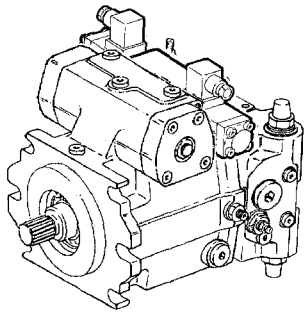
102 Achtung!
Korrekte mechanische Nullageneinstellung muß nach Einbau im Gerät bzw. Prüfstand erfolgen.

Attention!
Adjustments of the correct zero position to be carried out after installation into the machine or on the bench test.



103 Hilfspumpe montieren.
Hinweis: Drehrichtung beachten.

Assemble auxiliary pump.
Note: Take care of direction of rotation.



104 Ansteuergerät montieren.

Assemble control device.

Anziehdrehmomente für Schaftschrauben (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Schaftschrauben mit metrischem ISO-Regelgewinde und Kopfauflagemaßen nach DIN 912, DIN 931 und DIN 933. Außerdem gelten diese Werte nur für leicht oder nicht geölte, unbehandelte Oberflächen, sowie nur bei Verwendung von Drehmoment- und Kraftbegrenzungsschlüsseln.

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment(Nm)		
M 3	1,1	1,6	1,9
M 4	2,9	4,1	4,9
M 5	6	8,5	10
M 6	10	14	17
M 8	25	96	41
M10	49	69	83
M12	86	120	145
M14	135	190	230
M16	210	295	355
M18	290	405	485
M 20	410	580	690
M 22	550	780	930
M 24	710	1000	1200
M 27	1050	1500	1800
M 30	1450	2000	2400

Tightening torques for shaft bolts (Metric ISO Standard Thread)

The values for tightening torques shown in the table are valid only for shaft bolts with metric ISO- standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or unoiled, untreated surface as well as for use only with torque-indicating wrenches and force limiting tools.

Thread size	Strength Classes 8.8	10.9	12.9
	Tightening Torque (lb.ft)		
M 3	0,8	1,2	1,4
M 4	2,1	3,0	3,6
M 5	4,4	6,3	7,4
M 6	7,4	10,3	12,5
M 8	18,4	25,8	30,2
M10	36,1	50,9	61,2
M12	63,4	88,4	106,9
M14	99,5	140,0	169,5
M16	154,8	217,4	261,6
M18	213,7	298,5	357,4
M 20	302,2	427,5	508,5
M 22	405,4	574,9	685,4
M 24	523,5	737,0	884,4
M 27	773,9	1105,5	1326,6
M 30	1068,7	1474,0	1768,8

Anziehdrehmomente für Verschlußschrauben VSTI (Metrisches Feingewinde)

Gewindegröße	Bezeichnung		Anziehdrehmoment(Nm)
M 8 x 1	VSTI 8 x 1	-ED/SA	= 5
M 10 x 1	VSTI 10 x1	-ED	= 10
M 12 x 1,5	VSTI 12 x 1,5	-ED	= 20
M 14 x 1,5	VSTI 14 x 1,5	-ED	= 30
M 16 x 1,5	VSTI 16 x 1,5	-ED/SA	= 30
M 18 x 1,5	VSTI 18 x 1,5	-ED/SA	= 40
M 20 x 1,5	VSTI 20 x 1,5	-ED/SA	= 50
M 22 x 1,5	VSTI 22 x 1,5	-ED	= 60
M 26 x 1,5	VSTI 16 x 1,5	-ED/SA	= 70
M 27 x 2	VSTI 27 x 2	-ED	= 90
M 30 x 1 ,5	VSTI 30 x 1,5	-ED/SA	= 100
M 33 x 2	VSTI 33 x 2	-ED/SA	= 120
M 42 x 2	VSTI 42 x 2	-ED/SA	= 200
M 48 x 2	VSTI 48 x 2	-ED	= 300

Tightening torques for locking screws VSTI (Metric ISO fine thread)

Thread size	Designation		Tightening torques (lb.ft)
M 8 x 1	VSTI 8 x 1	-ED/SA	= 4
M 10 x 1	VSTI 10 x1	-ED	= 7
M 12 x 1,5	VSTI 12 x 1,5	-ED	= 15
M 14 x 1,5	VSTI 14 x 1,5	-ED	= 22
M 16 x 1,5	VSTI 16 x 1,5	-ED/SA	= 22
M 18 x 1,5	VSTI 18 x 1,5	-ED/SA	= 29
M 20 x 1,5	VSTI 20 x 1,5	-ED/SA	= 37
M 22 x 1,5	VSTI 22 x 1,5	-ED	= 44
M 26 x 1,5	VSTI 16 x 1,5	-ED/SA	= 51
M 27 x 2	VSTI 27 x 2	-ED	= 66
M 30 x 1 ,5	VSTI 30 x 1,5	-ED/SA	= 74
M 33 x 2	VSTI 33 x 2	-ED/SA	= 88
M 42 x 2	VSTI 42 x 2	-ED/SA	= 147
M 48 x 2	VSTI 48 x 2	-ED	= 220

Anziehdrehmomente für Seal-Lock Bundmuttern (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Seal-Lock Bundmuttern der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde.

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment (Nm)		
M 6	10		
M 8	22		
M 10	40		
M 12	69		
M 14	110		
M 16	170		

Tightening torques for seal-lock nuts (Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal-lock nuts of the strength class 8.8 and with metric ISO-standard thread.

Thread size	Strength classes 8.8	10.9	12.9
	Tightening torque (lb.ft)		
M 6	7,4		
M 8	16,2		
M 10	29,5		
M 12	50,9		
M 14	81,1		
M 16	125,3		

Anziehdrehmomente für Linsenschrauben mit Kreuzschlitz DIN 7985 (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Linsenschrauben mit Kreuzschlitz DIN 7985 der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment(Nm)		
M 3	1,1		
M 4	2,9		
M 5	6		
M 6	10		
M 8	25		
M10	49		

Tightening torques for cross-slotted lens head screws DIN 7985 (Metric ISO- Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.

Thread size	Strength classes 8.8	10.9	12.9
	Tightening torques (lb.ft)		
M 3	0,8		
M 4	2,1		
M 5	4,4		
M 6	7,4		
M 8	18,4		
M10	36,1		

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers

Vor dem Start

- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine auf auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontrolleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ihrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine, ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine, benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.

Before starting

- Observe the operating instructions before starting.
- Check the machine for obvious faults.
- Do not operate the machine with defective instruments, warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering the driver's cabin, check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver's cabin, use stairs and handles.
- Adjust your seat before starting.

Starten

- Beim Starten müssen alle Bedienhebel in "Neutralstellung" stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start, um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht, während der Motor läuft.
- Beim Start mit Batterieverbindungskabeln verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

Start

- When starting all operating levers must be in "neutral position".
- Only start the machine from the driver's seat
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect negative (-) cable last and disconnect negative cable first.

Vorsicht

- Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Attention

- Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulikanlage

1. Hydraulikanlage steht unter hohem Druck!

   ⚠ Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!
2. Bei der Suche nach Leckstellen wegen Ver letzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Maschine gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

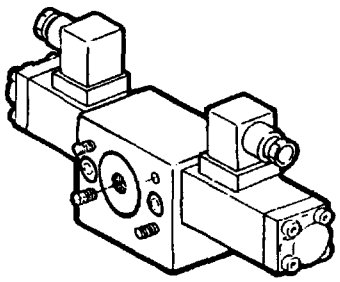
⚠ Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

Hydraulic equipment

1. Hydraulic equipment is standing under high pressure.

   ⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries. Therefore immediately consult a doctor as otherwise heavy infections can be caused.
2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the machine.
4. When working at the hydraulic equipment, absolutely stop motor and secure machine against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the tunctions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of dammage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!



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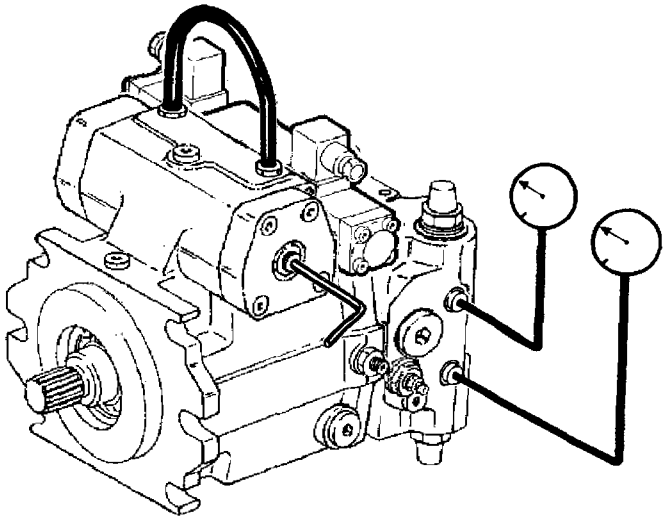

Achtung!
Sicherheitsbestimmungen beachten!
Mit Schlauch NW6 beide Stellkammern verbinden. Vermeidung von Restsignal aus hydraulischer Nullage.
Manometer an M_A und M_B anschließen.
Nullage so einstellen, daß bei blockiertem Antrieb beide Manometer auf gleichem Druckwert stehen.
Hinweis:
Totband der Nullage - vermitteln.

Attention!
Observe safety regulations!
Connect both control chambers with hose NW6. Avoidance of rest signal from hydraulic zero position.
Connect manometer to M_A and M_B. Adjust zero position so that at blocked drive both manometer indicate the same pressure valve.
Note:
Adjust death line of zero position.

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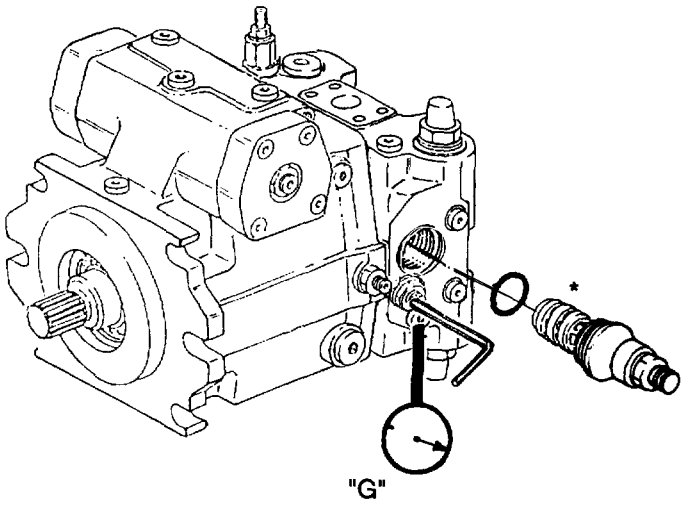


Achtung!
Sicherheitsbestimmungen beachten!

Hinweis:
Nachjustierung nur bei Betriebstemperatur.

Manometer an "G" anschließen.

Achtung!
* Speisedruckeinstellung!
Nenndruck p_H - 18 bar
Höchstdruck p_H - 40 bar
Bei Max.-Drehzahl.

Hinweis:
Einstelldaten nach Werksauftrag.

* bei DA-Ausführung

Attention!
Observe safety regulations!

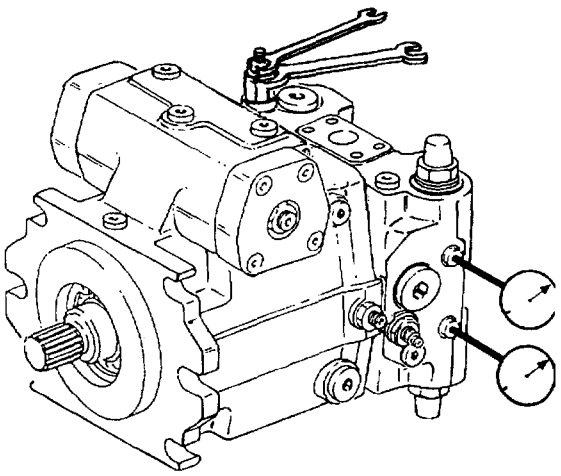
Note:
Readjusting only at operating temperature.

Connect manometer to "G".

Attention!
* Boost pressure setting!
Nominal pressure p_H - 18 bar
Peak pressure p_H - 40 bar
at max. speed.

Note:
Adjusting data according to order.

Druckabschneidung
Pressure cut-off



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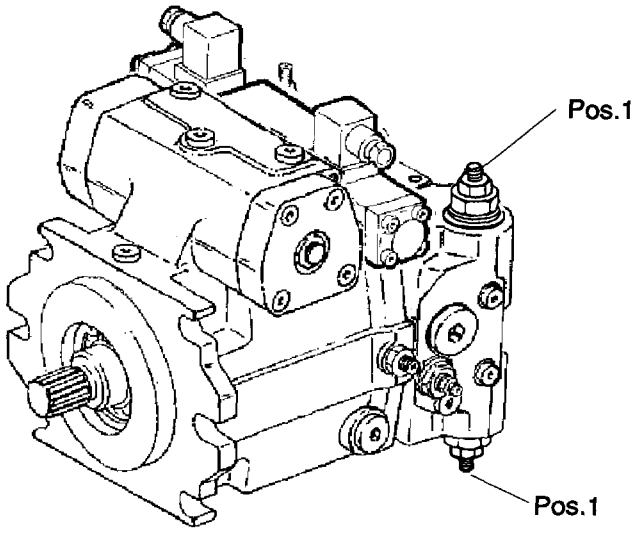
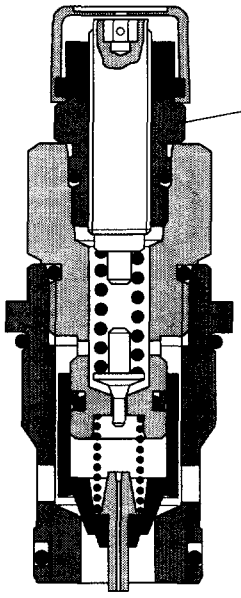
Achtung!
Sicherheitsbestimmungen beachten!

Druckabschneidung:
Einstellschraube auf Maß (*) zurückdrehen.
Druckwert kontrollieren bzw. nachjustieren.
Achtung! Differenz von 10% HD- Ventile und Druckabschneidung beachten!
Hinweis: Einstelldaten nach Werksauftrag.

Attention!
Observe safety regulations.

Pressure cut-off:
Turn back setting screw to measure (*).
Check pressure value and readjust.
Attention! Observe 10% pressure difference HP valves and pressure cut-off!





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Fahrzeuge mit rein-hydrostatischem Fahrantrieb bzw. mit hydrostatischem Fahrantrieb und Schaltgetriebe ohne Leerlaufstellung (Freilauf).

Hydrostatischer Antrieb / Bypaß-Schaltung

In diesem Fall wird der Fahrantrieb auf freien Umlauf geschaltet. Zu diesem Zweck haben die in der Verstellpumpe integrierten Hochdruckbegrenzungsventile eine sogenannte Bypaß-Funktion. D.h. durch Drehen der entsprechenden Schraube (Pos.1) wird der Ventil-Einsatz so entspannt, daß ein freier Öl-Umlauf möglich ist.

Schleppgeschwindigkeit
Die maximale Schleppgeschwindigkeit sollte 2 km/h nicht überschreiten.

- Höhere zulässige Schleppgeschwindigkeiten sind abhängig von der Hydromotordrehzahl bzw. dem eingelegten Gang.

Abschleppdistanz
Die Schleppentfernung sollte 1 km nicht überschreiten.

- Bei fehlender Einspeisung entleert sich der Hydraulik-Kreislauf.
  Zu beachten ist die Wärmeentwicklung im Hydromotor-Triebwerk.

Abschleppvorgang beendet
Nach beendetem Abschleppvorgang Pos.1 zurückdrehen. Der ursprüngliche Einstellwert der Hochdruckventile liegt somit wieder vor.

Vehicle with hydrostatic transmission and gear shift without idling setting position (free wheeling).

Hydrostatic transmission / Bypass-switching

In this case the travel transmission is switched on to free wheeling.For this purpose the variable displacement pump has incorporated high pressure relief valves with bypass function.
The screw (item 1) is unscrewed to such an extent, that the valve cartridge is released and free oil circulation is possible.

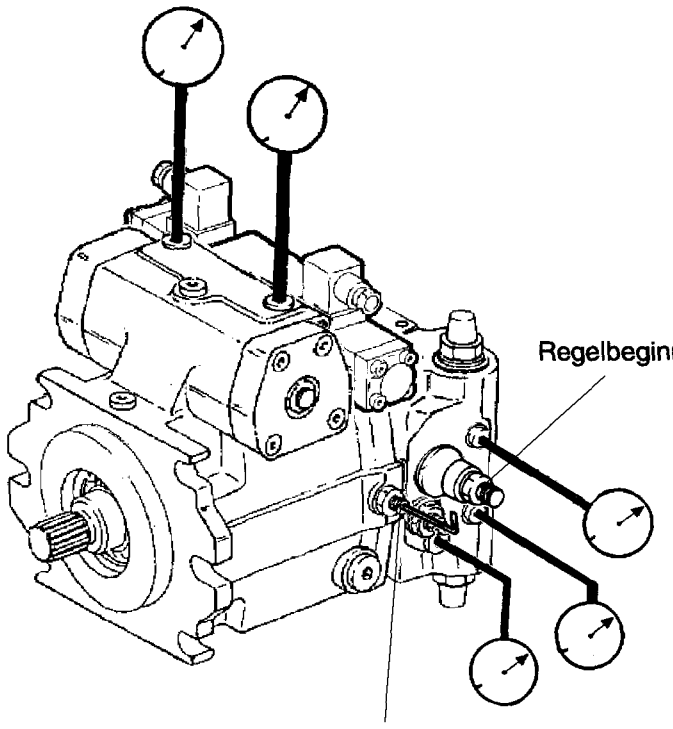
Towing speed
The max. towing speed of 2 km/h should not be exceeded.

- Higher admissible towing speeds depend on the avaiable hydr. motor speed and engaged gear shift.

Towing distance
The towing distance should not exceed 1 km.

- If there is a lack of oil boosting, the hydraulic circuit will get empty.
  Take care of the heat development in the hydr. motor-rotary group.

Towing operation terminated
After termination of the towing operation turn item 1 back. The original pressure value setting of the high pressure relief valves will be avaiable again.



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Achtung!
Sicherheitsbestimmungen beachten!

Überprüfung der Einstelldaten
Betriebstemperatur soll während des Überprüfungsvorgangs weitgehend konstant gehalten werden.
Antriebsmotor starten, Leerlaufdrehzahl

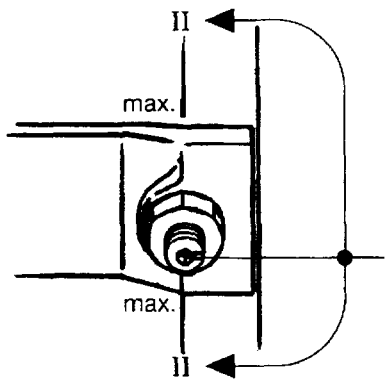
Blockzustand
Fahrtrichtungsschalter **"0"**
Motordrehzahl langsam steigern bis zur max. Motordrehzahl, dabei Meßgeräte beobachten.
Speisedruck:
Leerlaufdrehzahl
Psp = ca. 15-20 bar
max. Motordrehzahl
Psp = 25 ± 2 bar*

Blockzustand
Fahrtrichtungsschalter - vorwärts
(Straßengang und Festgebremst)

Einstelldaten Pumpe A4V/DA überprüfen
Regelbeginn
HD 40 - 50 bar
Motordrehzahl . min.[1] * Psp . . . . . bar*
HD 50 bar
Nachjustierung - Regelbeginnschraube

Regelende
HD 400 bar*
Motordrehzahl min.[1] * Psp . . . . . bar*
Nachjustierung - Verdrillschraube

Hinweis:
Excenterjustierung - Drehrichtung beachten



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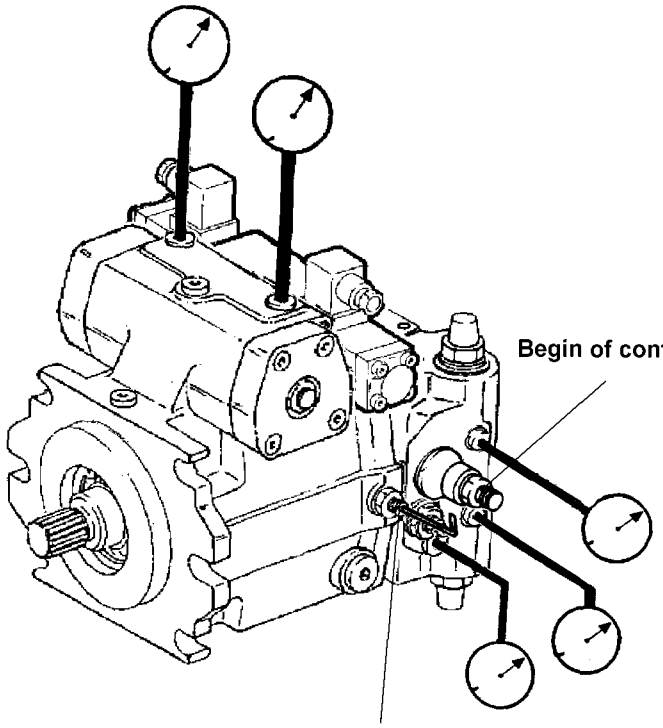
Hinweis: * Einstelldaten nach Werksauftrag!



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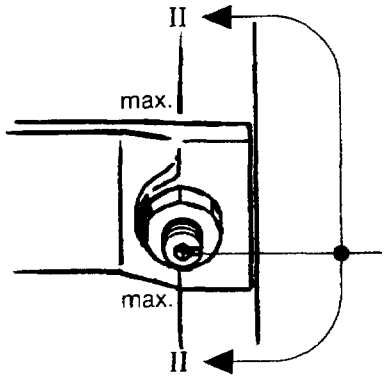

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Attention!
Observe safety regulations!

Check setting data.
Operating temperature should be kept largely constant during the check procedure.
Start prime mover, idle speed.

Block position
Drive direction switch - **"0"**.
Slowly increase motor speed up to the max. motor speed and thereby observe measuring instruments.

Boost pressure:
Idle speed of prime mover
Psp = approx. 15 - 20 bar
max. motor speed
Psp = 25 ± 2 bar*

Block position
Drive direction switch - **forward**
(Road gear and fully applied brake)

Check setting data pump A4VIDA
Begin of control:
HD 40 - 50 bar
Motor speed 1100 rpm* Psp . . . . . bar*
HD 50 bar*
Readjusting - control start screw

End of control
HD 400 bar
Motor speed 2000 rpm* Psp . . . . . bar*
Readjusting timing adjustment screw

Note:
Eccentric adjusting - observe direction of rotation

* Setting data according to order!

Hinweis!

Um eine ordnungsgemäße Abwicklung von Ersatzteil-Aufträgen sicherzustellen, muß die Bestellung folgende Angaben enthalten:

Typenschlüssel
Typ-Nr.
Fabrikations-Nr.
Baugruppe
Position
Benennung

Zur Reparatur des Gerätes empfehlen wir die Verwendung von vormontierten und teilgeprüften Baugruppen.

Note!

In order to supply proper spare parts, please provide following specifications when ordering spares:

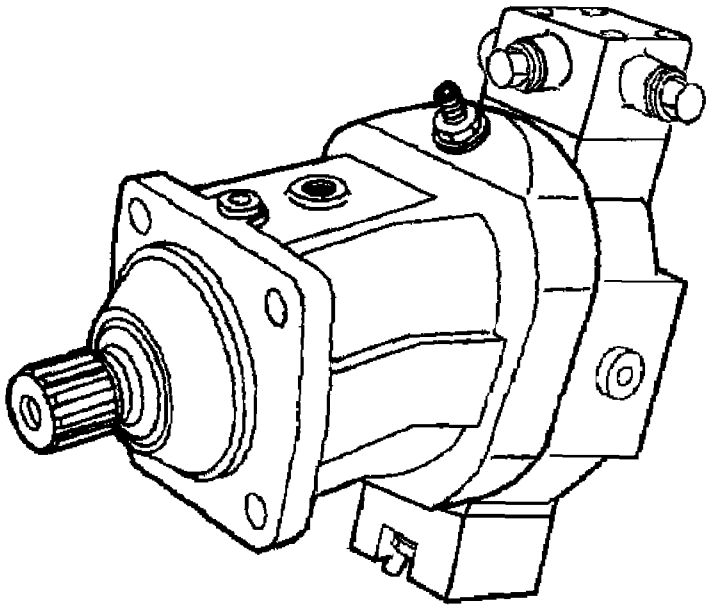
Type Code
Type Number
Serial Number
Assembly Group
Item
Designation

In repairing the unit, we recommend the use of pre-assembled partially tested assembly groups.

Reparaturanleitung
Repair Instructions

A6VM 107

Baureihe / Series 63



HINWEIS

Bezeichnungen, Beschreibungen und Darstellungen entsprechen dem Informationsstand zum Zeitpunkt der Drucklegung dieser Unterlage.

Änderungen können den Service am Produkt beeinflussen, Verpflichtungen entstehen uns daraus nicht.

Methoden und Vorrichtungen sind Empfehlungen, für deren Resultat wir keine Haftung übernehmen können.

Einstell- und Prüfarbeiten sind bei Betriebstemperatur auf dem Teststand vorzunehmen.

Schutz von Personen und Eigentum ist durch Vorkehrungen sicherzustellen.

Sachkenntnis, die Voraussetzung für jede Servicearbeit, vermitteln wir in unseren Schulungskursen.

NOTICE

Specifications, descriptions and illustrative material shown herein were as accurate as known at the time this publication was approved for printing.

The right to discontinue models or options at any time or to change specifications, materials, or design without notice and without incurring obligation, is reserved.

Optional equipment and accessories may add cost to the basic unit, and some options are available only in combination with certain models or other options.

For the available combinations refer to the relevant data sheet for the basic unit and the desired option.

Adjustment and tests have to be carried out on the test bench under operating temperatures.

Protection of personnel and property has to be guaranteed by appropriate measures.

Expert knowledge, the precondition of any service work, can be obtained in our training courses.

INHALT

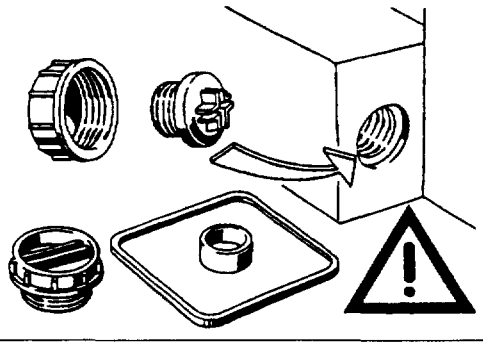
A6VM

CONTENTS

A6VM

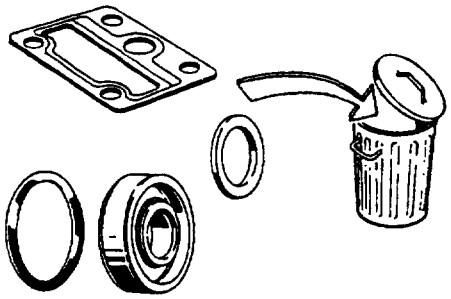
Achtung!
Nachfolgend Hinweise bei allen Reparaturarbeiten an Hydraulikaggregaten beachten!

Attention!
Observe the following notices when carrying out repair work at hydraulic aggregates!



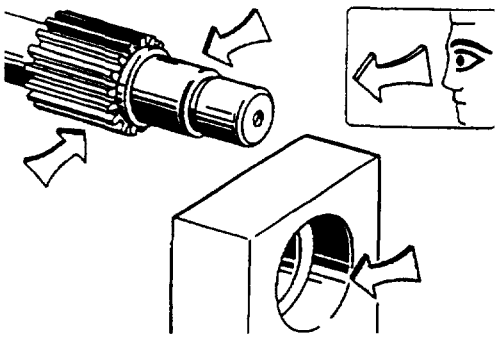
Alle Öffnungen der Hydraulikaggregate verschließen.

Close all ports of the hydraulic aggregates.



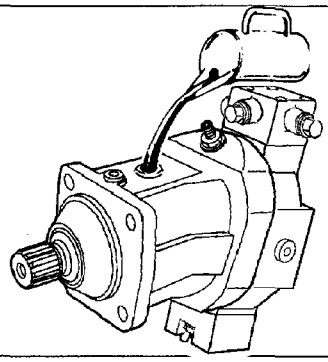
Alle Dichtungen erneuern.

Replace all seals.



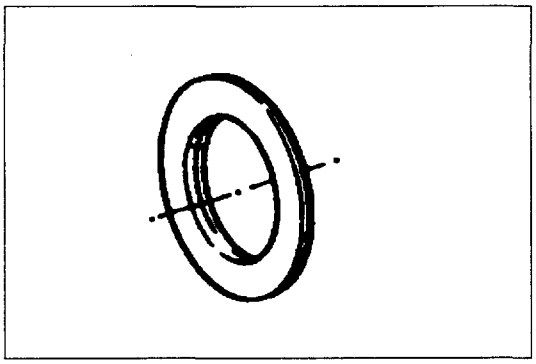
Alle Dicht- und Gleitflächen auf Verschleiß prüfen.
Achtung: Nacharbeiten an Dichtflächen z.B. durch Schleifpapier kann die Oberfläche beschädigen.

Check all seal and sliding surfaces for wear.
Attention: Rework of sealing area f. ex. with abrasive paper can damage surface.



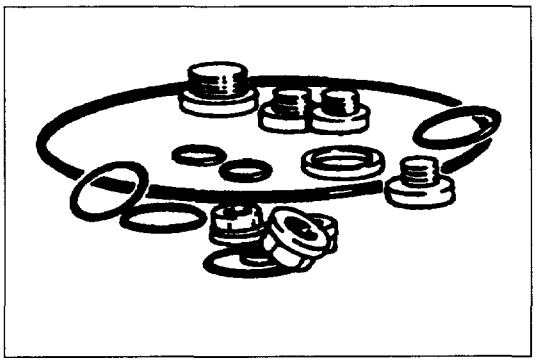
Hydraulikaggregate vor Inbetriebnahme mit Betriebsmedium befüllen.

Fill up hydraulic aggregates with medium before start- up.



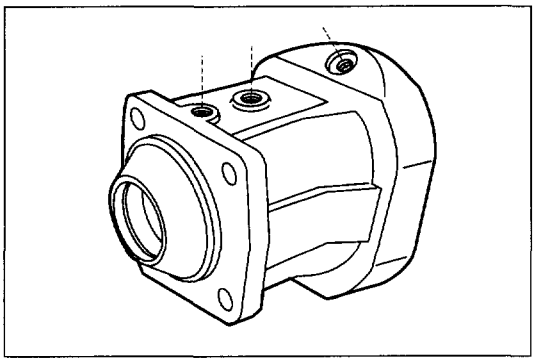
1 Dichtsatz für Triebwelle.

Seal kit for drive shaft.



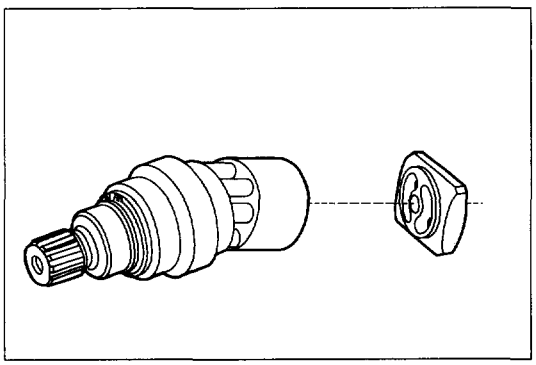
2 Äußerer Dichtsatz.

External seal kit.



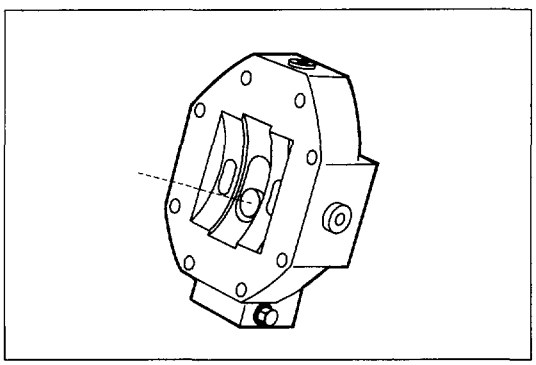
3 Gehäuse

Housing



4 Triebwerk komplett

Complete rotary group



5 Anschlußplatte mit Stellkolben

Port plate with control piston

6

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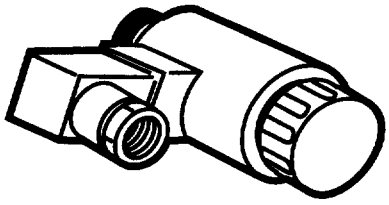

Schaltmagnet

Solenoid

8

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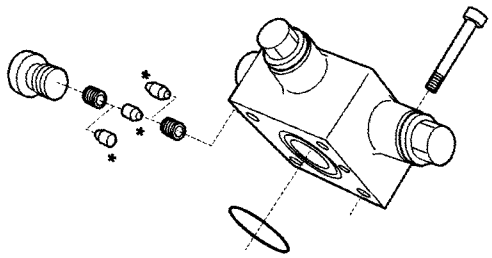
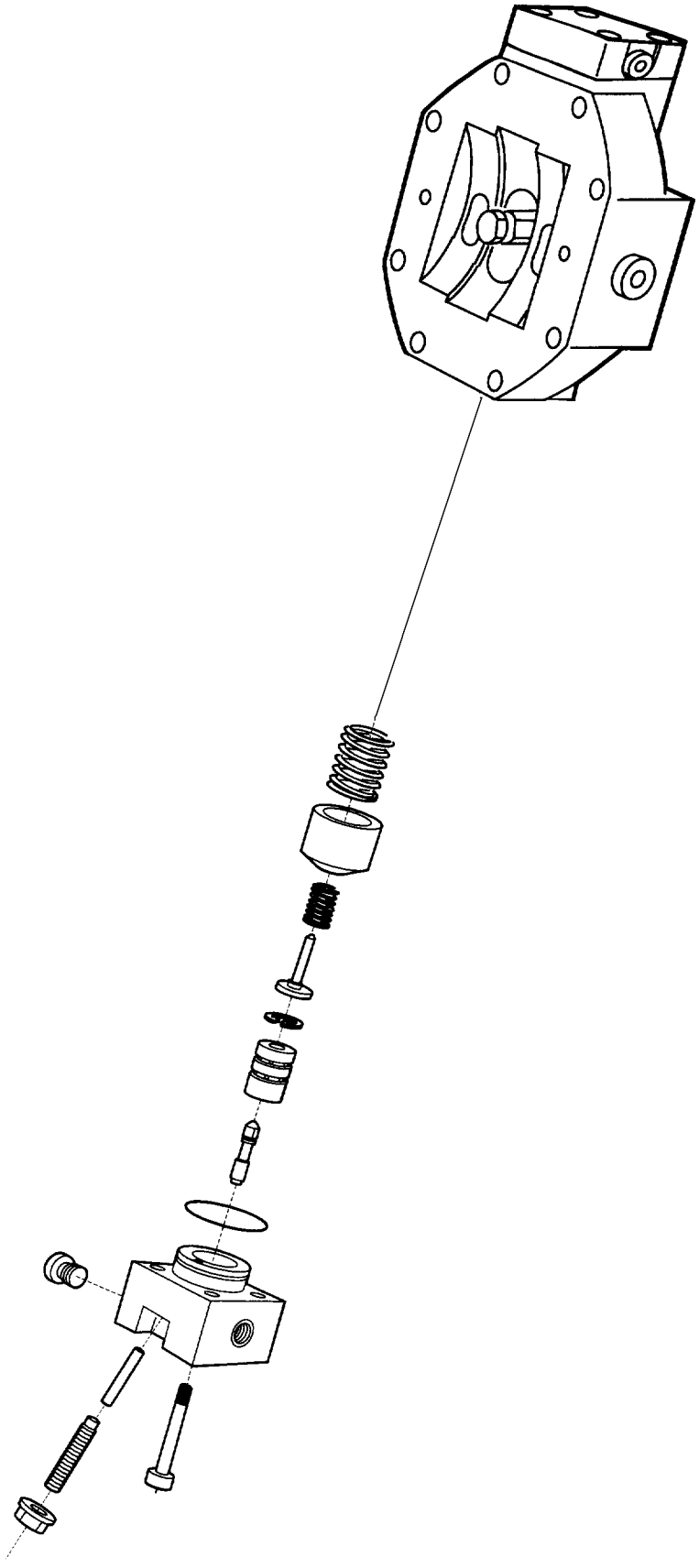
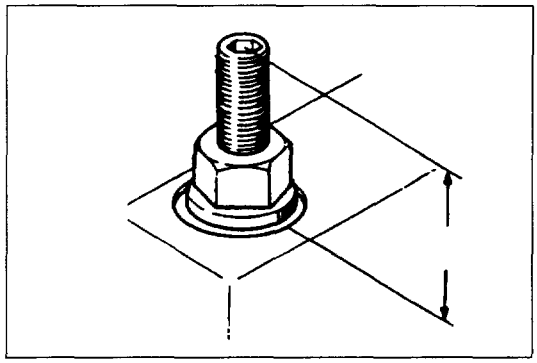


Deckel mit Spül- und Speisedruckventil und * Drosselstift
* Drosselstift "Auftragsbezogen".

Cover with flushing and boost pressure valve and
* throttle pin.
* Throttle pin "as to order requirement".

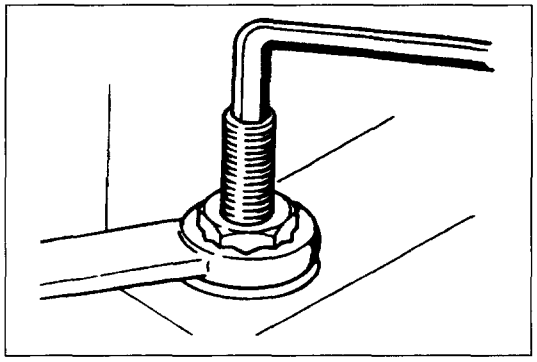
HA





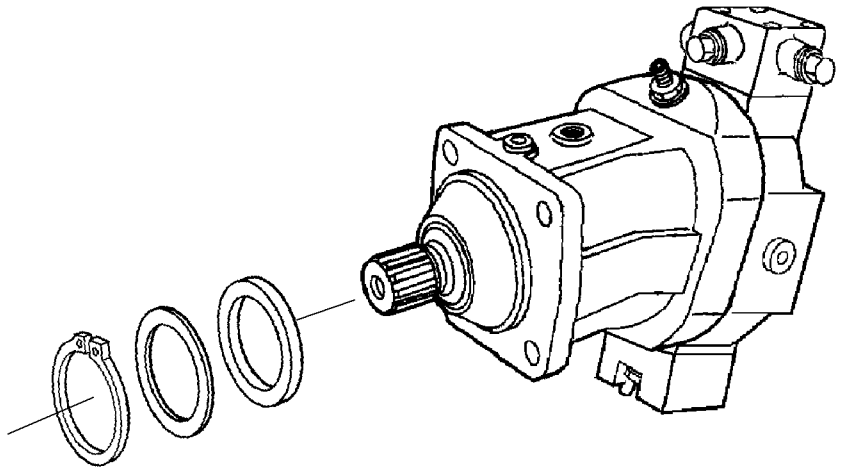
10 Dichtmutter austauschen.
Zuerst Einstellhöhe messen und festhalten.

Replace seal nut.
First measure and record setting height.



11 Beim Anziehen Einstellschraube gegenhalten, anschließend Einstellhöhe kontrollieren.

When tightening, counterhold setting screw, then check setting height.



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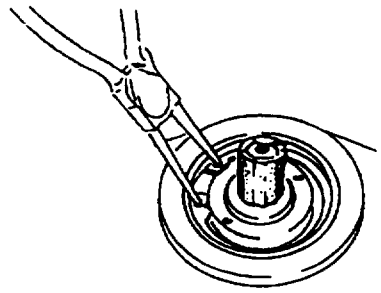
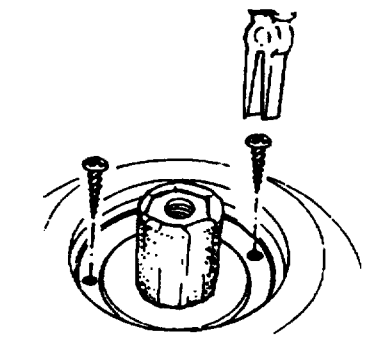


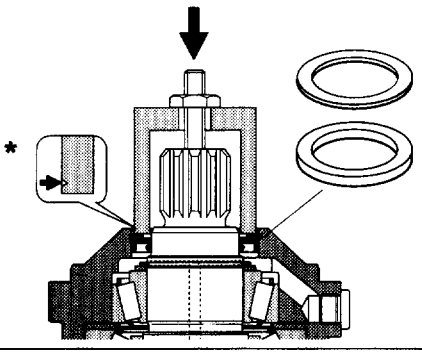
13 Triebwelle abkleben.
Sicherungsring und Scheibe ausbauen.

Protecting the drive shaft.
Remove retaining ring and shim.



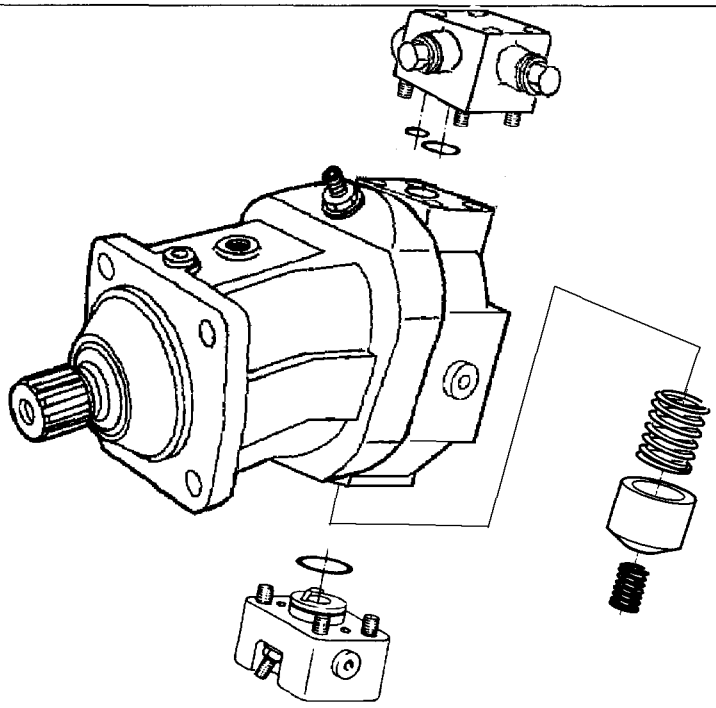
14 Blechschraube in die mit Gummi gefüllten Löcher eindrehen.
Mit Zange WDR herausziehen.

Screw in sheet metal screw into the holes fitted with rubber.
Pull out seal with pliers.



15 Wellendichtring und Scheibe mit Montagehülse einpressen.
⚠ Einpresstiefe beachten! * Marke für Einpresstiefe.
Sicherungsring einbauen.

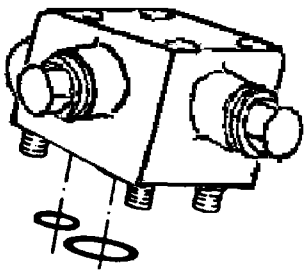
Press in shaft seal ring and shim with bush to stop.
⚠ Take note of press-in depth!
Install mark for press-in depth of safety ring.



Achtung!
Federvorspannung

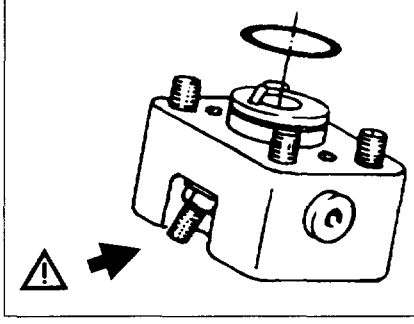
Attention!
Spring load

16



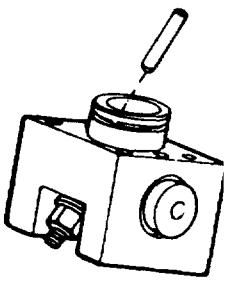
17 Kontrolle
Bohrung im Gehäuse, O-Ring, Nut.

Inspect
Drilling in housing, O-ring, groove.



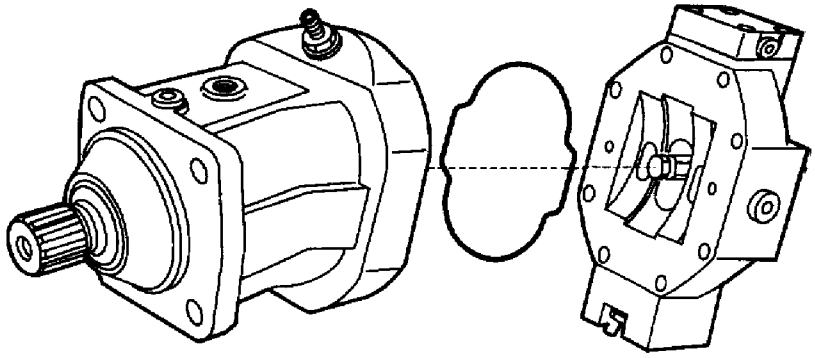
18 ⚠ Einstellschraube nicht ausbauen.
Kontrolle
O-Ring, O-Ring-Nut, Gehäuse

⚠ Do not remove adjustment screw.
Inspect
O-ring, O-ring groove, housing

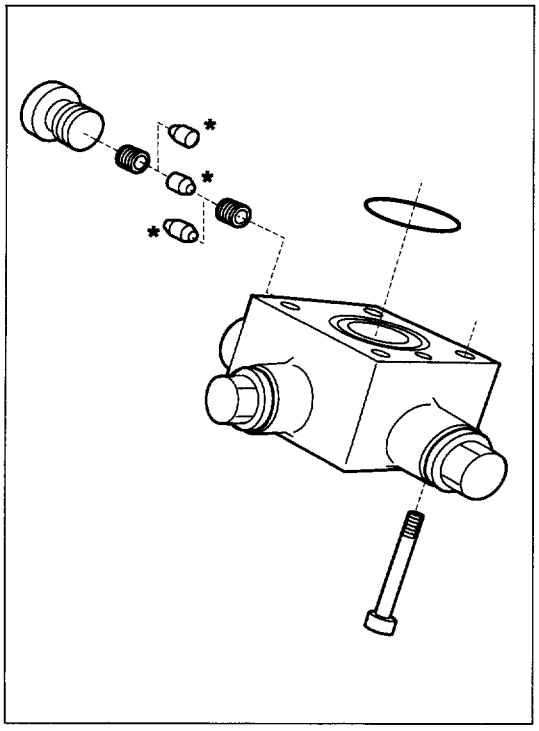


19 Montagehilfe
Stift mit Fett einkleben.

Assembly aid
Insert pin with grease.

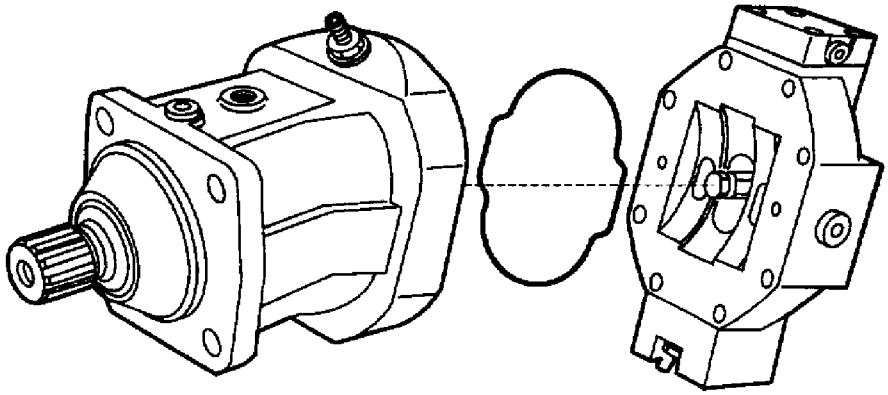


20

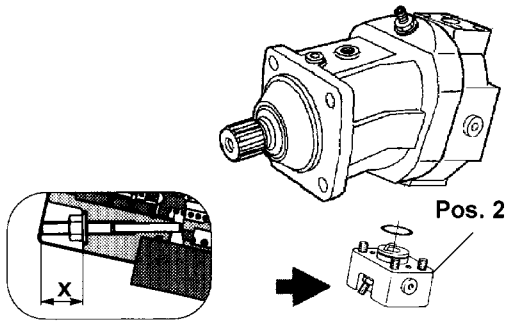


9 Deckel mit Spül- und Speisedruckventil und * Drosselstift
* Drosselstift "Auftragsbezogen".

Cover with flushing and boost pressure valve and
* throttle pin.
* Throttle pin "as to order requirement".



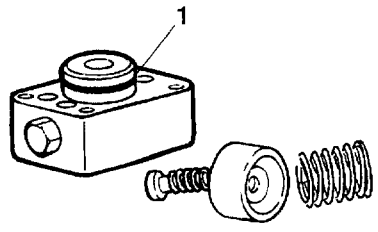
24



25

Beispiel: A6VM ... Verstellung - **Differentialkolben**
Demontageposition: Deckel Pos. 2 abbauen.
⚠ Achtung! Federvorspannung.
⚠ Maß x: Maß festhalten (Regelbeginn).

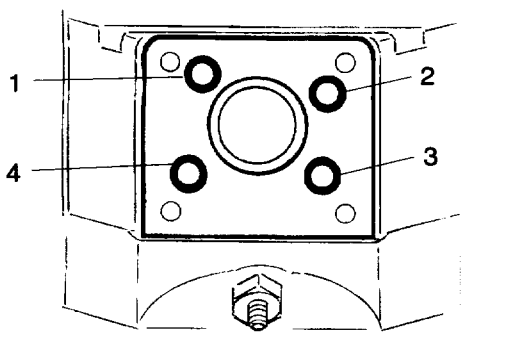
Example: A6VM... control - **differential piston**
Disassembly position: Remove cover pos. 2.
⚠ Attention! Spring load.
⚠ Dimension x: Note dimension (begin of regulation).



26

1. O-Ring Kontrolle

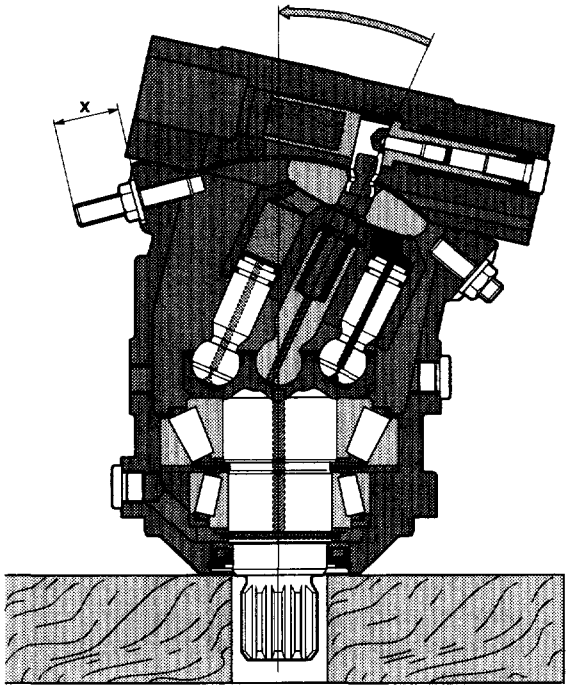
1. Check of O-ring



27

1. Hochdruck - kleine Stellkolbenseite
2. Stelldruck
3. Hochdruck - Rückschlagventil
4. Hochdruck - Rückschlagventil

1. High pressure - small control piston side
2. Control pressure
3. High pressure - check valve
4. High pressure - check valve



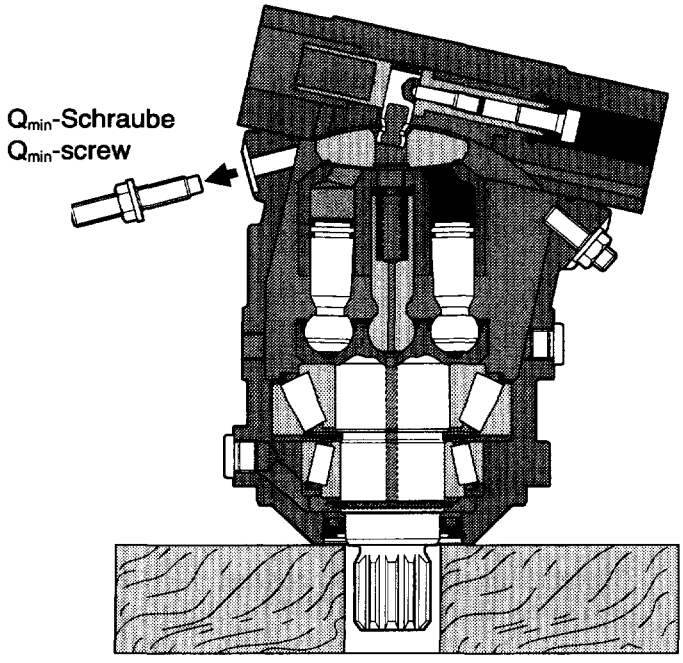
Gleichgangkolben:
Maß X festhalten.

Synchronizing piston:
Note dimension x

⚠

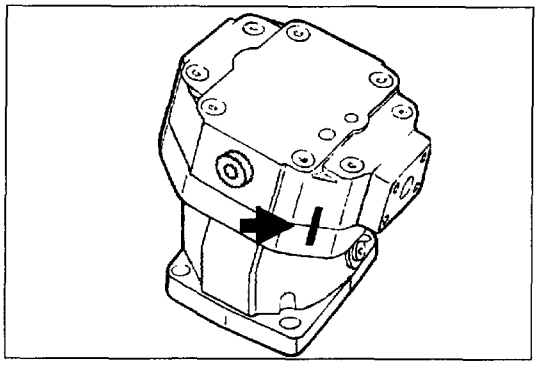
Bei "Demontage" der Anschlußplatte "Triebwerk" immer auf Null schwenken. Kolbenringe hängen aus der Zylinderbohrung aus.

For disassembly of the port plate, swivel always rotary group to zero position. Piston rings to hang out of the cylinder boring.



Q_{min}-Schraube ausbauen.
Triebwerk auf 0° schwenken.

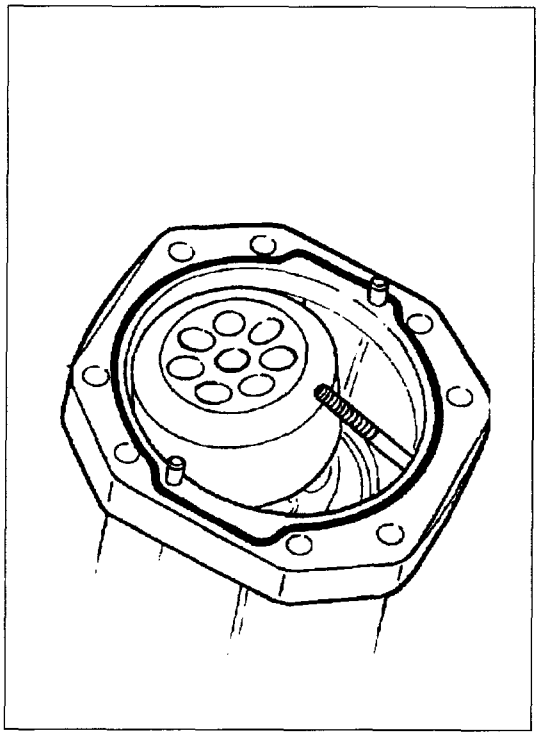
Remove Q_{min}-screw.
Swivel rotary group to 0°.



28

Anschlußplatte
Lage markieren. Schrauben lösen.
Abbauen

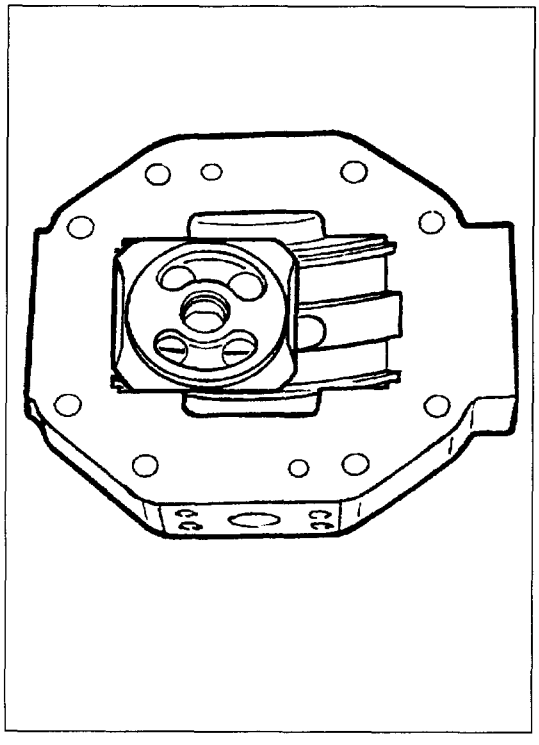
Port plate
Mark position. Loosen screws.
Removal



29

O-Ring austauschen.
Neuer O-Ring mit etwas Fett einkleben.
⚠ Treibwerk nicht ausschwenken.
Kolbenringe hängen aus der Zylinderbohrung aus.

Check O-ring.
Stick new O-ring with some grease.
⚠ Do not swivel rotary group.
Piston rings to hang out from the cylinder boring.



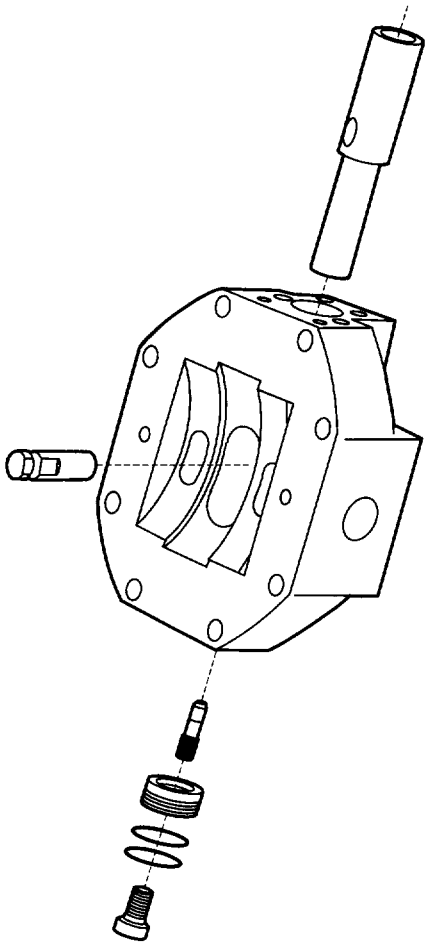
30

⚠ Steuerlinse in Gleitbahn mit Fett einkleben.
Fertigmontage in umgekehrter Reihenfolge.
Anschlußplatte aufsetzen.

⚠ Triebwerk senkrecht.

⚠ Stick control lens in sliding surface with grease.
Assembly in reversal order.
Mount port plate.

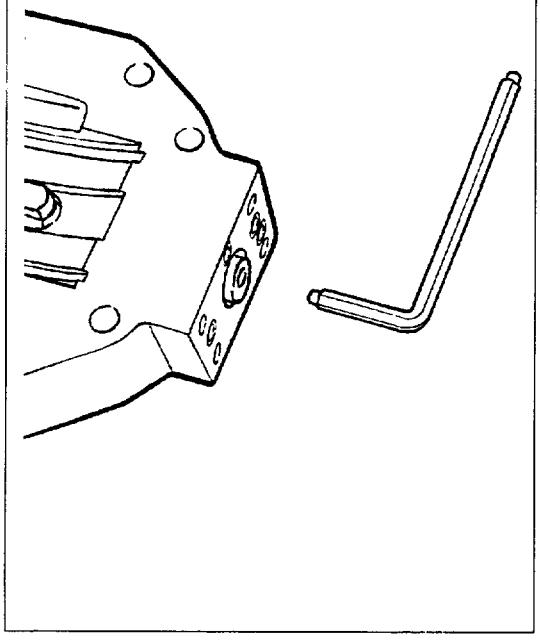
⚠ Rotary group vertical.



Gleichgangkolben

Synchronizing piston

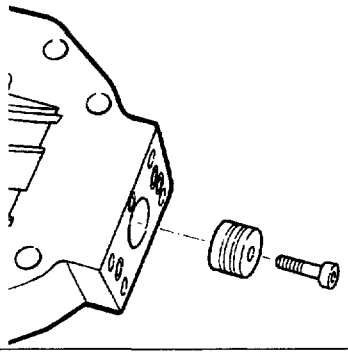
31



32

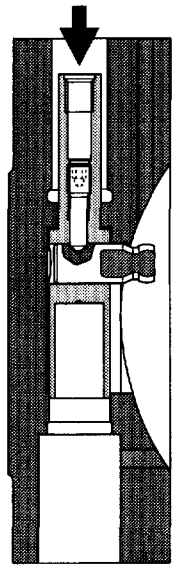
Befestigungsschraube lösen.
Nur Zapfenschlüssel verwenden.

Loosen fixing screw.
Use only socket wrench.



33 Kolben mit Kolbenring ausbauen.

Remove piston with piston ring



34 Gleichgangkolben

Befestigungsschraube für Stellzapfen über Bohrung erwärmen. (Schraube geklebt - herausdrehen)

Neue Schraube verwenden

⚠ Precote Beschichtung

⚠ Anziehdrehmomente beachten!

Synchronizing piston

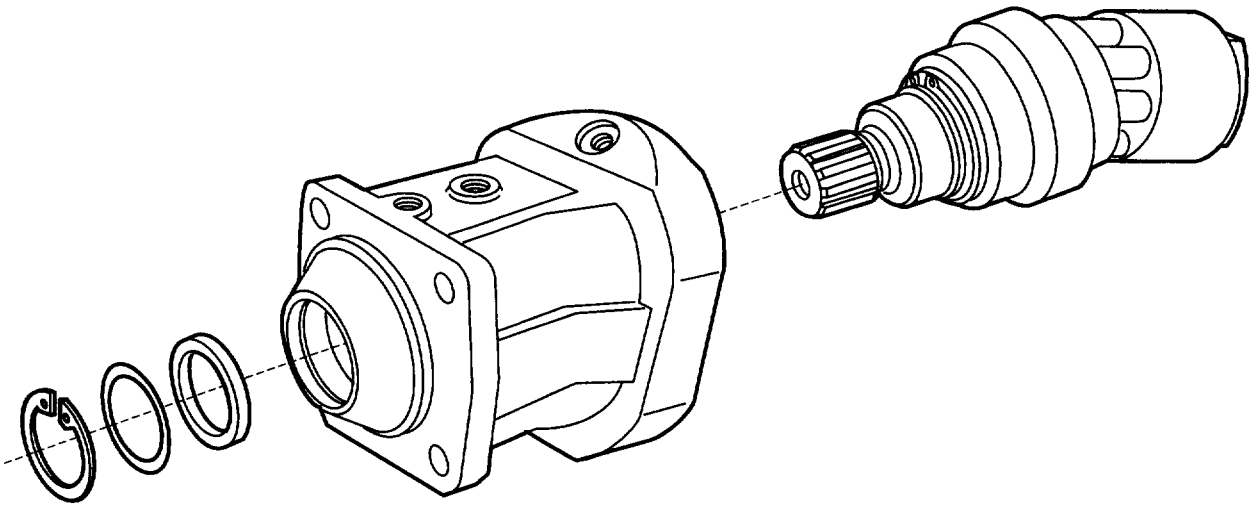
Warm up fixation screw for positioning plug via boring (screw glued - to turn out).

Use new screw.

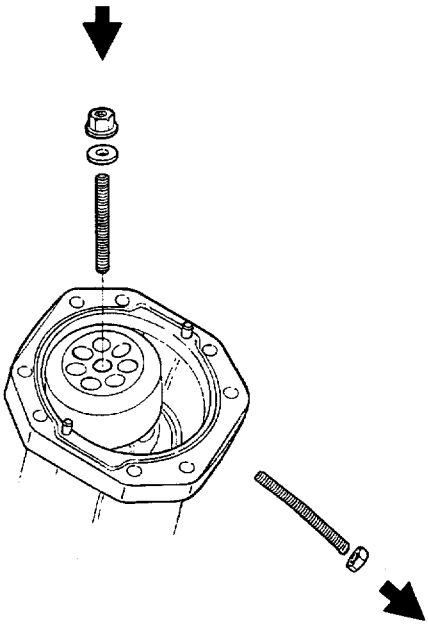
⚠ Precote coating.

⚠ Note tightening torque!

35



36

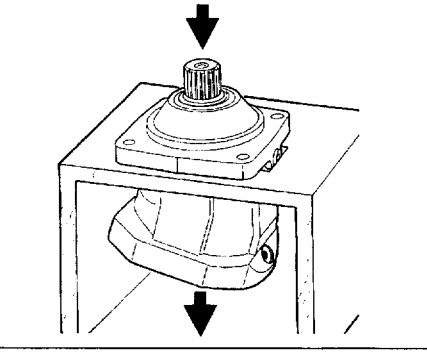


37

Gewindestift in Mittelzapfen einschrauben,
mit Scheibe und Mutter Zylinder befestigen.
Q_{max} - Anschlagschraube ausbauen.

Screw in threaded pin into center pin.
Fix the cylinder with disc and locknut.
Remove Q_{max} -stop screw.

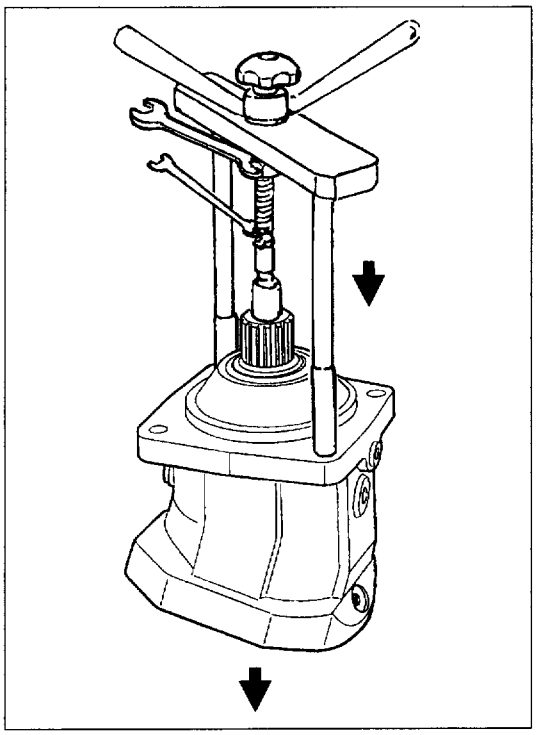
Nenngröße / Size	28 :	M4 x 58 mm
	55 :	M5 x 71 mm
	80 :	M6 x 82 mm
	107 :	M6 x 92 mm
	140 :	M8 x 105 mm
	160 :	M8 x 105 mm
	200 :	M8 x 109 mm



38

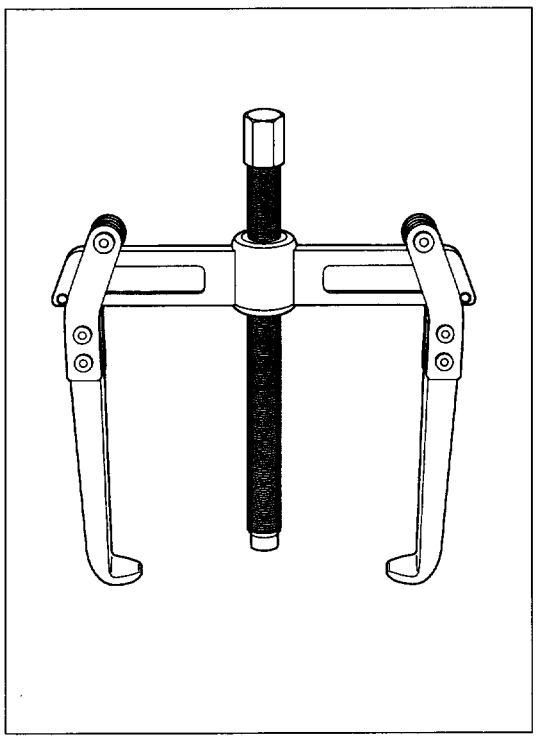
Triebwerk auspressen!
⚠ Bei Wiederverwendung der Lager nicht schlagen.

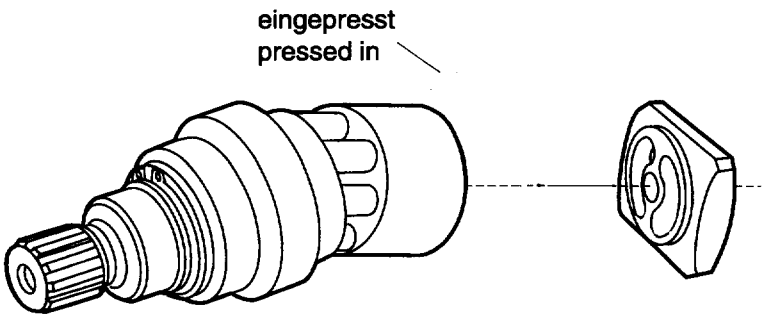
Press out rotary group!
⚠ If the bearings are used again do not hit on the drive shaft.



39 Oder mit Abziehvorrichtung ausdrücken.

Or press-out with extraction device.



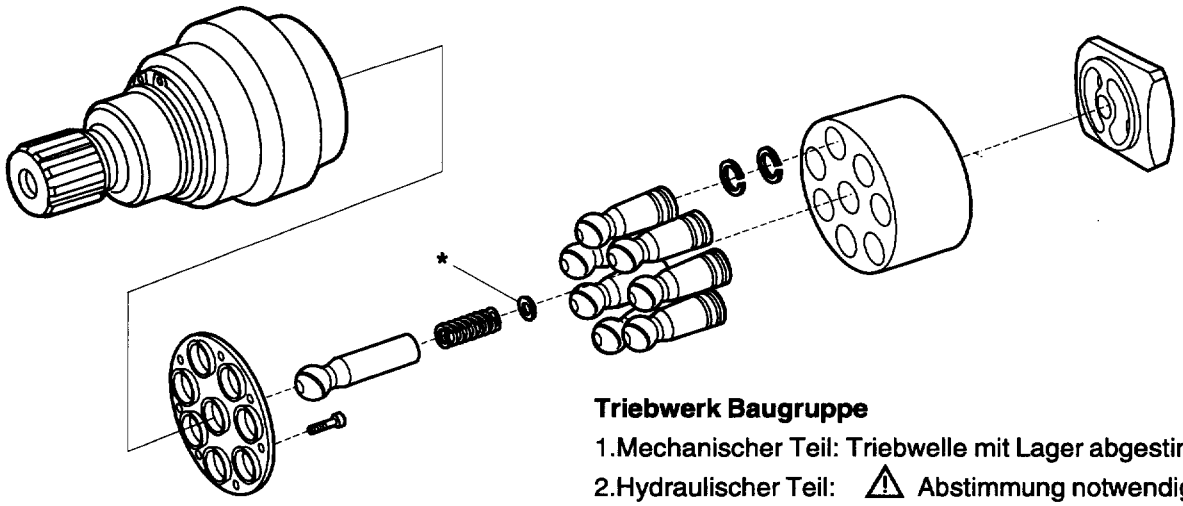


Triebwerk komplett

⚠ Abstimmung hydraulischer Teil notwendig.

Complete rotary group

⚠ Setting of hydraulic part necessary. 40



Triebwerk Baugruppe

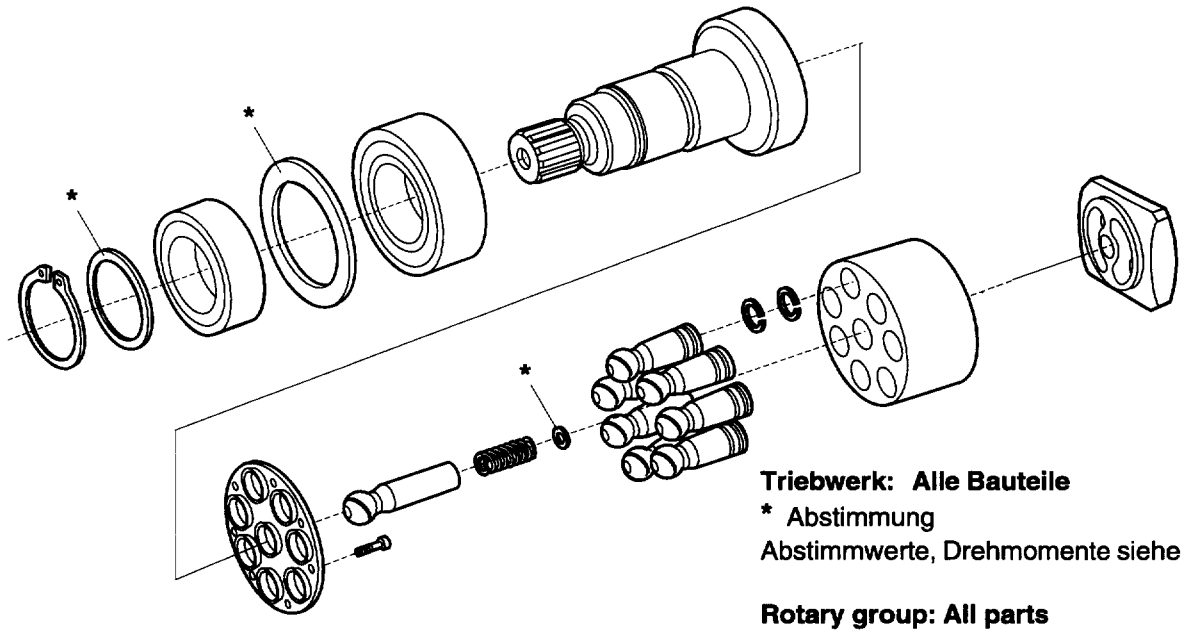
1.Mechanischer Teil: Triebwelle mit Lager abgestimmt.

2.Hydraulischer Teil: ⚠ Abstimmung notwendig *.

Rotary group

1. Mechanical part: Adjust drive shaft with bearing.

2. Hydraulic part: ⚠ Adjustment necessary 41



Triebwerk: Alle Bauteile

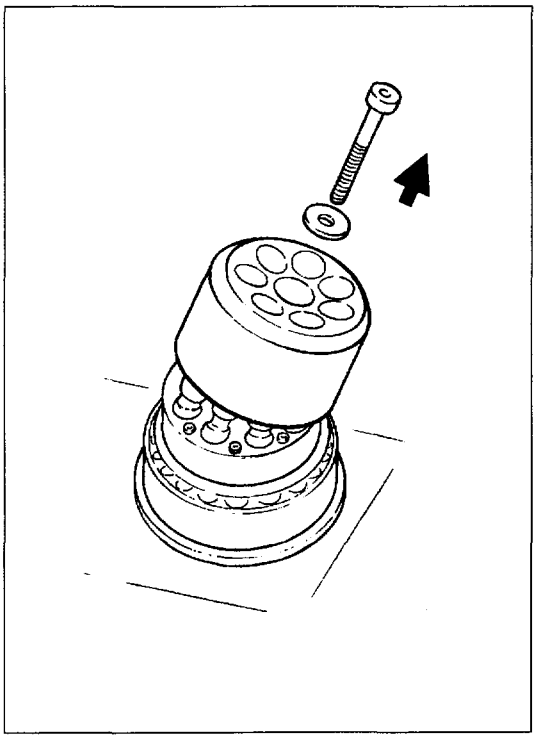
* Abstimmung

Abstimmwerte, Drehmomente siehe Serviceinfo.

Rotary group: All parts

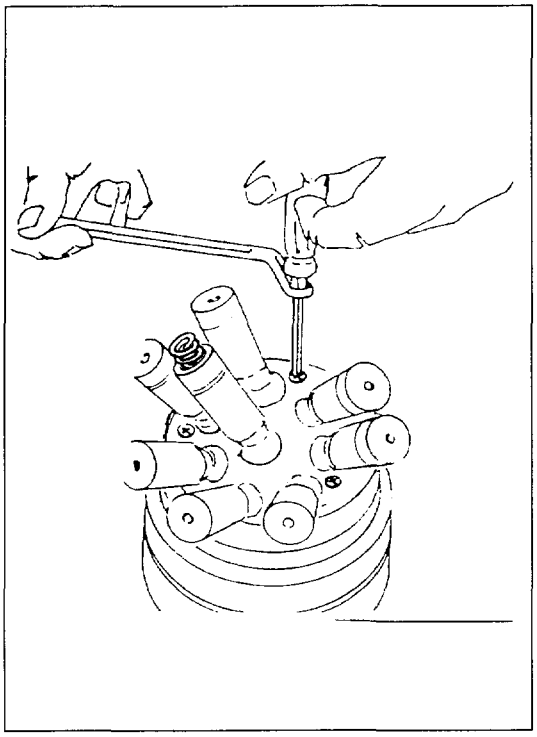
* Setting

Setting value, torque see service information. 42



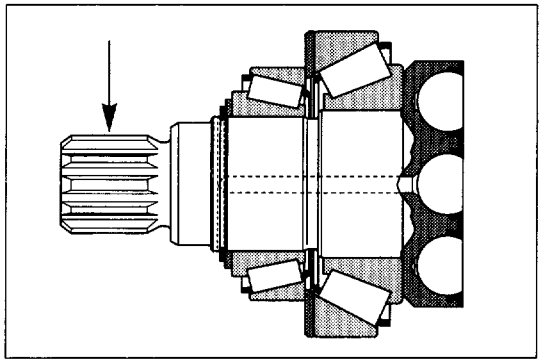
43 Befestigungsschraube (Zylinder) ausbauen.
Zylinder abheben.

Remove fixing screw (cylinder).
Remove cylinder.



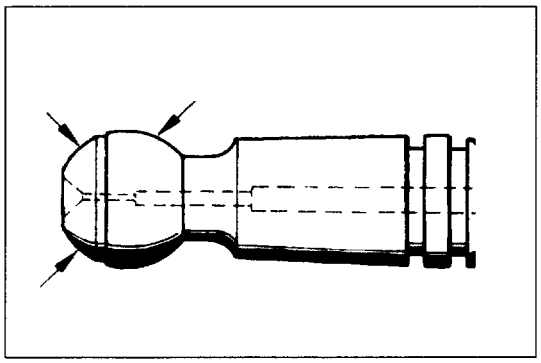
44 Rückzugplatte demontieren.
Schrauben sind eingeklebt.
⚠ Torx-Werkzeug verwenden.

Disassemble retaining plate.
Screws are glued.
⚠ Use Torx-tools.



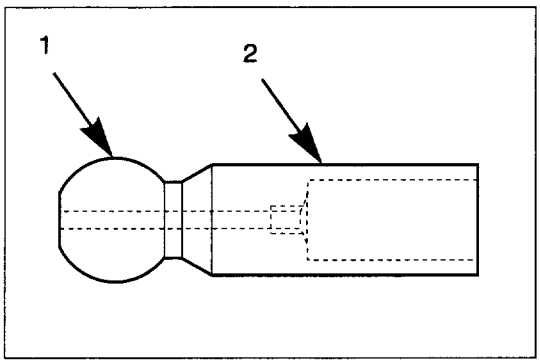
45 Kein Passungsrost, nicht ausgeschlagen.

Free of corrosion, erosion or fretting; no damage to splines or keyways.



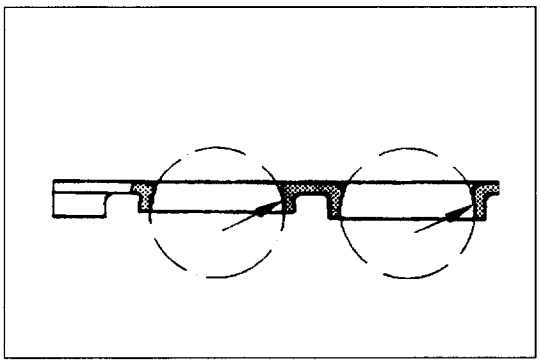
46 Kolben
Riefenfrei und keine Pittings.

Pistons
No scoring and no pittings.



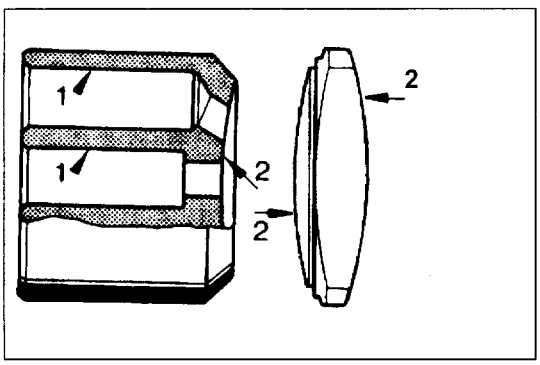
47 Mittelzapfen
Riefenfrei und keine Pittings.

Center pin
No scoring and no pittings.



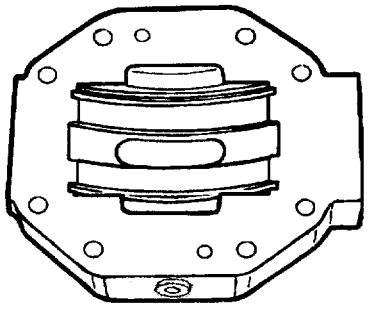
48 Rückzugplatte
Riefenfrei und keine Ausbrüche.

Retaining plate
No scoring and no evidence of wear



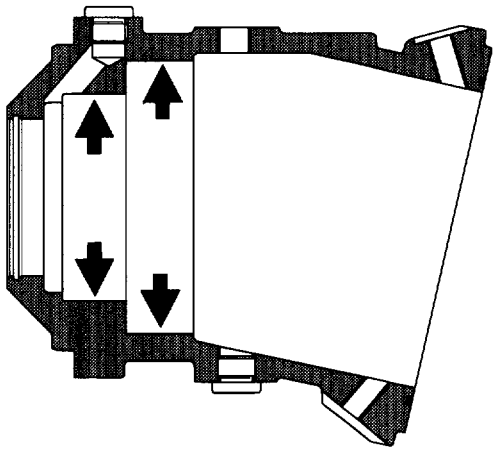
49 Zylinder / Steuerlinse
1 Bohrungen riefenfrei, nicht ausgelaufen.
2 Gleichmäßiges Tragbild, riß- und riefenfrei.

Cylinder block / control lens
1 Bores free of scoring, no evidence of wear.
2 Faces smooth and even, free of cracks and scoring.



50 Reglergehäuse
Gleitbahn und Seitenführung riefenfrei, nicht ausgelaufen.

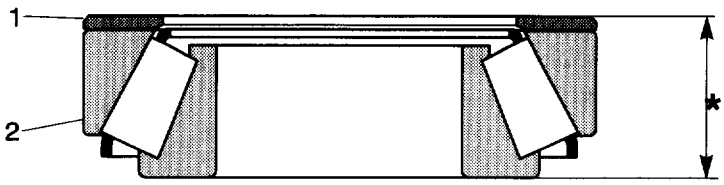
Control housing
Sliding surface and side guides free of scoring and no wear.



51 Sichtkontrolle:
Im Lagerbereich riefenfrei und keine Einlaufspuren.

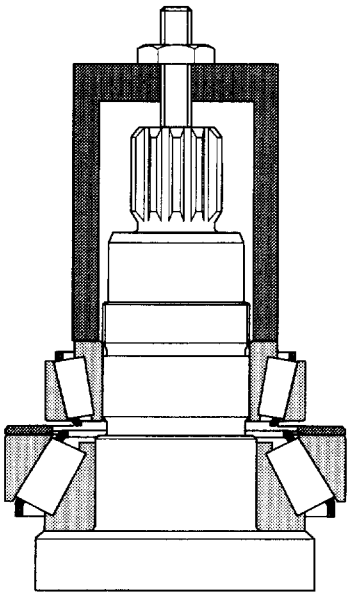
Visual check:
Bearing areas free of scoring and no evidence of wear.

Triebwelle: mechanischer Teil
Rotary group: mechanical part



Abstimmung Maß *
und Lagerdrehmomente
siehe Serviceinfo.

Adjustment dimension *
and bearing torque
see service infoprmation.

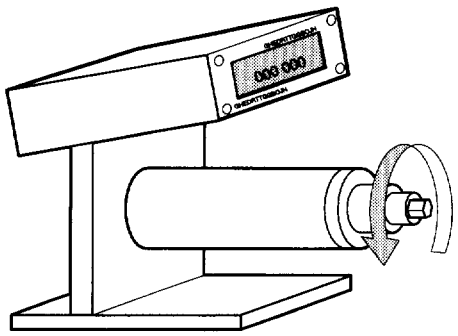


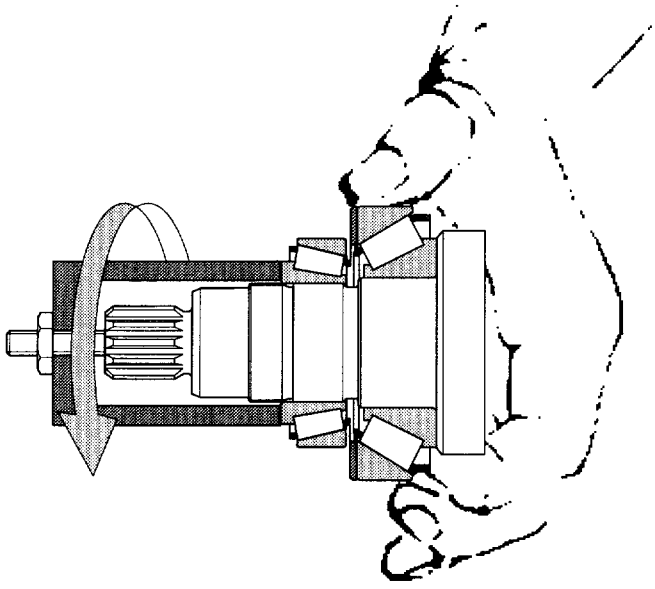
Lager aufpressen.
Beim Aufpressen Lager-
drehmoment nicht überschreiten.

Press on bearing.
Do not exeed bearing torque
during press-on.

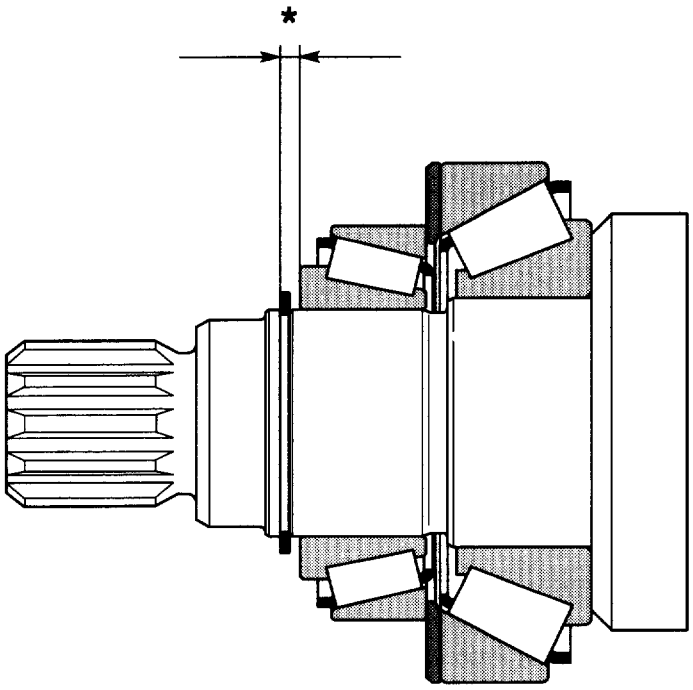
Lager mit Montagehülse vorspannen
und laufende Drehmomentenkontrolle.

Preload bearing with assembly sleeve
and steady control of the torque.



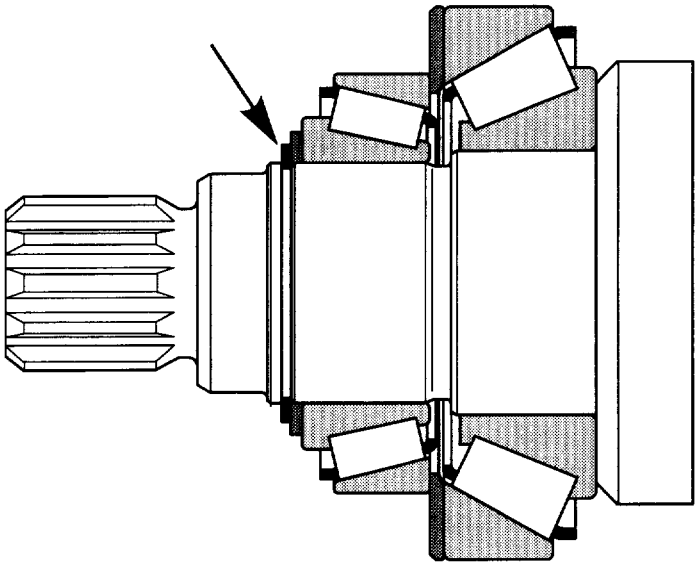


Triebwelle: mechanischer Teil
Rotary group: mechanical part



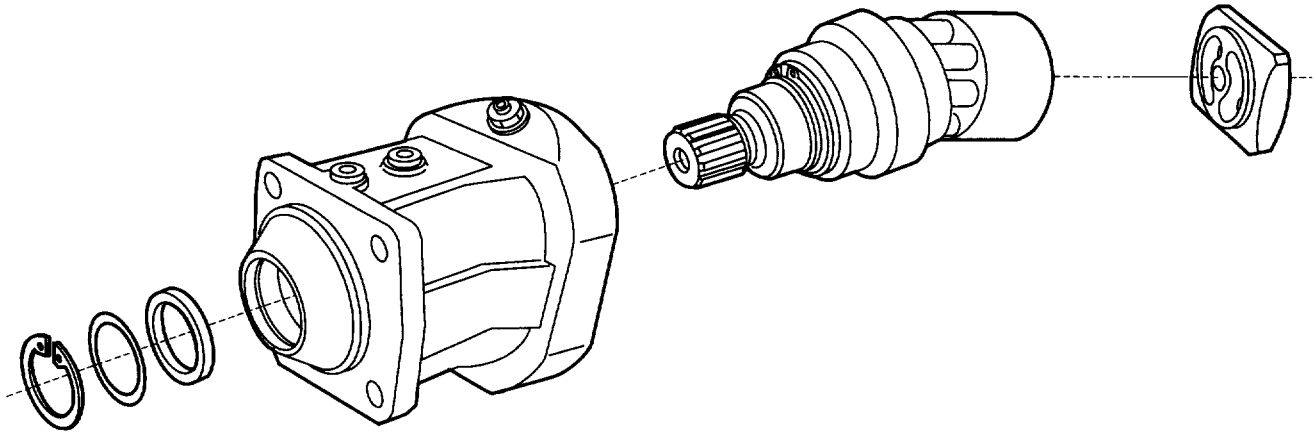
Sicherungsring montieren.
Maß * für Abstimmscheibe mit Endmaßen ermitteln (überkreuz).

Assemble safety ring.
Determine dimension for adjustment disc with final dimensions (crossover).

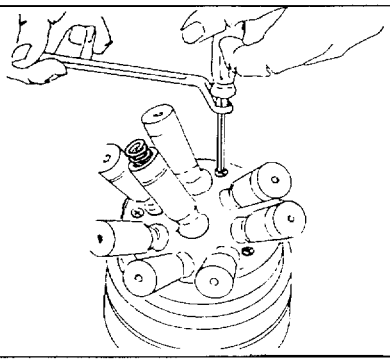


Abstimmscheibe einbauen.
Sicherungsring montieren.
Triebwelle einbaufertig.

Install adjustment disc.
Assemble safety ring.
Drve shaft ready for assembly.

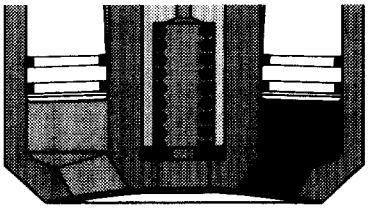


52



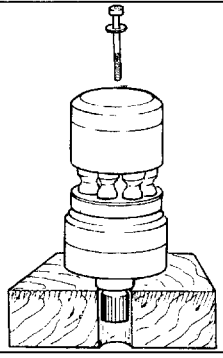
53 Rückzugplatte mit Kolben und Mittelzapfen einsetzen.
Schrauben mit Precote-Beschichtung verwenden.

Insert retaining plate with piston and center pin.
Use screw with Precote-coating.



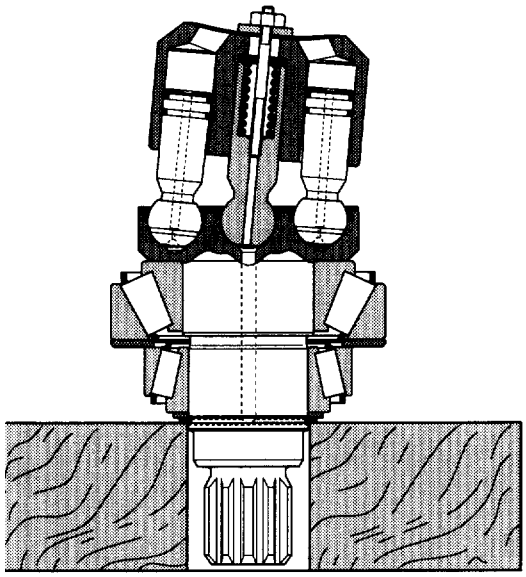
54 Auf richtige Schichtung aller Teile achten.

Make sure all parts are fitted in correctly.



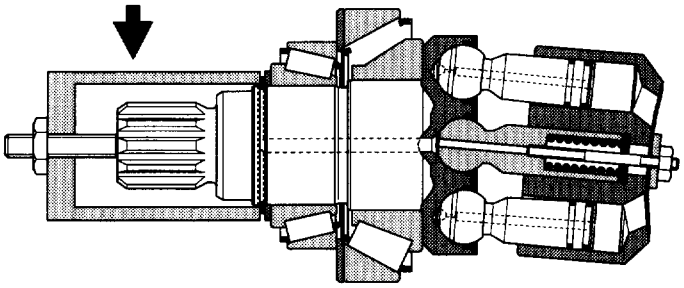
55 Triebwerk max. ausschwenken und Zylinder befestigen.

Swivel cylinder block to max. and fix the cylinder.



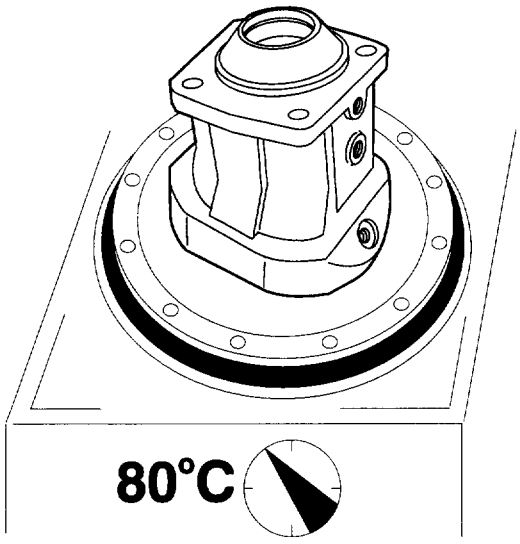
Triebwerk komplett zum Einbau fertig.

Rotary group completely assembled ready for assembly.



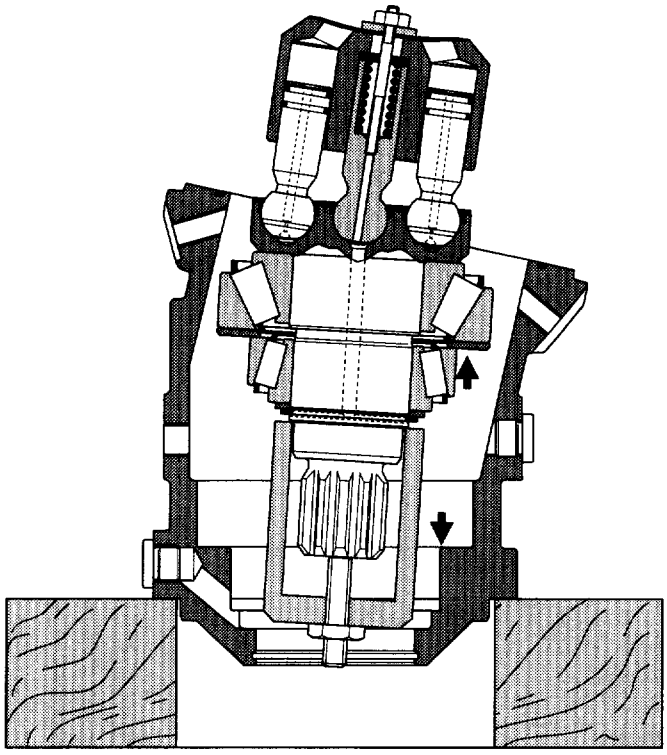
Montagehülse montieren.

Place assembly sleeve.



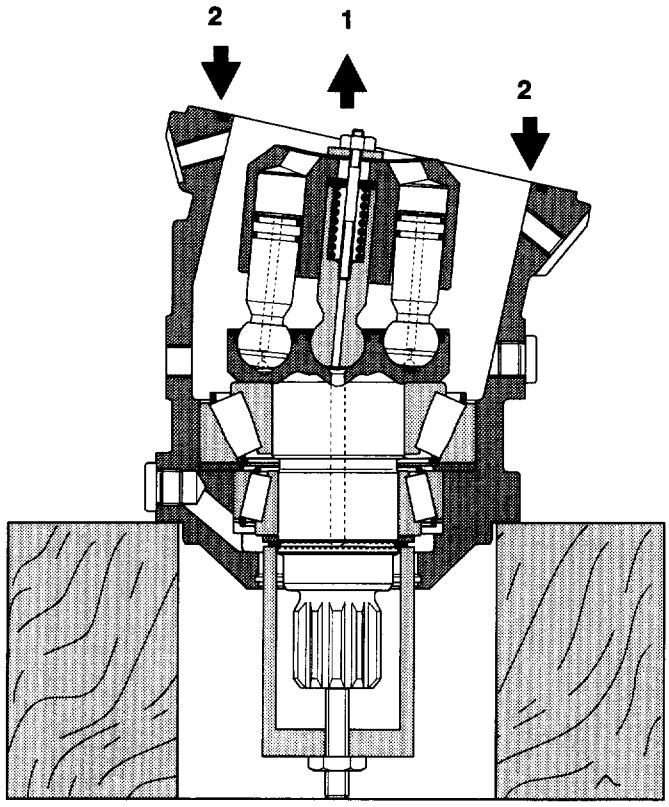
Gehäuse auf 80°C erwärmen.

Warm up housing to 80°C.



Triebwerk ins Gehäuse auf Anschlag einsetzen.

Insert rotary group into housing to seat position.

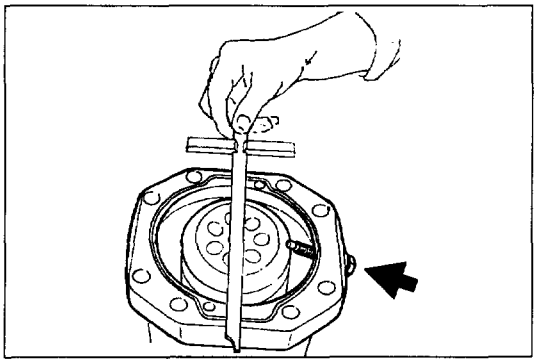


Zylinder in Nullposition ausrichten.

1. Zylinderbefestigungsschraube demontieren.
2. O-Ring einsetzen.

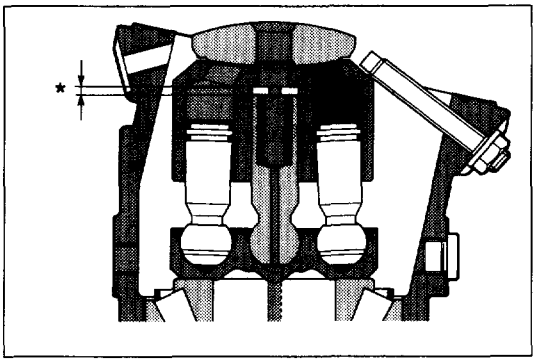
Fix zero position of cylinder with Q_{max}-screw.

1. Disassemble cylinder fixing screw.
2. Insert O-ring.



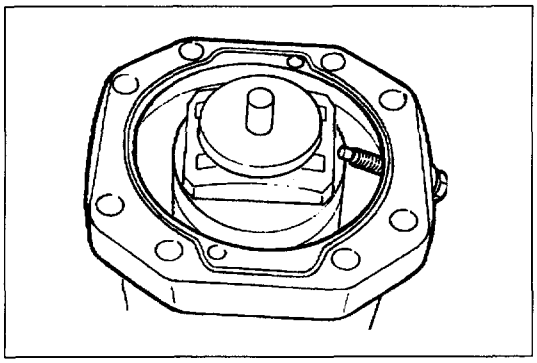
56 Mit Schraube Zylinderausschwenkung vermitteln.

Determine cylinder swivel range to max. angle with screw.



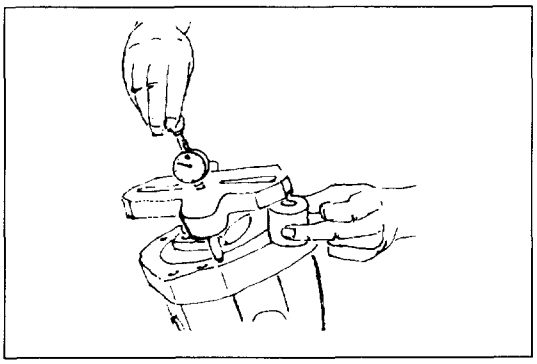
57 * Scheibe

* Disc



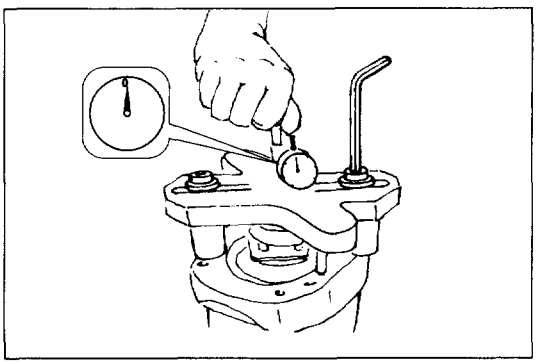
58 Zentrierscheibe aufsetzen.

Place centering disc.



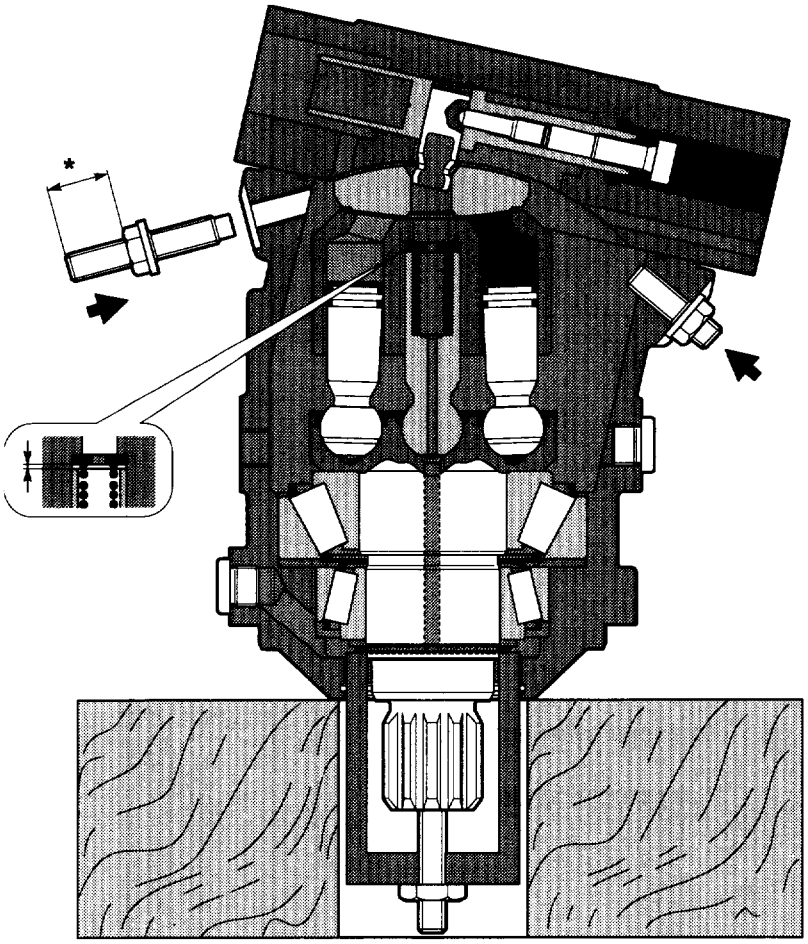
59 Meßvorrichtung aufbauen.

Mount measuring device.



60 Maß X überprüfen.

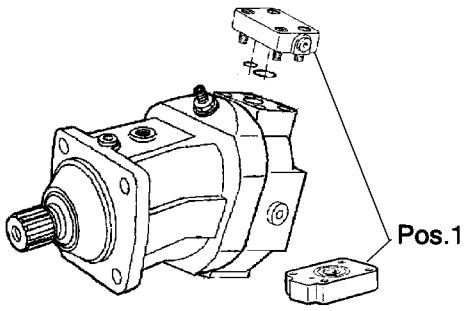
Check dimension X.



1. Anschlußplatte mit Gleichgang-kolben montieren.
⚠ Montageausführung beachten!
⚠ Befestigungsschrauben mit Drehmoment anziehen.
2. Triebwerk in "Ausgangsstellung" schwenken.
3. Q_{min}-Schraube auf Maß * einstellen.
4. Verschlußschraube einbauen.
5. Montagehülse demontieren.

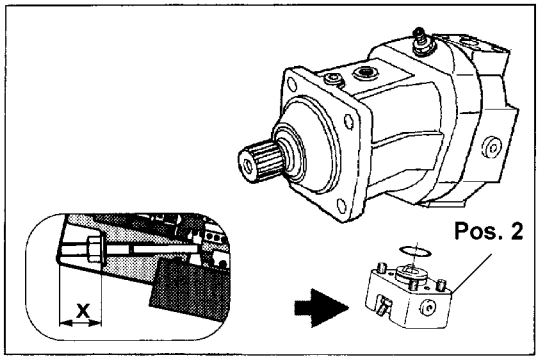
1. Assemble port plate with synchronizing piston.
⚠ Take care of assembly design!
⚠ Tighten fixing screws with torque.
2. Swivel rotary group to "starting position".
3. Set Q_{min}-screw to dimension*.
4. Assemble plug.
5. Remove assembly sleeve.

61



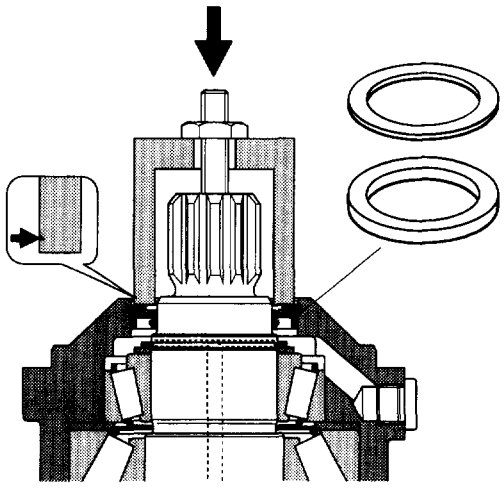
62 Deckel montieren.

Assemble cover.



63 Steuerteil montieren.

Assemble control components.



65 Wellendichtring, Scheiben und Sicherungsring montieren.
Mit Montagehülse einpressen.

⚠ Einpresstiefe beachten!

Assemble shaft seal, disc and safety ring.
Press-in with assembly sleeve.

⚠ Take care of press-in depth.

Anziehdrehmomente für Schaftschrauben (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Schaftschrauben mit metrischem ISO-Regelgewinde und Kopfauflagemaßen nach DIN 912, DIN 931 und DIN 933. Außerdem gelten diese Werte nur für leicht oder nicht geölte, unbehandelte Oberflächen, sowie nur bei Verwendung von Drehmoment- und Kraftbegrenzungsschlüsseln.

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment(Nm)		
M 3	1,1	1,6	1,9
M 4	2,9	4,1	4,9
M 5	6	8,5	10
M 6	10	14	17
M 8	25	96	41
M10	49	69	83
M12	86	120	145
M14	135	190	230
M16	210	295	355
M18	290	405	485
M 20	410	580	690
M 22	550	780	930
M 24	710	1000	1200
M 27	1050	1500	1800
M 30	1450	2000	2400

Tightening torques for shaft bolts (Metric ISO Standard Thread)

The values for tightening torques shown in the table are valid only for shaft bolts with metric ISO- standard threads and head support surface dimensions in accordance with DIN 912, DIN 931 and DIN 933. These values are also valid only for light or unoiled, untreated surface as well as for use only with torque-indicating wrenches and force limiting tools.

Thread size	Strength Classes 8.8	10.9	12.9
	Tightening Torque (lb.ft)		
M 3	0,8	1,2	1,4
M 4	2,1	3,0	3,6
M 5	4,4	6,3	7,4
M 6	7,4	10,3	12,5
M 8	18,4	25,8	30,2
M10	36,1	50,9	61,2
M12	63,4	88,4	106,9
M14	99,5	140,0	169,5
M16	154,8	217,4	261,6
M18	213,7	298,5	357,4
M 20	302,2	427,5	508,5
M 22	405,4	574,9	685,4
M 24	523,5	737,0	884,4
M 27	773,9	1105,5	1326,6
M 30	1068,7	1474,0	1768,8

Anziehdrehmomente für Verschlußschrauben VSTI (Metrisches Feingewinde)

Gewindegröße	Bezeichnung		Anziehdrehmoment(Nm)
M 8 x 1	VSTI 8 x 1	-ED/SA	= 5
M 10 x 1	VSTI 10 x1	-ED	= 10
M 12 x 1,5	VSTI 12 x 1,5	-ED	= 20
M 14 x 1,5	VSTI 14 x 1,5	-ED	= 30
M 16 x 1,5	VSTI 16 x 1,5	-ED/SA	= 30
M 18 x 1,5	VSTI 18 x 1,5	-ED/SA	= 40
M 20 x 1,5	VSTI 20 x 1,5	-ED/SA	= 50
M 22 x 1,5	VSTI 22 x 1,5	-ED	= 60
M 26 x 1,5	VSTI 16 x 1,5	-ED/SA	= 70
M 27 x 2	VSTI 27 x 2	-ED	= 90
M 30 x 1 ,5	VSTI 30 x 1,5	-ED/SA	= 100
M 33 x 2	VSTI 33 x 2	-ED/SA	= 120
M 42 x 2	VSTI 42 x 2	-ED/SA	= 200
M 48 x 2	VSTI 48 x 2	-ED	= 300

Tightening torques for locking screws VSTI (Metric ISO fine thread)

Thread size	Designation		Tightening torques (lb.ft)
M 8 x 1	VSTI 8 x 1	-ED/SA	= 4
M 10 x 1	VSTI 10 x1	-ED	= 7
M 12 x 1,5	VSTI 12 x 1,5	-ED	= 15
M 14 x 1,5	VSTI 14 x 1,5	-ED	= 22
M 16 x 1,5	VSTI 16 x 1,5	-ED/SA	= 22
M 18 x 1,5	VSTI 18 x 1,5	-ED/SA	= 29
M 20 x 1,5	VSTI 20 x 1,5	-ED/SA	= 37
M 22 x 1,5	VSTI 22 x 1,5	-ED	= 44
M 26 x 1,5	VSTI 16 x 1,5	-ED/SA	= 51
M 27 x 2	VSTI 27 x 2	-ED	= 66
M 30 x 1 ,5	VSTI 30 x 1,5	-ED/SA	= 74
M 33 x 2	VSTI 33 x 2	-ED/SA	= 88
M 42 x 2	VSTI 42 x 2	-ED/SA	= 147
M 48 x 2	VSTI 48 x 2	-ED	= 220

Anziehdrehmomente für Seal-Lock Bundmuttern (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Seal-Lock Bundmuttern der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde.

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment (Nm)		
M 6	10		
M 8	22		
M 10	40		
M 12	69		
M 14	110		
M 16	170		

Tightening torques for seal-lock nuts (Metric ISO-Standard Thread)

The values for tightening torques shown in the table are valid only for seal-lock nuts of the strength class 8.8 and with metric ISO-standard thread.

Thread size	Strength classes 8.8	10.9	12.9
	Tightening torque (lb.ft)		
M 6	7,4		
M 8	16,2		
M 10	29,5		
M 12	50,9		
M 14	81,1		
M 16	125,3		

Anziehdrehmomente für Linsenschrauben mit Kreuzschlitz DIN 7985 (Metrisches ISO-Regelgewinde)

Die nebenstehenden Werte für Anziehdrehmomente gelten nur für Linsenschrauben mit Kreuzschlitz DIN 7985 der Festigkeitsklasse 8.8 mit metrischem ISO-Regelgewinde

Gewinde größe	Festigkeitsklassen 8.8	10.9	12.9
	Anziehdrehmoment(Nm)		
M 3	1,1		
M 4	2,9		
M 5	6		
M 6	10		
M 8	25		
M10	49		

Tightening torques for cross-slotted lens head screws DIN 7985 (Metric ISO- Standard Thread)

The values for tightening torques shown in the table are valid only for cross-slotted lens head screws DIN 7985 of the strength class 8.8 and with metric ISO-standard thread.

Thread size	Strength classes 8.8	10.9	12.9
	Tightening torques (lb.ft)		
M 3	0,8		
M 4	2,1		
M 5	4,4		
M 6	7,4		
M 8	18,4		
M10	36,1		

Allgemein

- Machen Sie sich mit der Ausstattung der Maschine vertraut.
- Fahren Sie die Maschine nur, wenn Sie sich völlig mit den Bedien- und Steuerelementen sowie der Arbeitsweise der Maschine vertraut gemacht haben.
- Benutzen Sie Ihre Schutzausrüstung wie Schutzhelm, Sicherheitsschuhe und Gehörschutz.
- Machen Sie sich mit Ihrem Arbeitsgebiet vertraut.
- Benutzen Sie die Maschine nur für den ihr zugedachten Zweck.

Beachten Sie bitte die Richtlinien der Berufsgenossenschaft und des Maschinenherstellers

Vor dem Start

- Beachten Sie die Bedienungshinweise vor dem Starten.
- Prüfen Sie die Maschine aut auffällige Fehler.
- Fahren Sie die Maschine nicht mit defekten Instrumenten, Kontrolleuchten oder Steuerorganen.
- Alle Schutzvorrichtungen müssen fest auf ihrem Platz sein.
- Nehmen Sie keine losen Gegenstände mit bzw. befestigen Sie diese an der Maschine.
- Halten Sie die Maschine von öligem und zündfähigem Material frei.
- Prüfen Sie vor dem Besteigen der Maschine, ob sich Personen oder Hindernisse neben oder unter der Maschine befinden.
- Vorsicht beim Besteigen der Maschine, benützen Sie Treppen und Griffe.
- Stellen Sie vor dem Start Ihren Sitz ein.

Starten

- Beim Starten müssen alle Bedienhebel in "Neutralstellung" stehen.
- Die Maschine nur vom Fahrersitz aus Starten.
- Prüfen Sie die Anzeigeinstrumente nach dem Start, um sicher zu gehen, daß alles ordnungsgemäß funktioniert.
- Lassen Sie die Maschine nicht unbewacht, während der Motor läuft.
- Beim Start mit Batterieverbindungskabeln verbinden Sie Plus mit Plus und Minus mit Minus. Massekabel (Minus) immer zuletzt anschliesen und zuerst abtrennen.

General advice

- Make yourself familiar with the equipment of the machine.
- Only operate the machine if your are completely familiar with the operating and control elements as well as the functioning of the machine.
- Use your safety equipment like helmet, safety shoes and hearing protection.
- Make yourself familiar with your working field.
- Only operate the machine for its intended purpose.

Please observe the guidelines of the Professional Association and the machine manufacturer.

Before starting

- Observe the operating instructions before starting.
- Check the machine for remarkable faults.
- Do not operate the machine with defective instruments, warning lights or control elements.
- All safety devices must be in a secure position.
- Do not carry with you movable objects or secure them to the machine.
- Keep oily and inflammable material away from the machine.
- Before entering thc driver's cabin, check if persons or obstacles are beside or beneath the machine.
- Be careful when entering the driver's cabin, use stairs and handles.
- Adjust your seat before starting.

Start

- When starting all operating levers must be in "neutral position".
- Only start the machine from the driver's seat
- Check the indicating instruments after start to assure that all functions are in order.
- Do not leave the machine unobserved when the motor is running.
- When starting with battery connection cables connect plus with plus and minus with minus. Always connect mass cable (minus) at last and cut off at first.

Vorsicht

· Auspuffgase sind lebensgefährlich. Bei Start in geschlossenen Räumen für ausreichende Luftzufuhr sorgen!

Hydraulikanlage

1. Hydraulikanlage steht unter hohem Druck!

⚠ Unter hohem Druck austretende Hochdruck-Flüssigkeiten (Kraftstoff, Hydrauliköl) können die Haut durchdringen und schwere Verletzungen verursachen. Daher sofort einen Arzt aufsuchen, da anderenfalls schwere Infektionen entstehen können!

2. Bei der Suche nach Leckstellen wegen Ver letzungsgefahr geeignete Hilfsmittel verwenden!
3. Vor Arbeiten an der Hydraulikanlage diese unbedingt drucklos machen und angebaute Geräte absenken!
4. Bei Arbeiten an der Hydraulikanlage unbedingt Motor abstellen und Traktor gegen Wegrollen sichern (Feststellbremse, Unterlegkeil)!
5. Beim Anschließen von Hydraulikzylindern und -motoren ist auf vorgeschriebenen Anschluß der Hydraulikschläuche zu achten!
6. Bei Vertauschen der Anschlüsse umgekehrte Funktionen (z.B. Heben/Senken) - Unfallgefahr!
7. Hydraulikschlauchleitungen regelmäßig kontrollieren und bei Beschädigung und Alterung austauschen! Die Austauschschlauchleitungen müssen den technischen Anforderungen des Geräteherstellers entsprechen!

⚠ Öle, Kraftstoffe und Filter ordnungsgemäß entsorgen!

Attention

· Exhaust gas is dangerous. Assure sufficient fresh air when starting in closed rooms!

Hydraulic equipment

1. Hydraulic equipment is standing under high pressure.

⚠ High pressure fluids (fuel, hydraulic oil) which escape under high pressure can penetrate the skin and cause heavy injuries.
Therefore immediately consult a doctor as otherwise heavy infections can be caused.

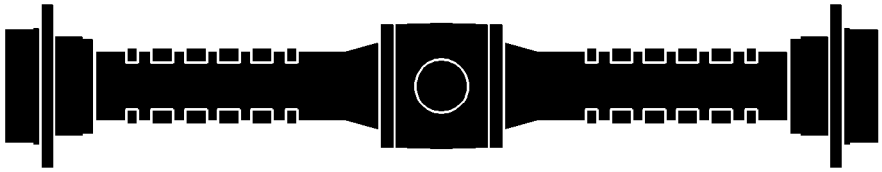
2. When searching leakages use appropriate auxiliary devices because of the danger of accidents.
3. Before working at the hydraulic equipment, lower pressure to zero and lower working arms of the rnachine.
4. When working at the hydraulic equipment, absolutely stop motor and secure tractor against rolling away (parking brake, shim)!
5. When connecting hydraulic cylinders and motor pay attention to correct connection of hydraulic flexible hoses.
6. In case of exchanging the ports, the tunctions are vice versa (f. ex. lift-up/lower) - danger of accidents!
7. Check hydraulic flexible hoses regularly and replace them in case of dammage or wear! The new hose pipes must comply with the technical requirements of the machine manufacturer!

⚠ Orderly disposal or recycling of oil, fuel and filters!

Technical Handbook

Wheel loader

Axles



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Preface

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As far as the assembly procedure is concerned, all axle versions are of identical design. There may be differences, however, in the transmission ratio and in the number of individual components (e.g. disks in multiple-disk brakes). Items shown in the Illustrations may deviate from the actual conditions. Illustrations of front or rear axles have been used several times when the same working sequence is concerned.

The Technical Handbook is not subjet to permanent revision. Changes will be incorporated in new editions which are identified by the rising index at the end of the 7-digit Part Number.

General

Design

The front and rear axles are rigid axles. The **front axle** is firmly bolted to the front chassis of the loader. A multi-disk self-locking differential is built in which has a locking factor of approx. 45 %.

The **rear axle** is free to float on the rear chassis. Two inner multi-disk brakes running in an oil bath and being operated hydraulically as service brake and mechanically as parking brake are arranged right and left to the axle drive and the differential, respectively. The transfer box bolted to the axle housing contains a countershaft stage for the flange-mounted hydraulic motor.

The rear and front axles are directly connected by a propeller shaft. Both axles have planetary gear systems in their hubs.

Maintenance

The wheel hubs, axles and the transfer box are not sealed with respect to one another. At inclined positions, the oil may flow over and then return. Oil level checks and oil changing on wheel hubs, axles and on the transfer box must, in each case, be done separately. Refer to the Operating Instructions.

Intervals for oil level checks and for oil changing are specified in the Operating Instructions.

Oil specification: API GL-5, SAE 90, LS. Refer to the Operating Instructions.

LS = Limited-slip-additives. They prevent noise and jerky rolling-off of the wheels as may be caused by locking differentials.

The **multi-disk brake** is operated by the oil of the hydraulic system.

Filling Quantities

Front axle	3.7 l (1.0 gal)
Rear axle	3.7 l (1.0 gal)
Wheel hub	4 x 0.6 l (4 x 0.16 gal)
Transfer box	1.0 l (0.3 gal)

Cf. machine operating instructions.

The **multiple-disk brake** is actuated with hydraulic oil from the hydraulic system.

For **checking of wear** remove plug (104) in the axle tube (101) and measure thickness of inner disks (84). Cf. machine operating instructions.

General Working Instructions

Thorougly clean the removed axle. As long as all openings are closed it can be cleaned with water or with a steam jet.

After dismantling, clean the parts in a suitable cleaning agent. Do not use water or a steam jet as this will result in rusting.

Remove old sealing compound.

Mark bolted parts such as axle housing and axle tube or differential housing, cap, before separating them.

Thoroughly check parts which are subject to wear, e. g. bearings, thrust washers, disks, if they are to be re-used. Checking antifriction bearings requires particular special knowledge.

Check gears for wear and surface cracks.

Replace bearings damaged or destroyed during dismantling. For tapered roller bearings, also replace the outer roller bearing ring in any case.

If specified, warm up bearings on hot plates or in heating ovens. Never warm up with a direct flame.

Parts shrunk on must be re-driven after cooling down to obtain perfect bearing.

Replace ring gears and pinion drive shafts only in couples.

Replace differential bevel pinions only in sets, even though only one of them may need to be changed. The may have been manufactured by different methods in the course of time.

Replace disks for brakes and self-locking differentials only in sets.

Apply oil to shafts, bearings, bushes etc. before pressing them in.

Always replace sealing elements such as O-rings, circlips, shaft rings or collars. Apply grease to the sealing lips of the shaft rings when installing them.

Strictly observe all specified setting dimensions, check data and tightening torques for reassembling.

Alter factory settings only when replacing bearings and/or gears.

Keep the bevel gear couple backlash and surface appearance unchanged when re-installing them.

In the illustrations, special tools are marked "S" and bear continuous numbers. In "List of Special Tools", all tools are listed under their continuous numbers including their IDs, descriptions and illustrations. They can be ordered under their IDs.

Ersatzteile nur nach der jeweiligen Ersdatzteilliste bestellen.

Spare-parts order must be based on the relevant spare-parts list.

Use ORIGINAL SPARE-PARTS only.

All tools and measuring instruments must be in perfect condition.

Special tools are identified in the illustrations with the letter "S" and the number. The "List of special tools" lists all tools by number with P/N, designation and picture reference. They may be ordered by the Parts Number P/N.

Notes on working safety

The observance of all applicable safety rules and regulations is a prerequisite for protecting persons against harm and injury and to prevent damage to the product and the environment.

The repair personnel must have the know-how and the experience required for the repair of these axles or of axles of a similar kind. If such know-how is lacking, the repair personnel must be trained and instructed beforehand by authorized personnel.

Repair work must be carried out only after the Technical Handbook has been read and understood.

Secure the machine before carrying out work on installed axles:

- Park the machine on level and firm ground.
- Stand the working equipment on the ground.
- Apply the parking brake.
- Block the articulated joint or the superstructure.
- Shut off the engine.
- Withdraw the key.
- Secure the machine against inadvertent movements by placing chocks under the wheels.
- Observe the warning and instruction signs on the machine.

All tools and auxiliary means must be in a safe state of operation.

Assembling Procedure

The complete overhauling of the front and rear axles is described. According to circumstances, operations necessary for partial repair work can be derived from there.

Wheel hubs including the planetary gear systems as well as the rear axle transfer box may also be repaired with the axle mounted. To repair brakes and axle drives, the axles must be completely dismantled. Then, the particular brakes or axle drives can be laid open by removing the respective axle tube. The wheel hubs and planetary gear systems remain enclosed.

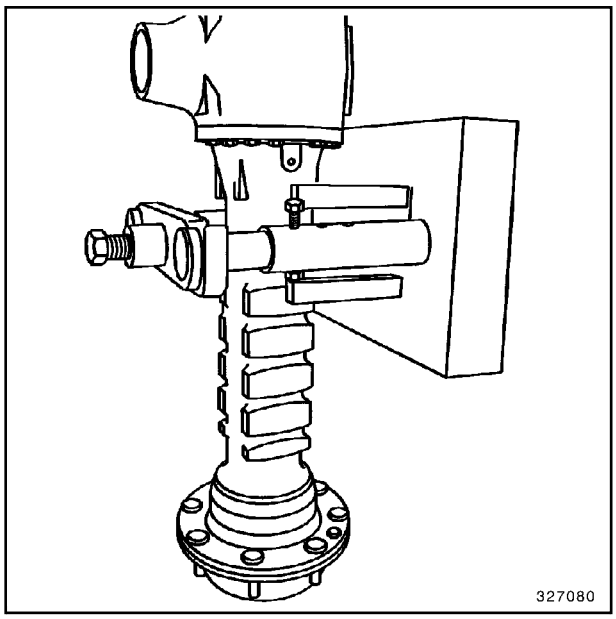


Fig. 1

For dismantling and reassembling, removed axles are put in a vertical position, the lower axle tube being held in a fixture. Wheel hub assembling should be done on the vertically placed axle tubes.

All assembling illustrations show the axle in vertical position.

Weights

Front axle, complete:	approx. 185 kg (408 lb)
Rear axle incl. transfer box	approx. 265 kg (585 lb)

Survey

Front Axle Components, Screw Qualities, Tightening Torques, Screw Locking

Front Axle

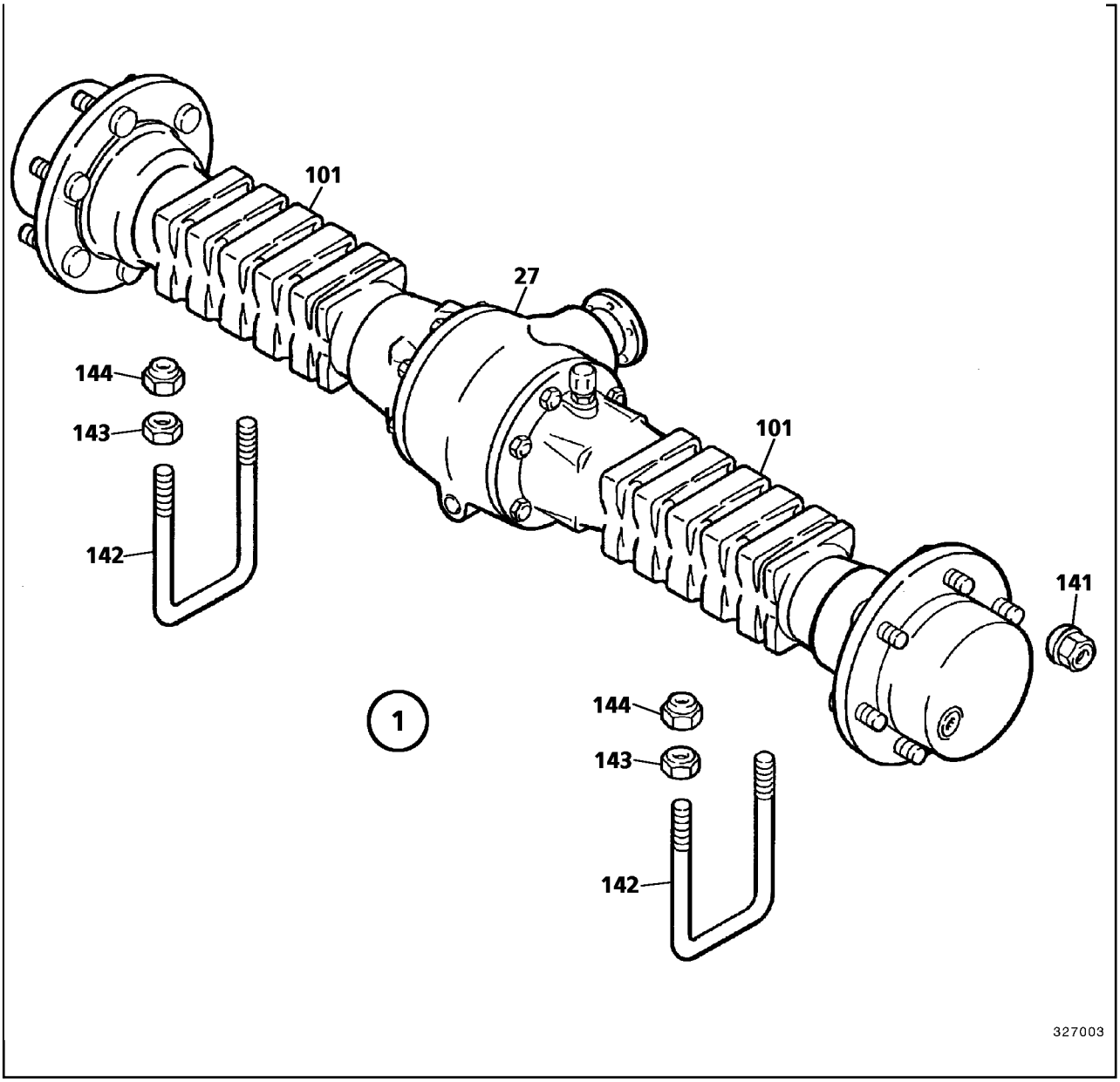


Fig. 1

Front Axle

Item	Quantity	Description
1	1	Front axle
141	16	Wheel nut
142	2	Screw clip
143	4	Hex nut, M 24-8 M_A = 710 Nm (524 lbft)
144	4	Lock nut

Axle Drive Assembly

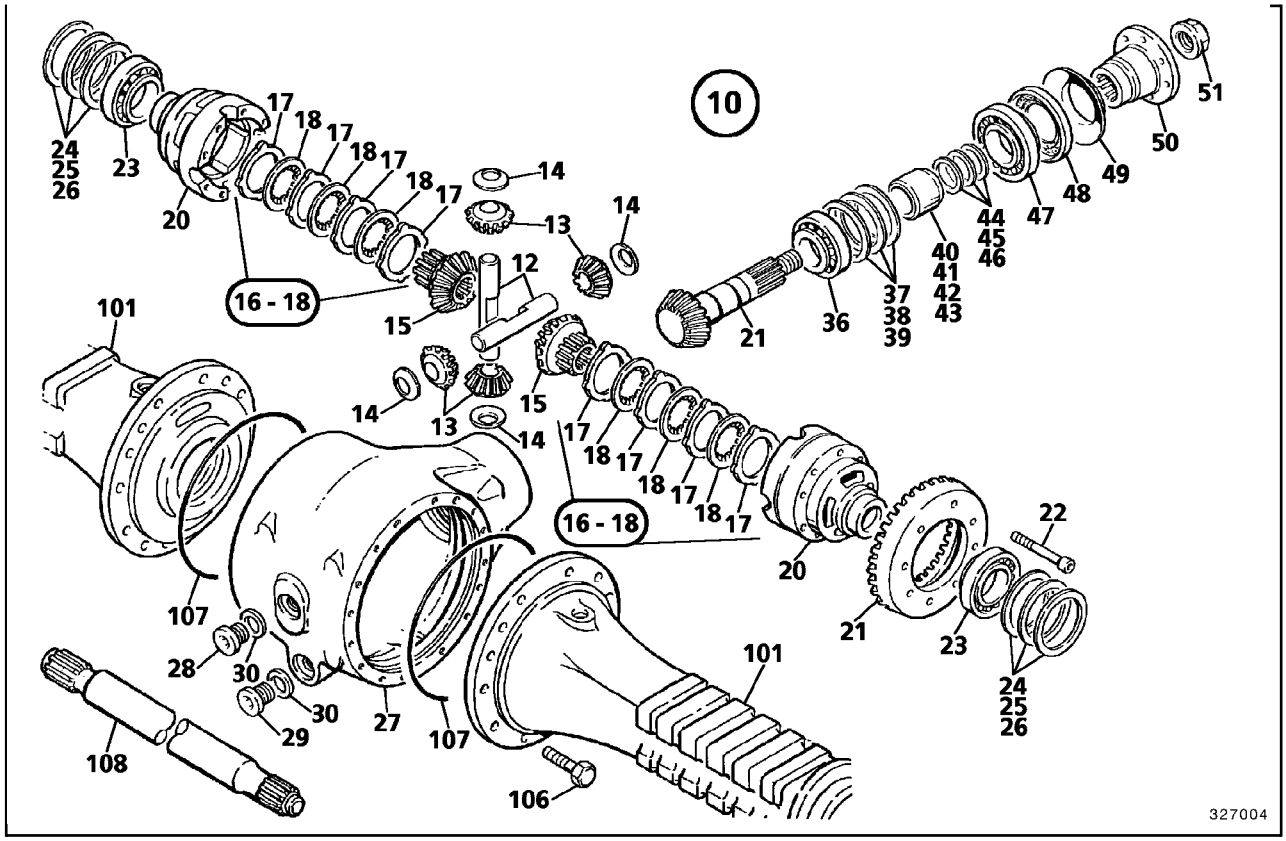


Fig. 2

Axle Drive Assembly

Item	Quantity	Description
10	1	Axle drive assembly
12	2	Differential pin
13	4	Bevel gear
14	4	Washer
15	2	Bevel gear
16	2	Disk set
17	10	Outer disk
18	8	Inner disk
20	1	Differential housing
21	1	Bevel gear set
22	12	Fillister-head screw, M 12 - 10.9 M_A = 129 Nm (95 lbft), LOCTITE 243
23	2	Tapered roller bearing
24		Spacing washer, 0.1 mm
25		Spacing washer, 0.3 mm
26		Spacing washer, 0.5 mm
27	1	Housing
28	1	Cap screw
29	1	Cap screw
30	2	Packing ring
36	1	Tapered roller bearing
37		Spacing washer, 0.1 mm
38		Spacing washer, 0.3 mm
39		Spacing washer, 0.5 mm
40	1	Liner
41	1	Liner
42	1	Liner
43	1	Liner
44		Spacing washer, 0.1 mm
45		Spacing washer, 0.3 mm
46		Spacing washer, 0.5 mm
47	1	Tapered roller bearing
48	1	Shaft ring
49	1	Cap
50	1	Flange
51	1	Collar unit M_A = 200 Nm (148 lbft), LOCTITE 243

Wheel Hub Assembly

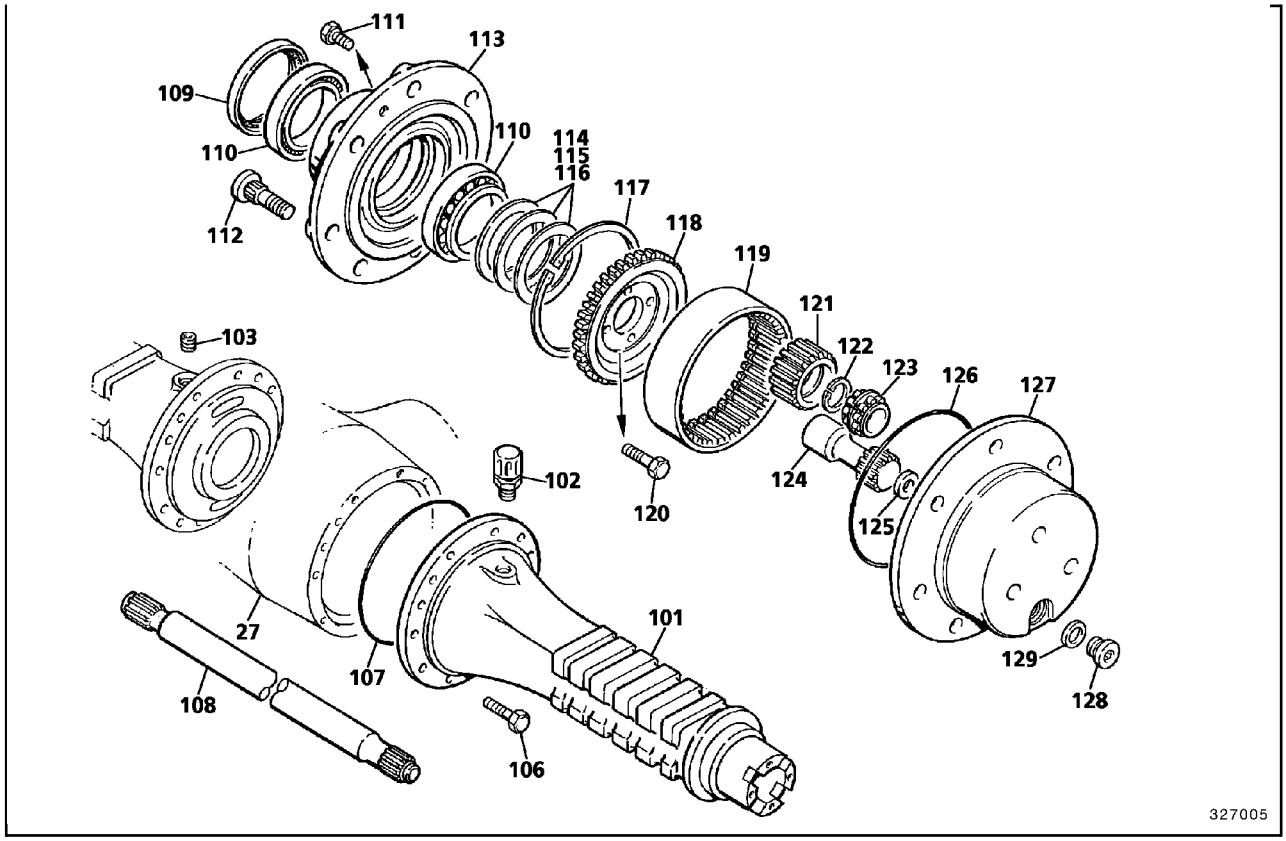


Fig. 3

Wheel Hub Assembly

Item	Quantity	Description
101	2	Axle tube
102	1	Vent plug
103	1	Cap screw
106	32	Hex screw, M 12 - 10.9 M_A = 120 Nm (89 lbft), LOCTITE 243
107	2	O-ring
108	2	Drive shaft
109	2	Shaft ring
110	4	Tapered roller bearing
111	4	Hex screw, M 12 - 8.8 M_A = 65 Nm (48 lbft)
112	16	Wheel bolt
113	2	Hub
114		Spacing washer, 0.1 mm
115		Spacing washer, 0.3 mm
116		Spacing washer, 0.5 mm
117	2	Snap ring
118	2	Ring gear carrier
119	2	Ring gear
120	16	Hex screw, M 12 - 10.9 M_A = 120 Nm (89 lbft), LOCTITE 243
121	6	Spur gear
122	6	Snap ring
123	6	Roller bearing
124	2	Pinion shaft
125	2	Thrust washer, LOCTITE 243
126	2	O-ring
127	2	Planetary carrier
128	2	Cap screw
129	2	Packing ring

Rear Axle Components, Screw Qualities, Tightening Torques, Screw Locking

Rear Axle Assembly

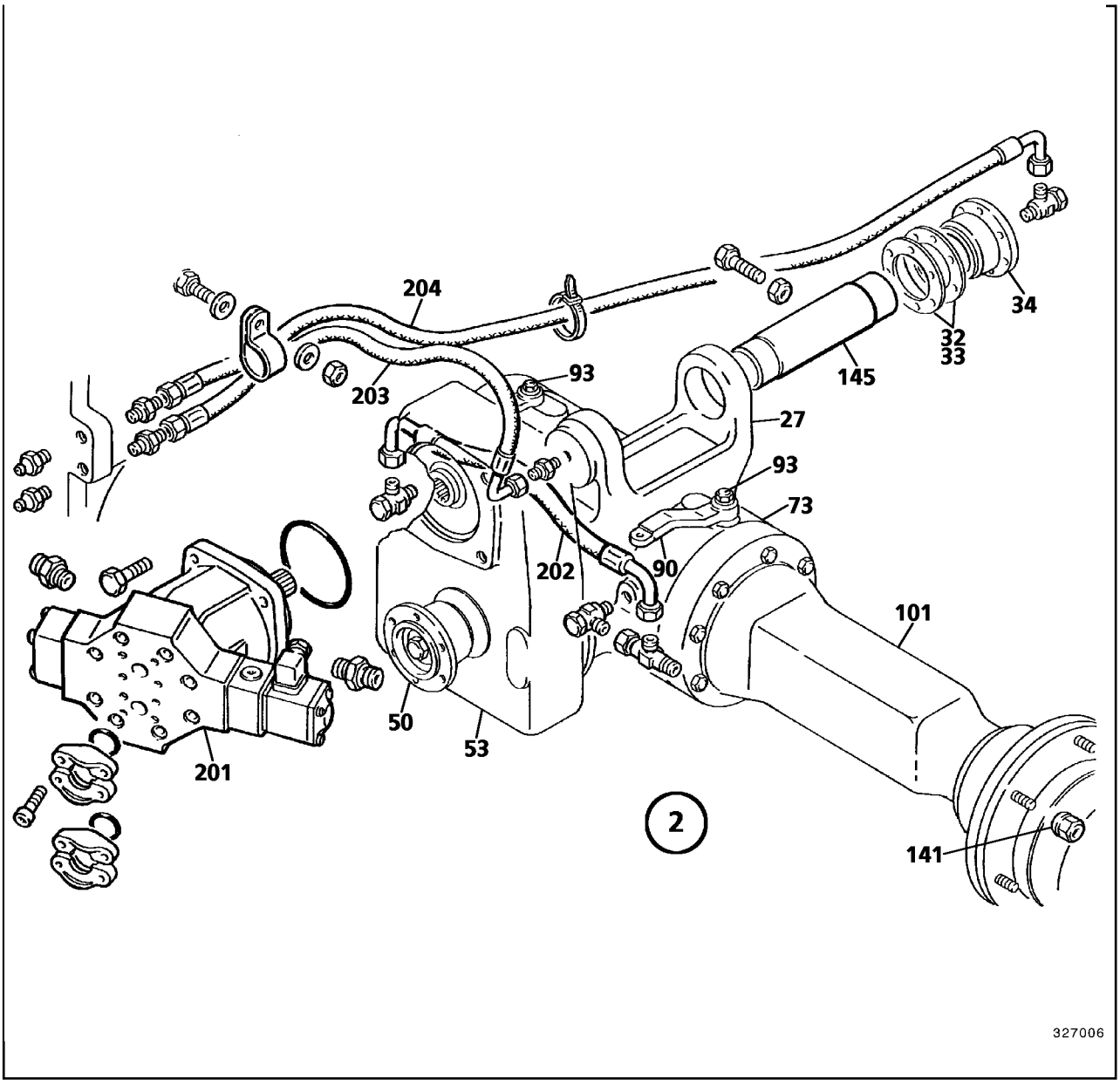


Fig. 4

Rear Axle Assembly

Item	Quantity	Description
2	1	Rear axle assembly
141	16	Wheel nut
145	1	Pin
201	1	Hydraulic motor
202	1	Brake line
203	1	Lubrication piping
204	1	Lubrication piping

Axle Drive Assembly

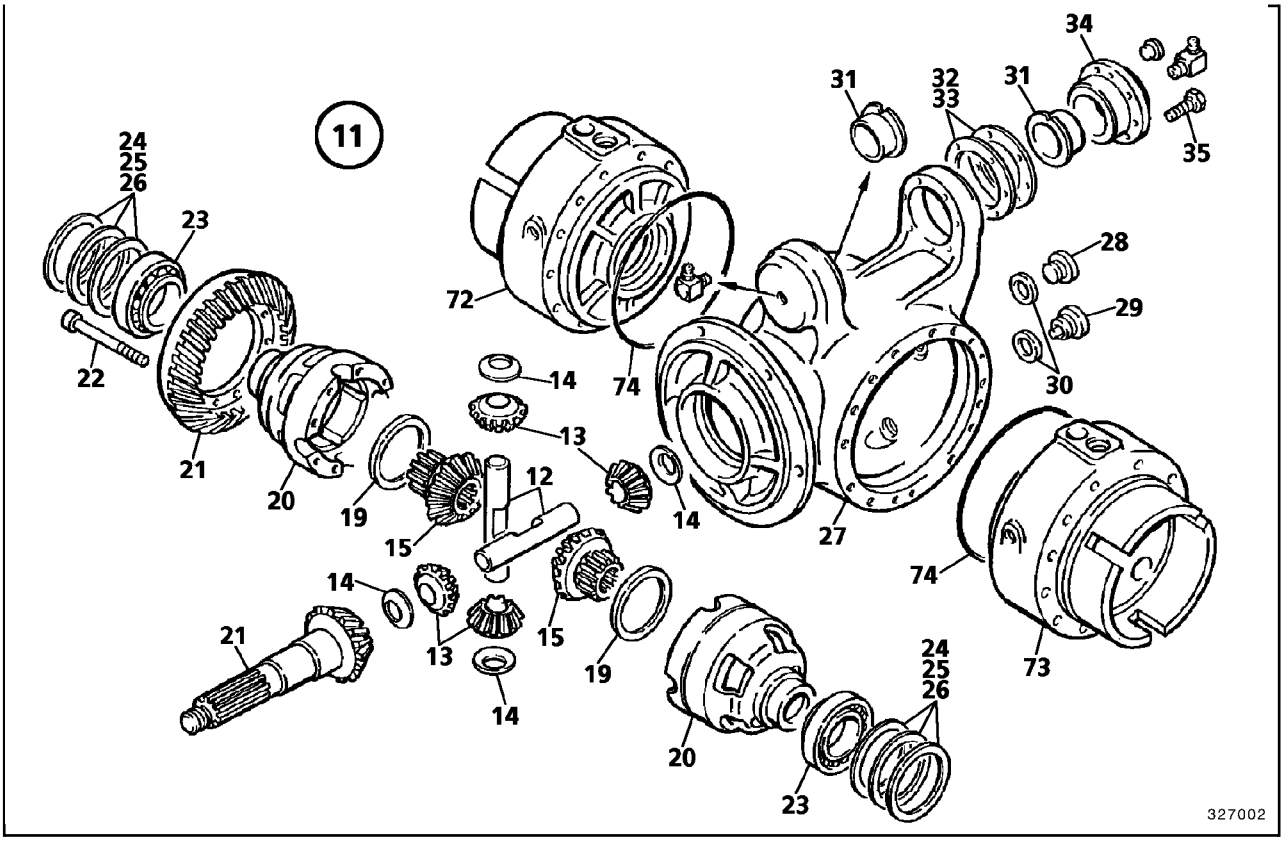


Fig. 5

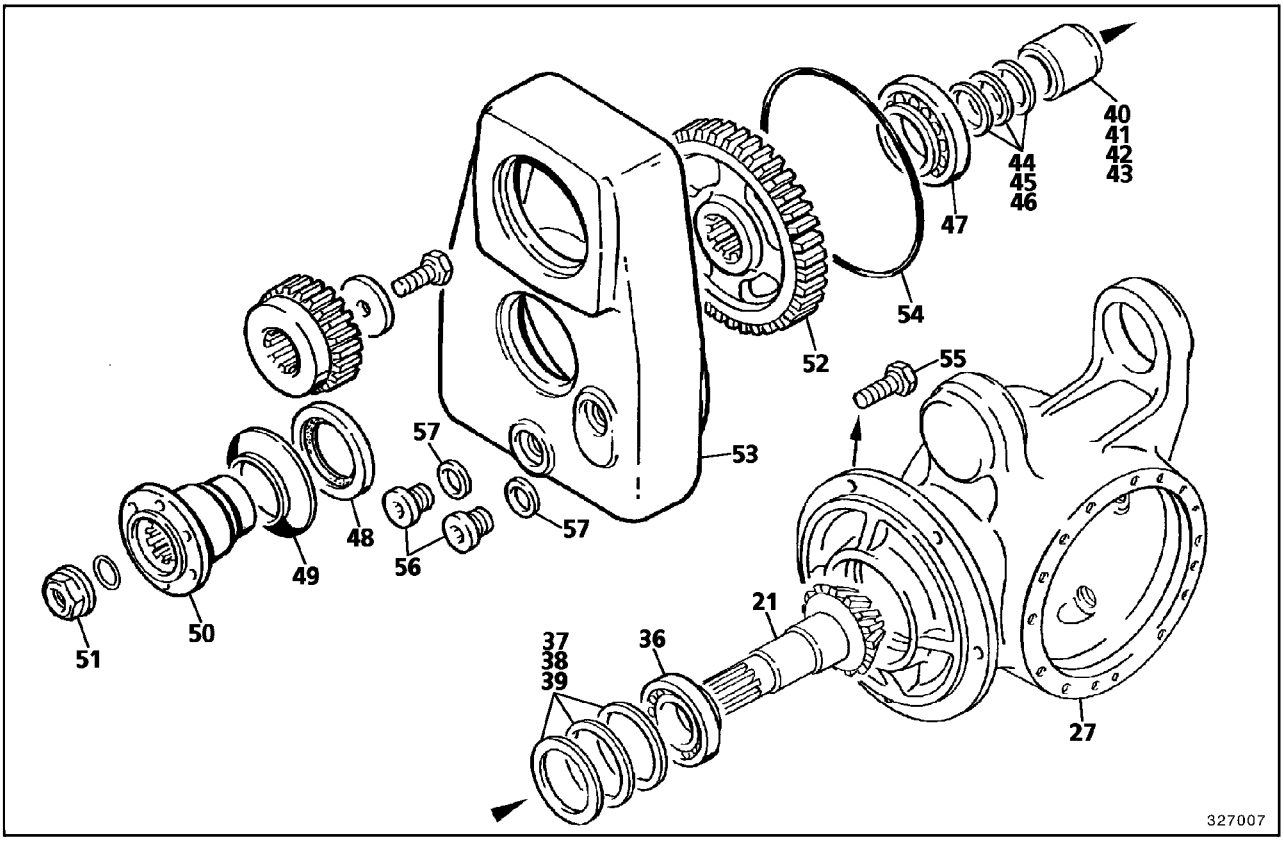


Fig. 6

Axle Drive Assembly

Item	Quantity	Description
11	1	Axle drive assembly
12	2	Differential pin
13	4	Bevel gear
14	4	Washer
15	2	Bevel gear
19	2	Washer
20	1	Differential housing
21	1	Bevel gear set
22	12	Fillister-head screw, M 12 - 10.9 M_A = 120 Nm (89 lbft), LOCTITE 243
23	2	Tapered roller bearing
24		Spacing washer, 0.1 mm
25		Spacing washer, 0.3 mm
26		Spacing washer, 0.5 mm
27	1	Housing
28	1	Cap screw
29	1	Screw cap
30	2	Packing ring
31	2	Collar bush
32		Spacing washer
33		Spacing washer
34	1	Cap
35	6	Hex screw
36	1	Tapered roller bearing
37		Spacing washer, 0.1 mm
38		Spacing washer, 0.3 mm
39		Spacing washer, 0.5 mm
40	1	Bush
41	1	Bush
42	1	Bush
43	1	Bush
44		Spacing washer, 0.1 mm
45		Spacing washer, 0.3 mm
46		Spacing washer, 0.5 mm
47	1	Tapered roller bearing
48	1	Shaft ring
49	1	Cap
50	1	Flange
51	1	Collar unit M_A = 200 Nm (148 lbft), LOCTITE 243
52	1	Gear
53	2	Housing
54	3	O-ring
55	6	Hex screw M_A = 53 Nm (39 lbft), LOCTITE 243
56	2	Screw cap
57	2	Packing ring

Brake Assembly

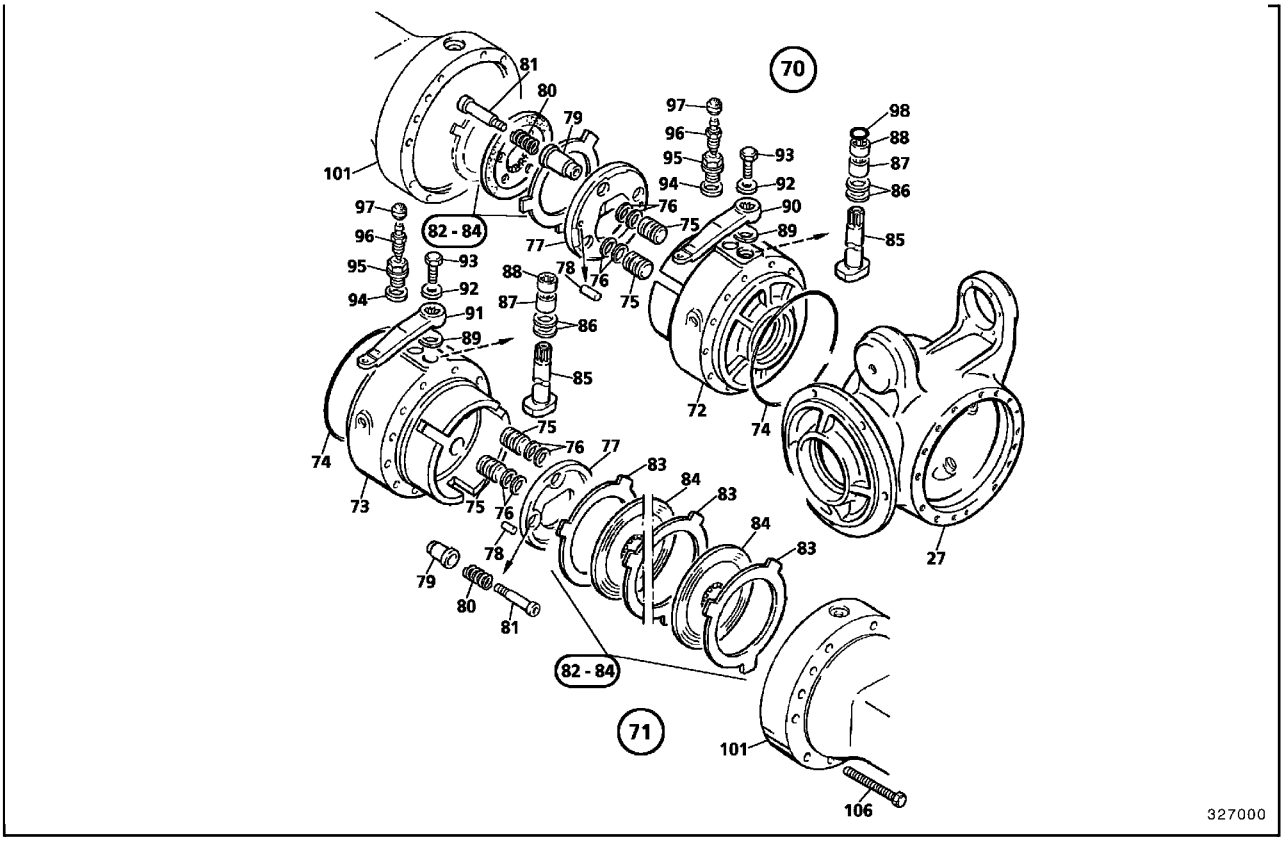


Fig. 7

Brake Assembly

Item	Quantity	Description
70	1	Brake assembly, right-hand
71	1	Brake assembly, left-hand
72	1	Brake plate, right-hand
73	1	Brake plate, left-hand
74	2	O-ring
75	8	Piston
76	8	Piston seal
77	2	Back-up ring
78	4	Pin
79	6	Bush
80	6	Spring
81	6	Fillister-head screw, M 6 M_A = 8 Nm (6 lbft), LOCTITE 243
82	2	Disk set
83	12	Outer disk
84	10	Inner disk
85	2	Brake shaft
86	4	Washer
87	2	Needle sleeve
88	2	Needle sleeve
89	2	Washer
90	1	Brake lever, right-hand
91	1	Brake lever, left-hand
92	2	Washer
93	2	Hex screw, M 8 - 8.8 M_A = 26 Nm (19 lbft)
94	2	Packing ring
95	2	Reducer
96	2	Vent plug
97	2	Dust protection cap

Wheel Hub Assembly

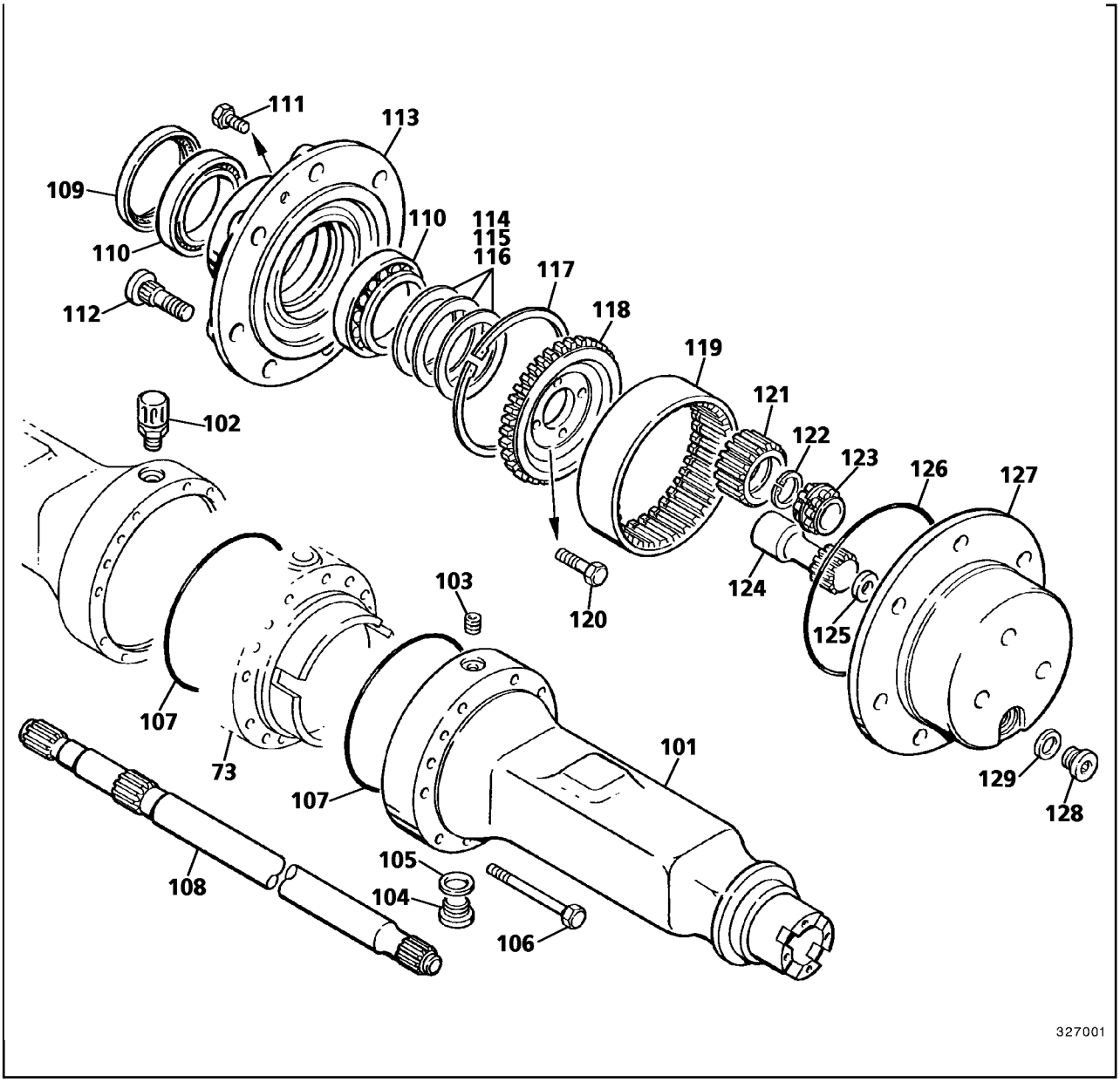


Fig. 8

Wheel Hub Assembly

Item	Qunatity	Description
101	2	Axle tube
102	1	Vent plug
103	1	Screw cap
104	2	Screw cap
105	2	Packing ring
106	32	Hex screw, M 12 - 10.9 M_A = 120 Nm (89 lbft), LOCTITE 243
107	2	O-ring
108	2	Drive shaft
109	2	Shaft ring
110	4	Tapered roller bearing
111	4	Hex screw, M 12 - 8.8 M_A = 65 Nm (48 lbft)
112	16	Wheel pin
113	2	Hub
114		Spacing washer, 0.1 mm
115		Spacing washer, 0.3 mm
116		Spacing washer, 0.5 mm
117	2	Snap ring
118	2	Ring gear carrier
119	2	Ring gear
120	16	Hex screw, M 12 - 10.9 M_A = 120 Nm (89 lbft), LOCTITE 243
121	6	Spur gear
122	6	Snap ring
123	6	Roller bearing
124	2	Pinion shaft
125	2	Thrust washer
126	2	O-ring
127	2	Planetary carrier
128	2	Screw cap
129	2	Packing ring

Front Axle Drawing

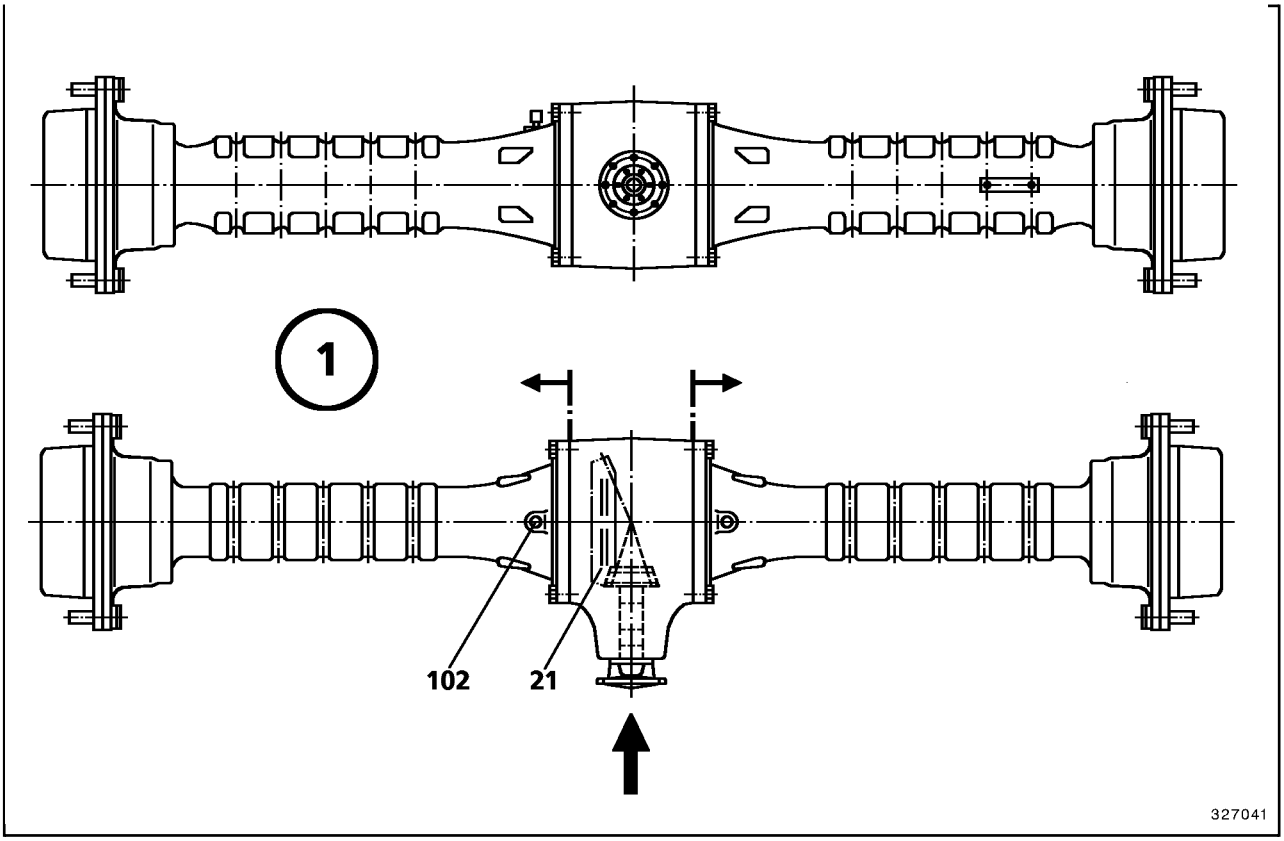


Fig. 9

Rear Axle Drawing

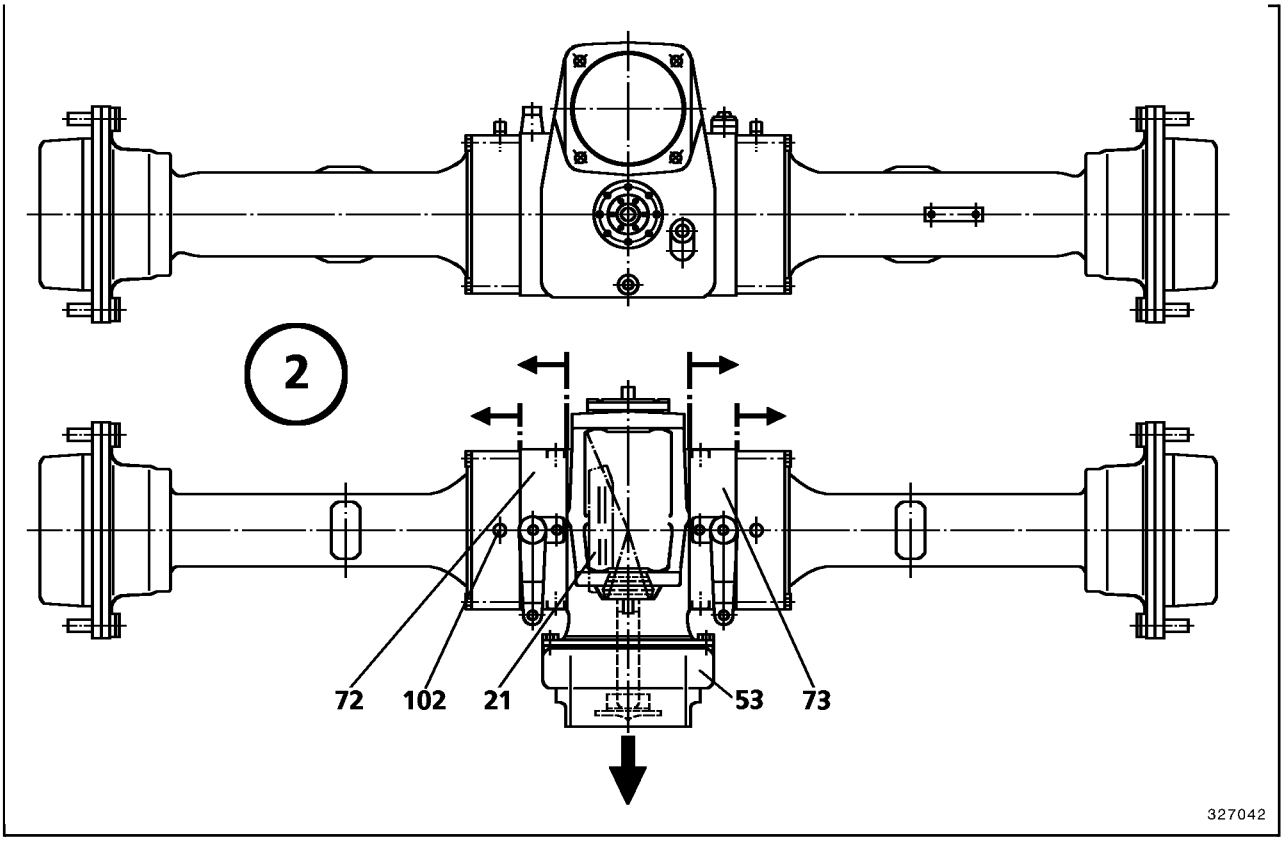


Fig. 10

Dismantling and Reassembling the Axles

Dismantling

- Slacken wheel nuts (141, Fig. 1 + 2).
- Lift loader and support safely. Drop bucket onto ground.
- Take off wheels.
- Remove propeller shaft.
- Move fork-lift truck under axle from the side, lift and jack up axle.

Front Axle:

- Remove two screw clips (142 - 144, Fig. 1).

Rear Axle:

- Disconnect hydraulic motor (201, Fig. 2) flange and suspend.
- Loosen parking brake bowden cable.
- Unscrew service brake pipings (202) and close openings.
- Unscrew self-aligning bearing lubrication piping (203, 204).
- Extract pin (145).
- Lower fork-lift truck and pull out axle.

Reassembling

- Reassemble the axles in the reverse order.
- Successively fill oil into wheel hubs, transfer box (rear axle only) and axle drive assembly. Refer to Operating Instructions.
- Vent brake assembly.
- After adjusting parking brake, tighten brake lever screws (93).
  Tightening torque M_A = 26 Nm (19 lbft).
- Lubricate self-aligning bearing (rear axle only).

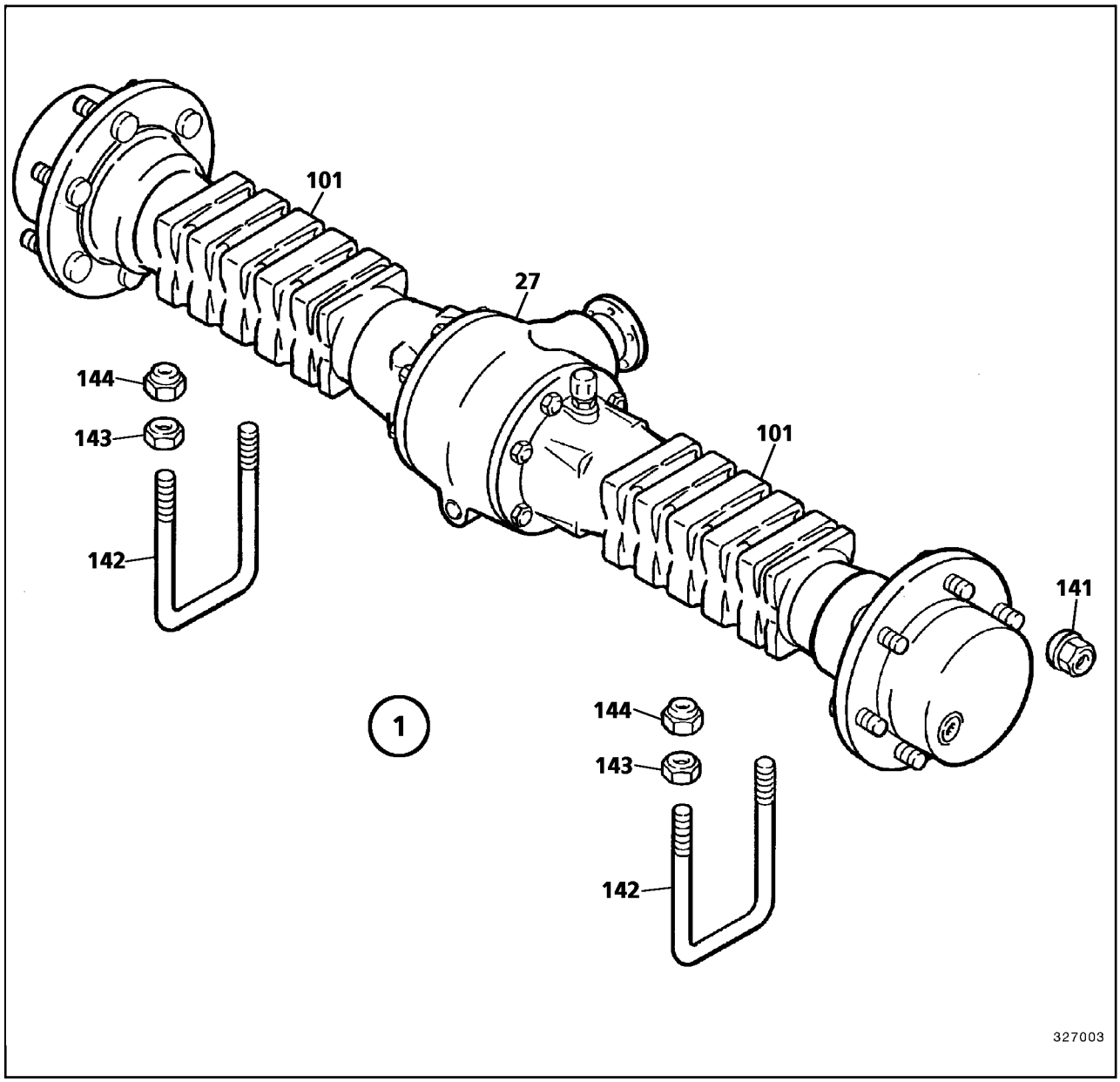


Fig. 1

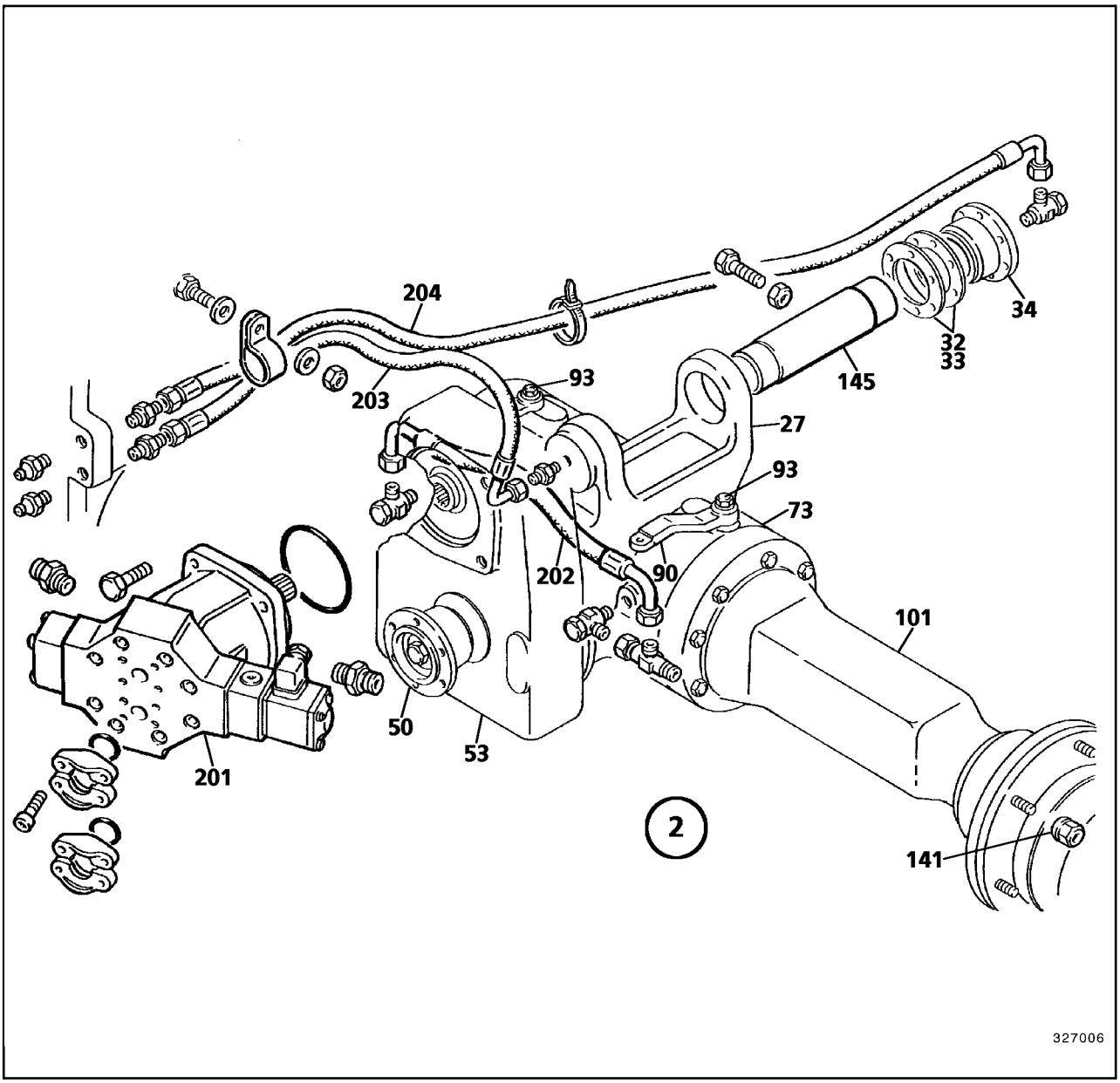


Fig. 2

Dismantling the Front Axle

Wheel Hub Assembly

If the repair is restricted to the hub and the planetary gear set dismantling and reassembling may also be done on the wheel-mounted loader with the axle in horizontal position.

- **Axle Mounted:**
  - Remove wheel, bleed oil from wheel hub and drop oil level in axle.

- **Axle Removed:**
  - Bleed oil from hubs and axle.
  - Mark axle housing (27, Fig. 1) and both axle tubes (101).
  - Slacken hex screws (106).
  - Take off axle tubes (101) incl. wheel hubs and place in vertical position with hub on top.
- Slacken two hex screws (111), lift off planetary carrier (127) and remove O-ring (126).
- Unlock snap rings (122) and pull off spur gears (121) incl. bearing (123) with suitable extractor.
- Remove thrust washer (125).
- Extract pinion shaft (124).

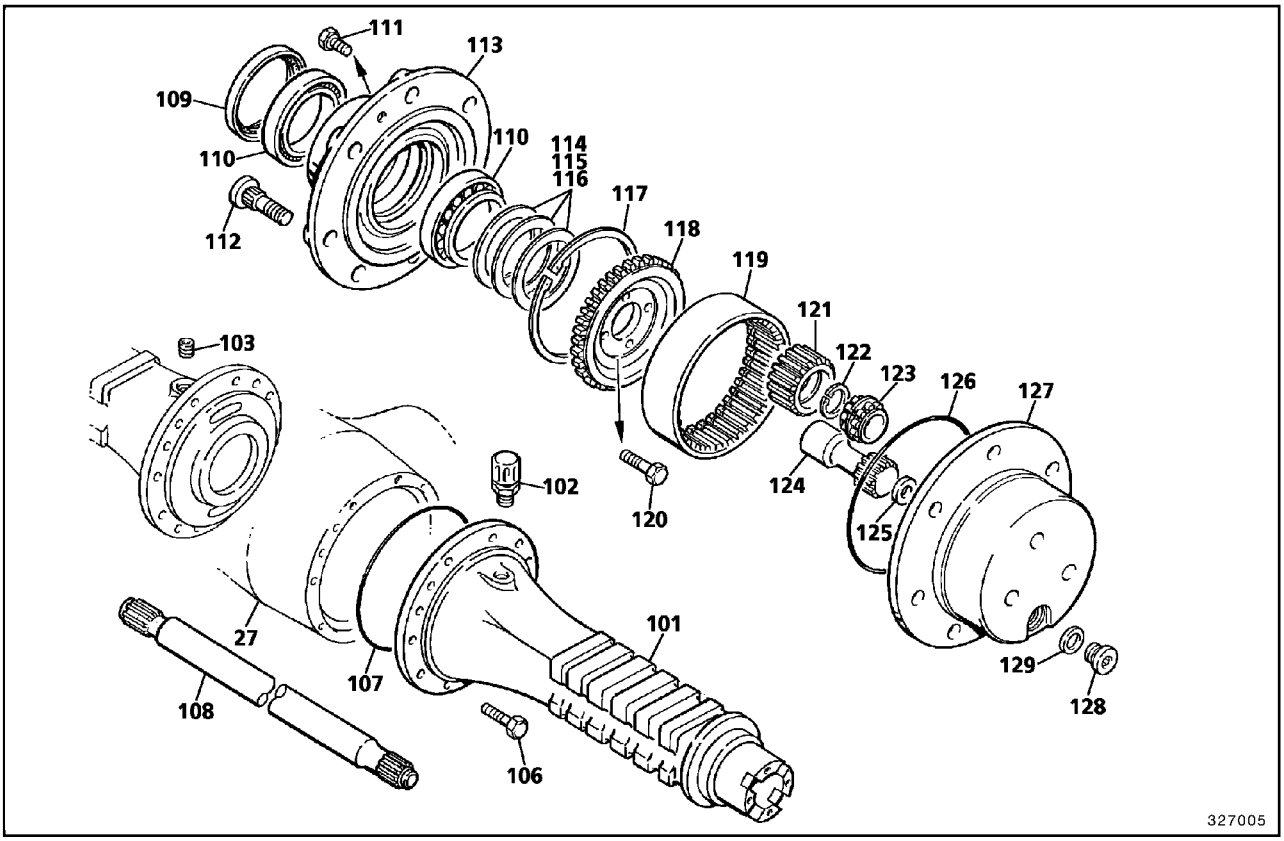


Fig. 1

- Slacken hex screws (120), loosen ring gear (119) and carrier (118) by mounting lever, see Fig. 2, and lift off.

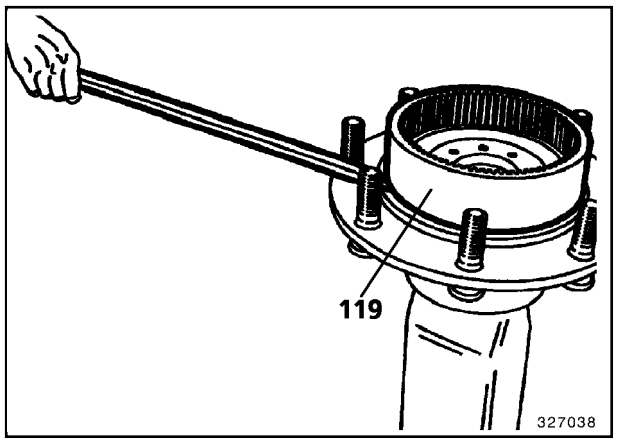


Fig. 2

- Unlock snap ring (117), push carrier (118) out of ring gear (119).
- Remove spacing washers (114 - 116).
- Close hole in axle tube (101) with suitable washer and pull off hub (113) with suitable extractor.

  Recommended: Extract hub (113) with conventional hydraulic press (Lukas). Refer to Fig. 3.

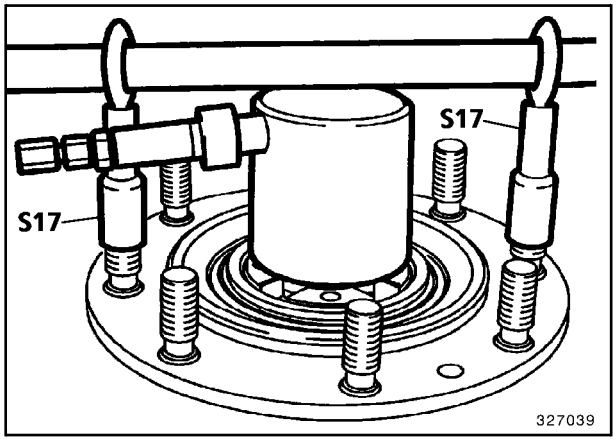


Fig. 3

- Remove tapered roller bearing (110), lift shaft ring (109) and remove second tapered roller bearing (110) from hub (113).
- Drive outer rings of bearings (110) out of hub, if bearings are to be replaced.
- Unscrew vent plug (102) and clean.

Axle Drive Assembly

- Dismantle complete axle. Refer to "Dismantling and Reassembling the Axles".
- Bleed oil from wheel hubs and axle
- Mark axle housing (27, Fig. 4) and both axle tubes (101). Place axle in vertical position so that - seen in driving direction - the left-hand axle half is on top. At this position, ring gear (21) is on top. Refer to "Front Axle Drawing". Fix lower axle tube. For holding fixture, refer to "List of Special Tools" chapter.
- Slacken hex screws (106) and lift off axle tube (101). Hub and planetary gear set remain closed.
- Remove O-ring (107).
- Extract drive shaft (108).
- Lift out complete differential assembly with device S28.
- Pull drive shaft (108)out of lower axle tube.
- Arrest flange (50) with crank S27, slacken collar unit (51) and pull off flange (50).
- Lift shaft ring (48).
- Drive pinion shaft (21) into axle housing (27), catch released tapered roller bearing.
- Extract spacing washers (44 - 46), bush (40) and tapered roller bearing (36) from pinion shaft.
- Drive outer rings of tapered roller bearings (36 + 47) out of axle housing if bearings are to be replaced. Remove spacing washers (37 - 39).

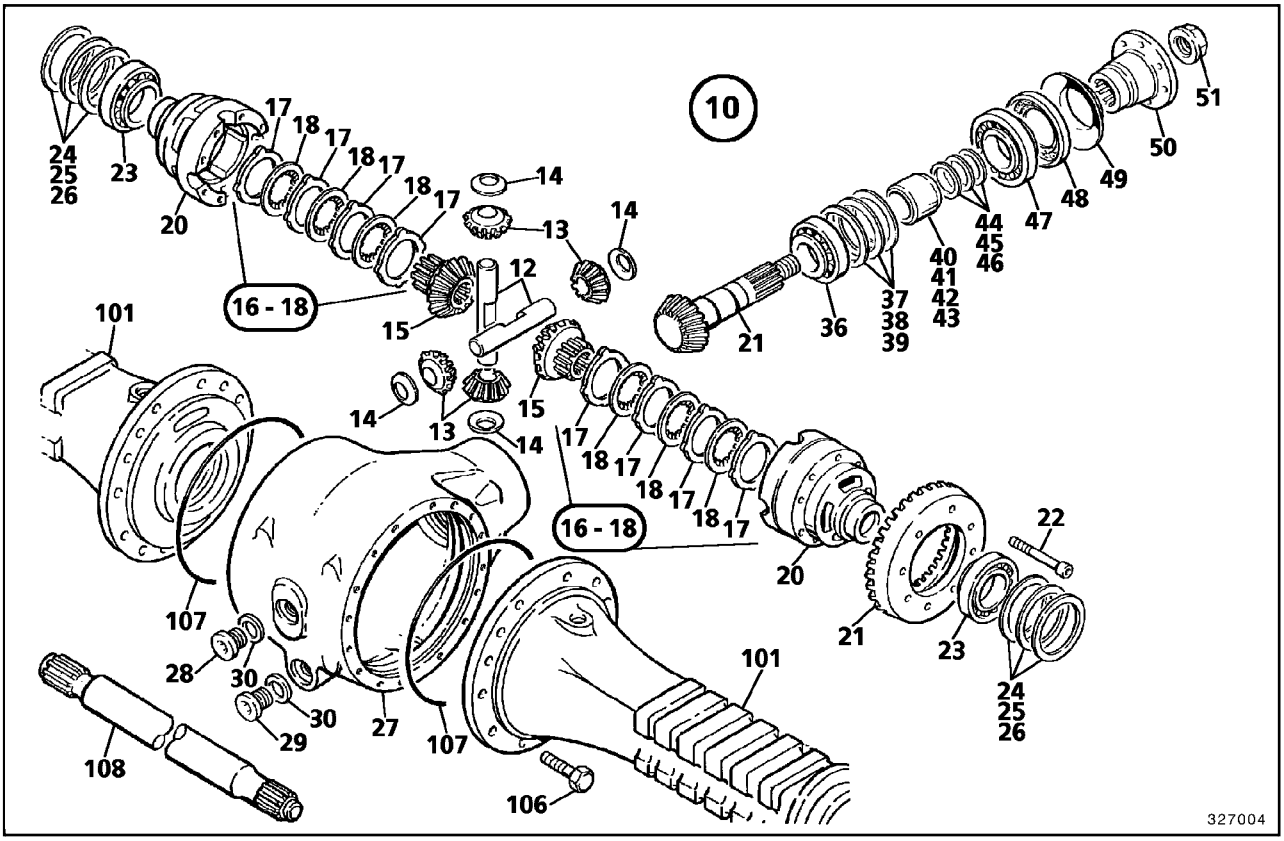


Fig. 4

Differential Assembly

- Mark both halves of differential housing (20, Fig. 6).
- Slacken fillister-head screws (22) and remove ring gear (21).
- Separate differential housing (20), remove pin (12) with bevel gears (13) and washers (14).
- Remove bevel gears (15) and disks (16 - 18) from casings (20).
- Drive both tapered roller bearings (23) off differential housing (20). Put suitable punch on inner bearing rings from inside through oil holes. Refer to Fig. 5.
- Pull rings of tapered roller bearings (23) out of axle tubes if bearings are to be replaced. Remove spacing washers (24 - 26).

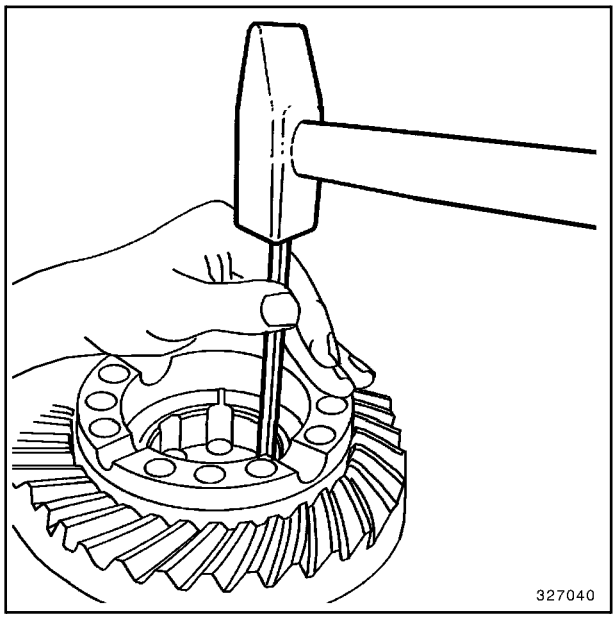


Fig. 5

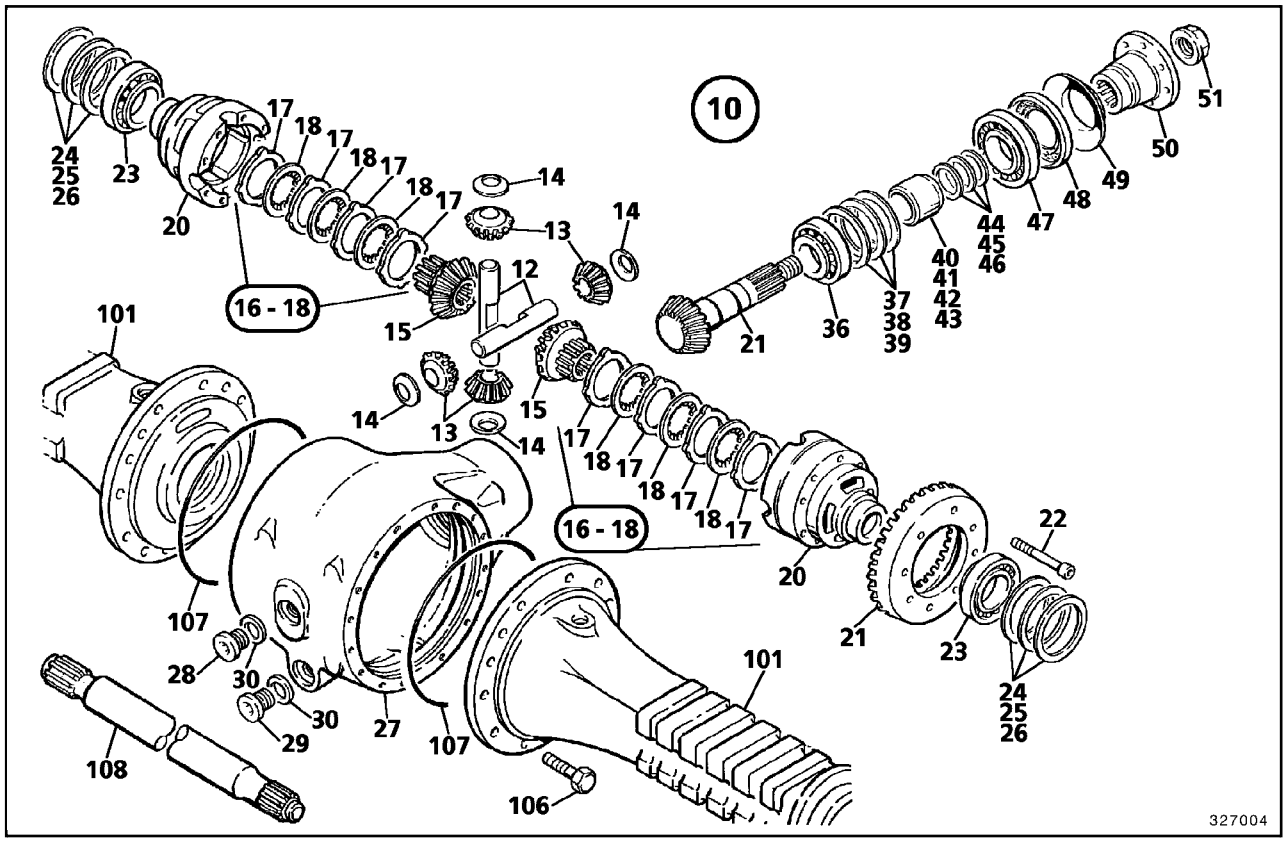


Fig. 6

Dismantling the Rear Axle

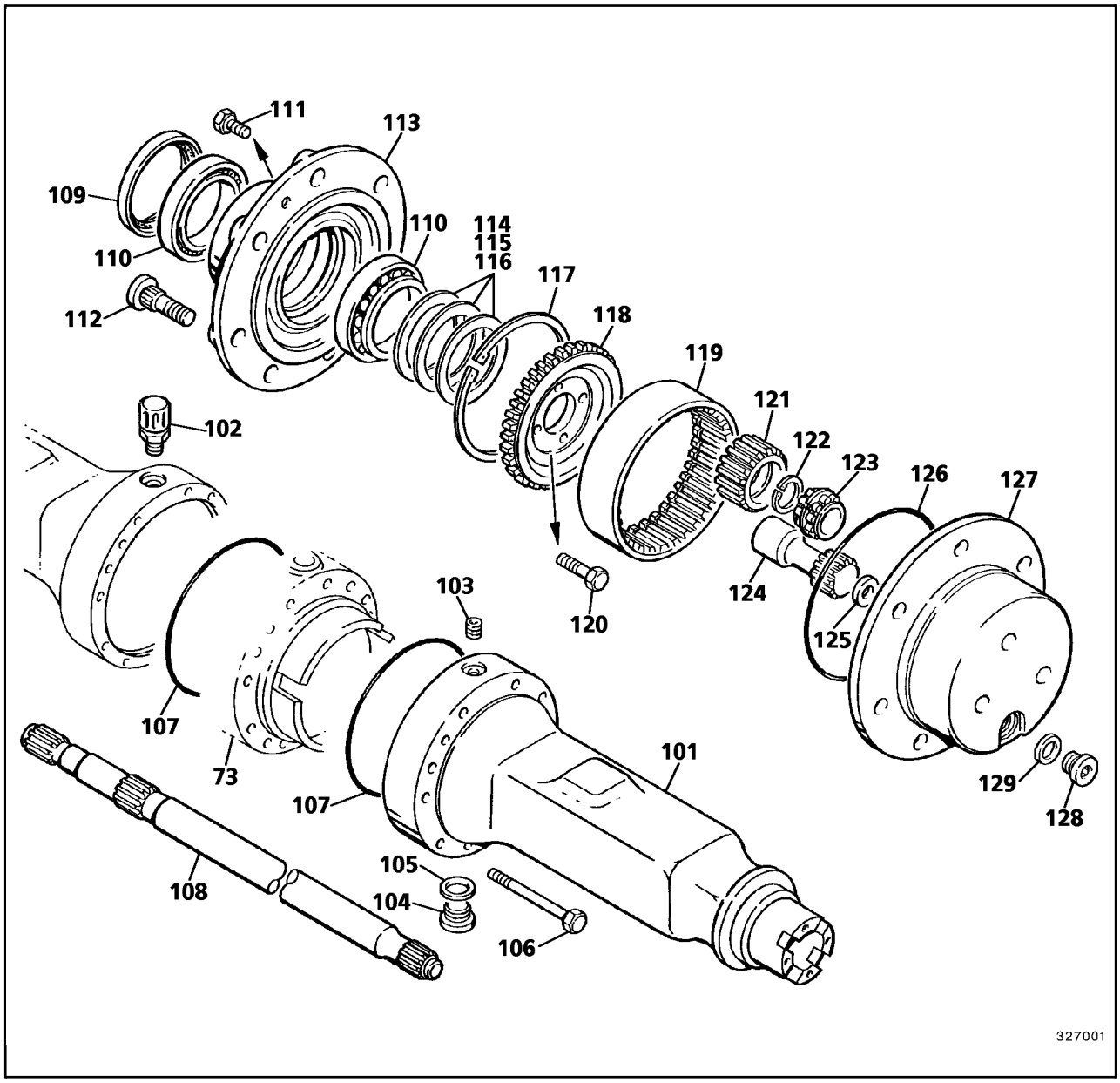


Fig. 1

Wheel Hub Assembly

Refer to Chapter "Wheel Hub Assembly". Only the tube shape differs from the front axle (101, Fig. 1).

Brake Assembly

- Remove complete rear axle. Refer to Chapter "Dismantling and Reassembling the Axles".
- Bleed oil from wheel hubs, axle tubes and axle drive.
- Mark axle tubes (101, Fig. 2), brakes (72 + 73) and axle housing (27).
- Place axle in vertical position and fix at lower tube. If one brake is to be repaired only the latter must be on top.
- Slacken hex screws (106, Fig. 1) and lift off axle tube (101). Hub and planetary gear set remain closed.
- Remove O-ring (107).
- Extract drive shaft (108).
- Remove disks (83 + 84, Fig. 2) from brake carrier.

- Lift off brake carrier (72/73) and remove O-ring (74).
- Remove second axle half from mount, turn and put on axle housing (27). Dismantle axle tube (101) and brake carrier (72/73) as described above.
- Bleed brakes completely (hydraulic oil).
- Remove fillister-head screws (81), take out springs (80) and bushes (79).
- Remove back-up ring (77).
- Screw fillister-head screws (81) into brake pistons (75) and pull out latter by hand.
  Remove packing rings (76).
- Dismantle lever (90/91), push shaft (85) into brake carrier and drive out needle sleeves (87 + 88).
- Check brake piston (75) and cylinder for marks and wear.
- Check and measure brake disks (83 + 84).

  The disks will have to be replaced if the inner ones (84) have worn down to their minimum thickness of 4.5 mm. The wear of the lining must be equal on either side, with a minimum groove depth of 0.2 mm/side.

Brake disk	Thickness (mm) NEW	MIN
Inner disk (84)	$4{,}9^{-0{,}1}$	4,5
Outer disk (83)	$3^{\pm 0{,}1}$	

The outer disks (83) must be replaced if the surface (steel) is rough or scratched. All inner disks (84) bzw.
Replace disks (83 + 84) **only in sets.**

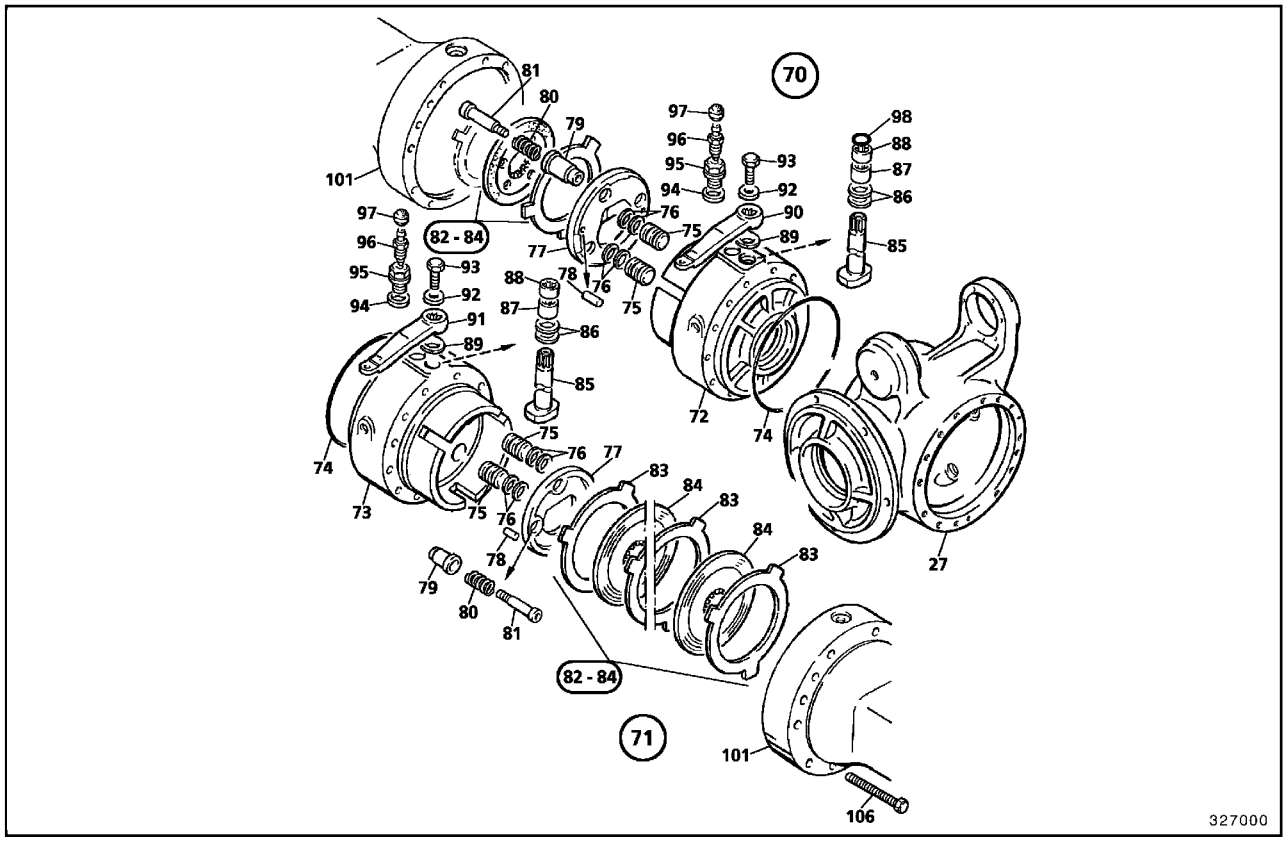


Fig. 2

Axle Drive Assembly

- Remove complete rear axle. Refer to Chapter "Dismantling and Reassembling the Axles".
- Bleed oil from wheel hubs and axle. Mark axle tubes (101, Fig. 2), brake carrier (72/73) and axle housing (27).
- Place axle in vertical position so that - seen in driving direction - the right-hand axle half is on top. At this position, ring gear (21) is on top. Refer to Chapter "Rear Axle Drawing". Fix lower axle tube. For holding fixture, refer to Chapter "List of Special Tools" chapter.
- Lift off hex screws (106, Fig. 1) and axle tube (101). Hub and planetary gear set remain closed.
- Remove O-ring (107).
- Extraxt drive shaft (108).
- Lift off complete brake assembly (72, Fig. 3) and remove O-ring (74).
- Lift out spacing washers (24 - 26) and complete differential assembly with device S28.
- Extract drive shaft (108) from lower axle tube.
- Arrest flange (50, Fig. 4) with crank S27, slacken collar unit (51) and pull off flange (50).

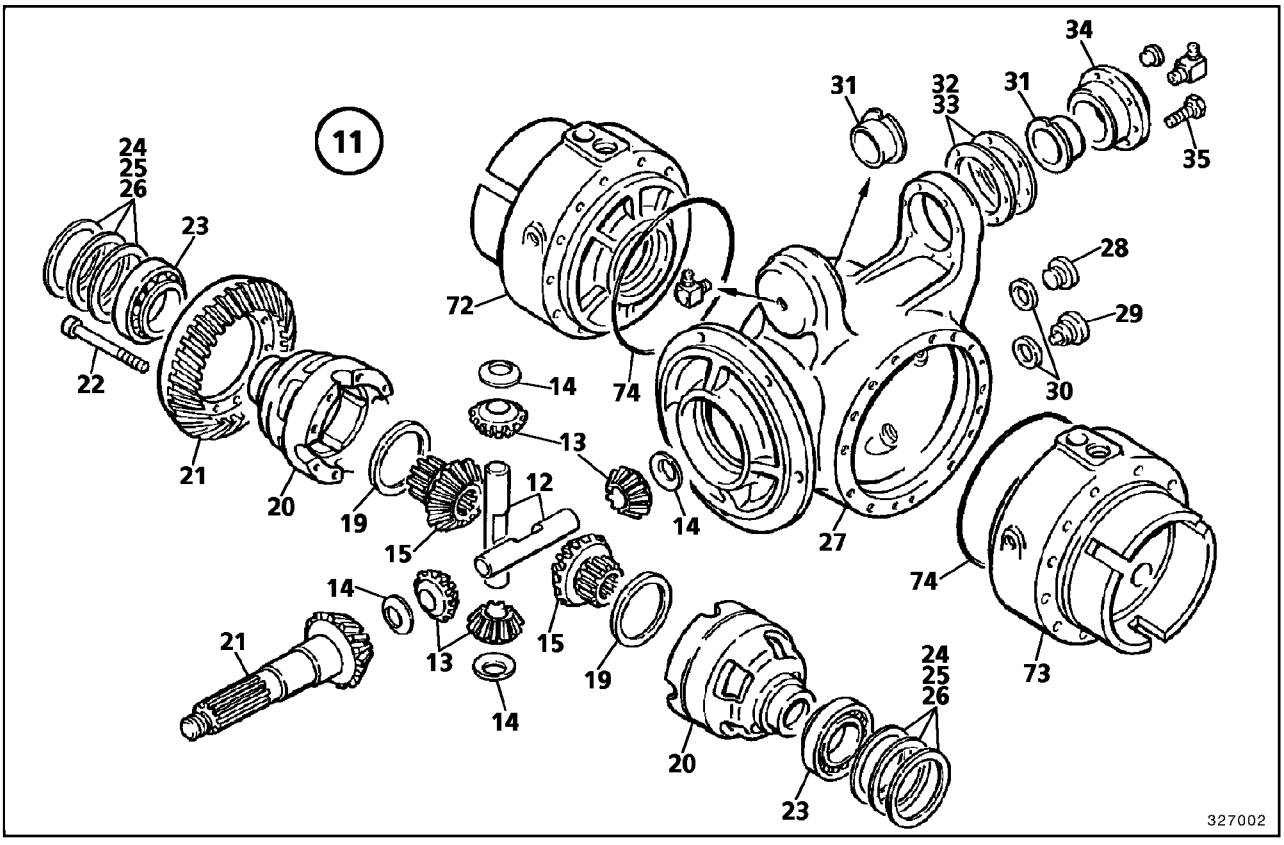


Fig. 3

- Slacken hex screws (55). Take off transfer box (53) and remove O-ring (54).
- Drive shaft ring (48) out of housing.
- Pull off spur gear (52).
- Push pinion shaft (21) into axle housing (27), remove spacing washers (44 - 46), extract bush (40) and tapered roller bearing (36) from shaft.
- Extract tapered roller bearing (47) from spur gear (52).
- Drive outer rings of tapered roller bearings (36 + 47) out of axle housing if bearings are to be replaced. Remove spacing washers (37 + 39).

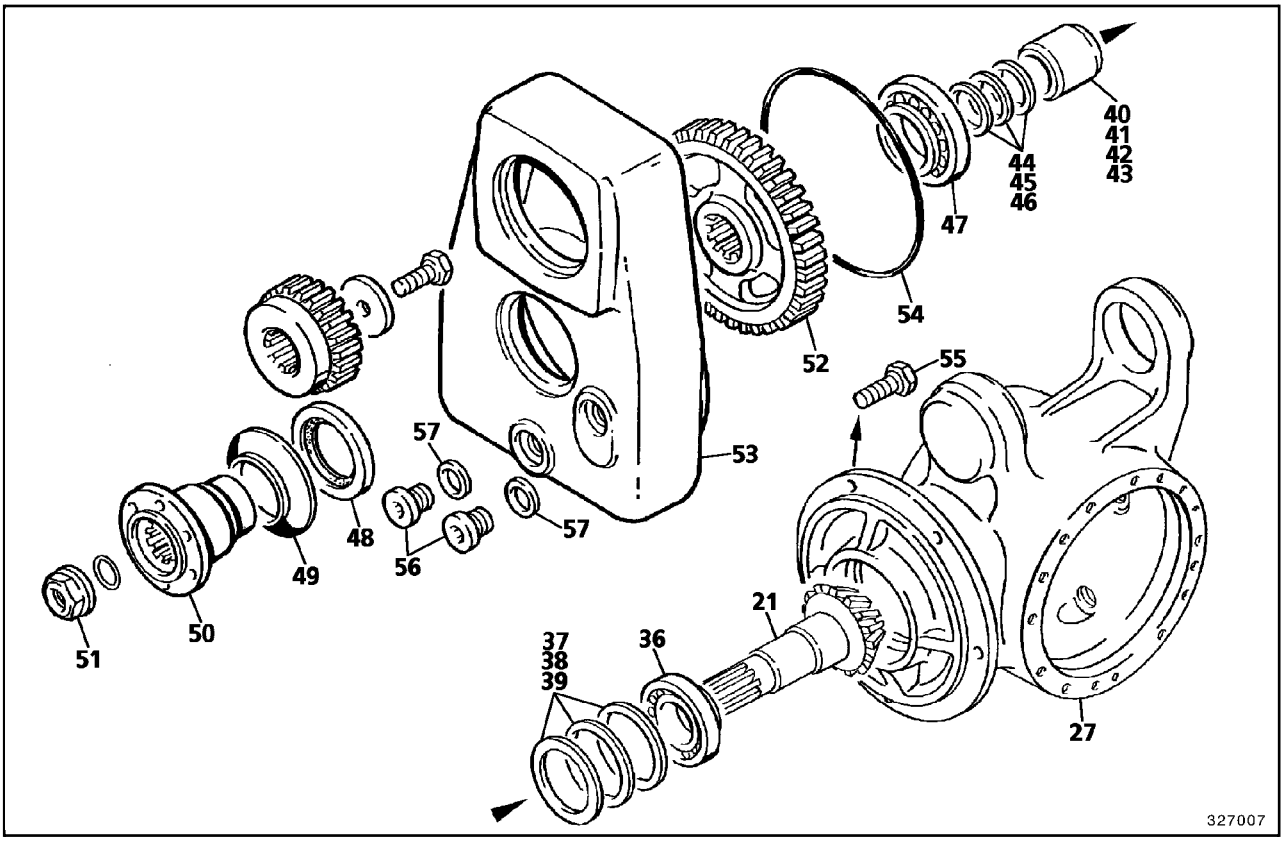


Fig. 4

Differential Assembly

Refer to Chapter "Differential Assembly". Instead of the self-locking differential disks, one bearing ring (19, Fig. 5) is installed on each side in the rear axle differential.

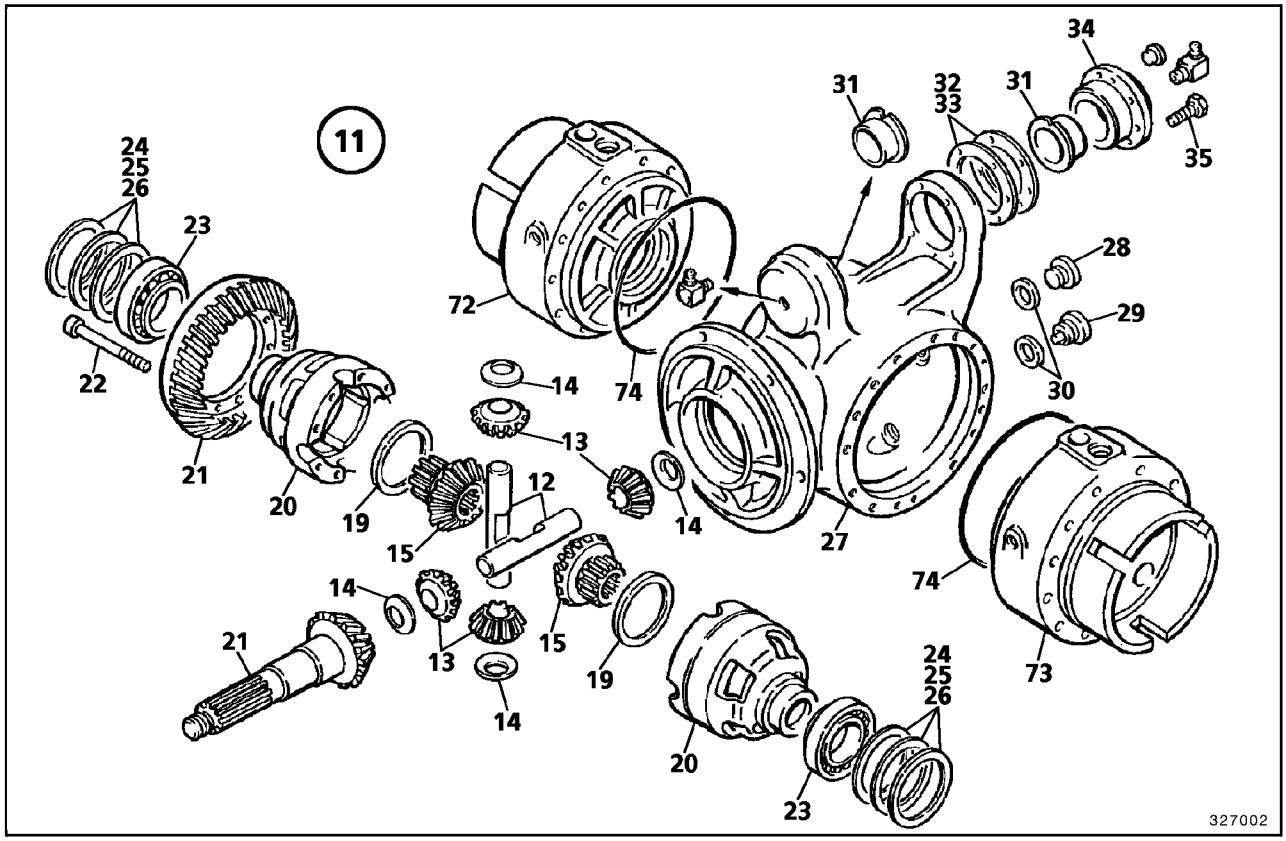


Fig. 5

Assembling the Front Axle

Wheel Hub Assembly

The following illustrations show axle tube (101) in vertical position, i. e. the complete axle is removed.

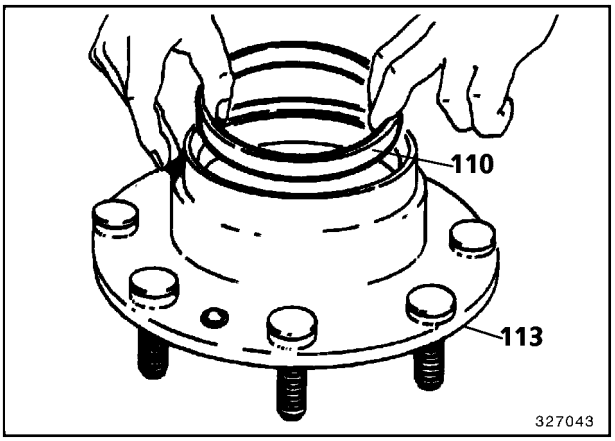


Fig. 1

Insert outer ring of tapered roller bearing (110) into hub (113).

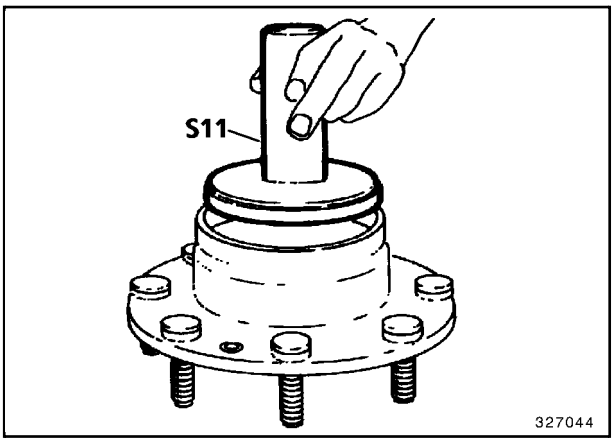


Fig. 2

Apply punch (S11).

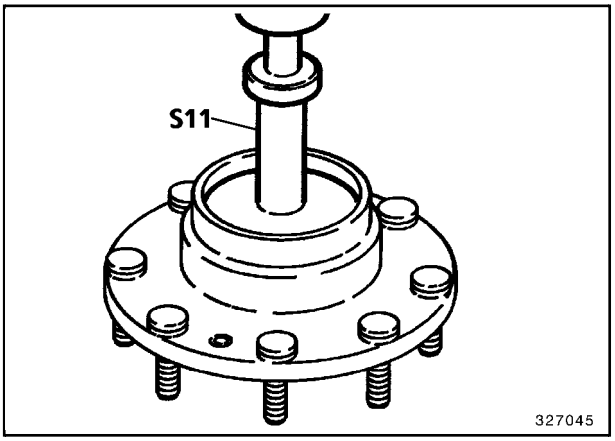


Fig. 3

Force bearing outer ring into hub by hydraulic press.

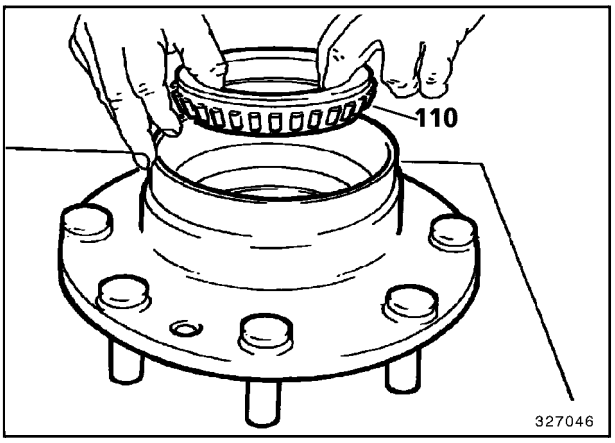


Fig. 4

Insert tapered roller bearing (110).

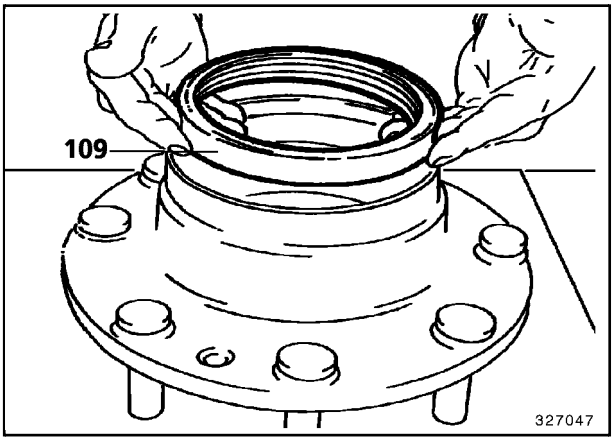


Fig. 5

Apply shaft ring (109) so that outer flange faces top. Refer to Fig. 6.

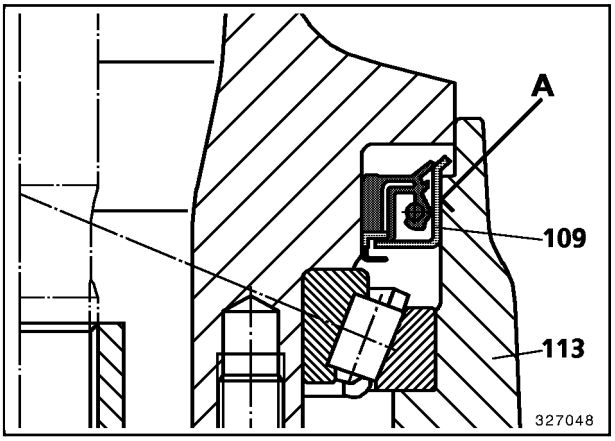


Fig. 6

Apply sealing compound to surface (A) of shaft ring (109) and hub (113).

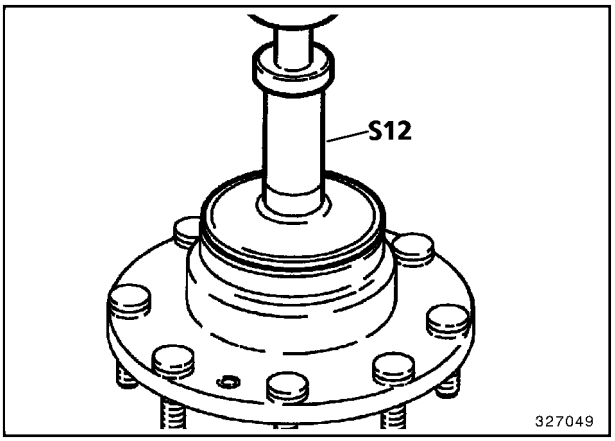


Fig. 7

Press in shaft ring (109). Pressing depth is limited by flange.

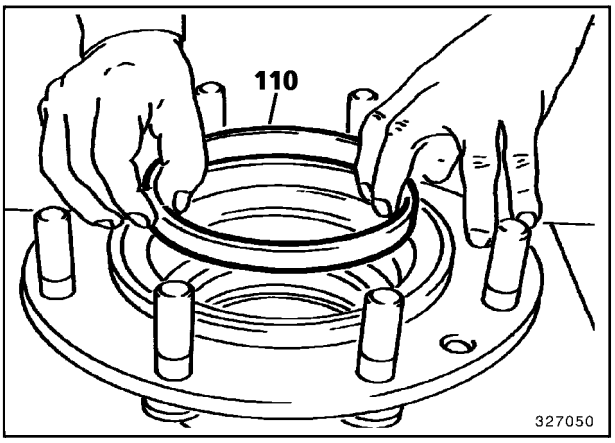


Fig. 8

Turn over hub.

Insert outer ring of tapered roller bearing (110).

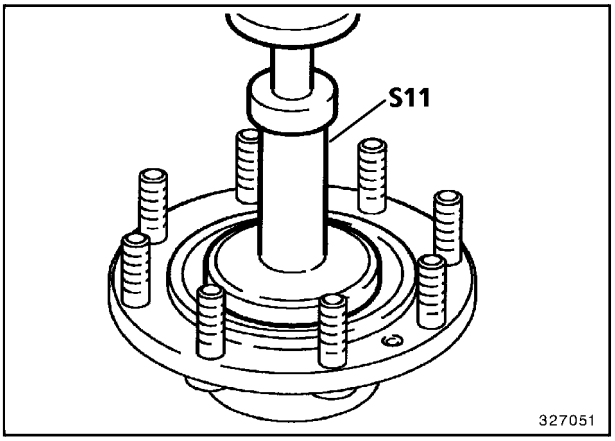


Fig. 9

Press in bearing ring.

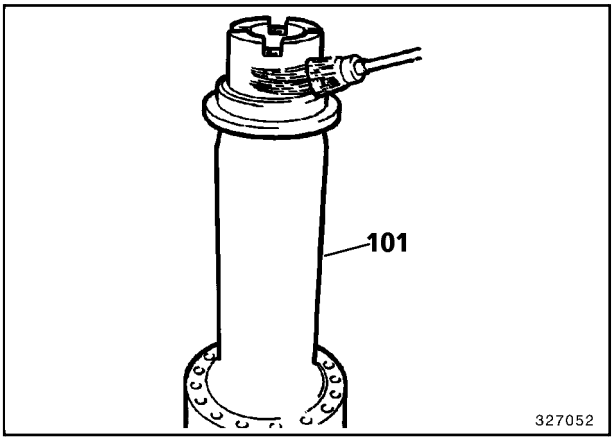


Fig. 10

Place axle tube (101) in vertical position.

Apply grease to hub carrier.

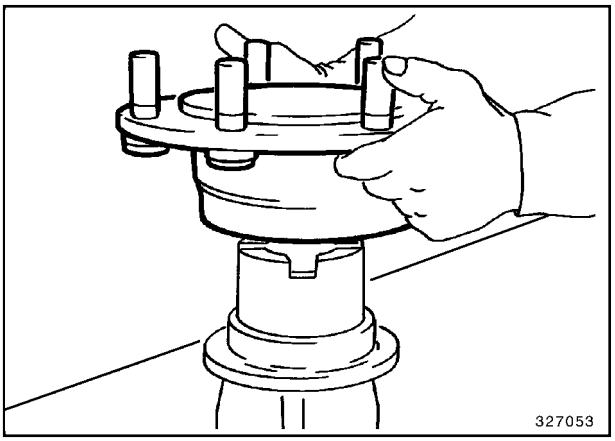


Fig. 11

Put hub on axle tube.

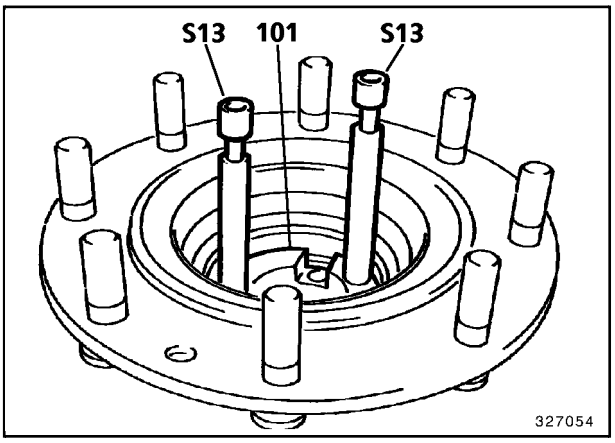


Fig. 12

Screw two pins of mounting fixture (S13) into axle tube (101).

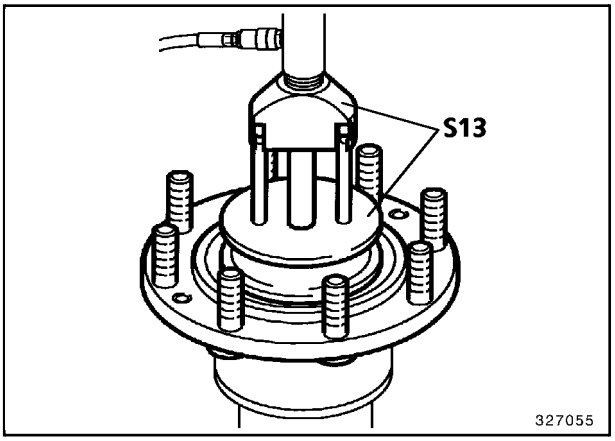


Fig. 13

Apply mounting fixture (S13) with screwed-in cylinder for conventional hydraulic presses (Lukas).

Fully press hub onto axle tube.

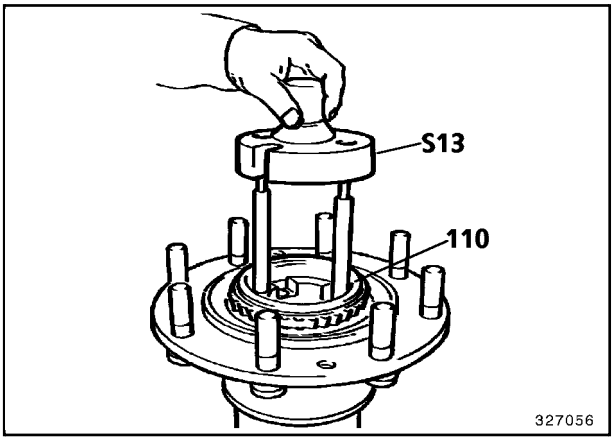


Fig. 14

Insert tapered roller bearing (110).

Apply new die of mounting fixture (S13) to bearing ring.

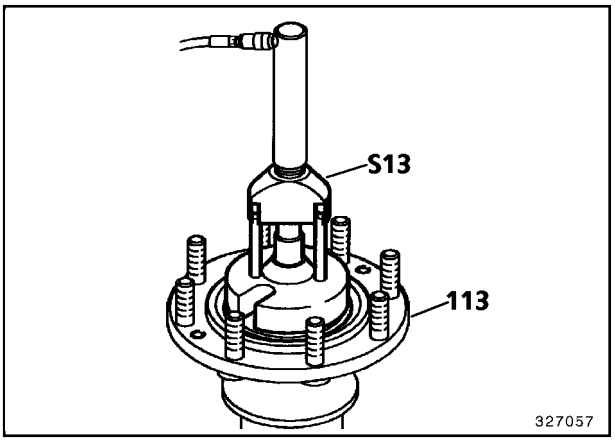


Fig. 15

Increase pressure of hydraulic press to approx. 200 bar (2903 psi). Give hub a few taps with plastic mallet for settling.

Reduce pressure to 50 bar (726 psi) and turn hub (113) by hand. This value yields the axial prestress of 0.05 - 0.15 mm required for new tapered roller bearings (110).

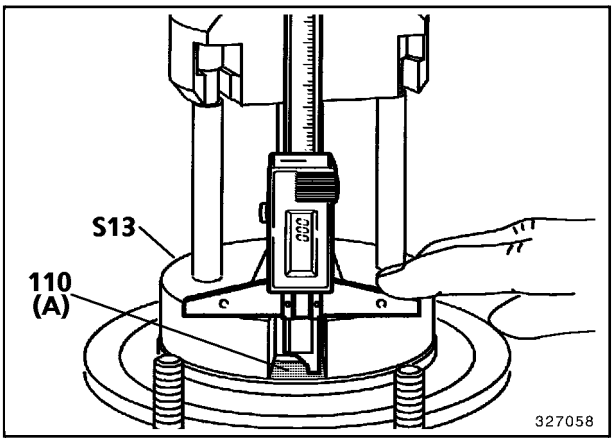


Fig. 16

Measure distance between die of mounting fixture (S13) and surface (A) on inner ring of tapered roller bearing (110) with depth gauge.

(Digital meter to be set to "0".)

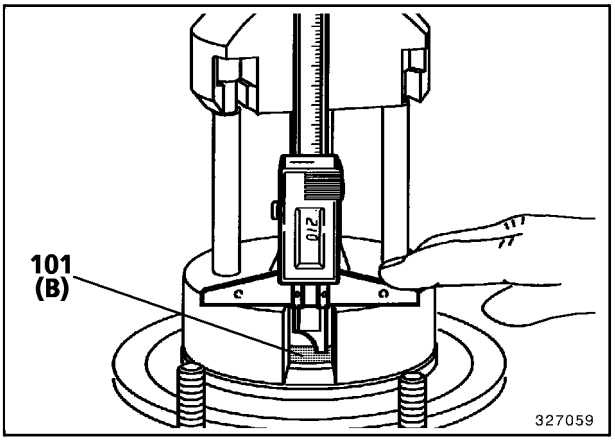


Fig. 17

Subsequently, measure face (B) of axle tube (101).

Difference between A and B = X.

The dismension may be in the positive or negative range.

Example 1 : X = 0.22 mm.
or
Example 2 : X = - 0.12 mm.

Record measured value.

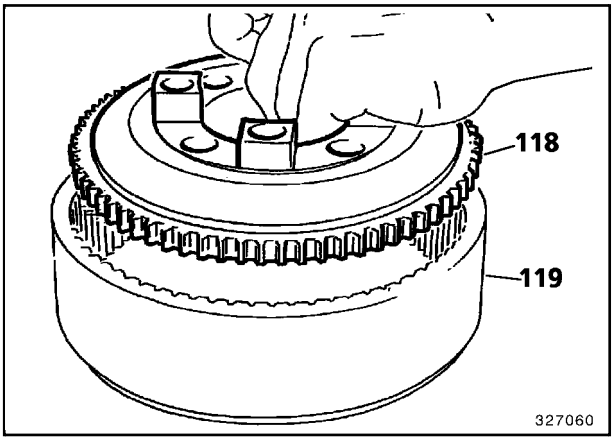


Fig. 18

Insert ring gear carrier (118) into ring gear (119).

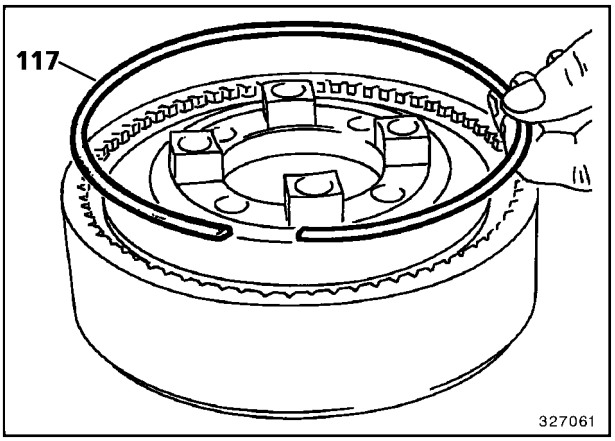
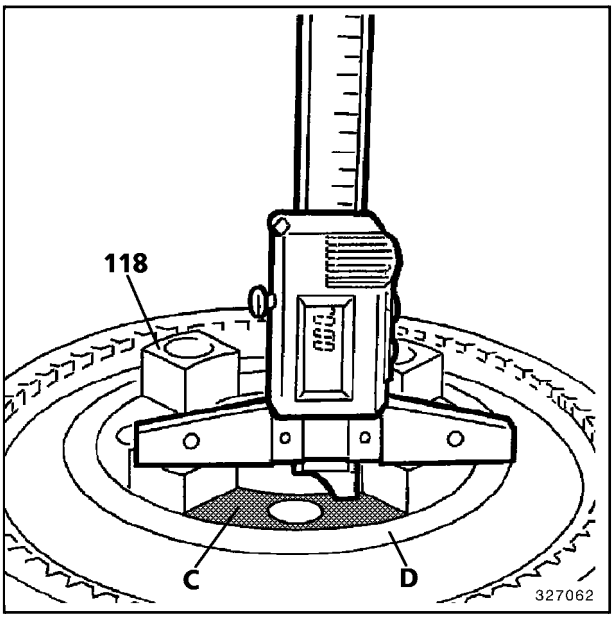


Fig. 19

Lock in snap ring (117).



Determine difference between recess (C) an annular surface (D) on ring gear carrier (118):

Fig. 20

Measure recess (C).

(Digital meter to be set to "0".)

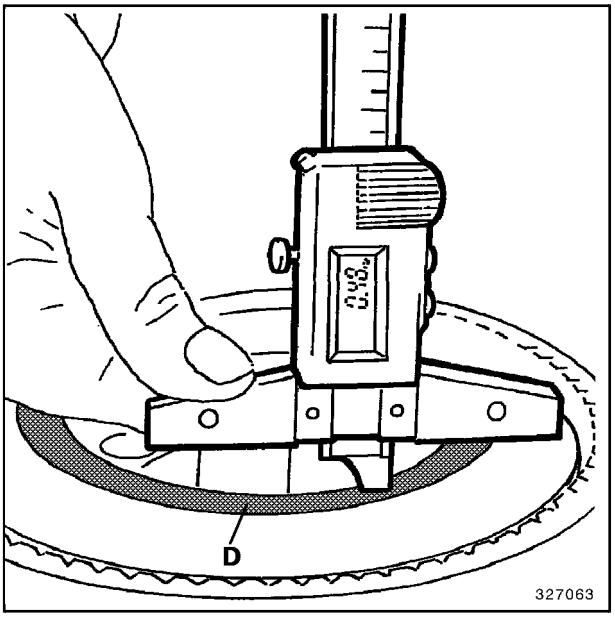


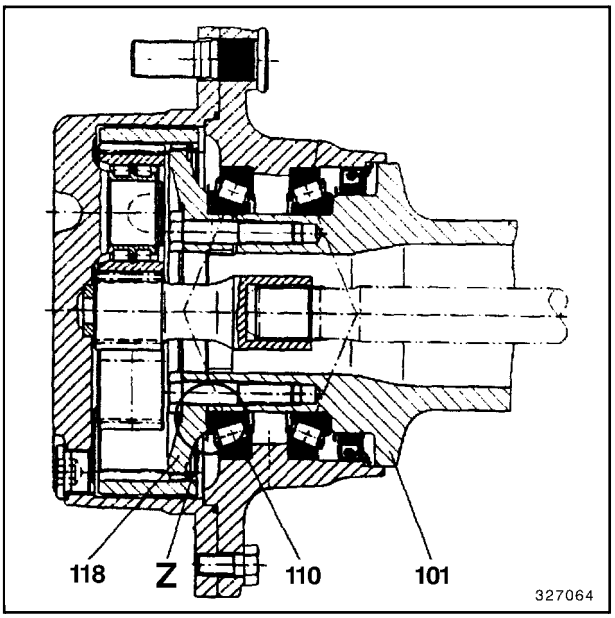
Fig. 21

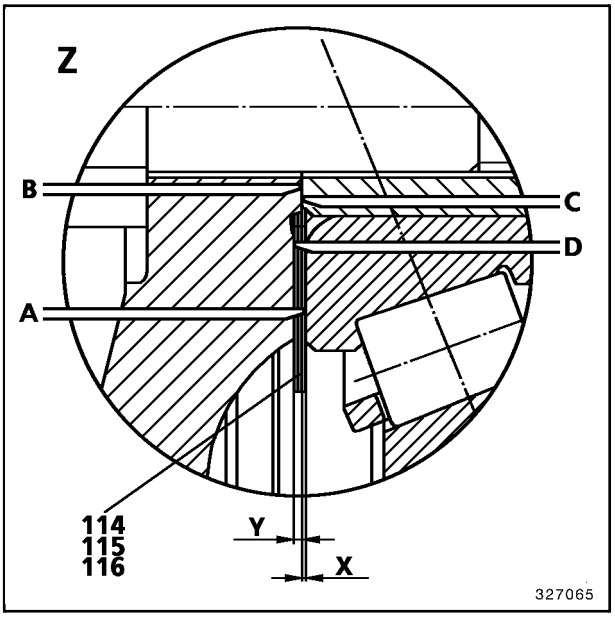
Measure annular surface (D) of ring gear carrier.

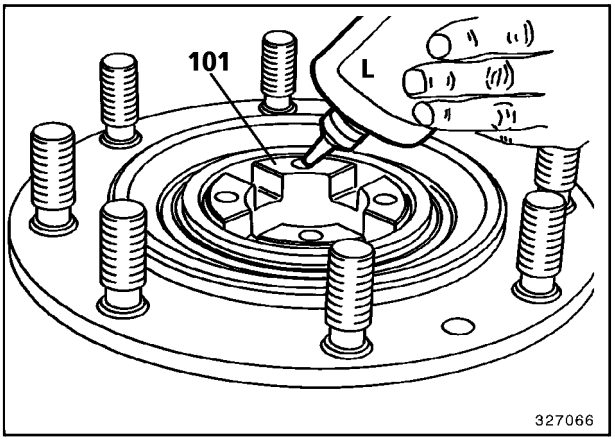
Repeat both measurement with a 180° offset. Average of between C and D = Y.

Example 1 : Y = 0.50 mm.
or
Example 2 : Y = 0.48 mm.

Record measured value.







Figs. 22 and 23

Calculating Spacing Washers (114 - 116)

Example 1:

X	0.22 mm
Y	+ 0.50 mm
	0.72 mm
Pre-tension	+ 0.03 mm
	0.75 mm
Rounded up	0.80 mm
1 no. of spacing washer	0.50 mm
1 no. of spacing washer	0.30 mm

Example 2:

X	- 0.12 mm
Y	+ 0.48 mm
	0.36 mm
Pre-tension	+ 0.03 mm
	0.39 mm
Rounded up	0.40 mm
1 no. of spacing washer	0.30 mm
1 no. of spacing washer	0.10 mm

Always round up the value calculated.

Spacing washers (114 - 116) 0.1 - 0.3 - 0.5 mm thick.
If possible, keep the number of spacing washers small.

Fig. 24

Moisten eight tapped holes of axle tube (101) with LOCTITE 243.

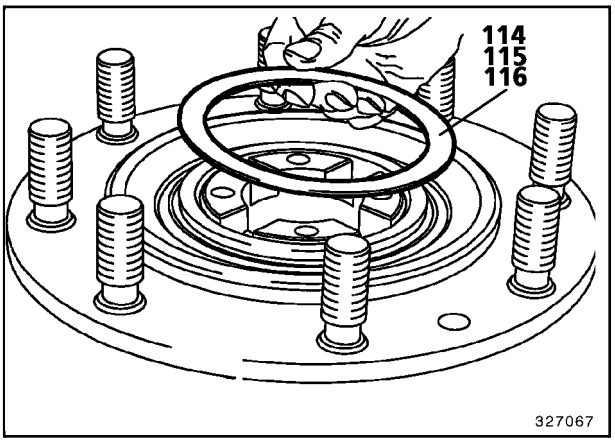


Fig. 25

Put on spacing washer(s) (114 - 116) determined.

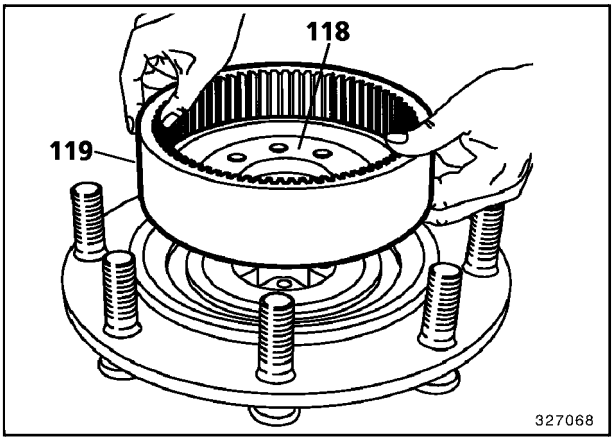


Fig. 26

Put on ring gear carrier (118) with ring gear (119).

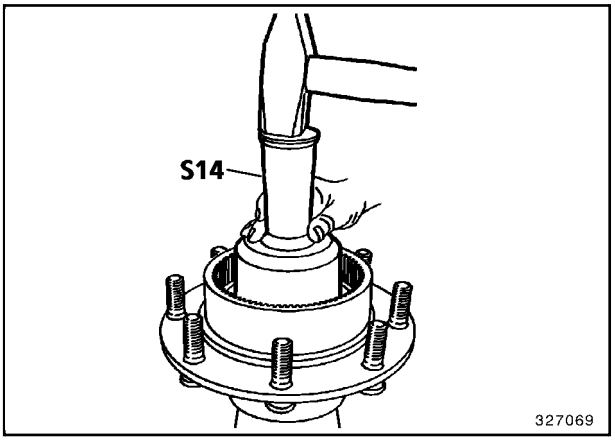


Fig. 27

Drive ring gear carrier fully down on bearing surface with punch (S14).

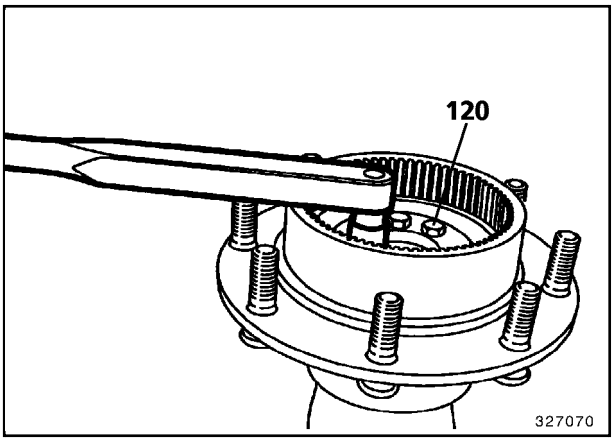


Fig. 28

Crosswise tighten hex screws (120).

Tightening torque M_A = 120 Nm (89 lbft).

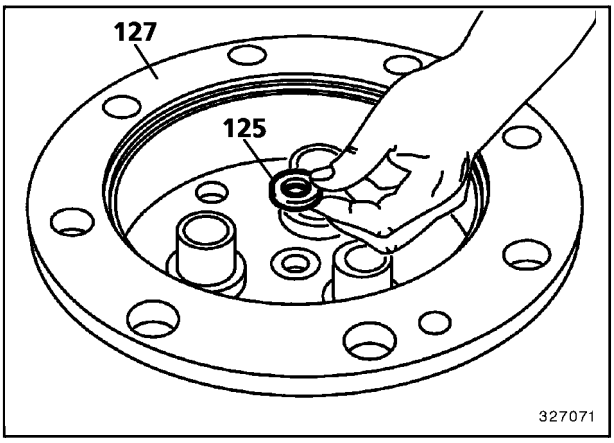


Fig. 29

Put thrust washer (125) with LOCTITE 243 in planetary carrier (127) and drive in with suitable punch.

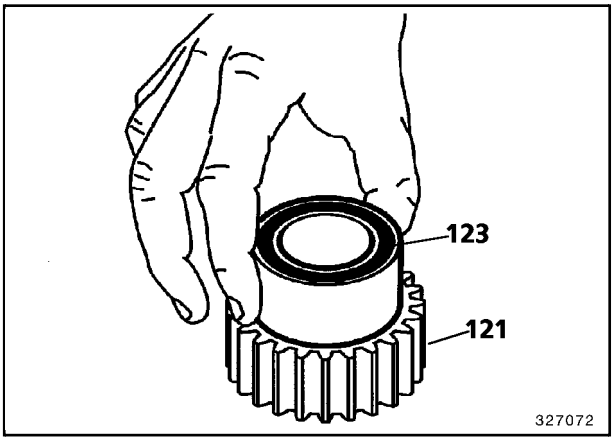


Fig. 30

Put up spur gears (121) with their big bevels down.

Put on spur gear new roller bearing (123) in PVC sleeve with radius in inner ring down and centre exactly.

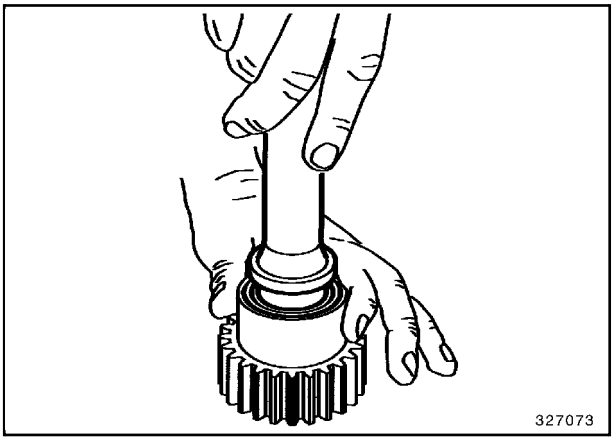


Fig. 31

Firmly press PVC sleeve onto spur gear.

Quickly push roller bearing (123) into spur gear with suitable punch until snap ring (123.1) locks into spur gear groove from bearing middle.

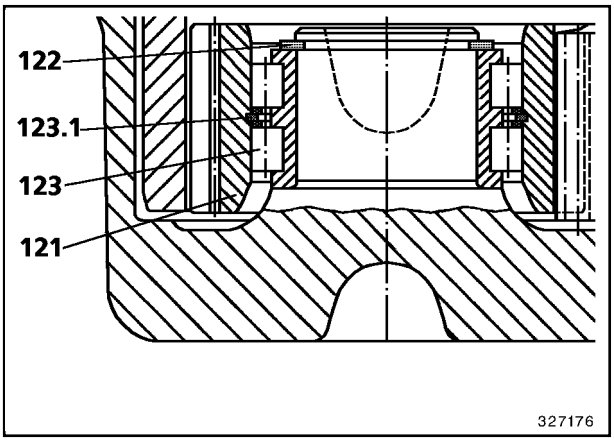


Fig. 32

Fitting position.

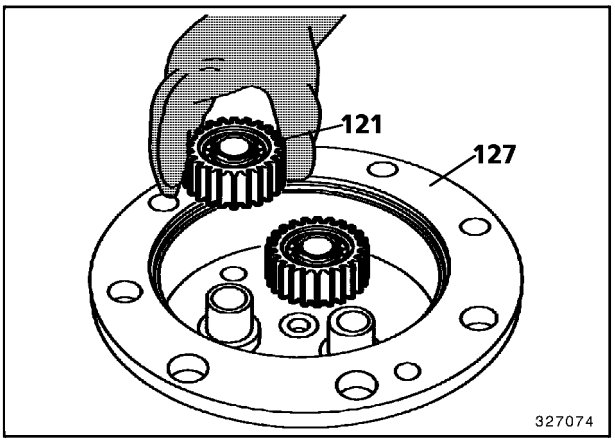


Fig. 33

Warm up in oven spur gears (121) with bearing for approx. 30 minutes at maximum of 100˚C (212˚F).

Put warm spur gear on planetary carrier pivot with big bevel down.

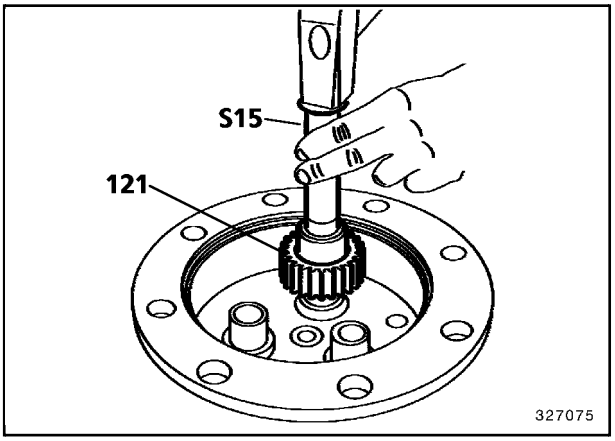


Fig. 34

Fully drive in bearing with punch (S15).

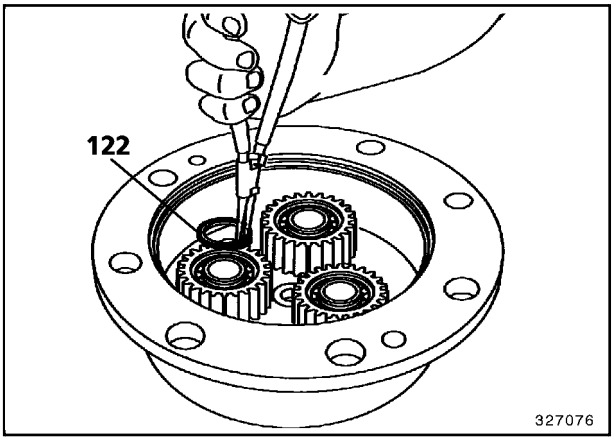


Fig. 35

Lock in snap rings (122).

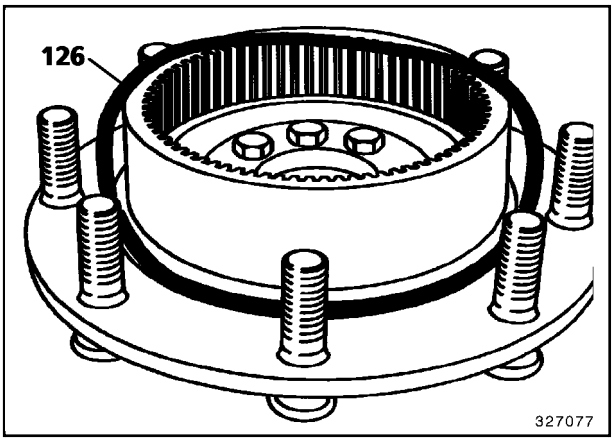


Fig. 36

Put on O-ring (126).

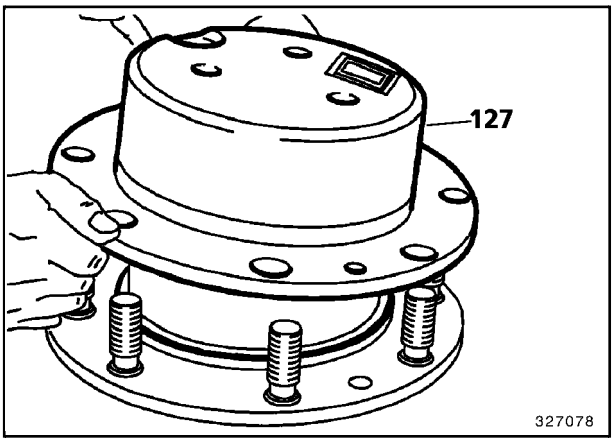


Fig. 37

Attach complete planetary carrier assembly. Mind small holes for hex screws (111, Fig. 38).

In case of partial repair of the installed axle, axle shaft (108) and pinion shaft (124) must be installed before hand.

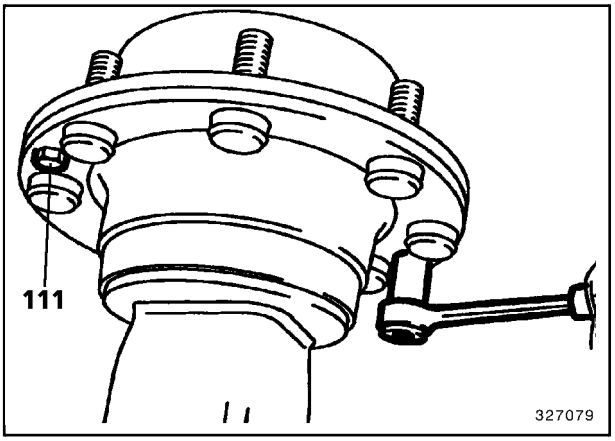


Fig. 38

Turn in two hex screws (111) and tighten.

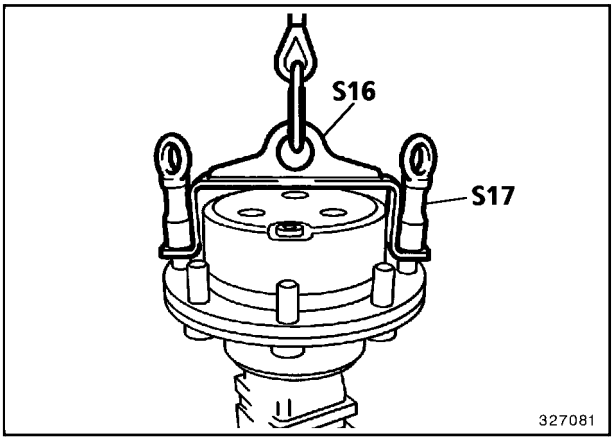


Fig. 39

Fixture for lifting the pre-assembled wheel hubs.

Differential (Pre-assembling)

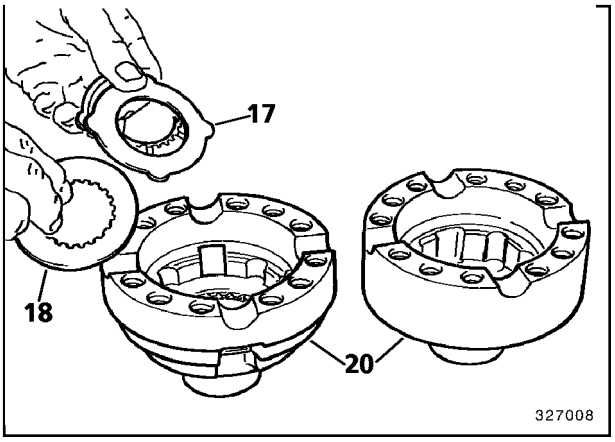


Fig. 40

Self-locking differential (front axle):

Put in each housing half (20)
4 outer disks (17),
3 inner disks (18).

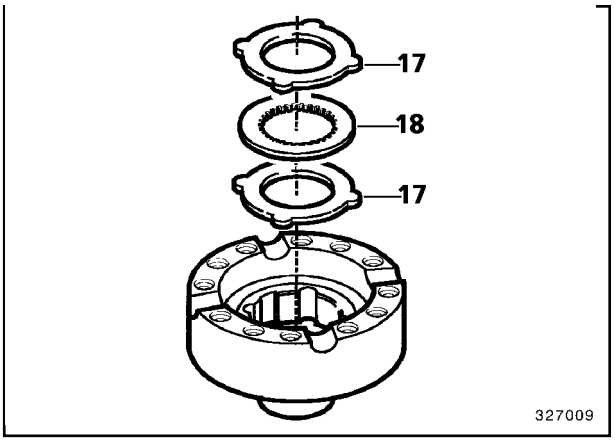


Fig. 41

Insert alternately, beginning with an outer disk (17).

Put new disks in LS 5-90 gear oil for 30 minutes before inserting.

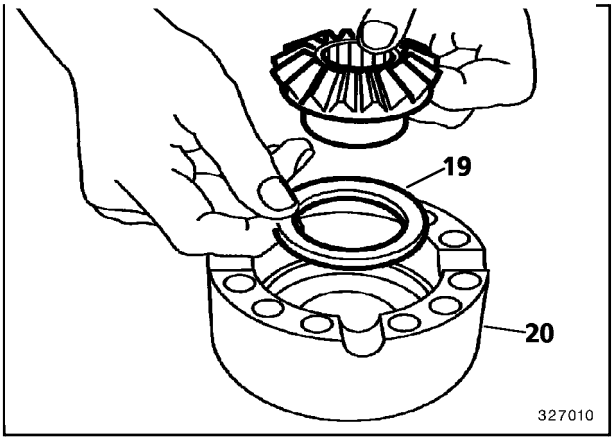


Fig. 42

Open differential (rear axle):

Instead of disks (17 + 18), apply grease to one washer (19) and put in each housing half (20).

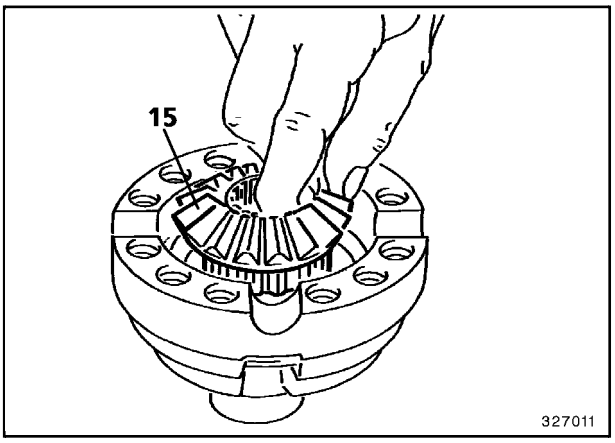


Fig. 43

Insert bevel gears (15).

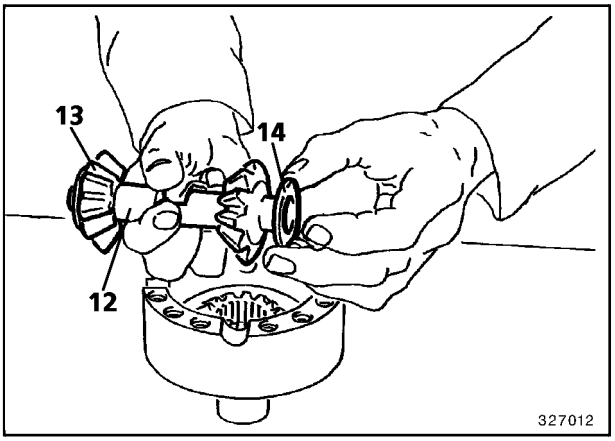


Fig. 44

Put bevel gears (13) and washers (14) on differential pin (12).

Bevel gears and washers should be slightly oiled.

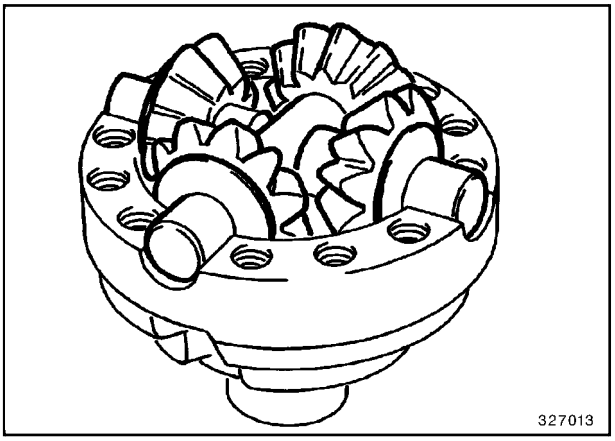


Fig. 45

Insert complete differential cross and press down. Pins must fully rest.

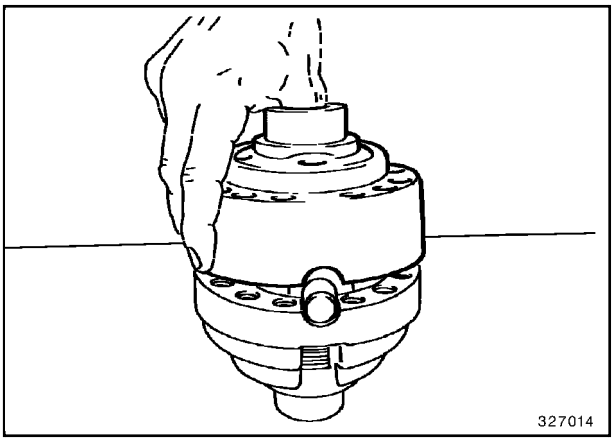


Fig. 46

Attach second housing half so that markings agree. Hold bevel gear (15) with your thumb when doing so.

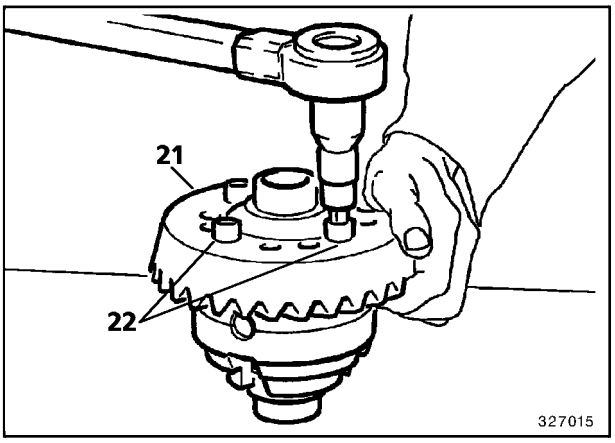


Fig. 47

Attach bevel gear (21). Turn in four fillister-head screws (22) with LOCTITE 243 and slightly tighten crosswise.

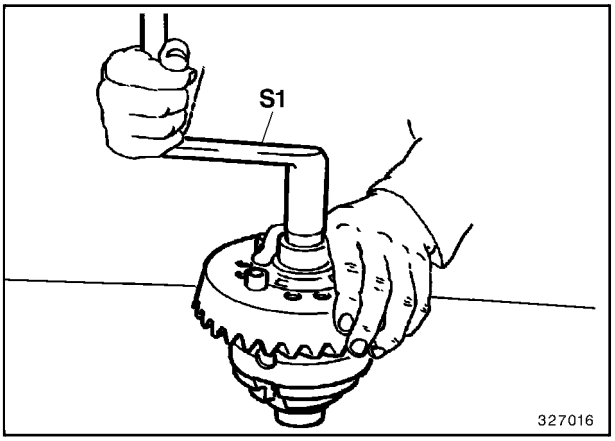


Fig. 48

Slip over hand crank (S1) and turn differential. To make the gears and pins settle give the bevel gear a few taps with a plastic mallet.

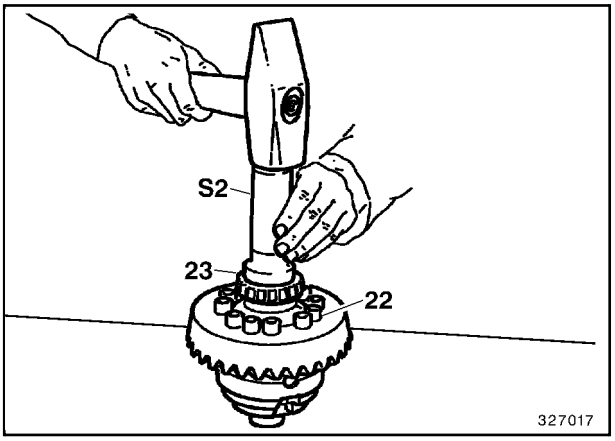


Fig. 49

Turn in remaining fillister-head screws (22) with LOCTITE 243. Tighten all screws.

Tightening torque M_A = 120 Nm (89 lbft).

Drive on tapered roller bearing (23).

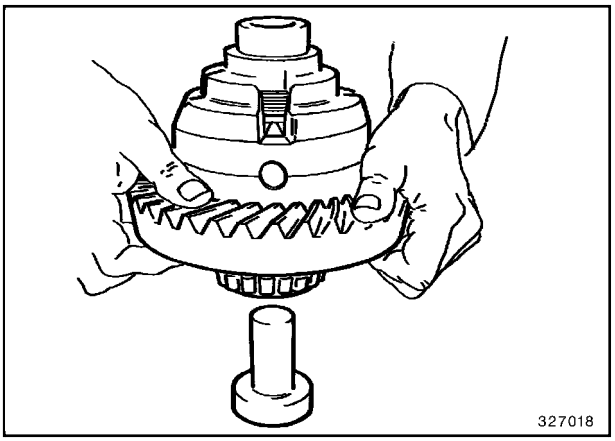


Fig. 50

Turn over differential and put on suitable punch.

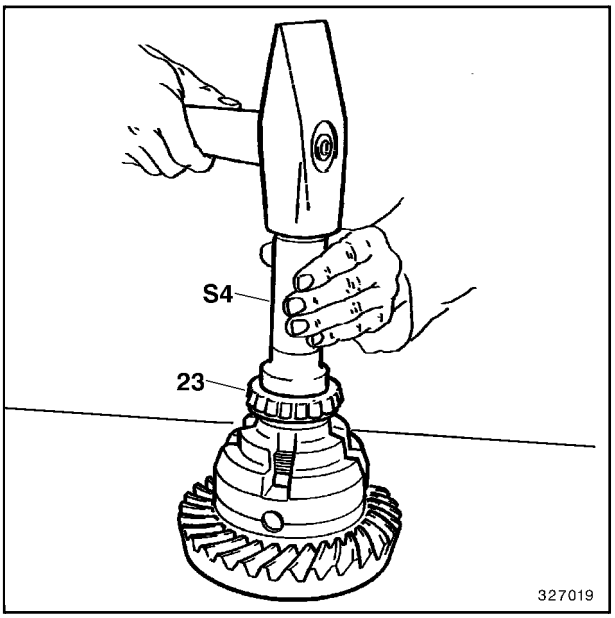


Fig. 51

Drive on second tapered roller bearing (23).

Complete Axle Drive and Axle Assemblies

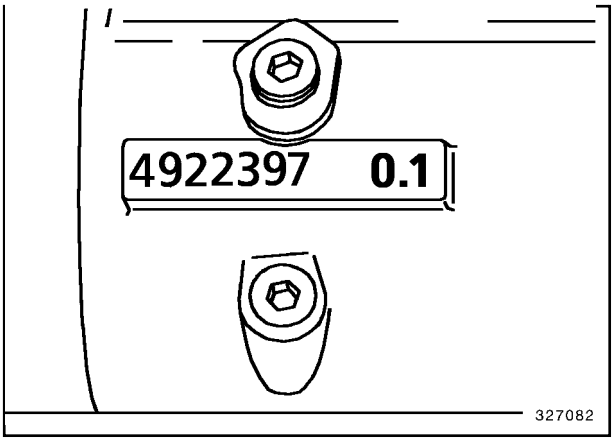


Fig. 52

An information field for stamping in the ID and dimensions is located between the filler cap and the drain plug.

The deviation from the nominal dimension (e. g. 0.10) or the complete dimension (e. g. 120.10) is stamped in.

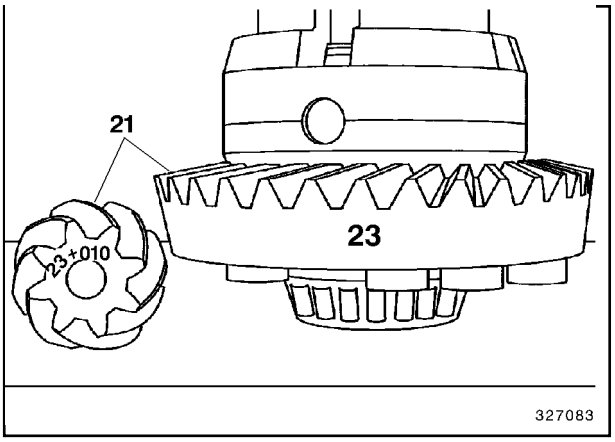


Fig. 53

Compare the figures engraved in the pinion shaft and in bevel gear (21). The mating number (e. g. 23) must, by all means, agree. The value (e. g. +0.10) given only on the pinion shaft is the deviation from the nominal dimension.

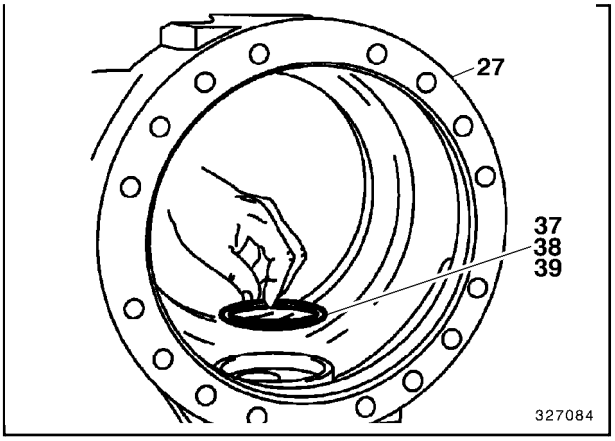


Fig. 54

Determine spacing washer(s) (37-39), refer to next page, and insert.

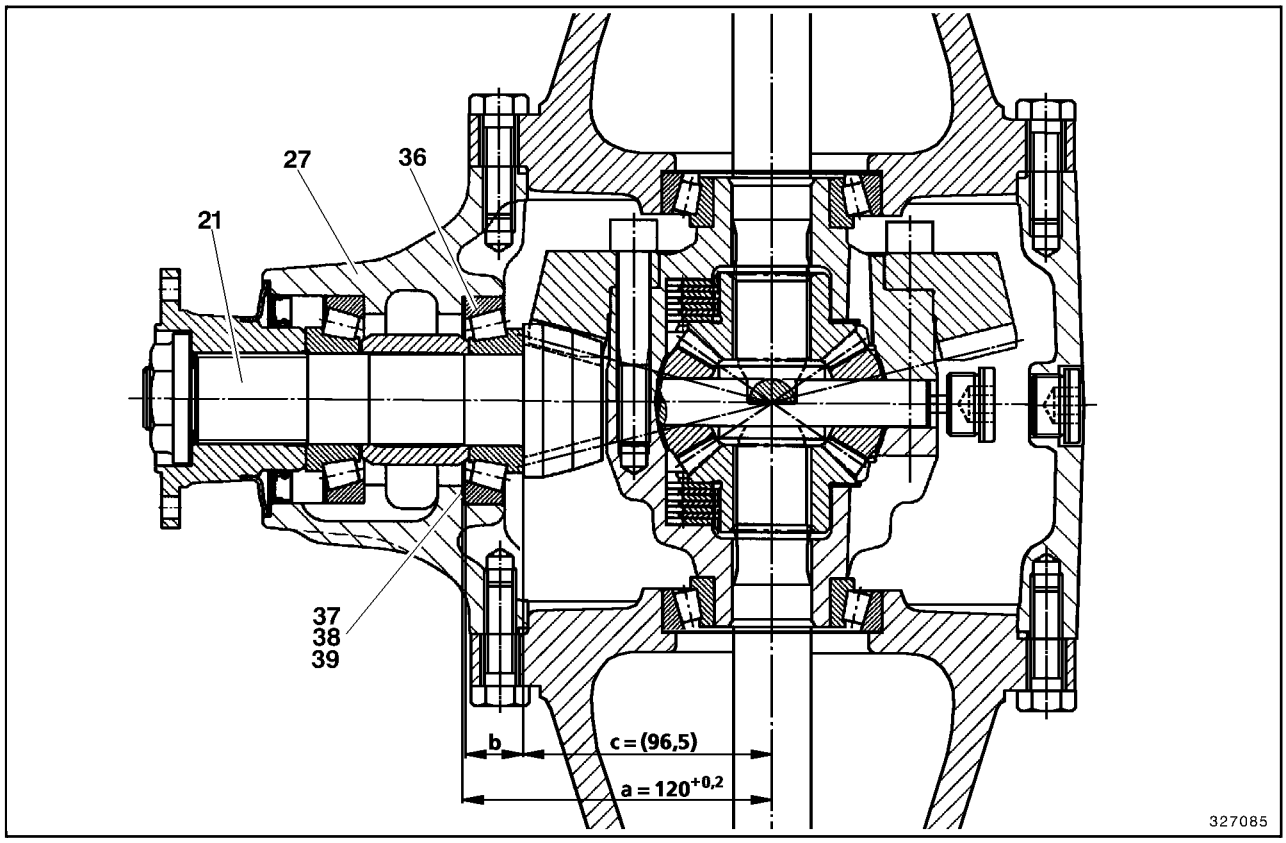


Fig. 6

Calculating Spacing Washers (37-39)

Original Dimensions (Fig. 55):

a : Bearing seat nominal dimensions = 120 $^{+02}$ mm

a1 : For deviation to be read off housing (27), refer to Fig. 52.

b : Measure width of tapered roller bearing (36).

c : Pinion shaft nominal dimension = (96.5 mm).

c1 : Read deviation (+ or -) off pinion shaft (21). Refer to Fig. 53.

Example 1:

a	120.00 mm
a1	+ 0.10 mm
	120.10 mm
b	- 23.00 mm
c	- 96.50 mm
	0.60 mm
c1 = + 0.10 ->	- 0.10 mm
	0.50 mm

1 no. of spacing washer 0.5 mm

Example 2:

a	120.00 mm
a1	+ 0.10 mm
	120.10 mm
b	- 23.00 mm
c	- 96.50 mm
	0.60 mm
c1 = - 0.10 ->	+ 0.10 mm
	0.70 mm

2 nos. of spacing washers 0.3 mm
1 no. of spacing washer 0.1 mm

Spacing washers (37 - 39): 0.1 - 0.3 - 0.5 mm thick.
If possible, keep number of inserted spacing washers small.

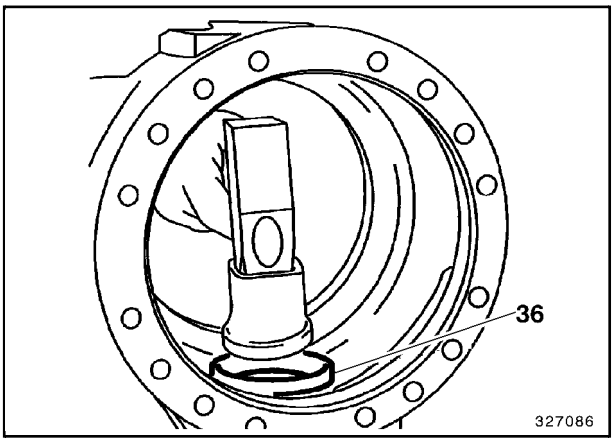


Fig. 56

Drive in outer ring of taperde roller bearing (36).

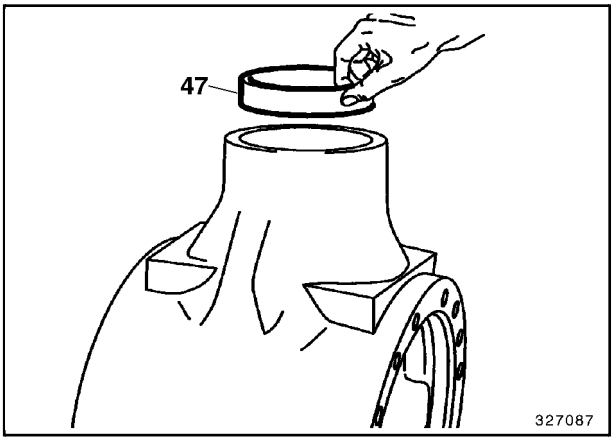


Fig. 57

Insert outer ring of tapered roller bearing (47). Do not add spacing washer

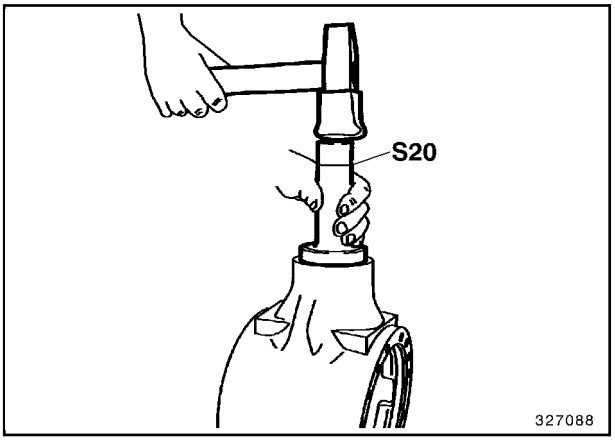


Fig. 58

and drive in with punch (S20).

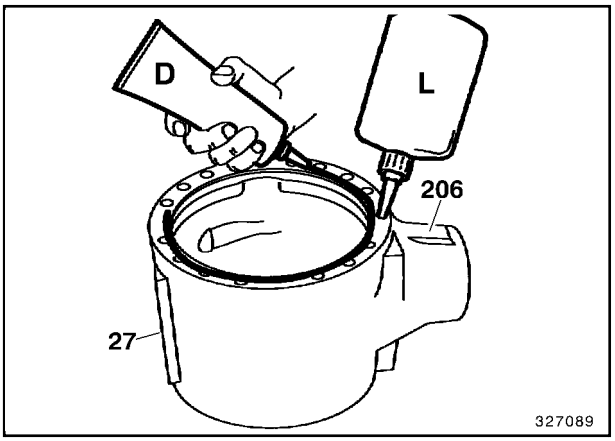


Fig. 59

Place axle housing (27) onto left-hand side - seen in driving direction. Oil pocket (206) to face top.

Moisten tapped holes of right-hand flange with LOCTITE 243. Apply a bead of sealing compound.

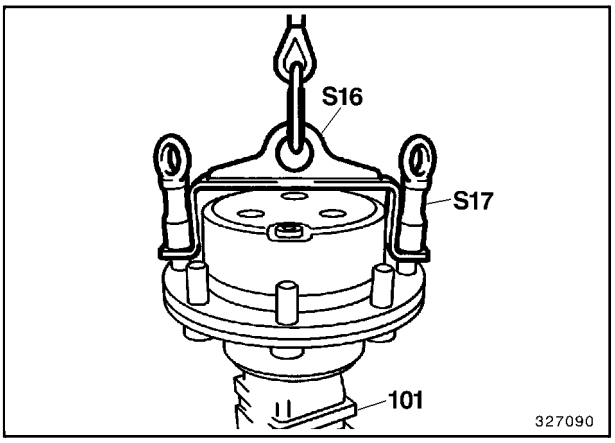


Fig. 60

Lift right-hand axle tube (101) with pre-assembled wheel hub.

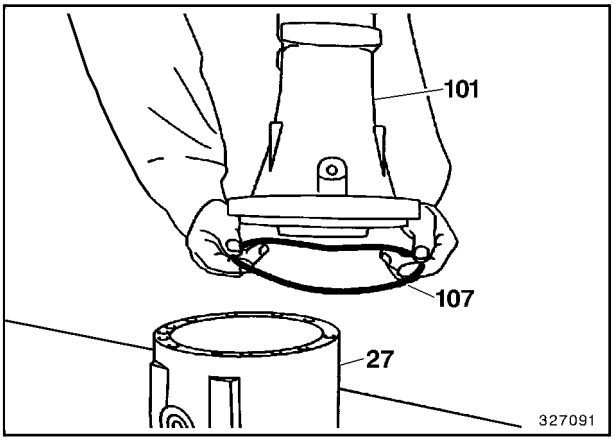


Fig. 61

Put O-ring (107) on flange of axle tube (101).

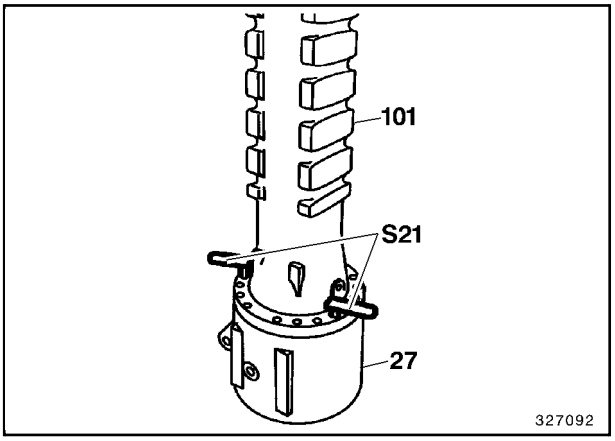


Fig. 62

Slip over axle tube (101). Prior to dismantling, mind marks made on axle housing (27) and axle tube (101).

Align axle tube (101) with two guide pins (S21) so that mounting surfaces will later be in parallel with second axle tube.

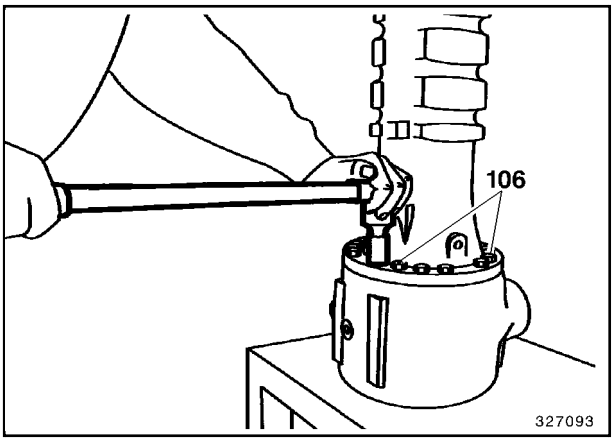


Fig. 63

Crosswise tighten hex screws (106).

Tightening torque M_A = 120 Nm (89 lbft).

Remove guide pins (S21) and turn in screws (106).

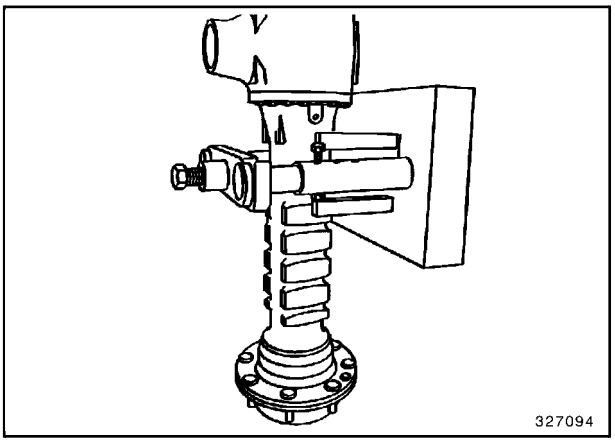


Fig. 64

Put completed axle half on wheel hub after turning over 180° and hold in a fixture.

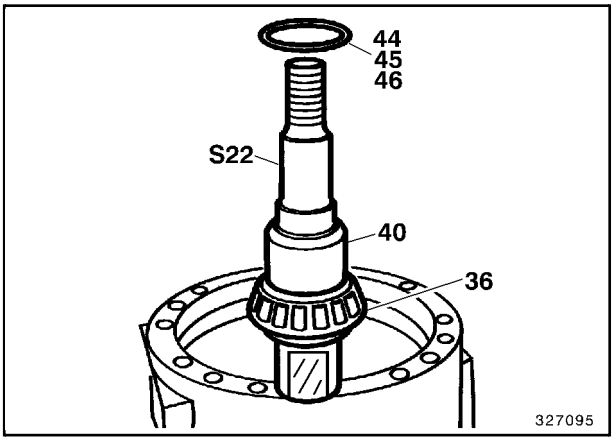


Fig. 65

Push tapered roller bearing (36) and bush (40) onto test shaft (S22).

Put on a 0.1 + 0.3 + 0.5 mm thick spacing washer (44-46) each as a basis for later compensation of the bearing friction torque.

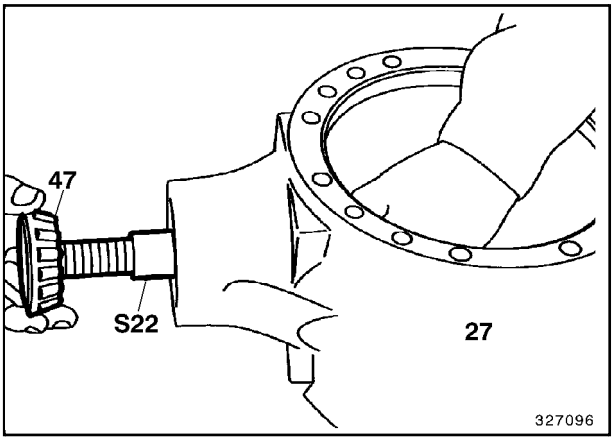


Fig. 66

Insert test shaft (S22) into axle housing from inside. Insert tapered roller bearing (47) from outside.

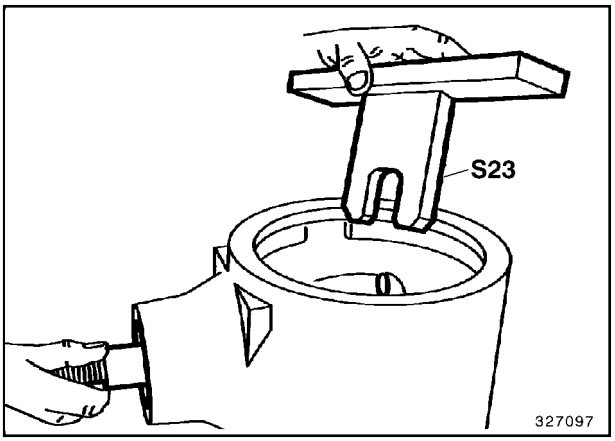


Fig. 67

Put lock (S23) on test shaft.

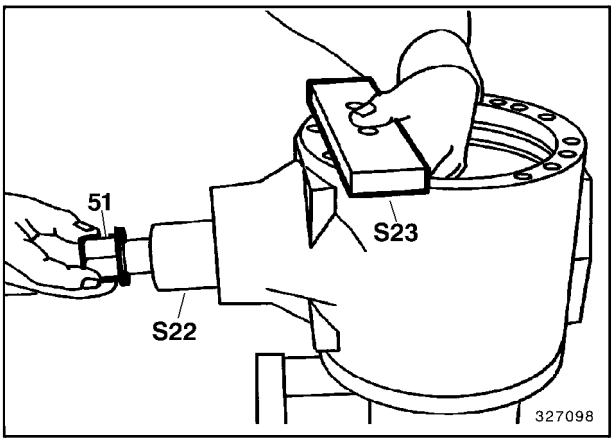


Fig. 68

Push on bush of test shaft (S22) to substitute flange (50).

Screw on collar unit (51) and tighten.

Tightening torque M_A = 200 Nm (148 lbft).

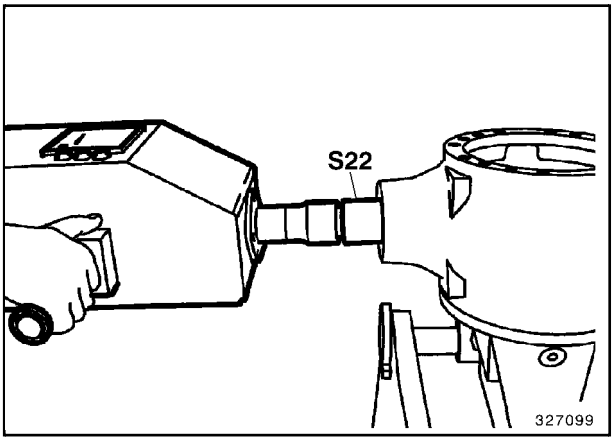


Fig. 69

Measure bearing friction torque with suitable test unit or spring balance.

Desired value 2 ... 3 Nm (1.5 ... 2.2 lbft).

Measured value greater: Insert spacing washer (44-46).
Measured value smaller: Remove spacing washer. Minor corrections can be achieved by shortening (grinding) bush (40).

Remove test shaft (S22).

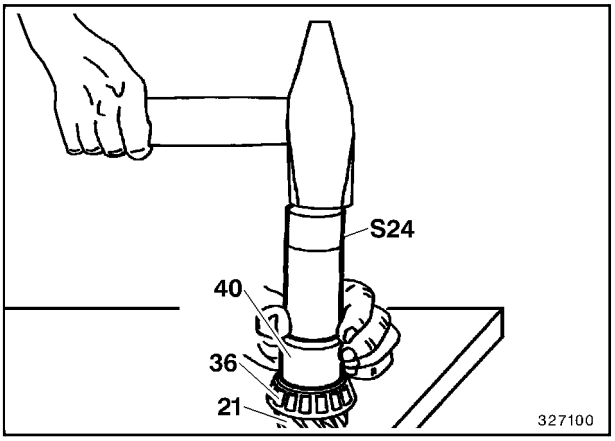


Fig. 70

Change tapered roller bearing (36) to pinion shaft (21) and drive on. Then, drive on bush (40). (New bushes (40-43) are available with different lengths from 42.0 to 42.9 mm.)

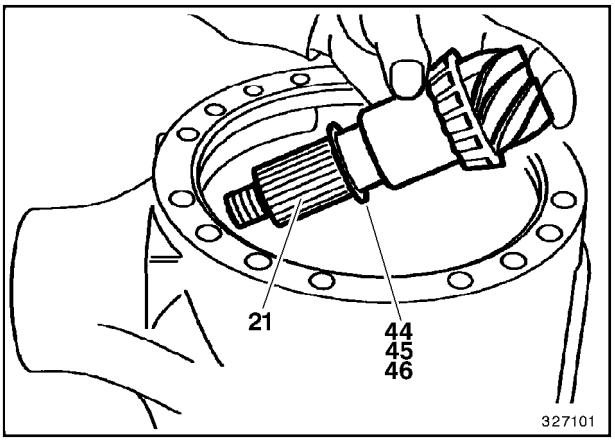


Fig. 71

Change spacing washers (44-46) from test shaft to pinion shaft (21).

Insert pinion shaft into housing from inside.

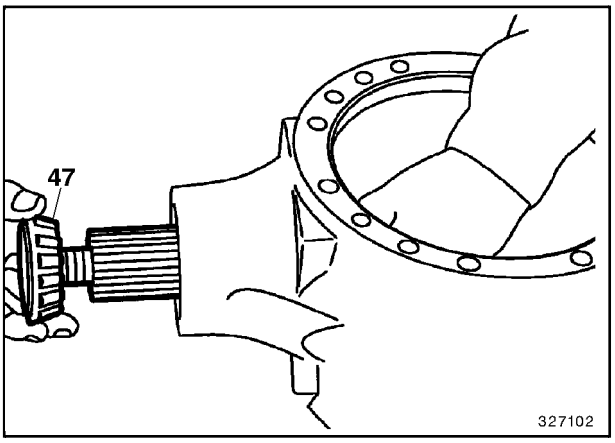


Fig. 72

Insert tapered roller bearing (47).

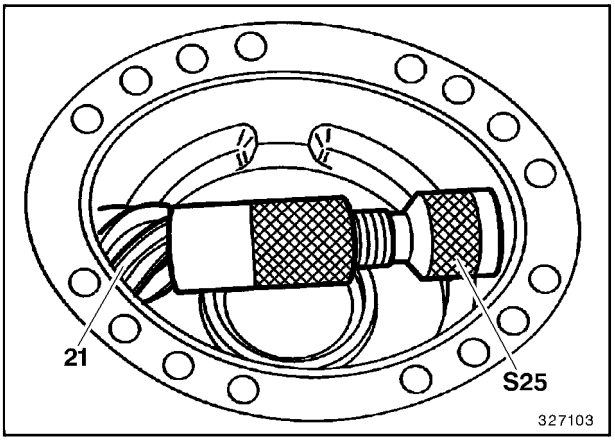


Fig. 73

Place prop (S25) against pinion shaft (21) from inside.

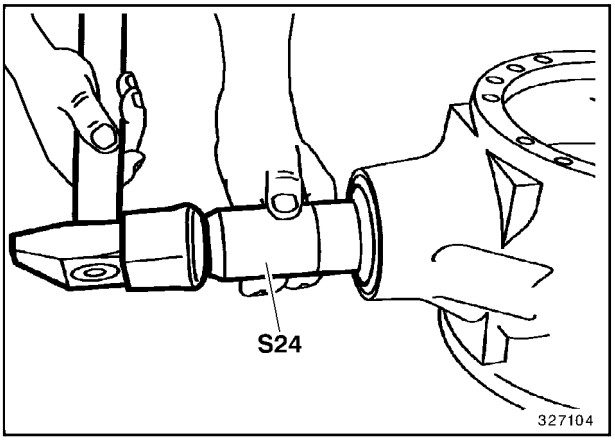


Fig. 74

Drive tapered roller bearing (47) onto pinion shaft.

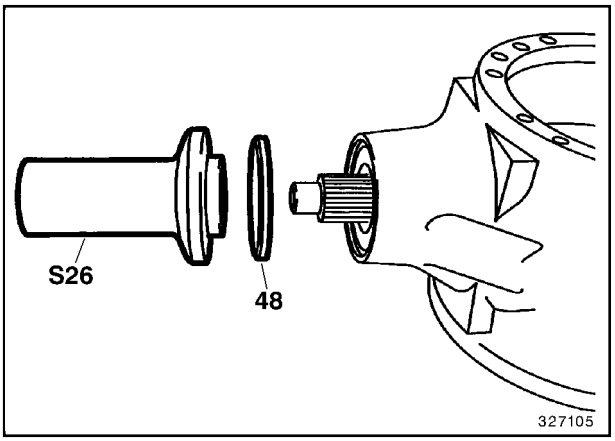


Fig. 75

Put shaft ring (48) on punch (S26). Apply sealing compound, and drive in shaft ring

Shaft ring filled 50 % with grease. Apply grease to sealing lips.

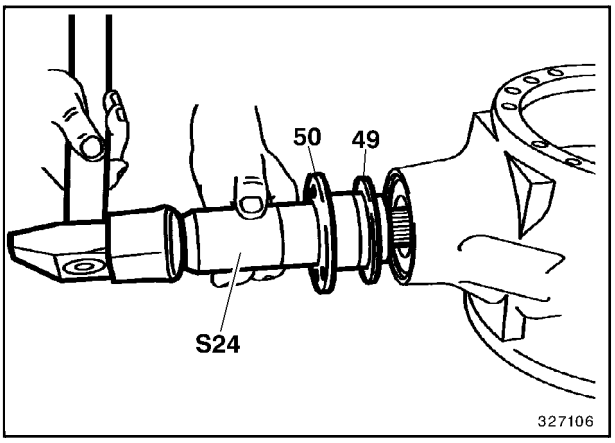


Fig. 76

Drive on flange (50) incl. cap (49).

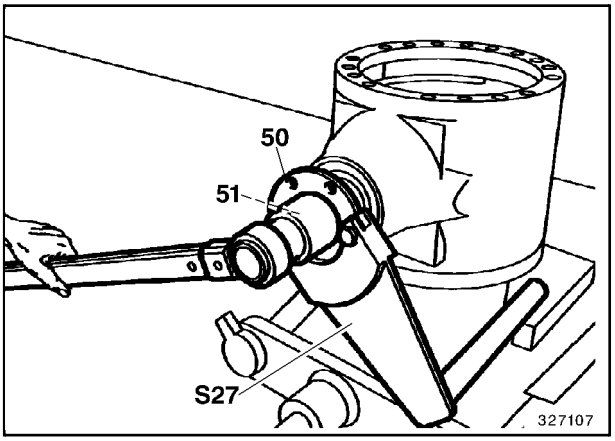


Fig. 77

Arrest flange (50) with crank (S27).

Screw on collar unit (51) with LOCTITE 243 and tighten.

Tightening torque M_A = 200 Nm (148 lbft).

Swing crank (S27) forth and back and remove.

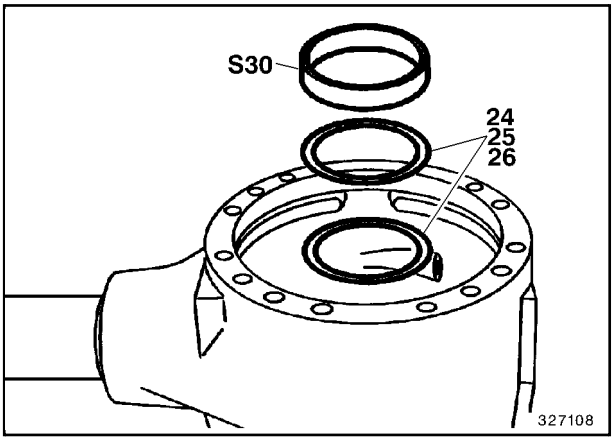


Fig. 78

Insert a spacing washer (24-26) 0.5+0.3+0.1 mm thick each into the mounted axle tube as a basis for backlash correction.

Insert specific ring (S30) for tapered roller bearing (23).

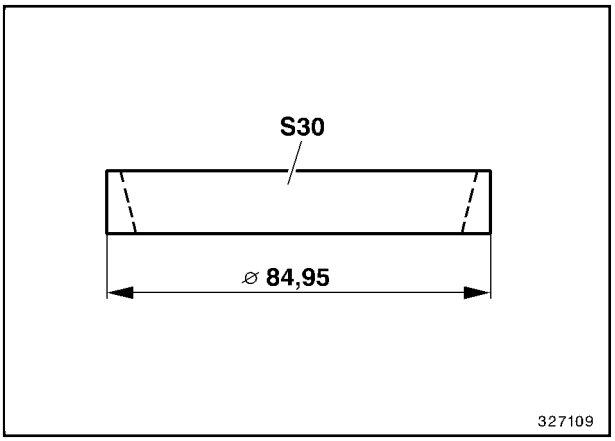


Fig. 79

Bearing ring (S30) with reduced outer diameter can be inserted and removed by hand in case spacing washers (24-26) need to be changed.

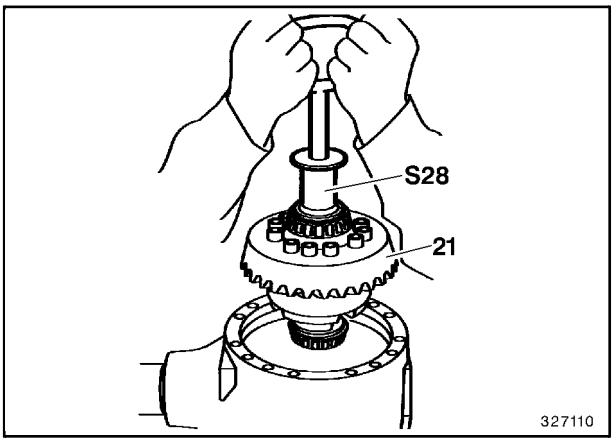


Fig. 80

Apply marking blue to the sides of a few teeth of bevel gear (21).

Insert pre-assembled differential with fixture (S28).

The teeth with the marking blue should be opposite to the pinion shaft.

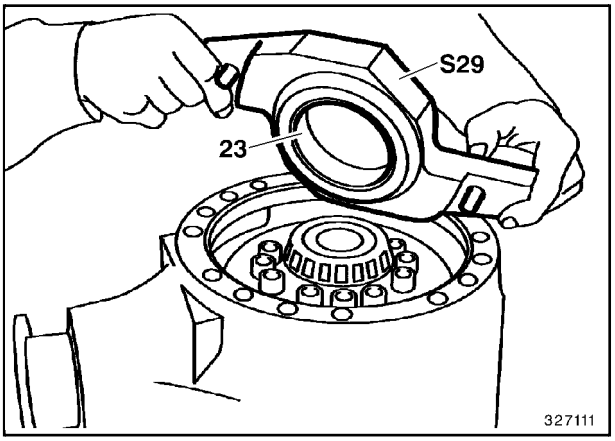


Fig. 81

Push original outer ring of tapered roller bearing (23) into fixture (S29).

Attach fixture and fasten with two screws.

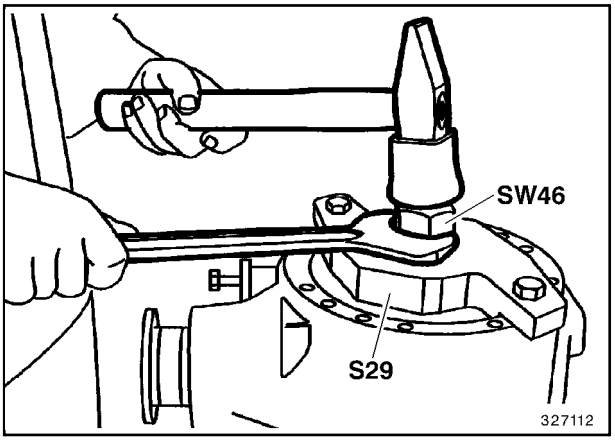


Fig. 82

Tighten 46 size hex screw and strike screw head with a heavy plastic mallet at the same time.

Slacken screw 1/4 turn and slightly re-tighten.

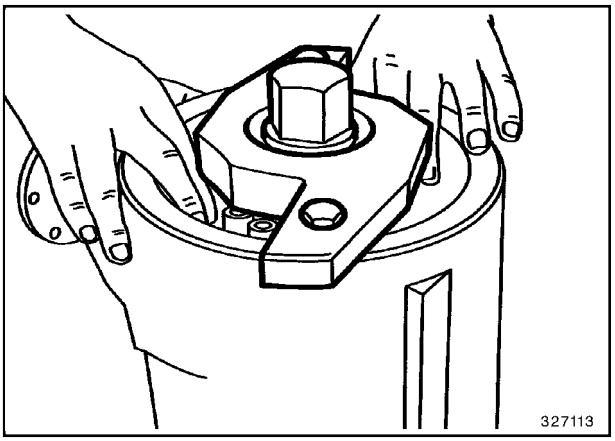


Fig. 83

Move bevel gear by hand.
Check backlash.

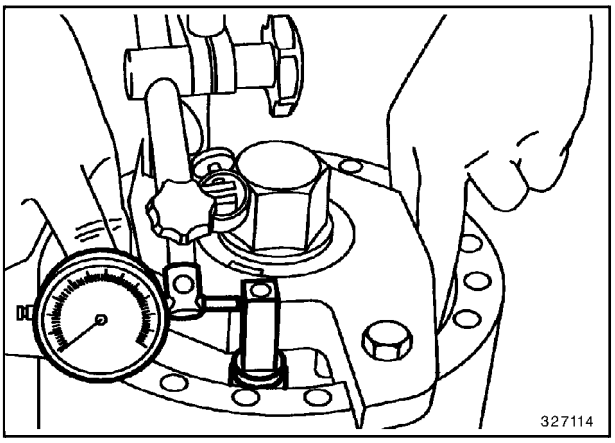


Fig. 84

Apply holder with dial gauge to axle housing and put magnet on bevel gear.

Backlash 0.15 ... 0.25 mm.

Backlash too small: Insert additional spacing washer (24-26, Fig. 78).

Backlash too big: Remove spacing washer.

If possible, keep number of spacing washers small.

To check surface appearance turn pinion shaft in either direction by means of crank (S27) so that bevel gear makes several revolutions. "Brake" bevel gear when doing so.

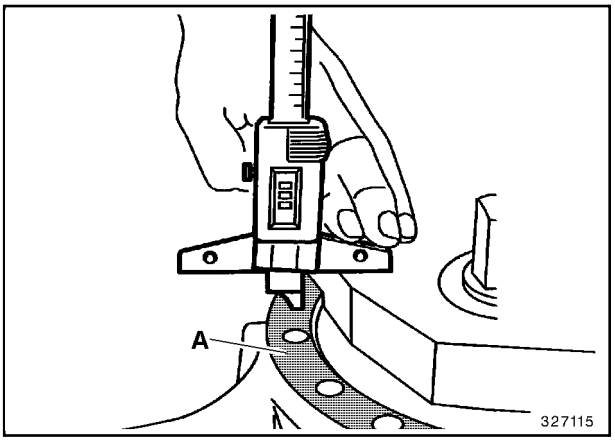


Fig. 85

Apply depth gauge to fixture (S29) and measure with respect to housing rim, surface (A).

(Digital meter to be set to "0".)

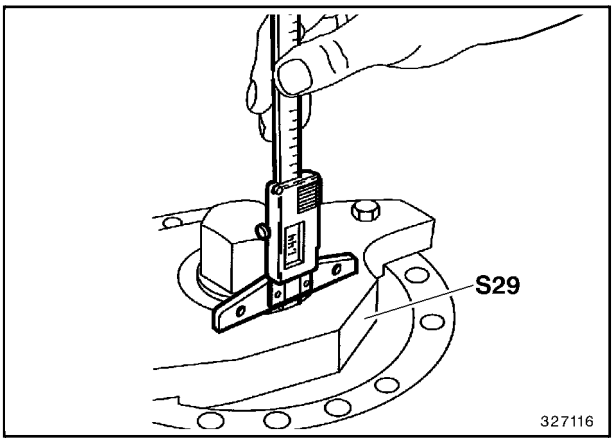


Fig. 86

Measure with respect to outer ring of tapered roller bearing (23), surface (B), with depth gauge through bore in fixture (S29). Refer to Fig. 95.

Difference between A and B = X.

Example: X = 1.60 mm.

Record measured value.

Remove fixture (S29).

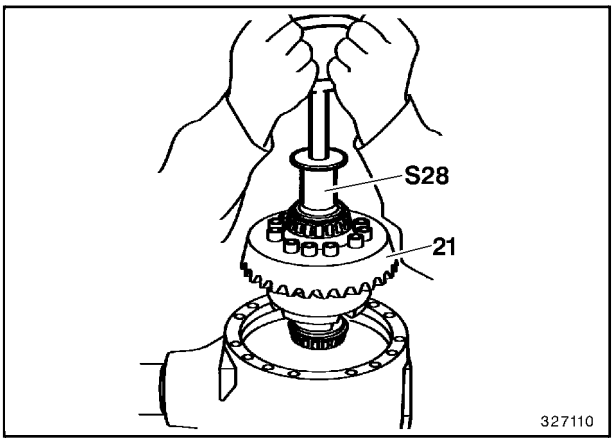


Fig. 87

Lift out differential. Check surface appearance on bevel gear. Refer to Chapter "GLEASON Toothing Surface Appearances". For major deviations, shift pinion shaft by changing spacing washers (37-39).

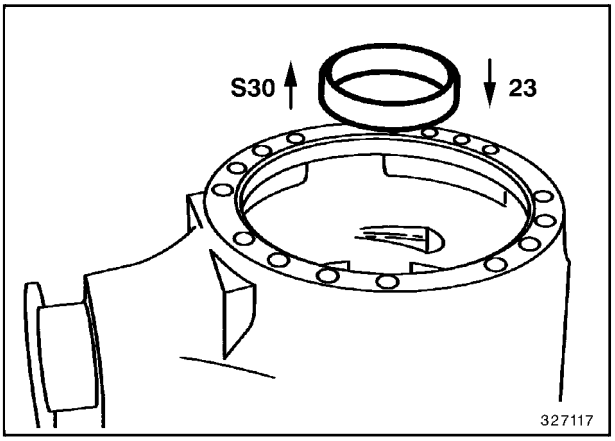


Fig. 88

Remove bearing ring (S30).

Insert original outer ring of tapered roller bearing (23)

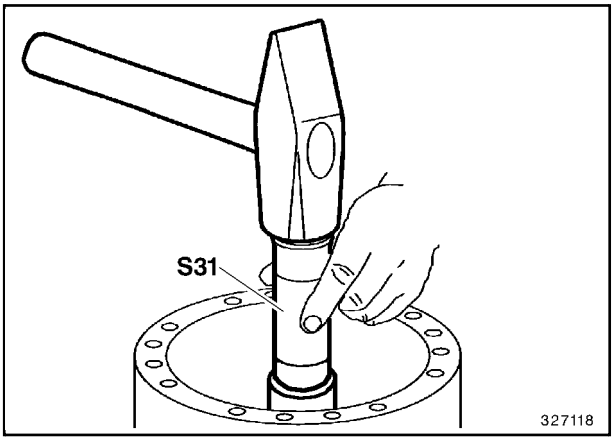


Fig. 89

and drive in with punch (S31).

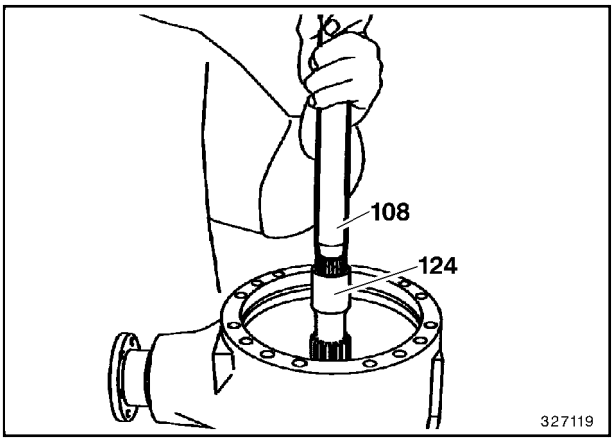


Fig. 90

Put together with stiff grease pinion shaft (124) and drive shaft (108) and fit down into planetary gear set.

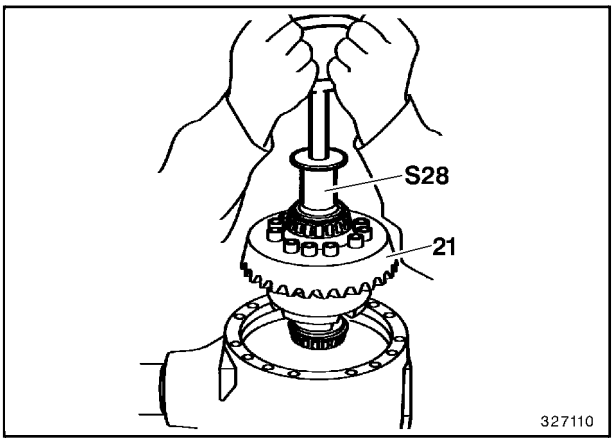


Fig. 91

Insert differential. Fit in drive shaft and differential when doing so.

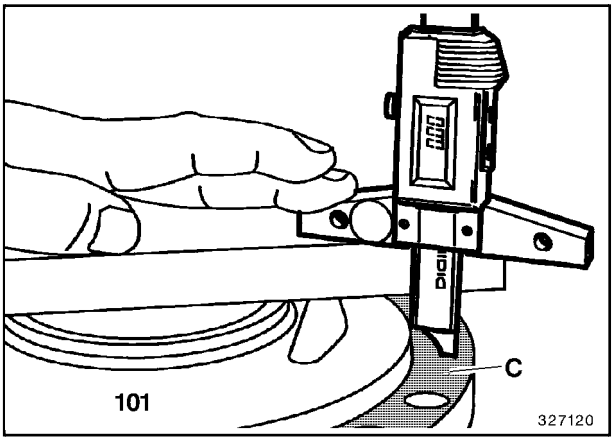


Fig. 92

Measure distance between suitable sheet metal gauge and flange of pre-assembled left-hand axle tube (101), surface (C), by means of depth gauge.

(Digital meter to be set to "0".)

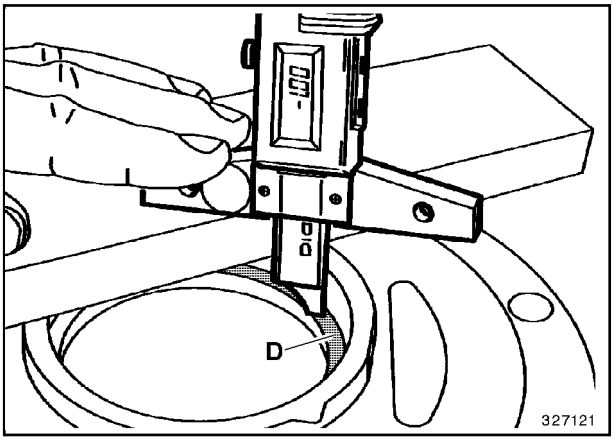


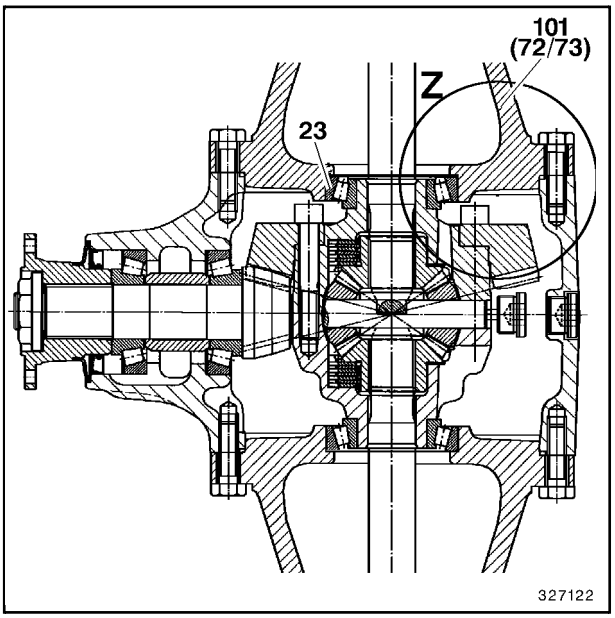
Fig. 93

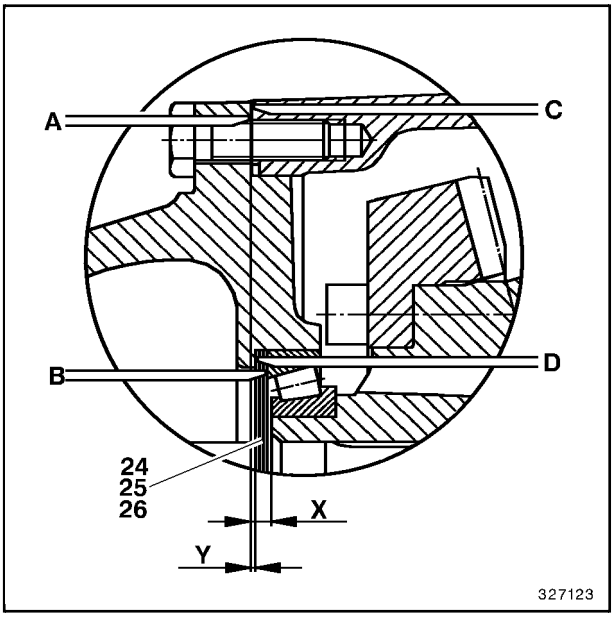
Subsequently, measure with respect to bearing seat, surface (D).

Difference between C and D = Y.

Example: Y = 1.05.

Record measured value.





Figs. 94 and 95

Calculating Spacing Washers (24-26)

Example 1:

X	1.60 mm
Y	- 1.05 mm
	0.55 mm
Pre-tension	+0.03 mm
	0.58 mm
Rounded up	0.60 mm
2 nos. of spacing washers	0.3 mm

Round up the value calculated.

Spacing washers (24-26): 0.1-0.3-0.5 mm thick.

If possible, keep number of inserted spacing washers small.

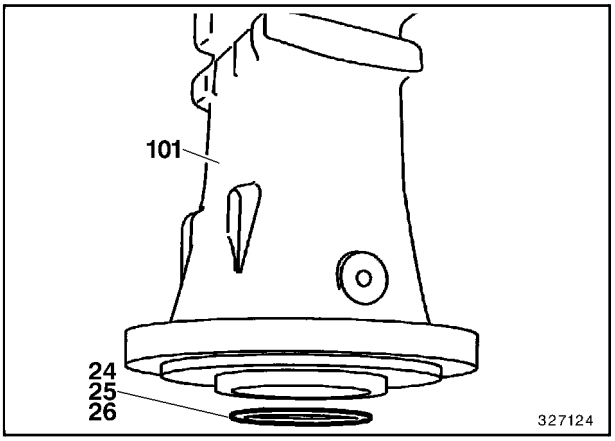


Fig. 96

Lift left-hand axle tube (101).

Stick with grease into axle tube (101) spacing washer(s) (24-26) determined.

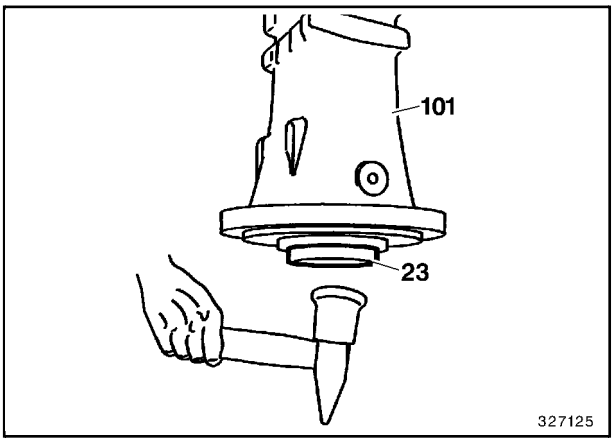


Fig. 97

Drive in outer ring of tapered roller bearing (23).

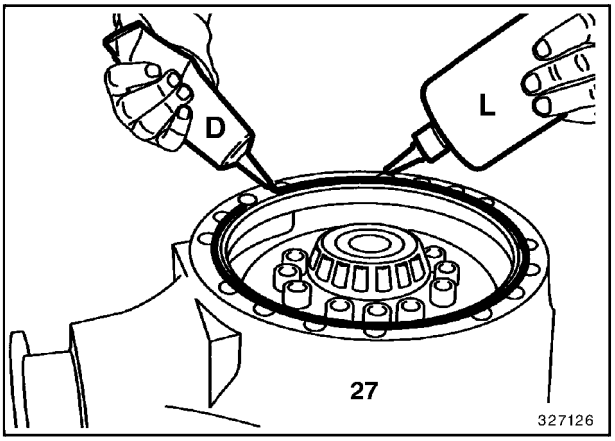


Fig. 98

Moisten tapped holes in axle housing (27) with LOCTITE 243.

Apply a bead of sealing compound.

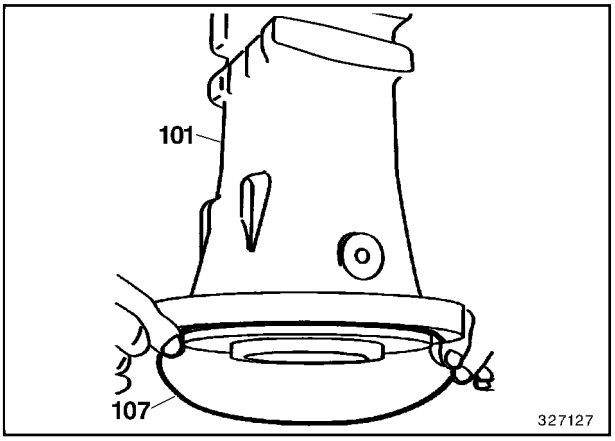


Fig. 99

Put on O-ring (107).

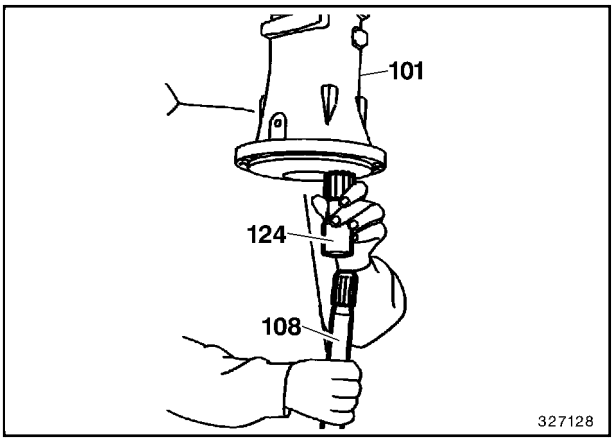


Fig. 100

Push pinion shaft (124) onto drive shaft (108) and fit up into planetary gear set.

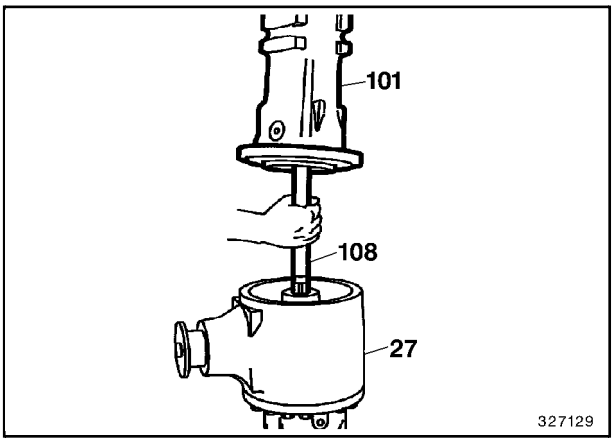


Fig. 101

Lower axle tube (101) and fit drive shaft (108) into differential.

Mind marks on axle housing (27) and axle tube.

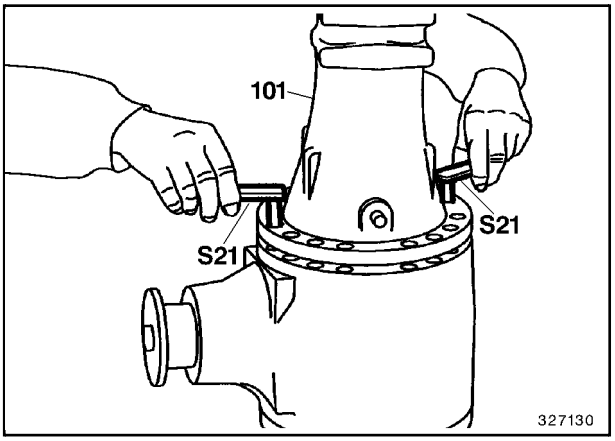


Fig. 102

Align axle tube (101) with two guide pins (S21) so that mounting surfaces are in parallel with axle tube mounted first.

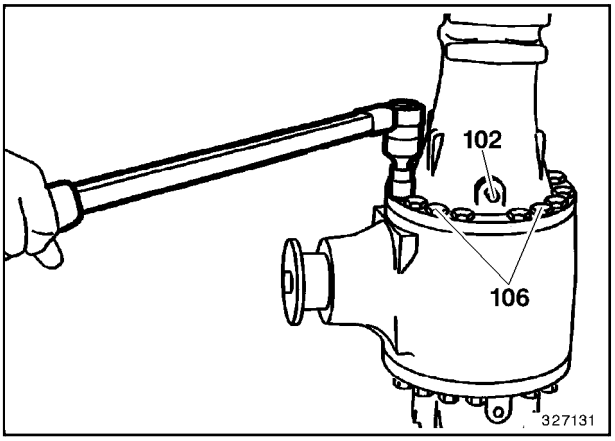


Fig. 103

Crosswise tighten hex screws (106).

Tightening torque M_A = 120 Nm (89 lbft).

Remove guide pins (S21) and turn in screws (106).

Screw in vent plug (102).

Assembling the Rear Axle

Wheel Hub Assembly

Refer to Chapter "Wheel Hub Assembly".

Brake Assembly (Pre-Assembling)

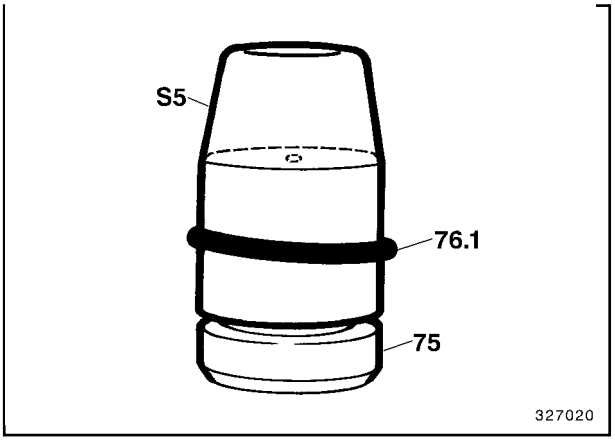


Fig. 1

Place piston (75) so that M6 centering hole is on top. Put on long mounting sleeve (S5) and insert O-ring (76.1) twist-free into free piston groove.

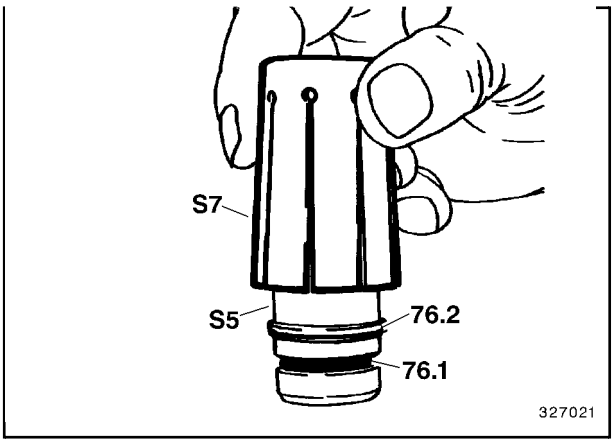


Fig. 2

Push piston seal (76.2) into groove using expansion sleeve (S7).

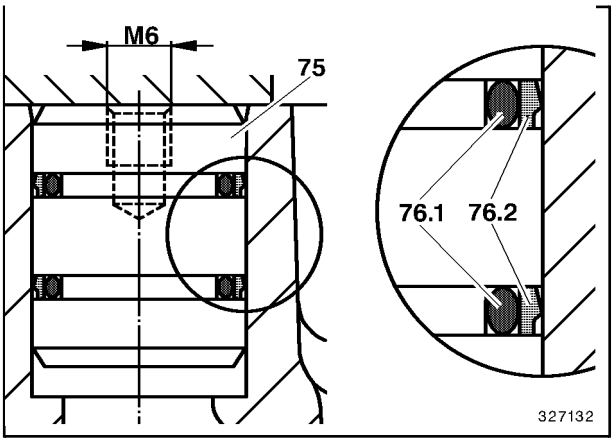


Fig. 3

Piston seal fitting position (76).

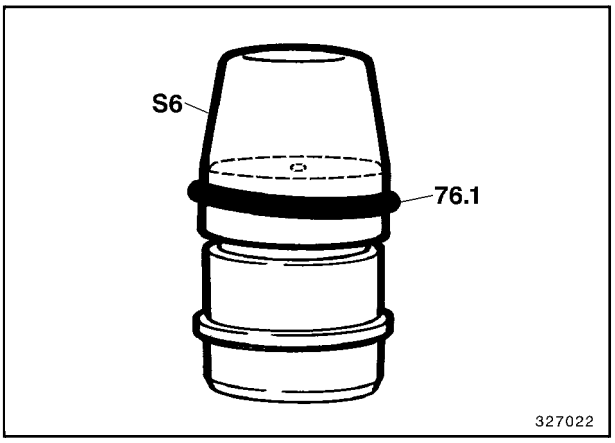


Fig. 4

Put on short mounting sleeve (S6) and insert O-ring (76.1) twist-free into upper piston groove.

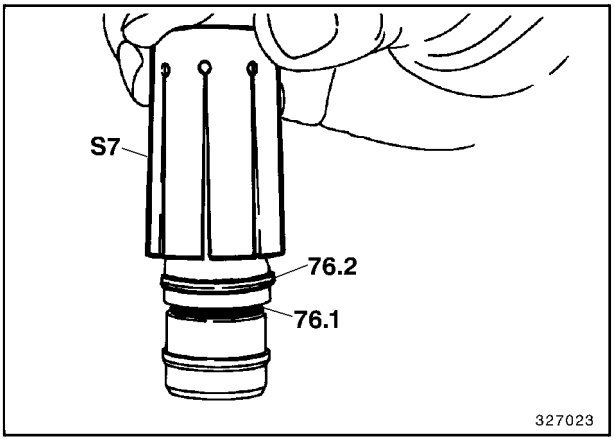


Fig. 5

Push piston seal (76.2) into groove using expansion sleeve (S7).

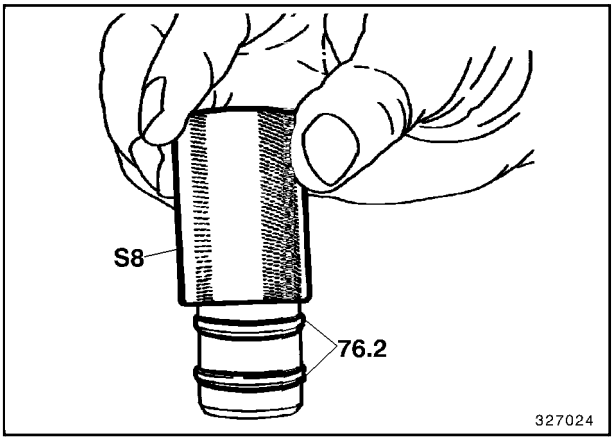


Fig. 6

Slightly lubricate piston seals with hydraulic oil.

Push sizing sleeve (S8) over both piston seals

Leave piston in sleeve for about 5 minutes.

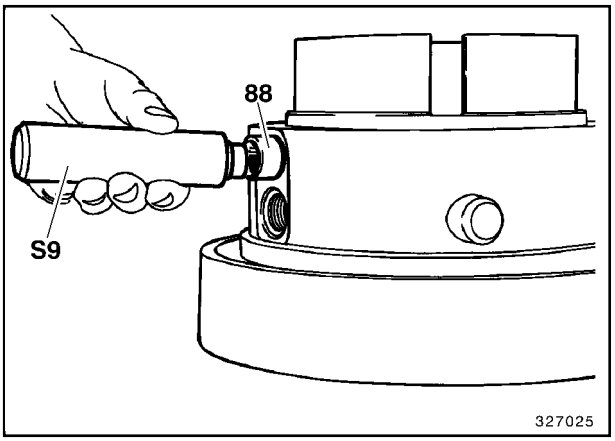


Fig. 7

Drive needle sleeve (88) into brake carrier. Packing ring in needle sleeve to be on outer side.

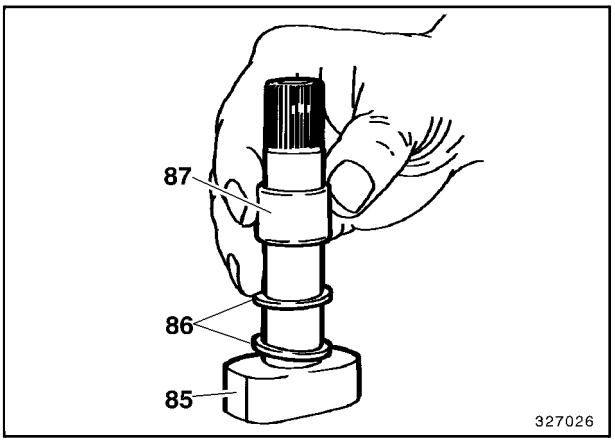


Fig. 8

Push washers (86) and needle sleeve (87) onto brake shaft (85).

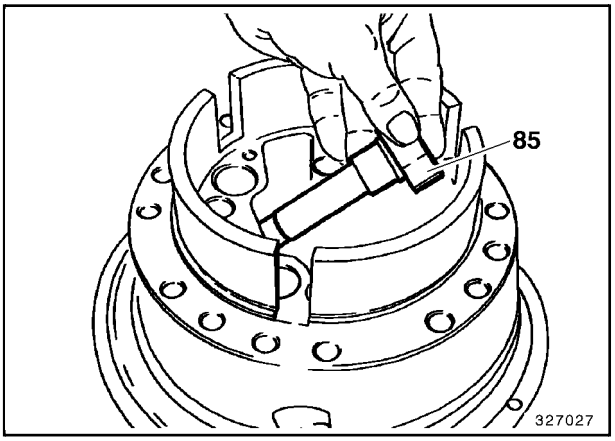


Fig. 9

Insert brake shaft (85) into brake carrier from inside.

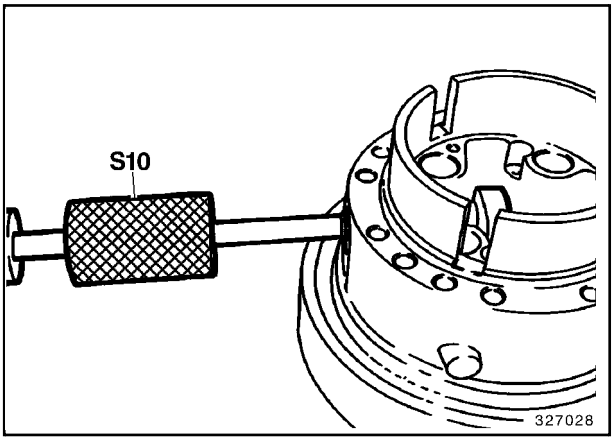


Fig. 10

Screw impact extractor (S10) - M 8 thread - into brake shaft and drive out shaft.

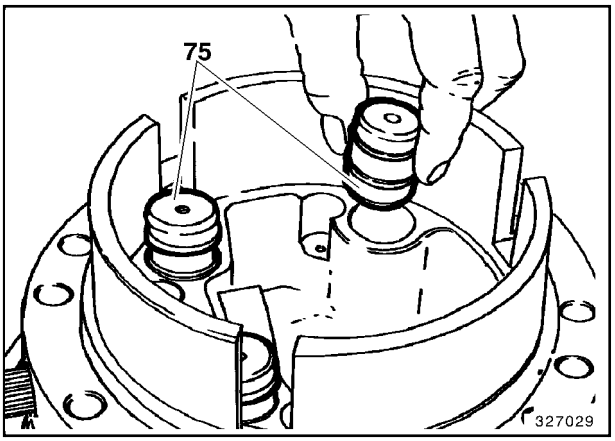


Fig. 11

Lubricate cylindrical bores in brake carrier (hydraulic oil) and insert piston (75). M 6 centering hole in piston to be on top.

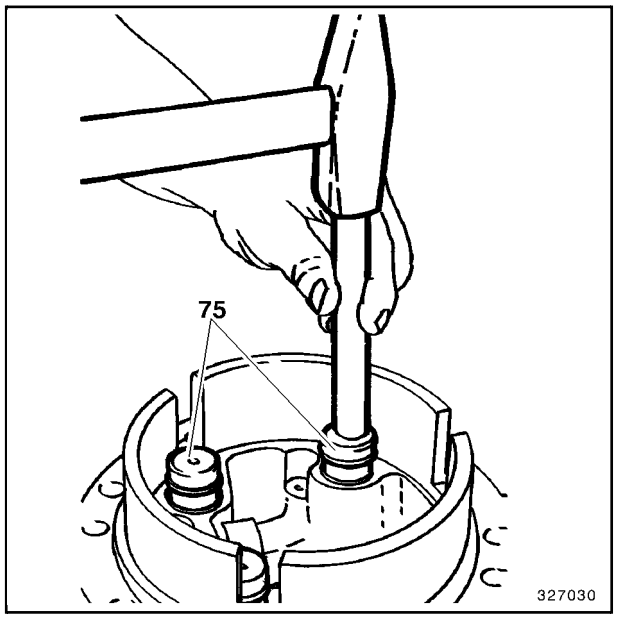


Fig. 12

Carefully drive piston (75) fully into cylindrical bores using a plastic punch.

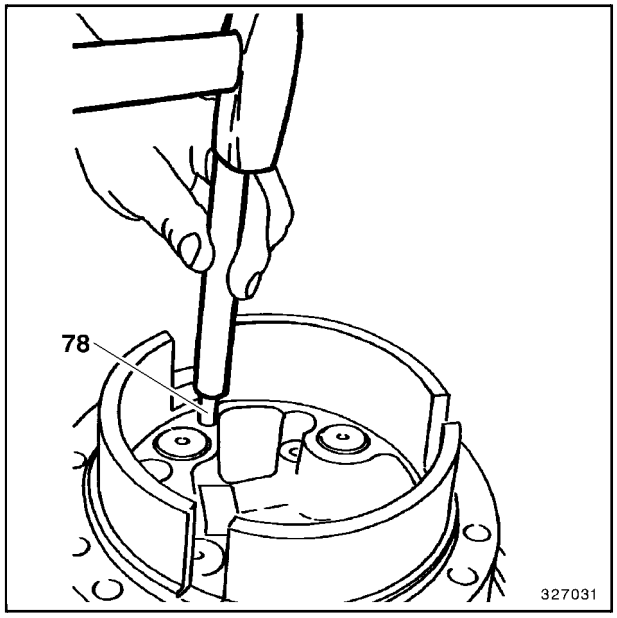


Fig. 13

Insert two guide pins (78).

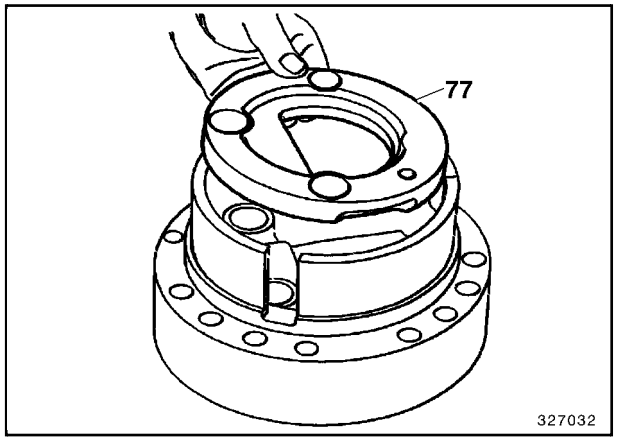


Fig. 14

Insert back-up ring (77).

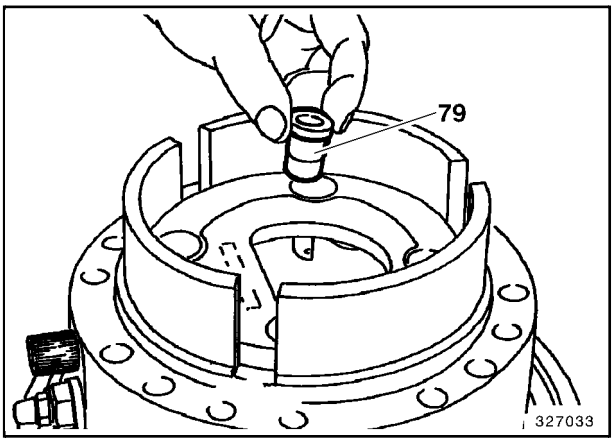


Fig. 15

Insert three bushes (79).

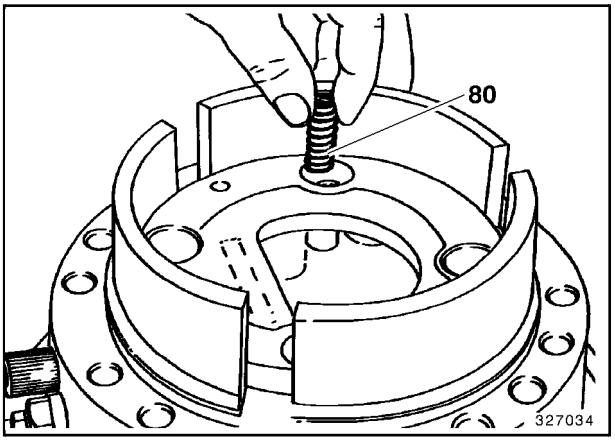


Fig. 16

Insert three springs (80).

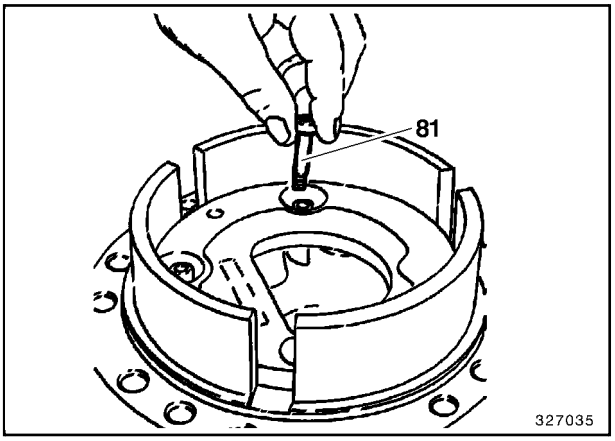


Fig. 17

Turn in three fillister-head screws (81) with LOC-TITE 243.

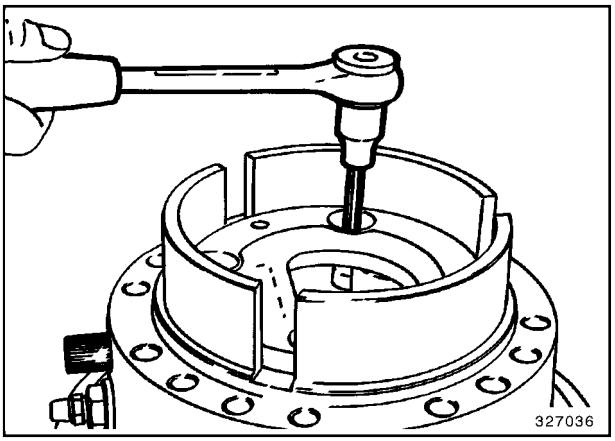


Fig. 18

Crosswise tighten fillister-head screws (81).

Tightening torque M_A = 8 Nm (6 lbft).

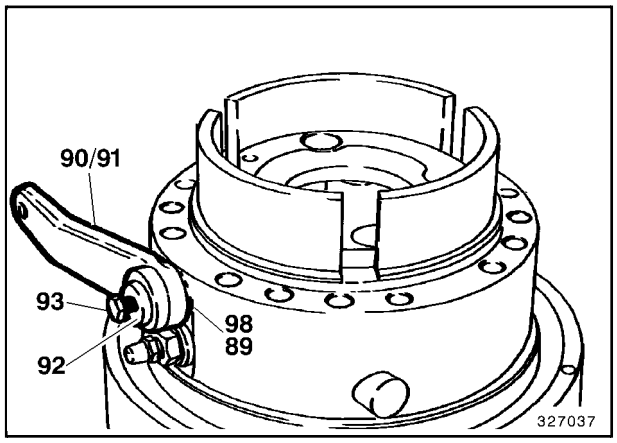


Fig. 19

Put washer (89) and lever (90/91) on brake shaft. Align lever 90° with respect to axle centre line (92) and fasten with washer (92) and screw (93).

For installing the pre-assembled brake carrier and the brake disks, refer to Chapter "Complete Axle Drive and Axle Assemblies".

Differential Assembly (Pre-Assembling)

Refer to Chapter "Differential Assembly".

Complete Axle Drive and Axle Assemblies

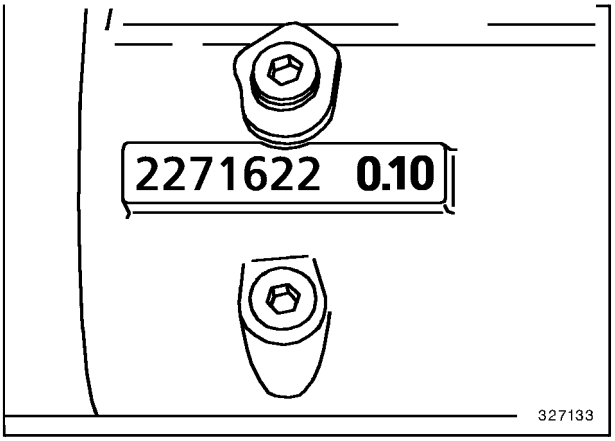


Fig. 20

An information field for stamping in the ID and dimensions is located between the filler cap and the drain plug or on the flange. Refer to arrow in Fig. 25.

The deviation from the nominal dimension (e. g. 0.10) or the complete dimension (e. g. 120.10) is stamped in.

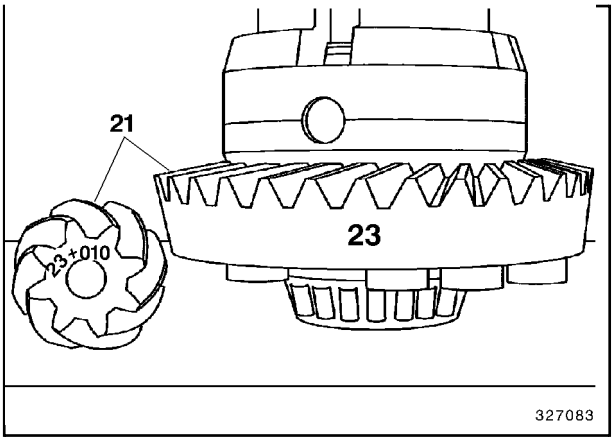


Fig. 21

Compare the figures engraved in the pinion shaft and in bevel gear (21). The mating number (e. g. 23) must, by all means, agree. The value (e. g. +0.10) given only on the pinion shaft is the deviation from the nominal dimension.

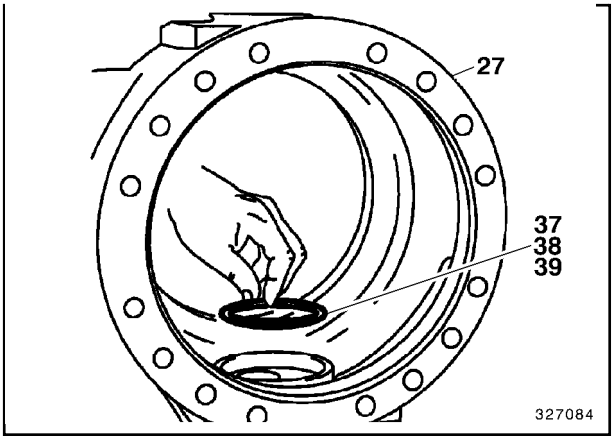


Fig. 22

Determine spacing washer(s) (37-39), refer to next page, and insert.

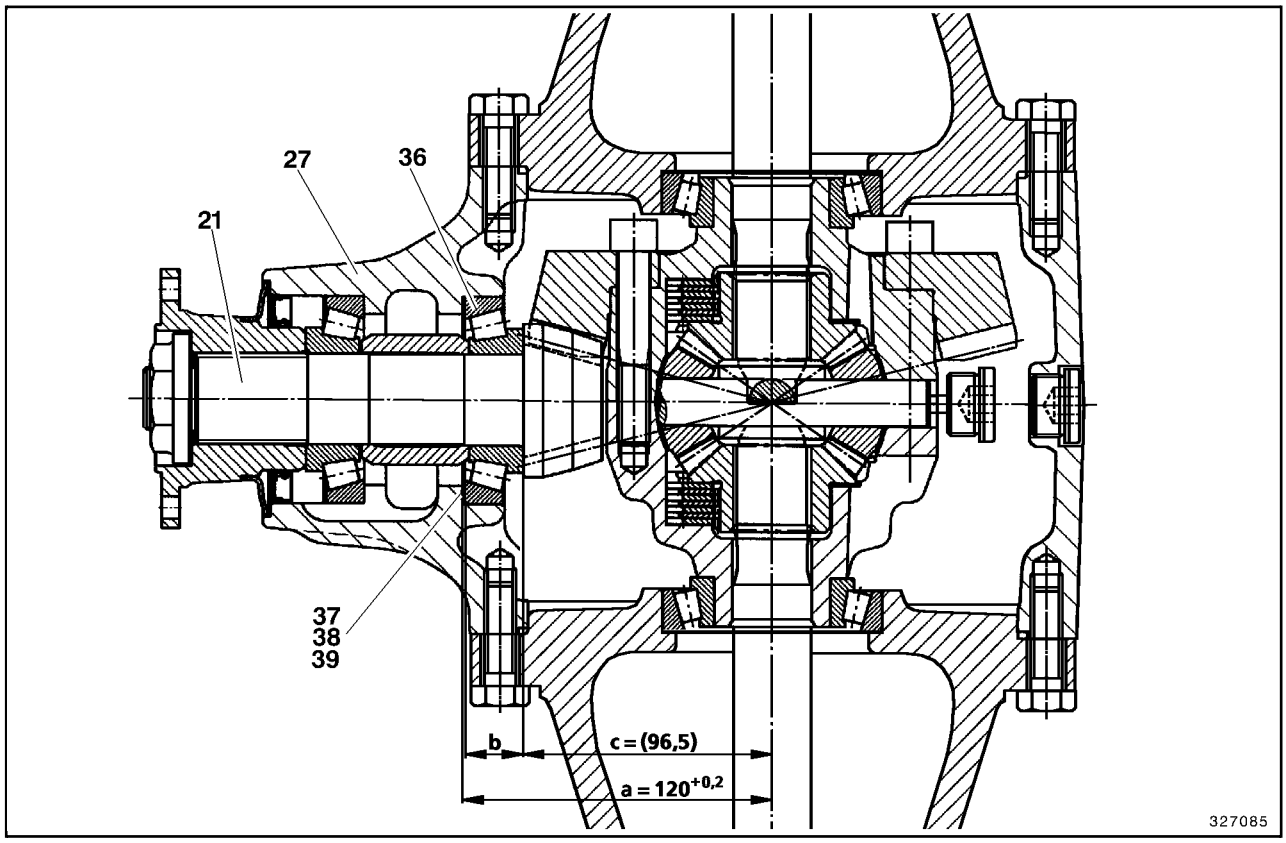


Fig. 7

Calculating Spacing Washers (37-39)

Original Dimensions (Fig. 23):

a : Bearing seat nominal dimensions = 120 $^{+02}$ mm

a1 : For deviation to be read off housing (27), refer to Fig. 20.

b : Measure width of tapered roller bearing (36).

c : Pinion shaft nominal dimension = (96.5 mm)

c1 : Read deviation (+ or -) off pinion shaft (21). Refer to Fig. 21.

Example 1:

a	120.00 mm
a1	+ 0.10 mm
	120.10 mm
b	- 23.00 mm
c	- 96.50 mm
	0.60 mm
c1 = + 0.10 ->	- 0.10 mm
	0.50 mm

1 no. of spacing washer 0.5 mm

Example 2:

a	120.00 mm
a1	+ 0.10 mm
	120.10 mm
b	- 23.00 mm
c	- 96.50 mm
	0.60 mm
c1 = - 0.10 ->	+ 0.10 mm
	0.70 mm

2 nos. of spacing washers 0.3 mm
1 no. of spacing washer 0.1 mm

Spacing washers (37 - 39): 0.1 - 0.3 - 0.5 mm thick.
If possible, keep number of inserted spacing washers small.

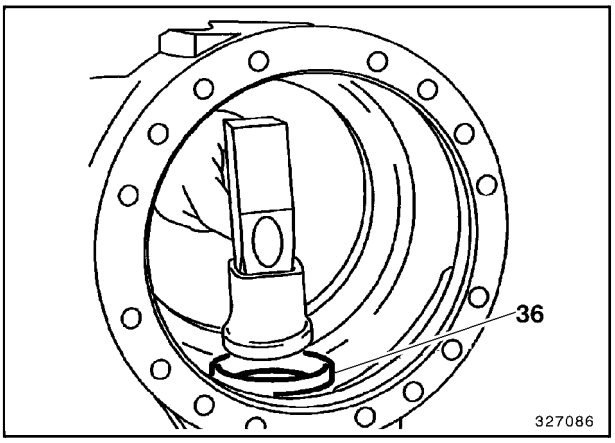


Fig. 24

Drive in outer ring of tapered roller bearing (36).

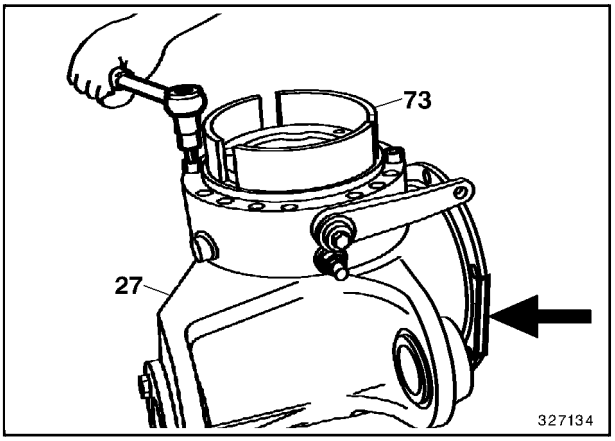


Fig. 25

Put left-hand brake carrier (73) on axle housing (27) and fasten provisionally with two screws. When dismantling, mind marks made.

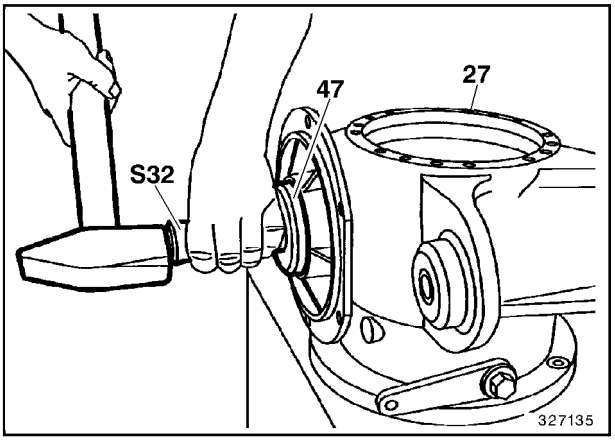


Fig. 26

Place axle housing with brake carrier (27) down-side onto a suitable working table or onto left-hand axle tube (101).

Drive in outer ring of tapered roller bearing (47). Do not insert any spacing washers.

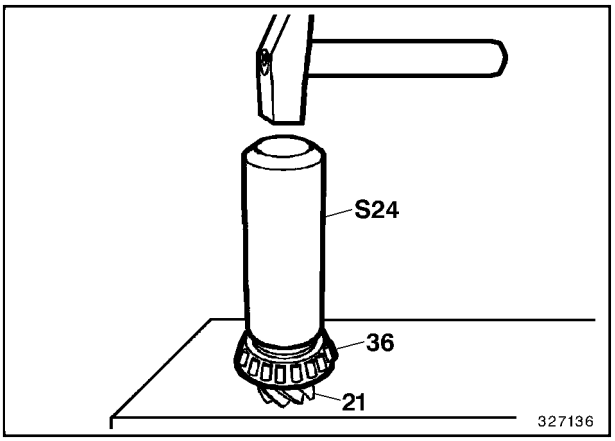


Fig. 27

Drive tapered roller bearing (36) onto pinion shaft (21).

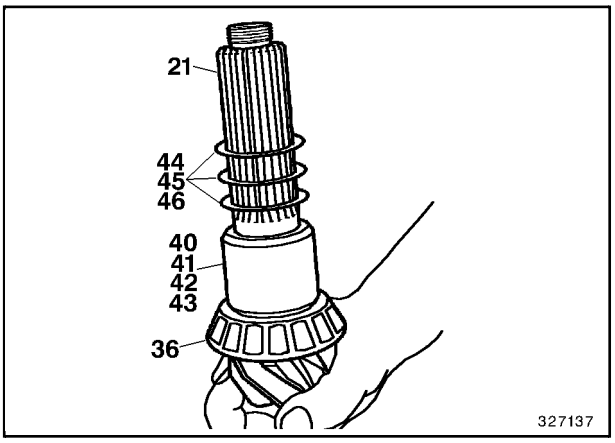


Fig. 28

Drive bush (40) onto pinion shaft (21) with same punch.

(New bushes (40-43) are available with different lengths from 42.0 to 42.9 mm.)

Put on a 0.5 + 0.3 + 0.1 mm thick spacing washer (44-46) each as a basis for possible compensation when adjusting the bearing friction torque.

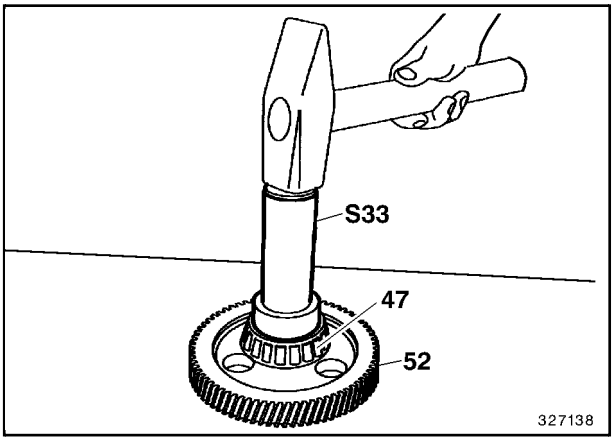


Fig. 29

Drive tapered roller bearing (47) onto spur gear (52).

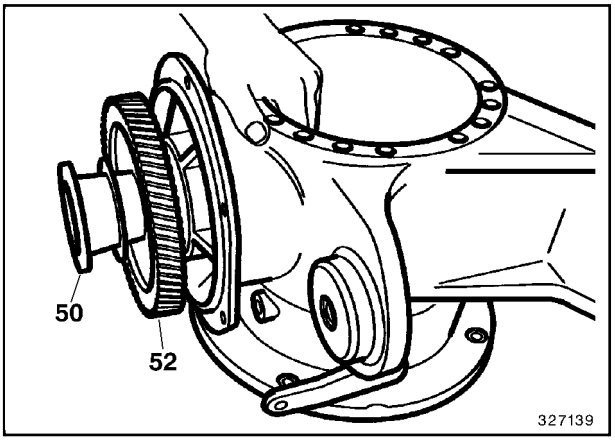


Fig. 30

Insert pinion shaft (21) with bearing, bush and spacing washers into housing.

Push spur gear (52) - bearing (47) to face housing - and flange (50) onto shaft.

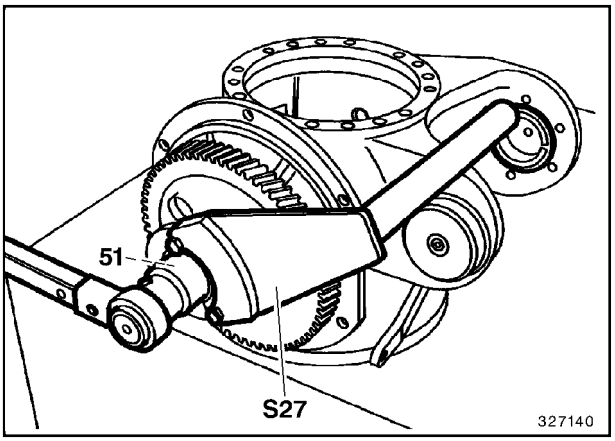


Fig. 31

Screw on collar unit (51). Arrest flange (50) with crank (S27).

Tighten collar unit (51).
Tightening torque M_A = 200 Nm (148 lbft).

Swing crank forth and back and remove.

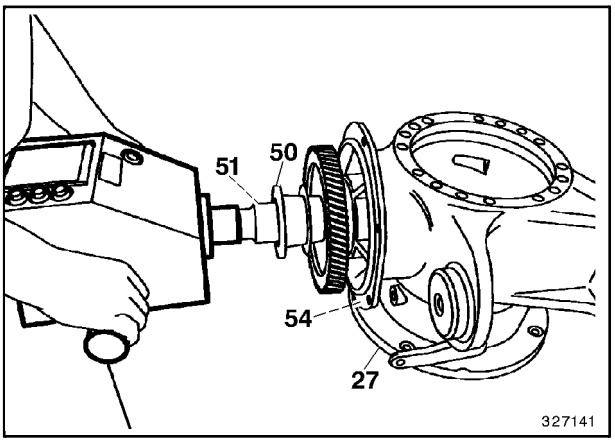


Fig. 32

Measure bearing friction torque with suitable test unit or spring balance.

Desired value 2 ... 3 Nm (1.5 ... 2.2 lbft).

Measured value greater: Insert spacing washer (44-46).

Measured value smaller: Remove spacing washer. Minor corrections can be achieved by shortening (grinding) bush (40).

Remove collar unit (51) and flange (50).

Put O-ring (54) on flange of housing (27).

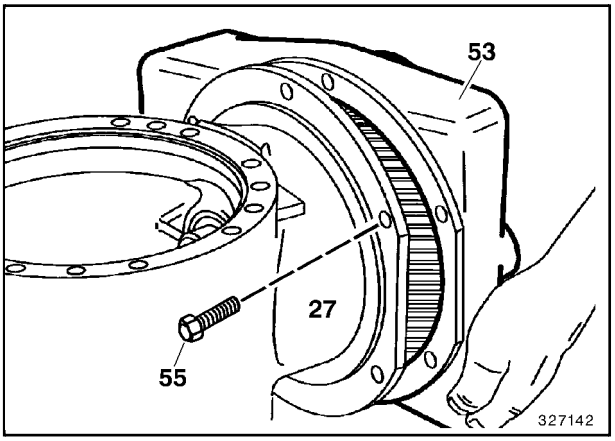


Fig. 33

Apply sealing compound to flange of housing (53).

Screw on housing (53), lock hex screws (55) with LOCTITE 243.

Tightening torque M_A = 53 Nm (39 lbft).

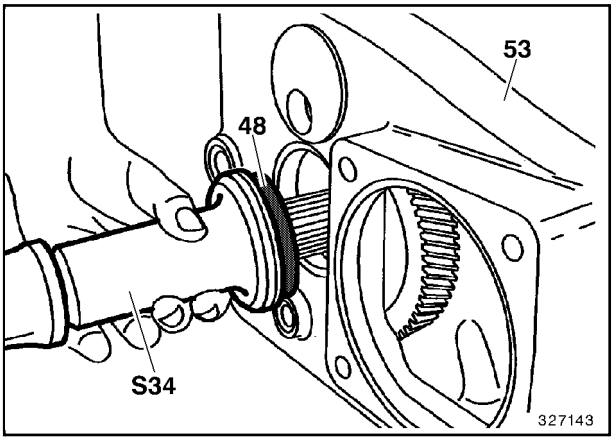


Fig. 34

Put shaft ring (48) on punch (S34), apply sealing compound and drive in shaft ring.

Shaft ring filled 50 % with grease. Apply grease to sealing lips.

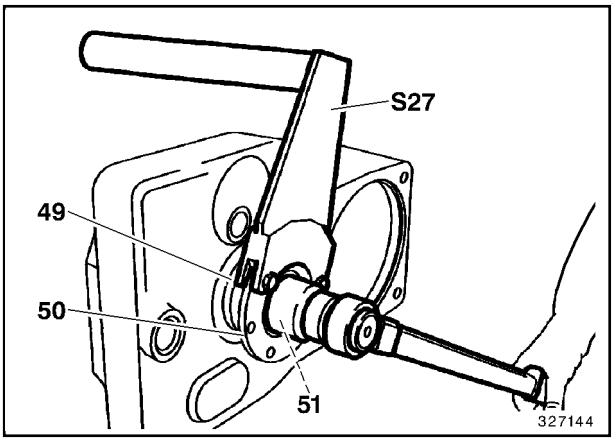


Fig. 35

Re-insert flange (50) incl. cap (49), screw on collar unit (51) with LOCTITE 243. Arrest flange with crank (S27) and tighten collar unit.

Tightening torque M_A = 200 Nm (148 lbft).

Swing crank forth and back and remove.

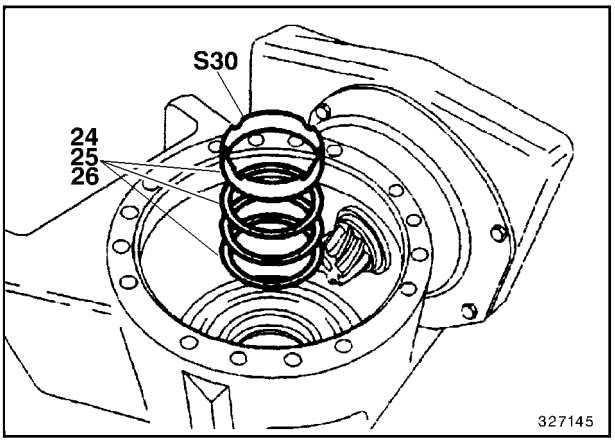


Fig. 36

Put a 0.5 + 0.3 + 0.1 mm thick spacing washer (24-26) each in brake carrier as a basis for backlash correction.

Insert specific ring (S30) for tapered roller bearing (23).

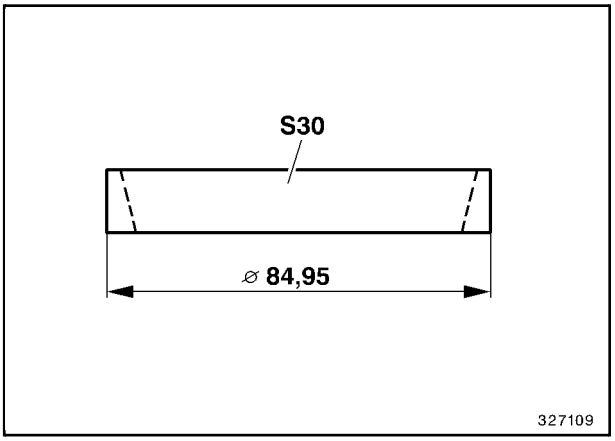


Fig. 37

Bearing ring (S30) with reduced outer diameter can be inserted and removed by hand in case spacing washers (24-26) need to be changed.

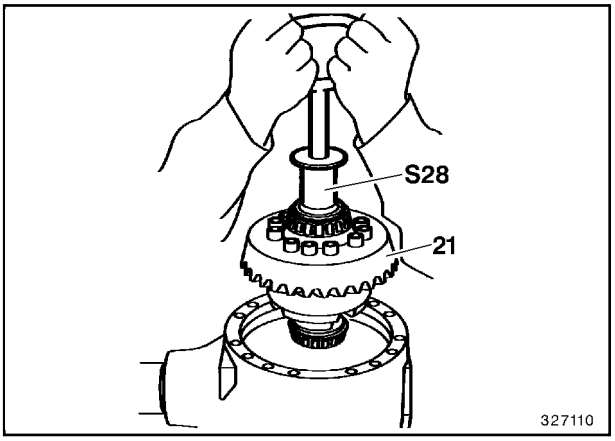


Fig. 38

Apply marking blue to the sides of a few teeth of bevel gear (21).

Insert pre-assembled differential. The teeth with the marking blue should be opposite to the pinion shaft

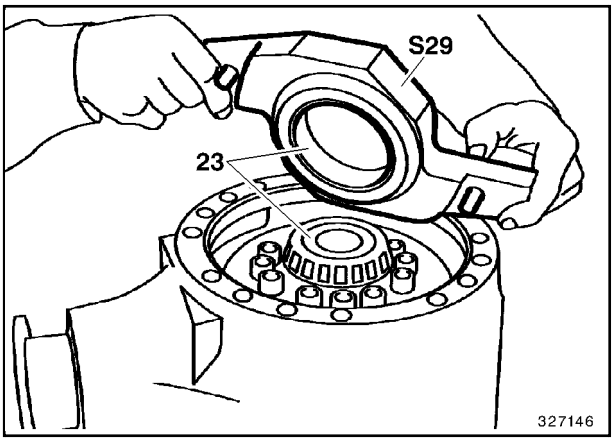


Fig. 39

Push original outer ring of tapered roller bearing (23) into fixture (S29).

Apply fixture and fasten with two screws.

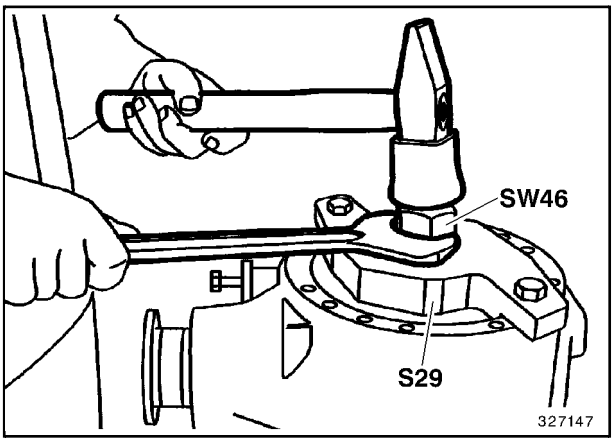


Fig. 40

Tighten 46 size hex screw and strike screw head with a heavy plastic mallet at the same time.

Slacken screw 1/4 turn and slightly re-tighten.

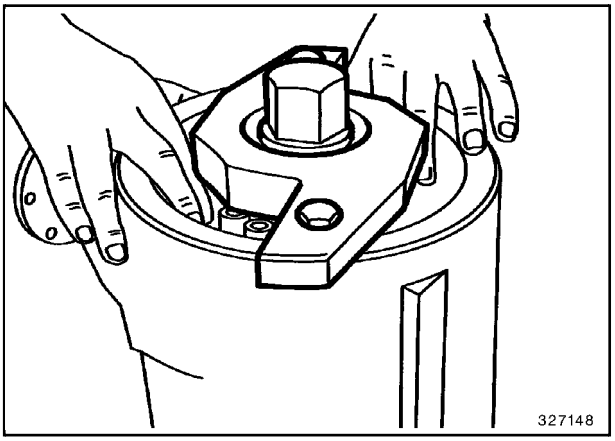


Fig. 41

Move bevel gear by hand.

Check backlash.

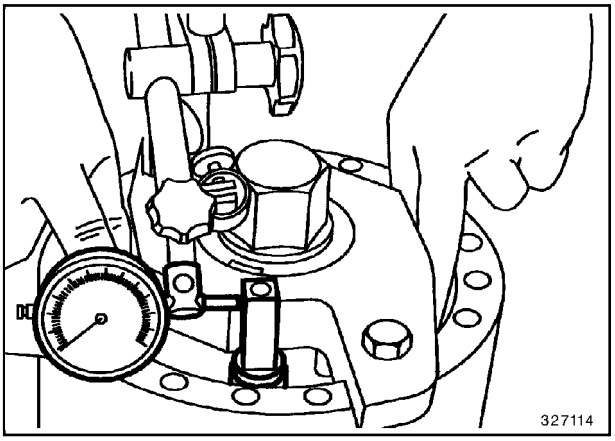


Fig. 42

Apply holder with dial gauge to axle housing and put magnet on bevel gear.

Backlash 0.15 ... 0.25 mm.

Backlash too small: Insert additional spacing washer (24-26, Fig. 36).
Backlash too big: Remove spacing washer.

If possible, keep number of spacing washers small.

To check surface appearance turn pinion shaft in either direction by means of crank (S27) so that bevel gear makes several revolutions.

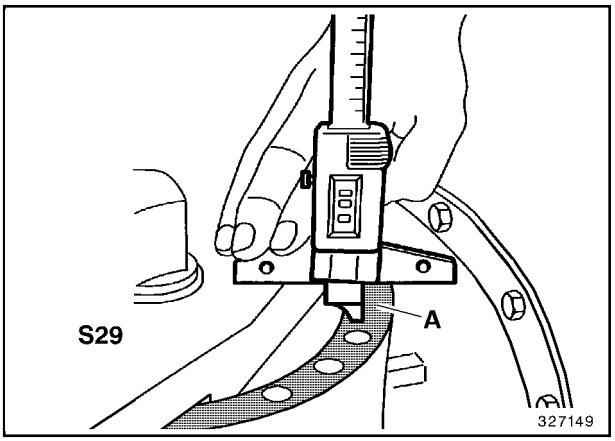


Fig. 43

Apply depth gauge to fixture (S29) and measure with respect to housing rim, surface (A).

(Digital meter to be set to "0".)

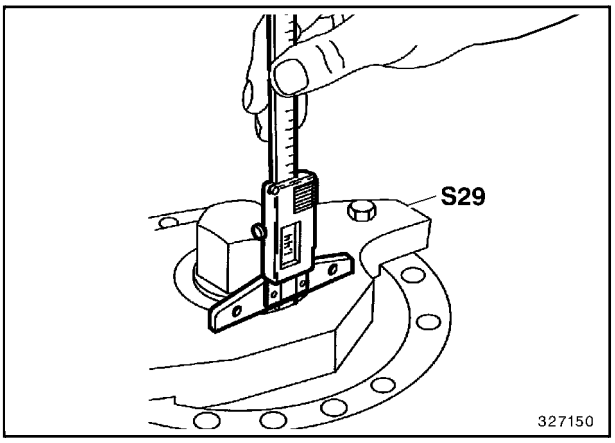


Fig. 44

Measure with respect to outer ring of tapered roller bearing (23), surface (B), with depth gauge through bore in fixture (S29). Refer to Fig. 52.
Difference between A and B = X.
Example: X = 1.60 mm.
Record measured value.

Remove fixture (S29).

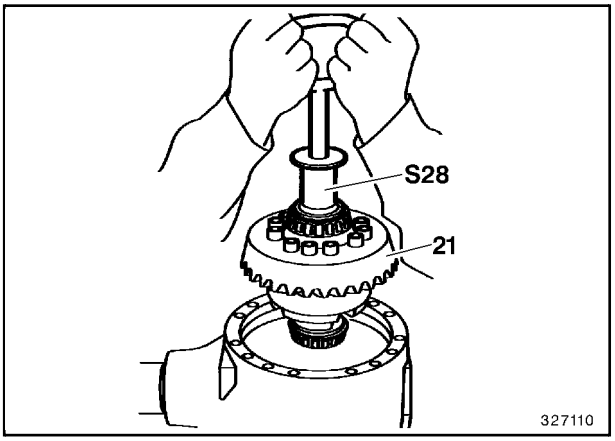


Fig. 45

Lift out differential.
Check surface appearance on bevel gear. Refer to Chapter "GLEASON Toothing Surface Appearances". For major deviations, shift pinion shaft by changing spacing washers (37-39).

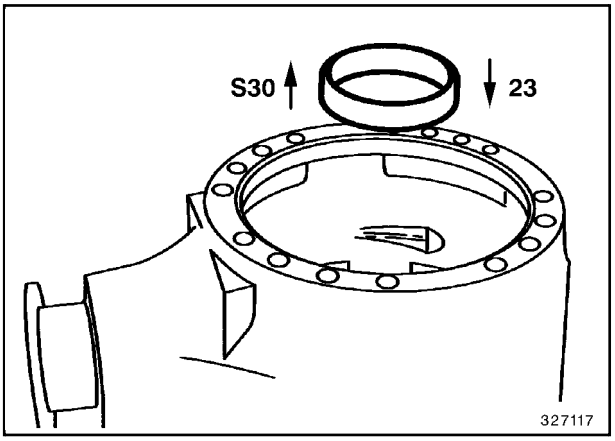


Fig. 46

Remove bearing ring (S30).
Insert original outer ring of tapered roller bearing (23)

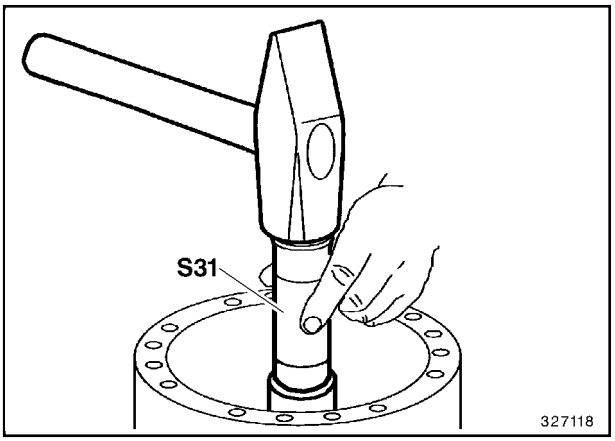


Fig. 47

and drive in with punch (S31).

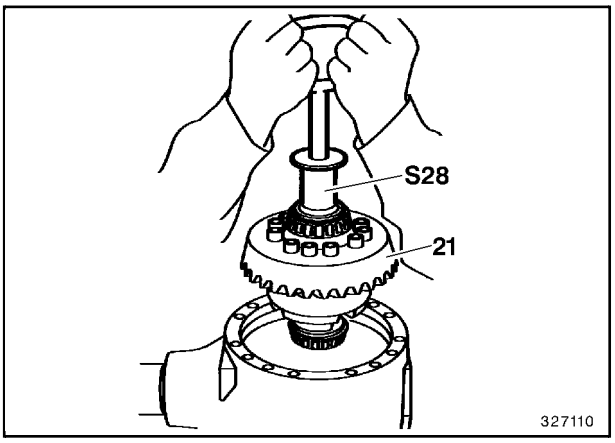


Fig. 48

Re-insert differential.

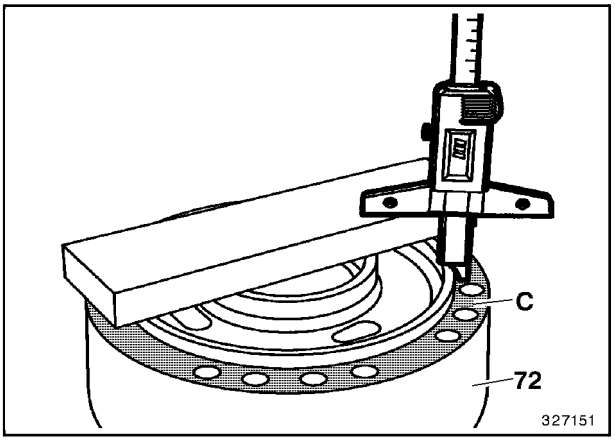


Fig. 49

Measure distance between suitable sheet metal gauge and flange of right-hand brake carrier (72), surface (C), by means of depth gauge.

(Digital meter to be set to "0".)

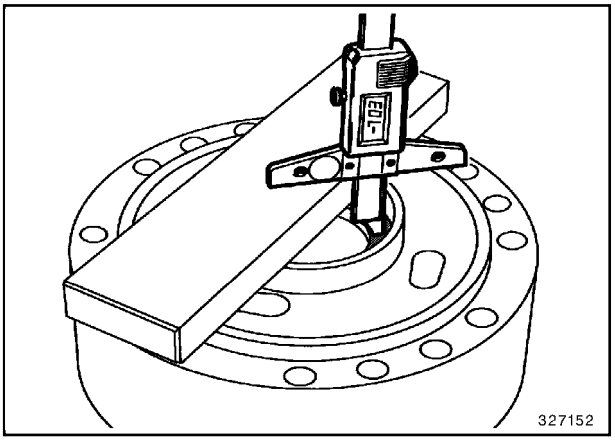


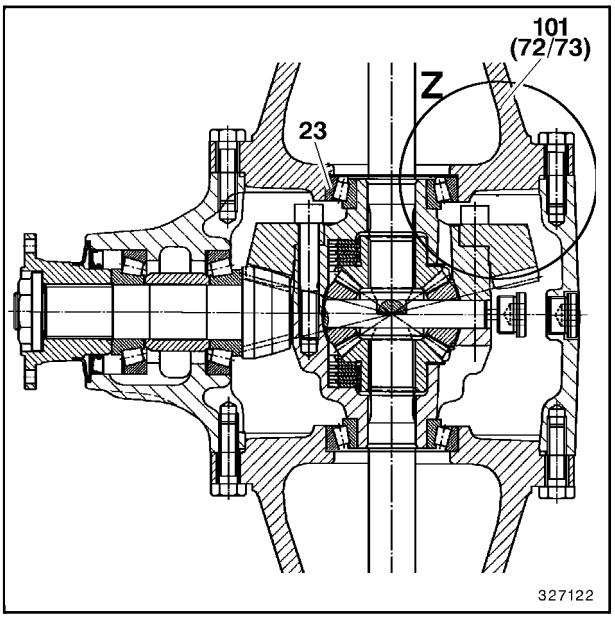
Fig. 50

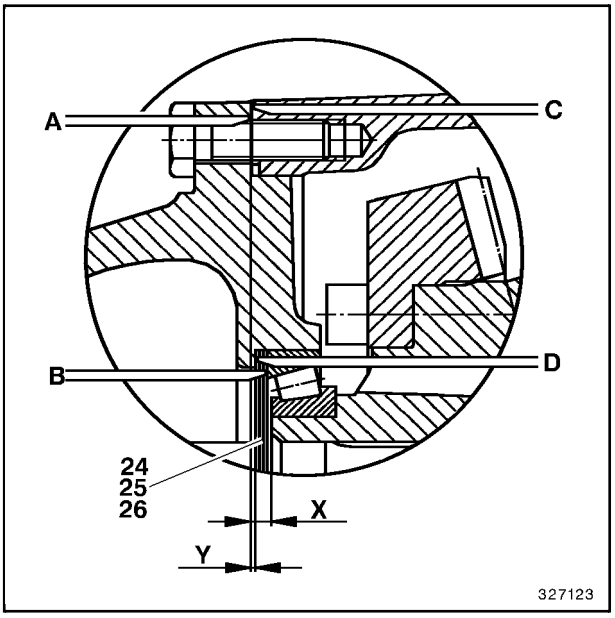
Subsequently, measure with respect to bearing seat, surface (D).

Difference between C and D = Y.

Example: Y = 1.03.

Record measured value.





Figs. 51 and 52

Calculating Spacing Washers (24-26)

Example 1:

X	1.60 mm
Y	- 1.05 mm
	0.55 mm
Pre-tension	+0.03 mm
	0.58 mm
Rounded up	0.60 mm
2 nos. of spacing washers	0.3 mm

Round up value calculated.

Spacing washers (24-26): 0.1-0.3-0.5 mm thick.

If possible, keep number of inserted spacing washers small.

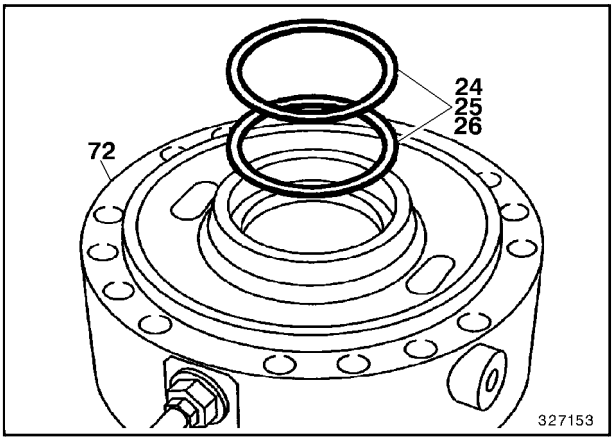


Fig. 53

Put spacing washer(s) determined (24-26) in pre-assembled brake carrier (72).

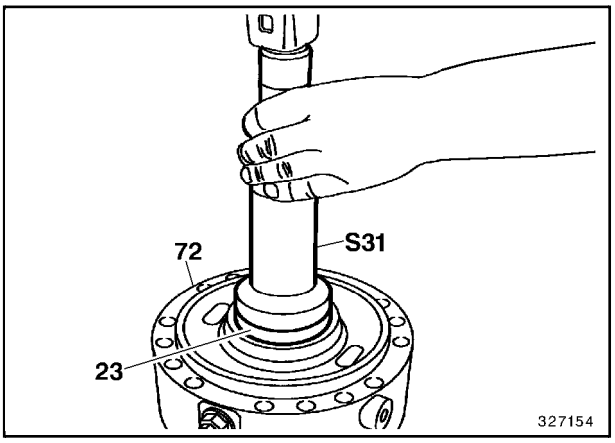


Fig. 54

Drive in outer ring of tapered roller bearing (23).

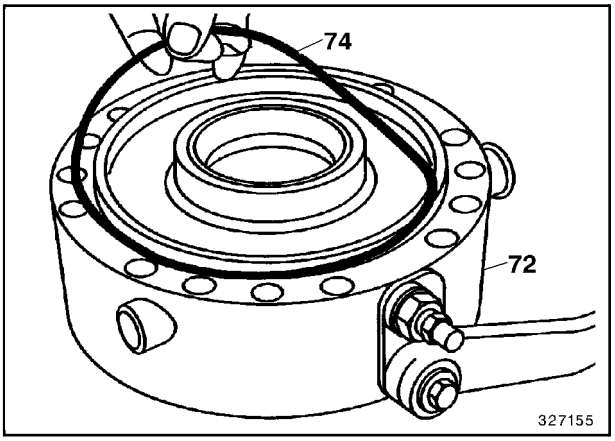


Fig. 55

Put O-ring (74) on brake carrier.

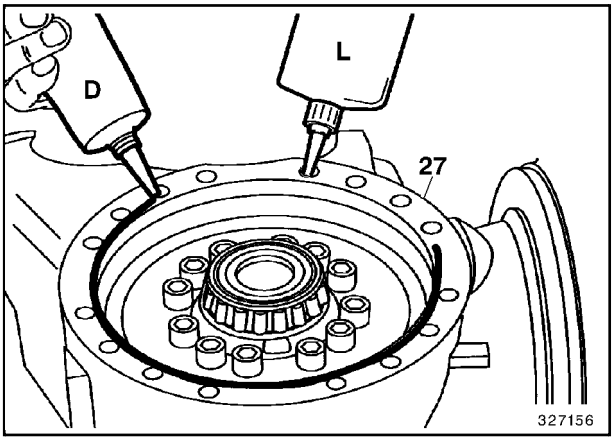


Fig. 56

Moisten tapped holes in axle housing (27) with LOCTITE 243.

Apply a bead of sealing compound (D).

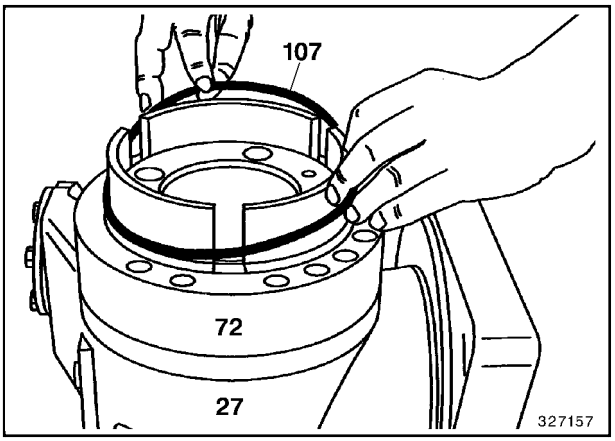


Fig. 57

Attach brake carrier (72). Mind marks made during dismantling and positions of brake levers.

Put on O-ring (107).

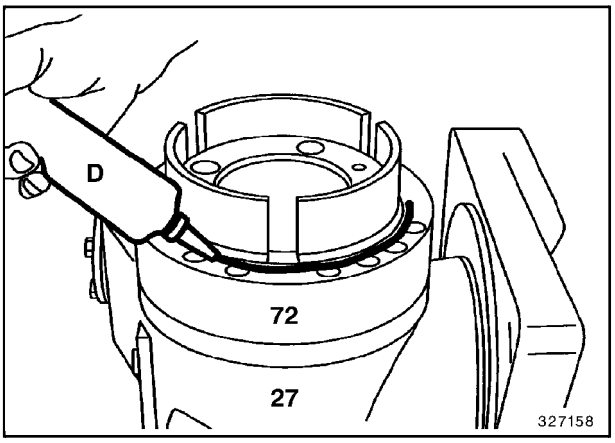


Fig. 58

Apply sealing compound.

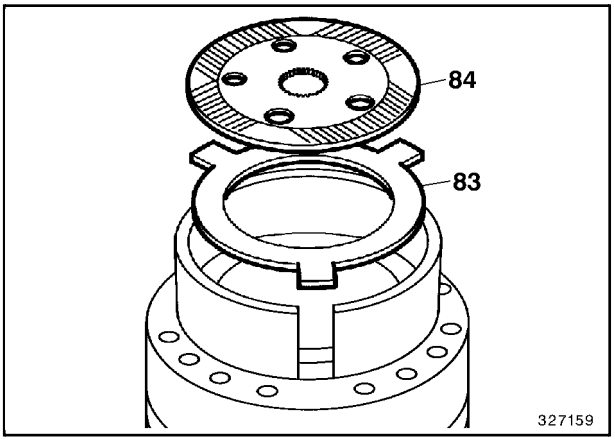


Fig. 59

Alternately insert 6 outer disks (83) and 5 inner disks (84), beginning with an outer disk (83).

Bring teeth of inner disks (84) and five oil exchange holes into perfect congruence.

Put new inner disks (84) in LS 5-90 gear oil for 30 minutes before inserting.

(Air gap = 0.16 mm/friction surface.)
(Air gap = 1.16 mm/brake.)

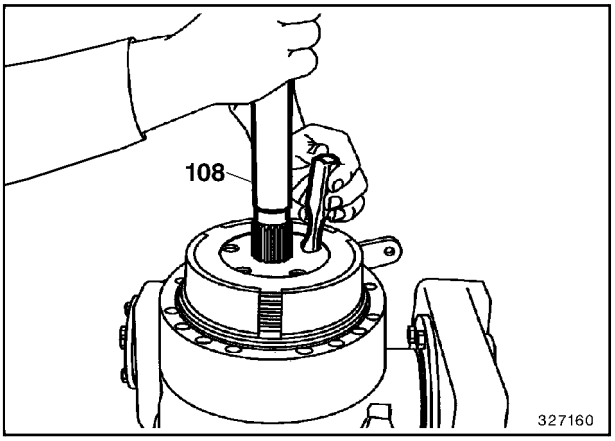


Fig. 60

Insert drive shaft (108). Shift inner disks (84) with punch when doing so.

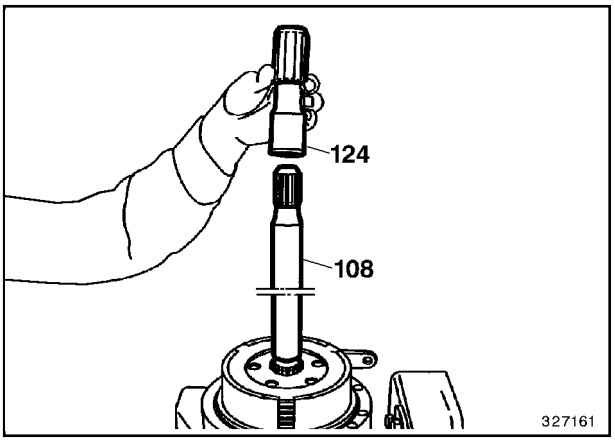


Fig. 61

Slip over pinion shaft (124).

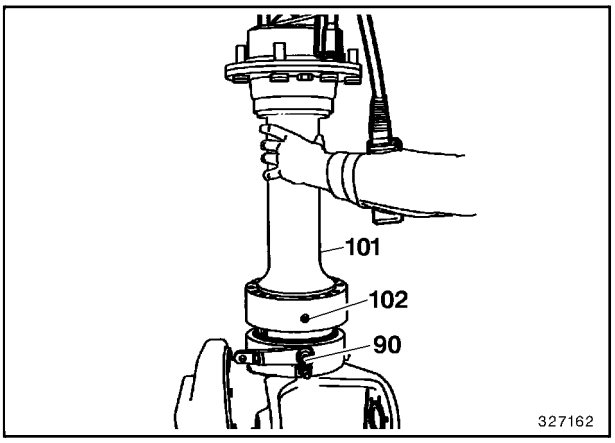


Fig. 62

Attach axle tube (101) with pre-assembled wheel hub. Fit drive shaft into planetary gear set.

Mind marks made on axle housing, brake carrier and axle tube. Brake lever (90) and vent plug (102) to be located one upon the other.

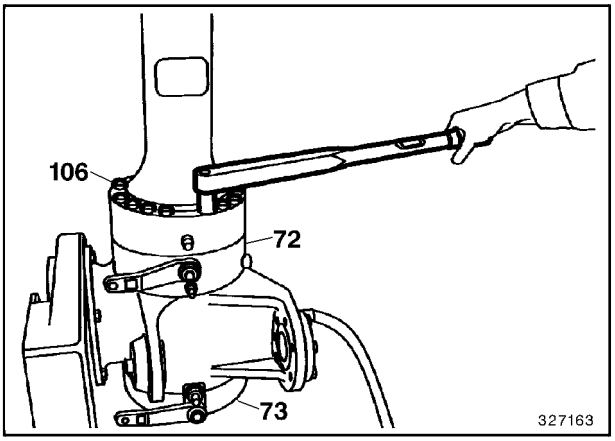


Fig. 63

Crosswise tighten hex screws (106).

Tightening torque M_A = 120 Nm (89 lbft).

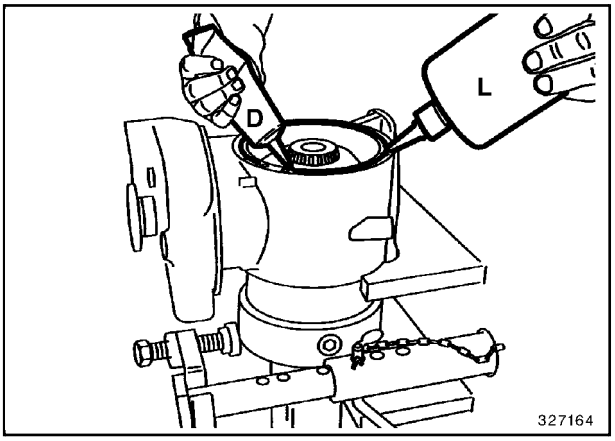


Fig. 64

Place completed axle half onto wheel hub after turning over 180°. Remove left-hand brake carrier (73). Moisten tapped holes in axle housing with LOCTITE 243.

Apply sealing compound.

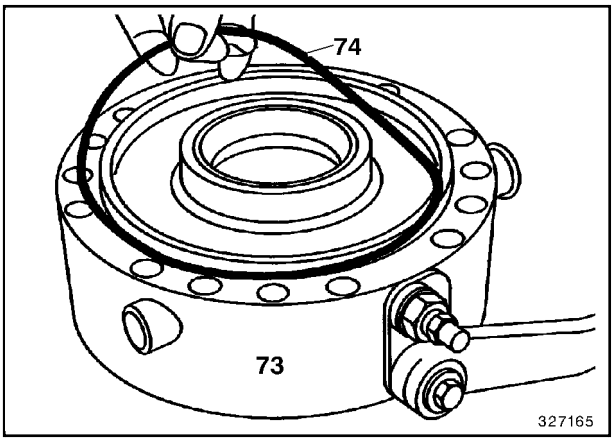


Fig. 65

Put on O-ring (74).

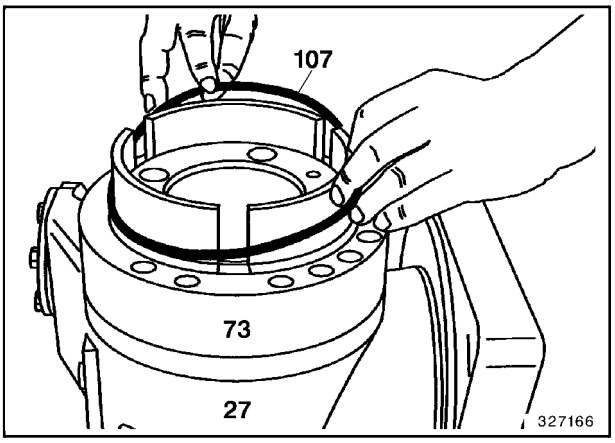


Fig. 66

Put on brake carrier (73). Mind marks made during dismantling.

Put on O-ring (107).

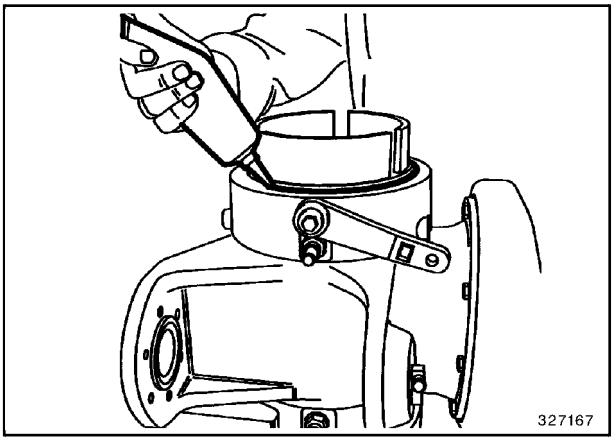


Fig. 67

Apply sealing compound.

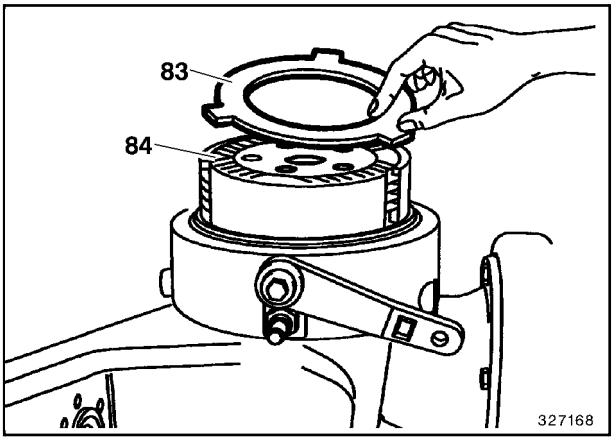


Fig. 68

Alternately insert 6 outer disks (83) and 5 inner disks (84), beginning with an outer disk (83).

Bring teeth of inner disks (84) and five oil exchange holes into perfect congruence.

Put new inner disks (84) in LS 5-90 gear oil for 30 minutes before inserting.

(Air gap = 0.16 mm/friction surface.)
(Air gap = 0.16 mm/brake.)

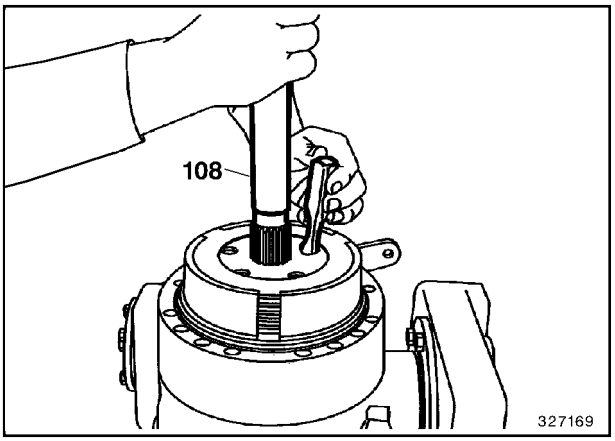


Fig. 69

Insert drive shaft (108).

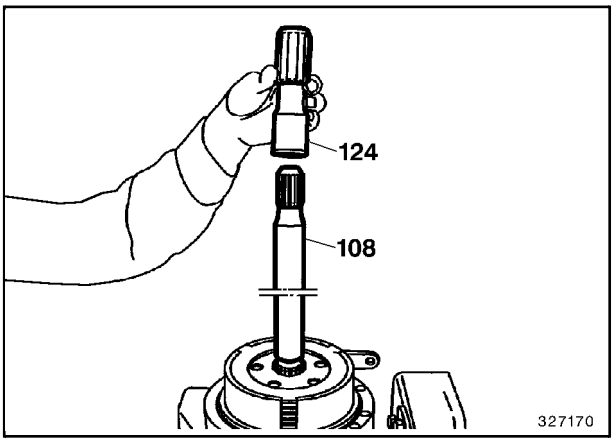


Fig. 70

Slip over pinion shaft (124).

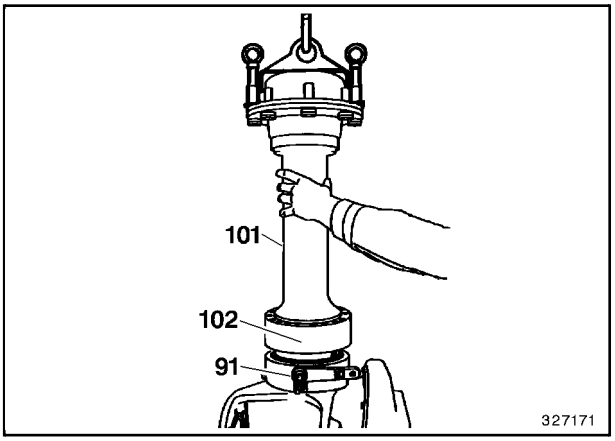


Fig. 71

Attach axle tube (101) with pre-assembled wheel hub. Fit drive shaft into planetary gear set.

Mind marks made on axle housing, brake carrier and axle tube. Vent plug (102) and brake lever (91) and to be located one upon the other.

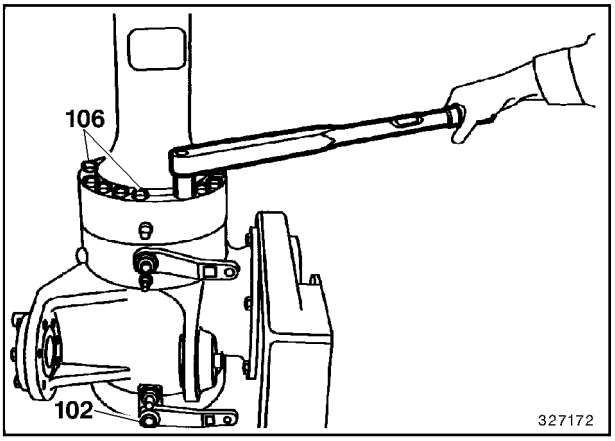


Fig. 72

Crosswise tighten hex screws (106).

Tightening torque M_A = 120 Nm (89 lbft).

Screw in vent plug (102).

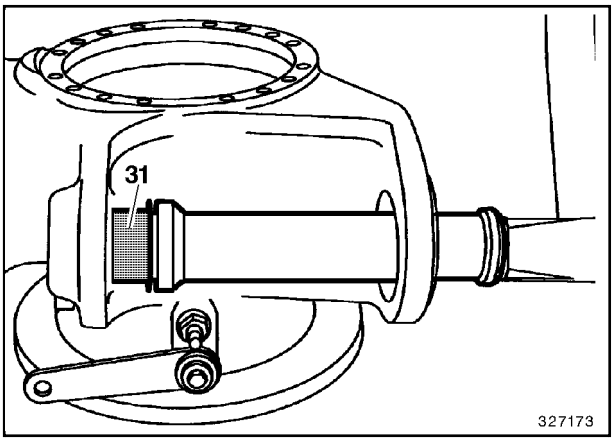


Fig. 73

Drive in self-aligning bearing collar bush (31).

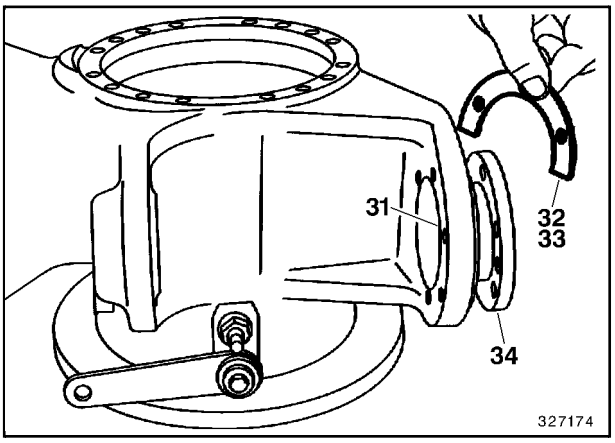


Fig. 74

Drive second collar bush (31) into cap (34).

Insert spacing washers (32, 33) removed during dismantling.

Checking the Brake for Tightness

Connect hydraulic hand pump (Lukas) with stopcock separately to each brake. It must be ensured that the hand pump is filled with unobjectionable, clean hydraulic oil. For specification, refer to the Operating Instructions manual of the wheel-mounted loader.

Vent the brake assembly and operate it several times.

Build up a pressure of 100 bar (1451 psi) and close the stopcock. The pressure must remain constant for 5 minutes.

Repeat the test with a pressure of 5 bar (73 psi).

GLEASON Toothing Surface Appearances

GLEASON Toothing Surface Appearances

Ideal tooth-contact pattern

Coast side (concave)

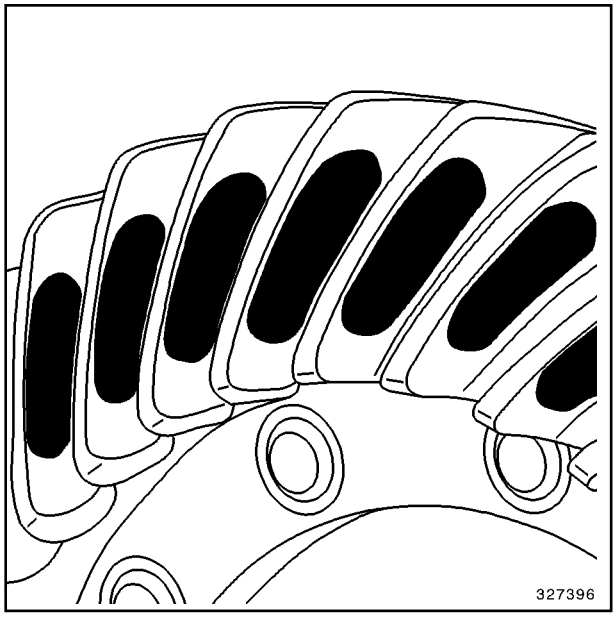


Fig. 1

Drive side (convex)

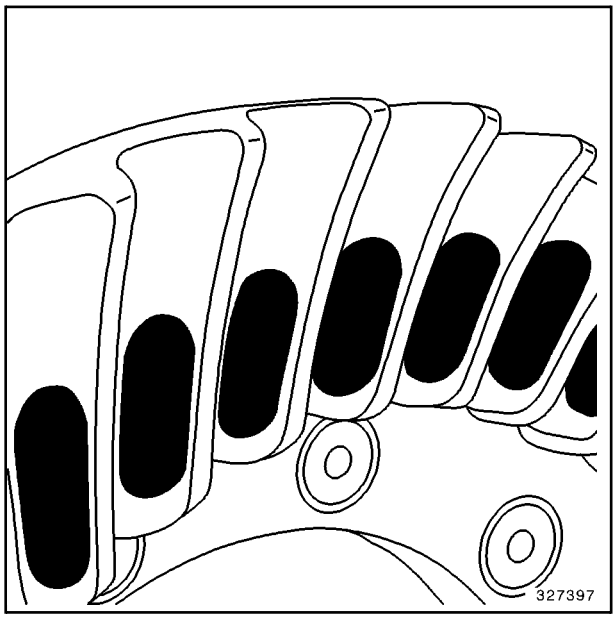


Fig. 2

Pinion distance must be increased.

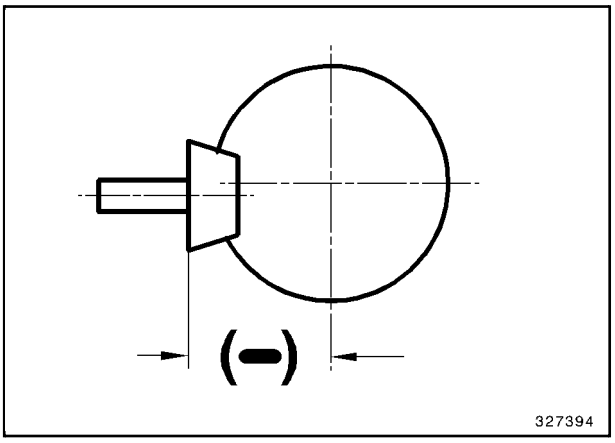


Fig. 3

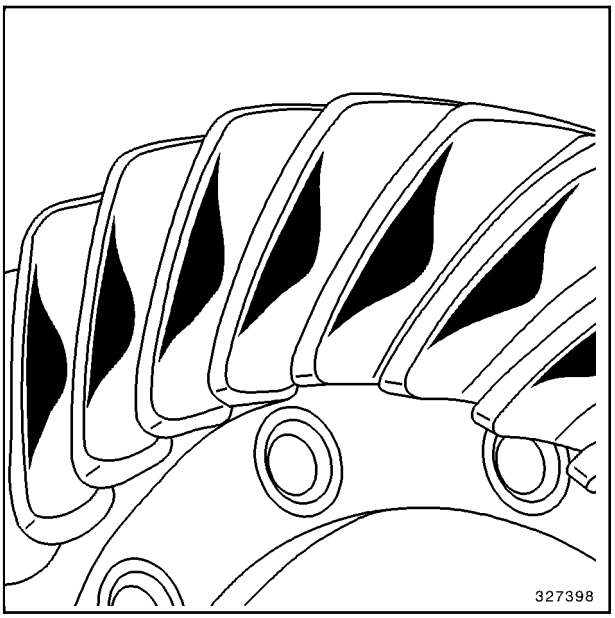


Fig. 4

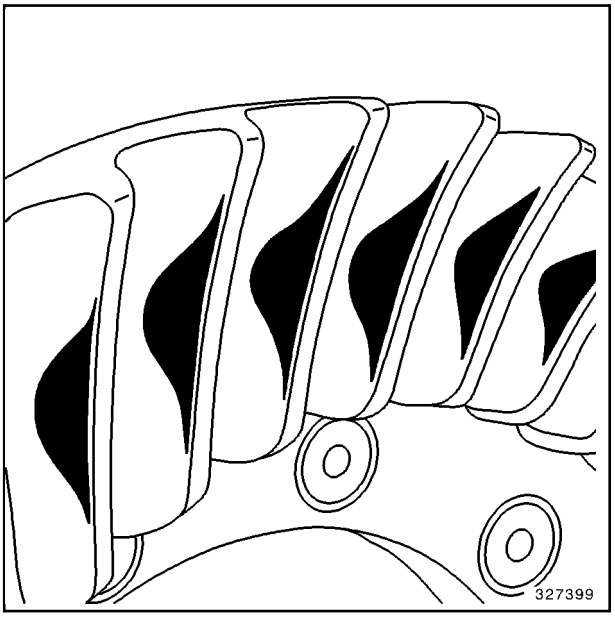


Fig. 5

Pinion distance must be decreased.

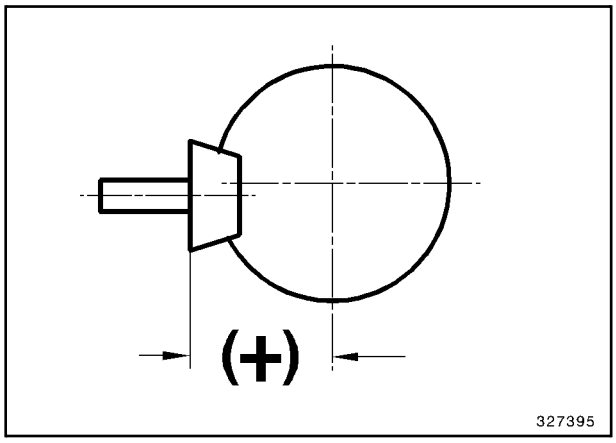


Fig. 6

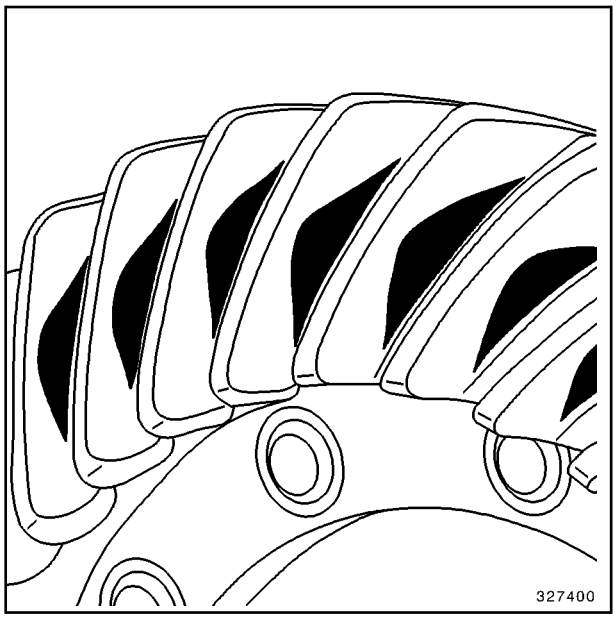


Fig. 7

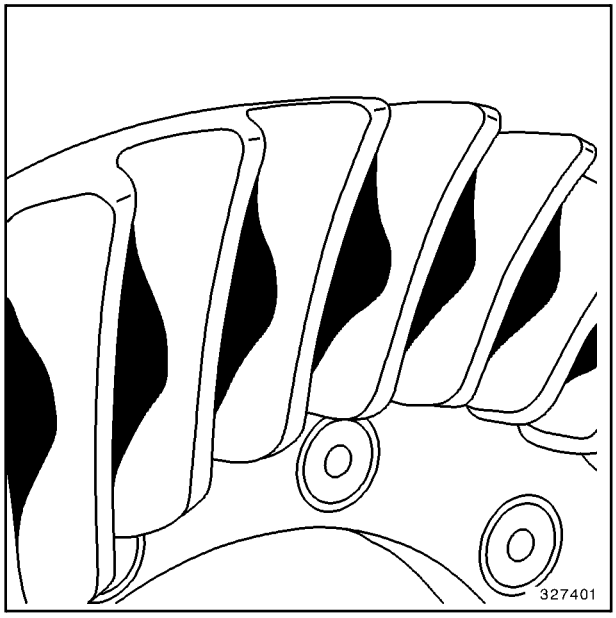


Fig. 8

List of Special Tools

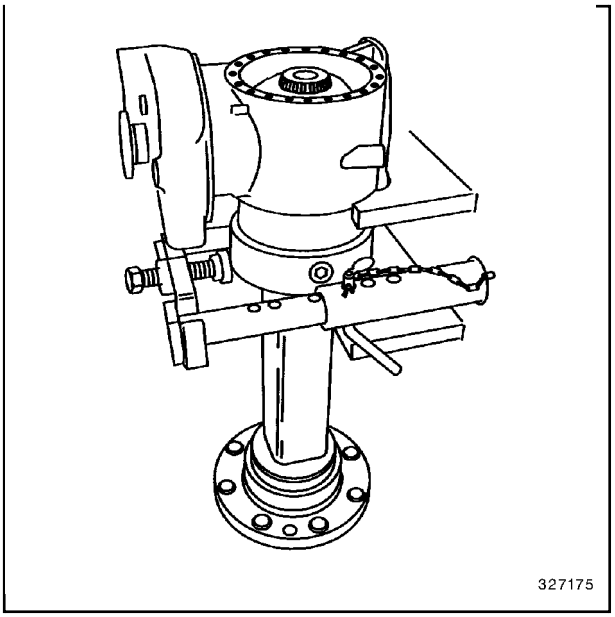


Fig. 1

Fixture for vertical axle mounting. Recommended for reproduction.

Serial No. (Item)	Page	Fig.	ID	Description
S 1	44	48	72181229	Hand crank
S 2	44 45	49 51	72181230	Punch
S 5	61	1	72181231	Mounting sleeve
S 6	62	4	72181232	Mounting sleeve
S 7	61	2	72181233	Expansion sleeve
S 8	62	6	72181234	Sizing sleeve
S 9	62	7	72181235	Punch
S 10	63	10	72181236	Impact extractor
S 11	31 33	2 9	72181237	Punch
S 12	32	7	72181238	Punch
S 13	34 34	13 15	72181239	Wheel hub mounting fixture
S 14	38	27	72181240	Punch
S 15	40	34	72181241	Punch
S 16	41	39	72181242	Lifting racket fixture
S 17	41	39	72181243	Ring nut
S 20	48	58	72181244	Punch
S 21	60	102	72181245	Guide pins
S 22	50	65	72181246	Test shaft
S 23	50	67	72181247	Lock

Serial No. (Item)	Page	Fig.	ID	Description
S 24	51 52 69	70 74 27	72181248	Punch
S 25	52	73	72181249	Prop
S 26	52	75	72181250	Punch
S 27	53 70	77 31	72181251	Crank
S 28	54 74	80 45	72181252	Lifting fixture
S 29	54 72	82 40	72181253	Mounting fixture
S 30	53 72	79 37	72181254	Bearing outer ring
S 31	56 77	89 54	72181255	Punch
S 32	69	26	72181256	Punch
S 33	70	29	72181257	Punch
S 34	71	34	72181258	Punch

Screw Tightening Torques (DIN tables)

2800497

General information

The following tables contain the tightening torques for screws with a DIN 13 - 13 metric thread.

The construction dept. may specify in certain cases tightening torques other than those set out in the standard. **The values set out in the tables are therefore applicable unless otherwise specified in the "Inspection and servicing" chapter of the operating instructions, the Technical Handbook or the drawings.**

The tightening torques specified do not only depend on the screw grade, but also on the friction at the thread and the bearing face of the screw head. Therefore, different friction coefficients (total) depending on the type and condition of the screws used must be applied when calculating tightening torques.

1. Friction coefficient total = 0.10:
   screw and/or nut electro-galvanized (surface protection A3B).

2. Friction coefficient total = 0.12:
   screw black-plated or phosphatized
   nut bright
   thread oiled

3. Friction coefficient total = 0.16:
   screws with liquid screw fixer, e.g. Loctite 242, 243, in acc. with application instructions.
   The corresponding column is marked in the tables with an "L".

The three figures given are mean friction coefficients.
The calculated tightening torques M_A are valid for tightening of the screws by hand

Units of measurement

The tightening torques specified in the tables are expressed in Nm (newtonmeter). If older torque wrenches are used for tightening, the Nm values must be converted to the formerly used kpm (kilopondmeter) unit. The conversion is simple since 1 kpm is almost exactly the same as 10 Nm (exact coversion factor: 1 kpm = 9.81 Nm). The small difference can be ignored so that for conversion purposes the Nm value must only be divided by 10.

Example:

$$1840\ \text{Nm} = \frac{1840}{10} = 184\ \text{kpm}$$

Screw Tightening Torques

Bolts with standard thread **DIN 13, sheet 33 (e.g. DIN 912, 931, 934)**

Thread nominal Ø	Material quality	Tightening torques M_A in Nm total 0.10[1)]	total 0.12[2)]	total 0.16 (L)[3)]
M 5	8.8 10.9 12.9	4.9 7.3 8.5	5.5 8.1 9.5	6.5 9.5 11.2
M 6	8.8 10.9 12.9	8.5 12.5 14.5	9.5 14 16.5	11.2 16.5 19.5
M 8	8.8 10.9 12.9	20.5 30 35	23 34 40	27 40 47
M 10	8.8 10.9 12.9	41 60 71	46 68 79	55 80 94
M 12	8.8 10.9 12.9	71 104 195	79 117 215	94 140 260
M 16	8.8 10.9 12.9	170 250 300	195 280 330	230 340 400
M 20	8.8 10.9 12.9	350 490 580	390 560 650	470 670 780
M 24	8.8 10.9 12.9	600 850 1000	670 960 1120	800 1140 1350
M 30	8.8 10.9 12.9	1190 1700 2000	1350 1900 2250	1600 2300 2700
M 36	8.8 10.9 12.9	2100 3000 3500	2350 3300 3900	2800 4000 4700

[1)] Screw and/or nut electro-galvanized.

[2)] Screw black-plated or phophatized, thread oiled.

[3)] Screws with liquid screw fixer, e.g. Loctite 242, 243.

Bolts with metric fine thread DIN 13 - 13

Thread nominal Ø	Material quality	Tightening torques M_A in Nm total 0.10[1)]	total 0.12[2)]	total 0.16 (L)[3)]
M 8x1	8.8 10.9 12.9	22 32 38	24.5 36 43	30 43 51
M 10x1	8.8 10.9 12.9	45 67 78	52 76 89	62 91 107
M 10x1.25	8.8 10.9 12.9	43 64 74	49 72 84	58 86 100
M 12x1.25	8.8 10.9 12.9	77 112 130	87 125 150	104 150 180
M 14x1.5	8.8 10.9 12.9	121 175 205	135 200 235	165 240 280
M 16x1.5	8.8 10.9 12.9	180 270 310	205 300 360	250 370 430
M 20x1.5	8.8 10.9 12.9	380 540 630	430 620 720	530 750 880
M 22x1.5	8.8 10.9 12.9	510 720 840	580 820 960	700 1000 1170
M 24x2	8.8 10.9 12.9	640 920 1070	730 1040 1220	890 1250 1500
M 27x2	8.8 10.9 12.9	940 1350 1550	1070 1500 1800	1300 1850 2150
M 30x2	8.8 10.9 12.9	1370 1940 2270	1490 2120 2480	1740 2480 2900

[1)] Screw and/or nut electro-galvanized.

[2)] Screw black-plated or phophatized, thread oiled.

[3)] Screws with liquid screw fixer, e.g. Loctite 242, 243. □

Notes

2800145

06 STEERING

Hydraulic System, Safety Instructions

2800476

DANGER

Read and observe the operating instruction: "Inspection and Servicing, Safety Instructions".

Before working on the hydraulic system, ensure that the system is depressurized and that any residual pressure is discharged.

Engine off.

Secure the machine as described in the operating instruction: "Securing the machine".

Avoid skin contact with hydraulic oils. Wear gloves and firm working gear. Skin contact with hydraulic oils is a health risk.

□

Explanations of circuit diagrams and illustrations

2800487

All circuit diagrams and illustrations in this Workshop Manual form one coherent system.

Each component has its own unique part number. In some cases a letter indicating the use is assigned to the digit for improved clarity.

Meanings:

A =	transmission drive,	z. B. **A7** =	servo-valve
B =	braking system,	z. B. **B1** =	brake fluid pump
L =	steering system,	z. B. **L1** =	steering cylinder
H =	working hydraulics,	z. B. **H8** =	primary valve
T =	tank, filter, cooling system	z. B. **T1** =	hydraulic tank

Part numbers without letters designate general components, e.g. Part **1** = diesel engine.

Encircled parts, e.g. (2), designate connections. They indicate the destination or the origin of the connection lines. Example (2) indicates that the connection designated in this way is connected with the dual pump.

Measuring connections are specified with rectangular boxes.

X1 designates, for example, the measuring point for control pressure. □

Depressurizing the hydraulic system

2800488

Before starting work, depressurize the hydraulic system:

- Secure the machine as described under "Securing the machine".
- Move control lever for operating equipment and 3rd function in all directions until the operating equipment makes no further movement.

The residual pressure in the operating equipment is then discharged. □

Hydraulic circuit diagram - steering hydraulics

2800929

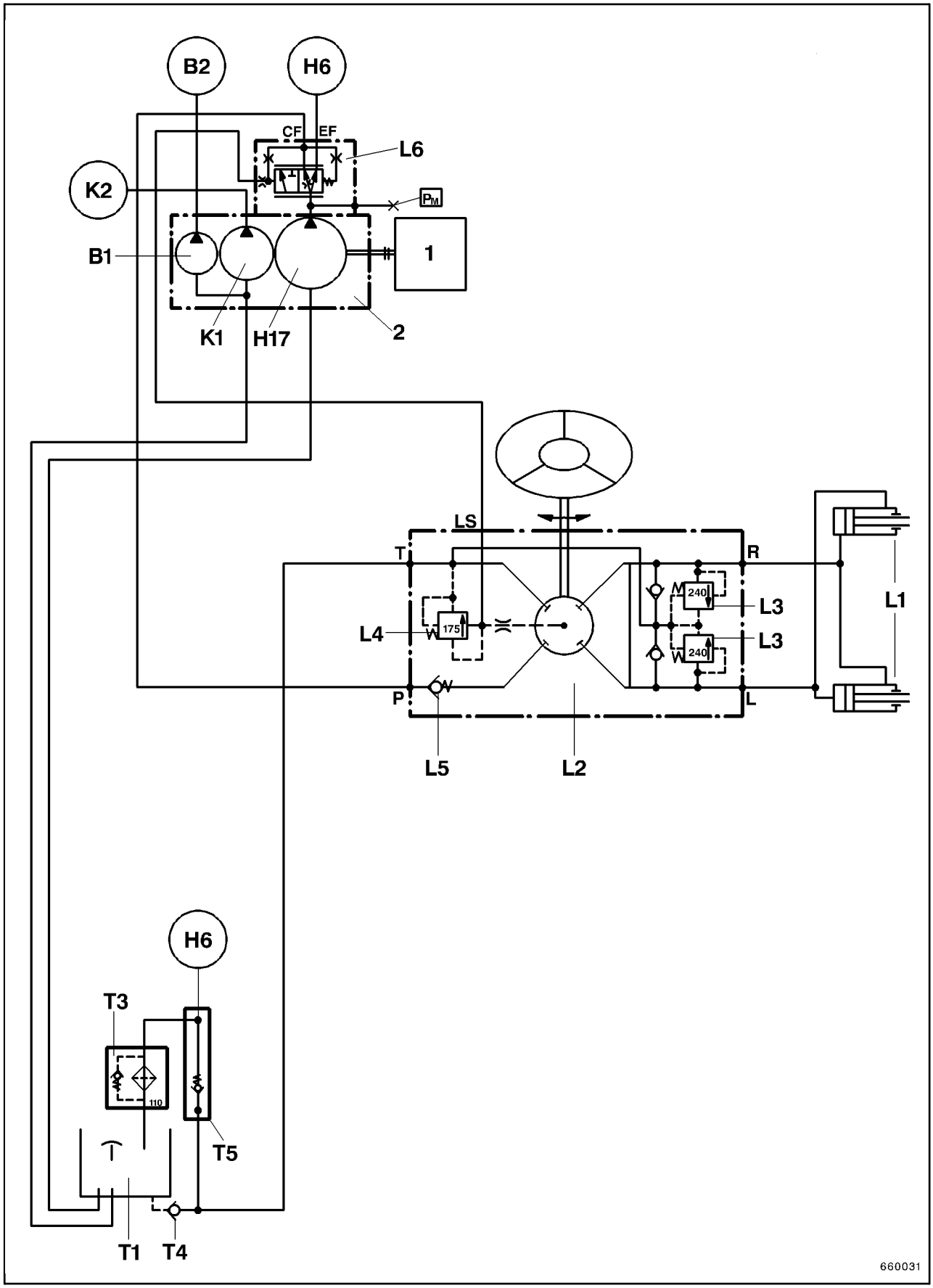


Fig. 1

Hydraulic circuit diagram, legend

1 - Diesel engine
2 - Triple pump, steering system / working hydraulics / braking system / fan drive
9 - Front axle
10 - Rear axle

T1 - Hydraulic tank
T2 - Hydraulic oil cooler
T3 - Hydraulic oil return-flow filter with bypass
T4 - Check valve
T5 - Distributor

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve, steering
L4 - Primary valve, steering system
L5 - Check valve
L6 - Priority valve

H1 - Lifting cylinder
H2 - Dumping cylinder
H3 - Quick-change locking cylinder
H4 - Hydraulic cylinder, 3rd function
H5 - Quick-change locking mechanism (multiway cock)
H6 - Control block, working hydraulics
H7 - Secondary valve "Rearward tilting" with replenishing valve
H8 - Secondary valve "Dumping" with replenishing valve
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve "Lifting/lowering"
H12 - Pressure-maintaining valve "Tilting"
H13 - Pressure-maintaining valve "3rd function "
H14 - Control piston "Lifting-lowering-floating" position
H15 - Control piston "Rearward tilting" dumping
H16 - Control piston "3rd function"
H17 - Hydraulic pump, steering and working hydraulics

B1 - Brake fluid pump
B2 - Accumulator charging valve
B4 - Brake accumulator
B5 - Pedal operated brake valve
B6 - Pressure switch, braking light
B7 - Pressure switch, accumulator warning
B8 - Sequence valve
B9 - Multiple-disc brake
B10 - Inching valve

K1 - Fan pump
K2 - Fan motor
K3 - Replenishing valve

A1 - Feed circuit filter
A2 - Feed pump
A3 - Variable displacement axial-piston pump A4VG-Da
A4 - High-pressure relief valves, deblockable
A5 - Replenishing valves
A6 - Soiling indicator, feed circuit filter
A7 - Servo-valve
A8 - Pressure cutout
A9 - Feed pressure relief valve
A10 - Restrictor
A11 - Electromagnetically activated switchover valve for forward and reverse travel
A12 - Scavenging needle
A13 - Adjusting cylinder forward/reverse/neutral
A14 - Bypass valve (feed circuit filter)
A15 - Axial-piston oil motor A6VM - HA 1U
A16 - Check valve
A17 - Electromagnetically activated switchover valve for slow travel (high displacement)
A18 - Adjusting cylinder for displacement change
A19 - Feed circuit filter

Pressure measuring points

P_H - Pump pressure for working and steering hydraulics

P_{SP} - Feed pressure

P_{HD} - High pressure at travelling

P_{HD*} - High pressure at travelling (at travel motor)

P_{BS} - Accumulator pressure

P_{in} - Actual braking pressure

P_{BL} - Braking pressure (for the multiple-disc brakes)

X_1 - Control pressure

X_2 - Control pressure

G - Regulation threshold (travel motor) □

Overview of the steering system

2800931

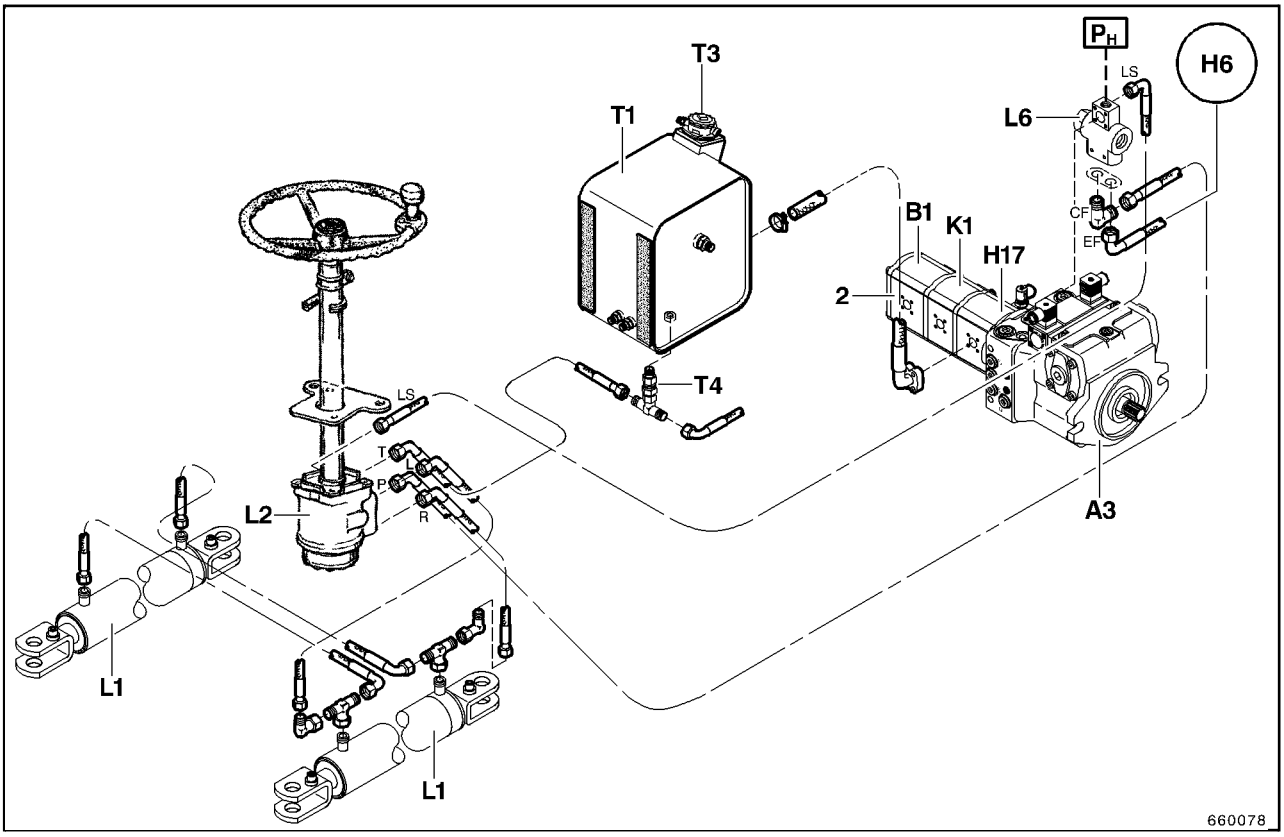


Fig. 2

Functional description

The hydraulic pump (H17), which is operated by the Diesel engine (1), pumps the oil from the hydraulic fluid tank (T1) to the priority valve (L6).
If the steering system is not actuated, no signal pressure is sent from the steering gear (L2) to the priority valve and the delivered fluid can be used by the working hydraulics.

If the steering system is actuated, pressure gathers in the signal line, which causes the change-over piston of the priority valve (L6) to switch.
Depending on the amount of the signal pressure, the priority valve (L6) conveys different quantities of oil to the steering valve (L2).

The primary valve of the steering system (L4) ensures that the pressure of the hydraulic fluid in the steering system does not exceed approx. 175 bars (2540 psi).

In the secondary circuit the pressure of the steering system is limited to 240 bars (3480 psi) by two secondary valves (L3).

When the steering cylinder (L1) has been actuated, the hydraulic fluid flows back to the hydraulic fluid tank (T1) over the steering valve (L2), the distributor (T5) and through the return filter (T3).
The check valve (T4) prevents the unfiltered steering fluid from flowing back to the hydraulic fluid tank (T1).

The check valve (T4) allows the steering valve (in case of pump damage etc.) to such oil out of the hydraulic tank (T1) and makes a emergency steering possible. □

Triple pump (2) of the steering and working hydraulics, the brake system and the fan drive

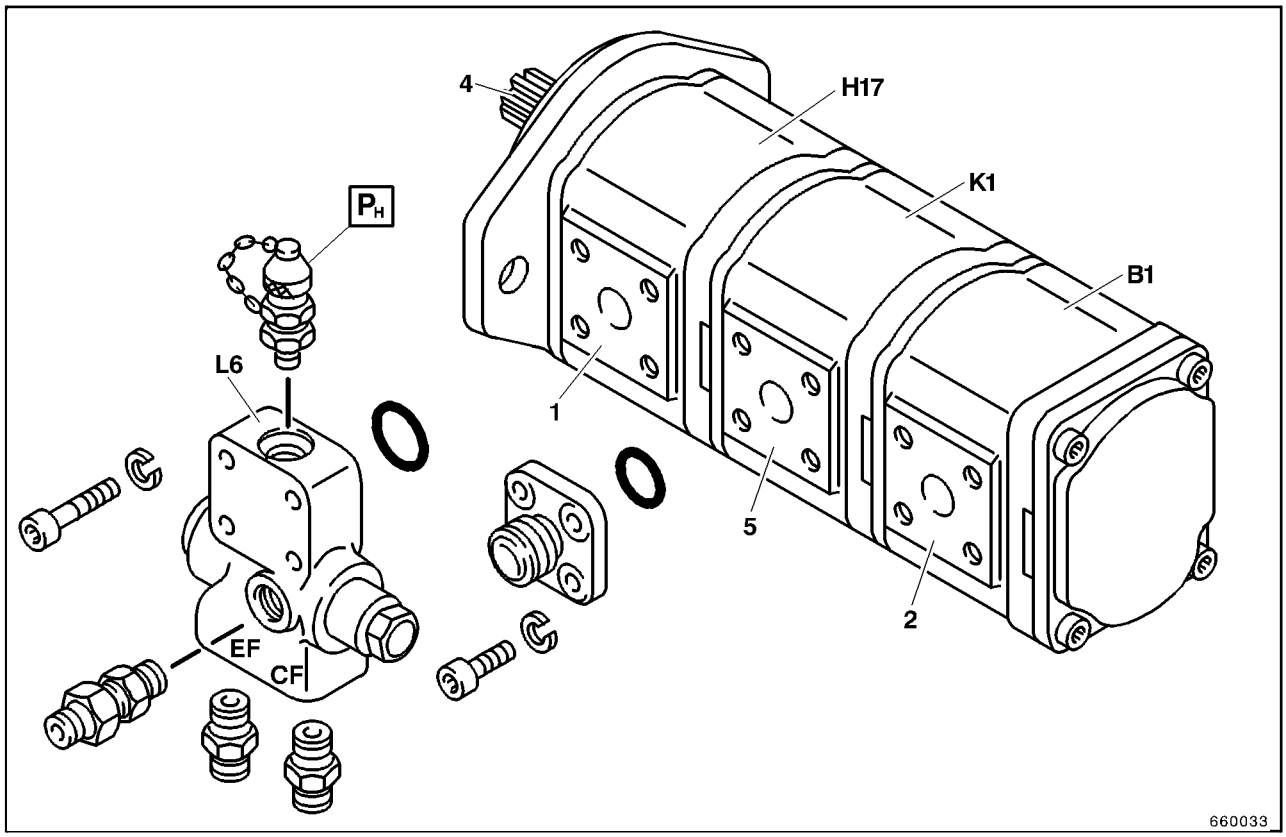


Fig. 3

Positions Fig. 3 and 4

1	-	Connection of the priority valve
2	-	Connection of the brake system
3	-	Connection of steering and working hydraulic
4	-	Drive shaft
5	-	Fan connection
6	-	Suck connection fan drive and braking system
B1	-	Brake pump
B2	-	Accumulator charging valve
H6	-	Control block
H17	-	Pump of the steering and working hydraulics
L2	-	Steering valve
L6	-	Priority valve
K1	-	Fan pump

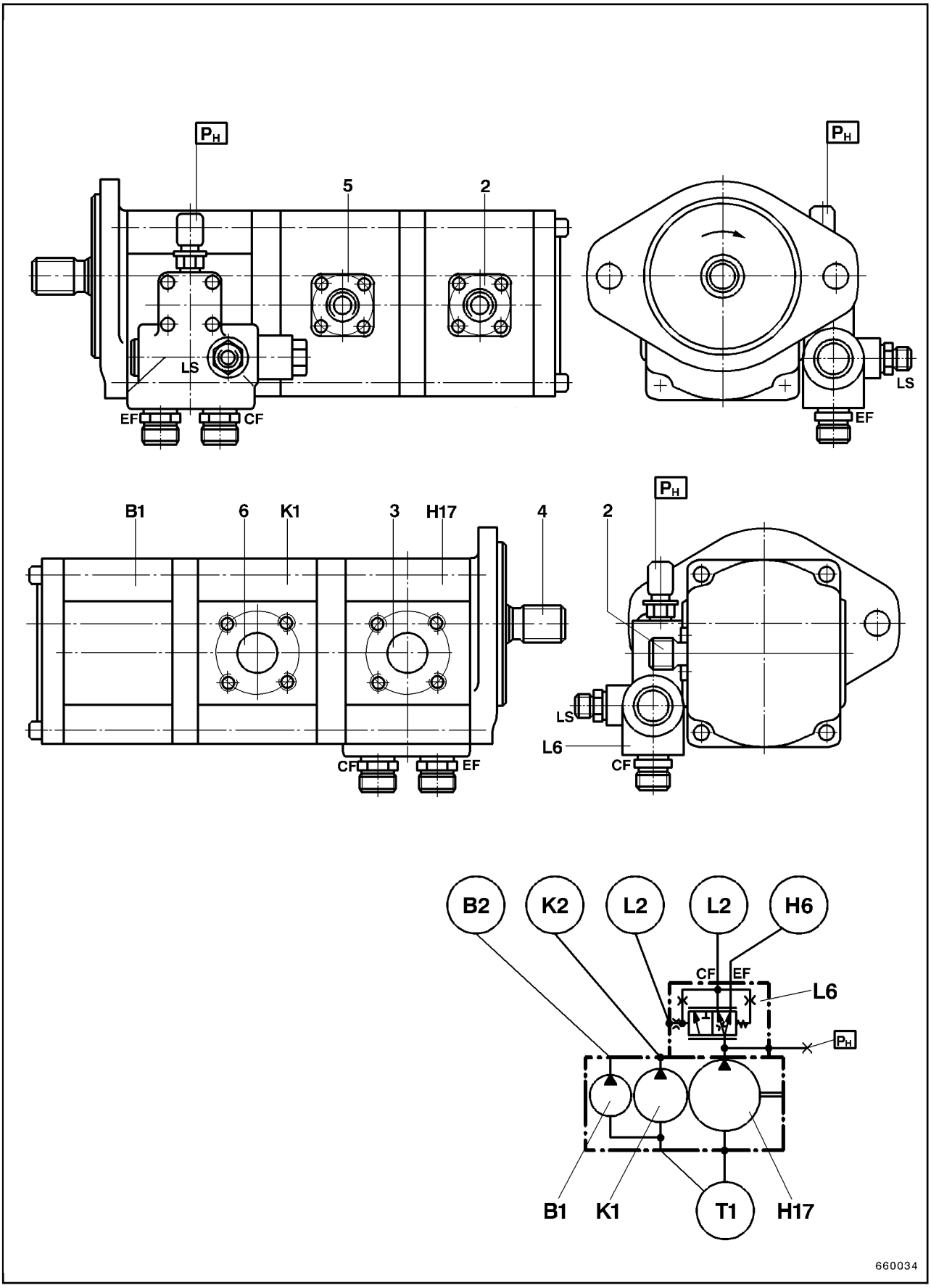

PH
5
2
LS
EF
CF
PH
LS
EF
B1
6
K1
3
H17
4
CF
EF
PH
2
LS
L6
CF
B2
K2
L2
L2
H6
CF
EF
L6
PH
B1
K1
T1
H17
660034

Fig. 4 □

Priority valve (L6)

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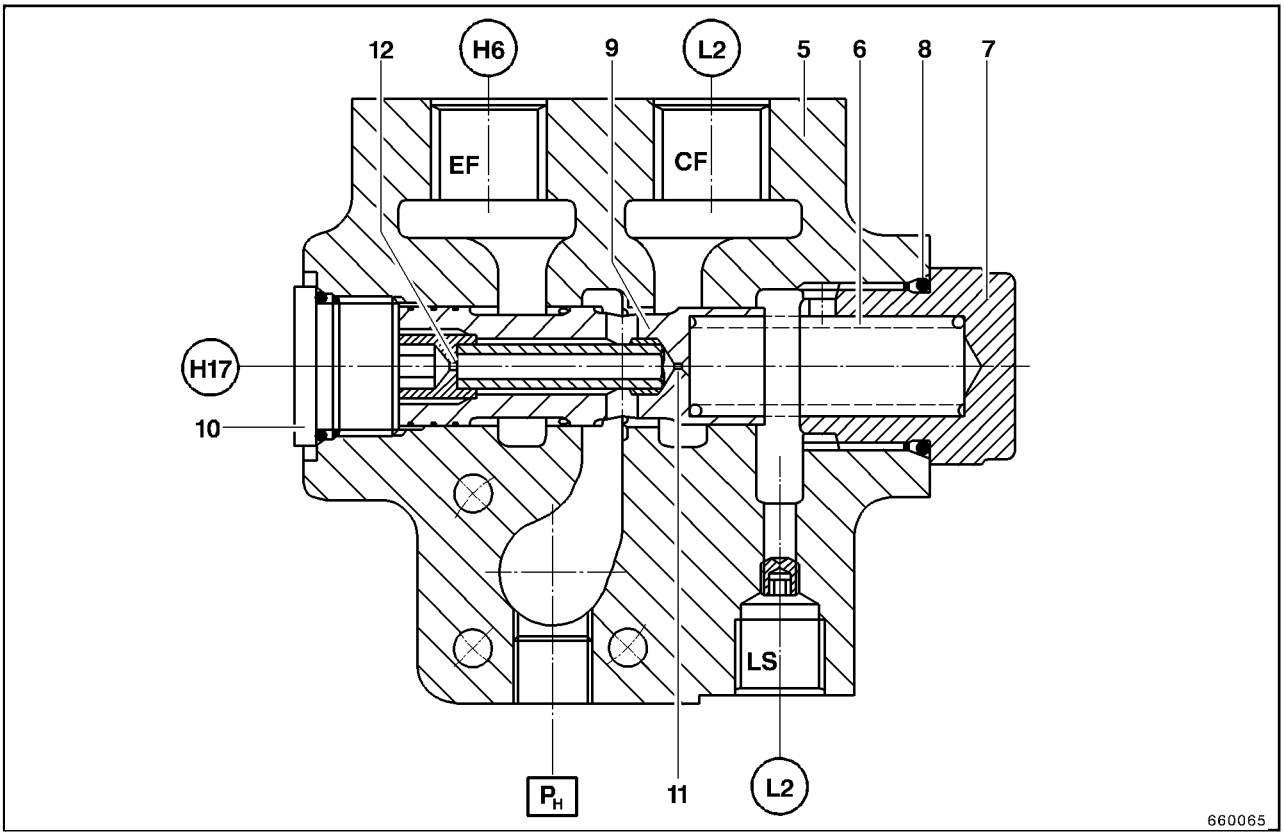

Fig. 5

Parts Fig. 5

5	-	Valve housing
6	-	Pressure spring
7	-	Spring retainer; M_A = 100 - 105 Nm (74 - 77 lbft)
8	-	Oil seal
9	-	Valve piston
10	-	Filler plug; M_A = 75 - 81 Nm (55 - 60 lbft)
11	-	Nozzle 0.7 mm
12	-	Nozzle 1.0 mm; M_A = 3.5 - 4.5 Nm (2.6 - 3.3 lbft)
L2	-	Steering valve
H6	-	Control block
H17	-	Steering and working hydraulics

□

Steering cylinder (L1)

2800934

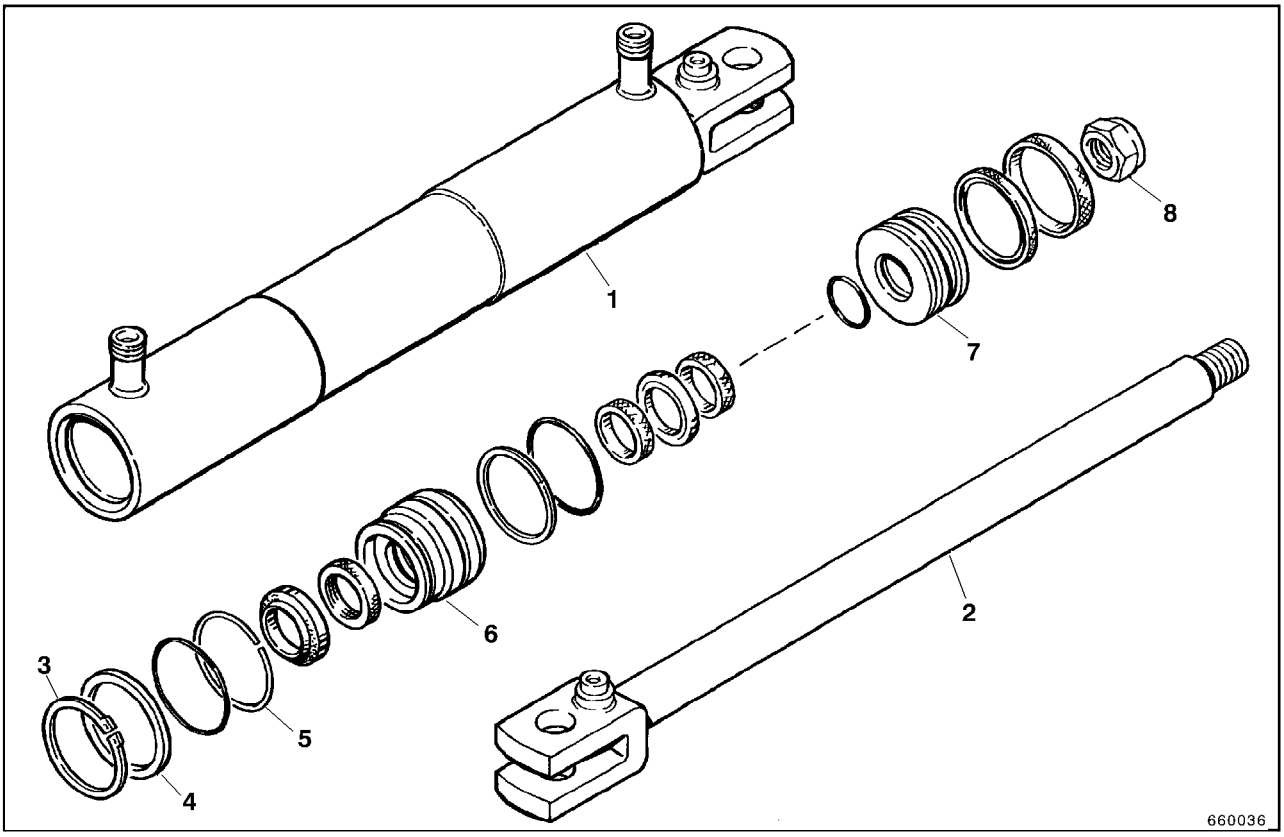

Fig. 6

Positions Fig. 6

1 - Cylinder tube
2 - Piston rod Ø 28 mm (1.10 inch)
3 - Locking ring
4 - Supporting ring
5 - Locking ring
6 - Guide bush
7 - Piston Ø 60 mm (2.36 inch)
8 - Hexagon nut

Mounting information

Stroke: 310 mm (12.20 inch)
Fluid connections: L12W DIN 3 653
Connection thread: M 18 x 1,5 □

Steering valve (L2)

2800935

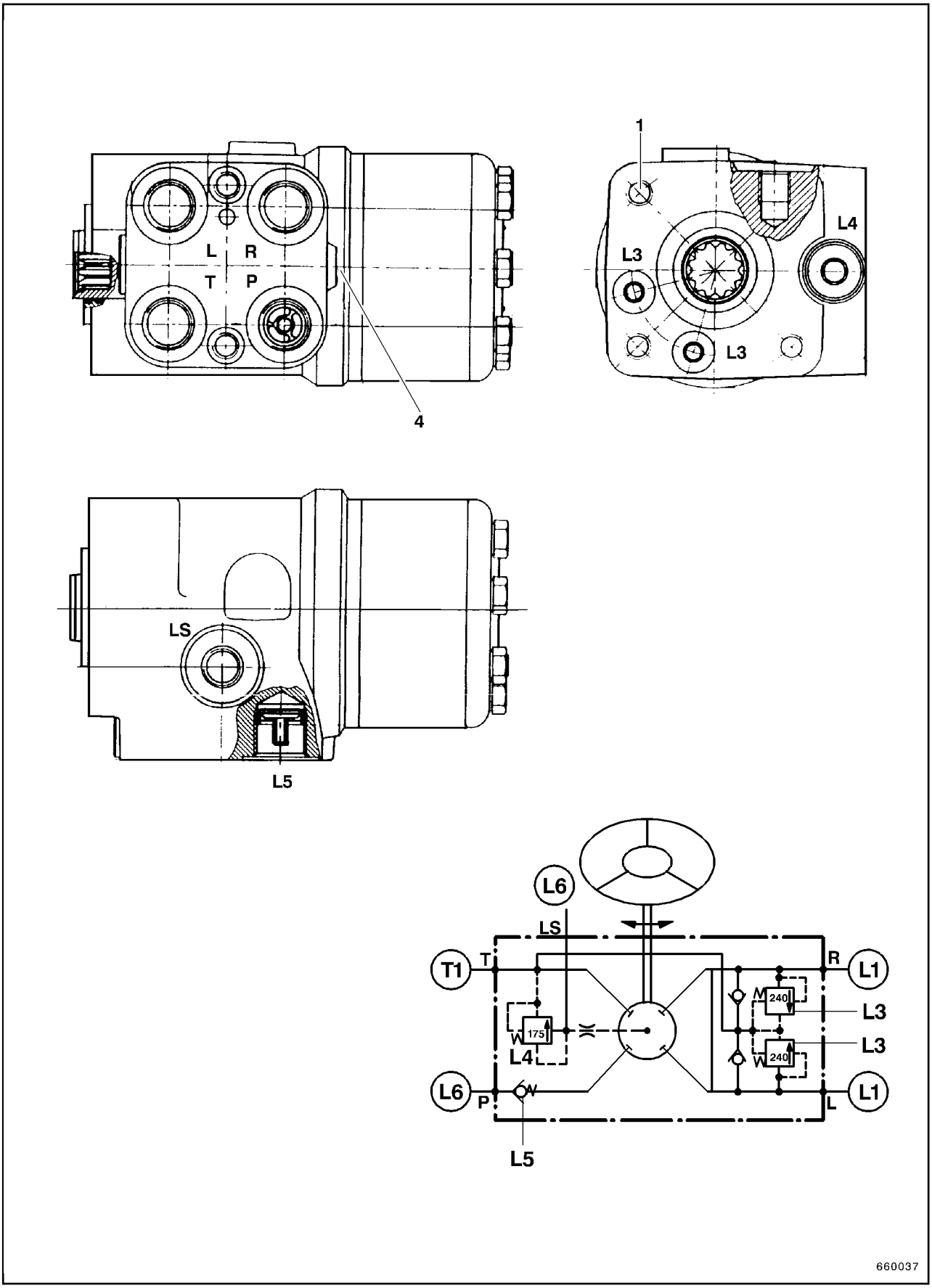

Fig. 7

Steering valve (L2)

Positions Fig. 7

1 - Inside thread M 10 x 1,5
2 - Bolt
3 - Bolt
4 - Date of manufacture Week/Year
5 - Washer
6 - O-Ring
7 - O-Ring
8 - Oil seal
9 - Wheel assembly
10 - Cover
11 - Washer
12 - Shaft
13 - Pin
14 - Ring
15 - Washer
16 - Plug
17 - Ball
18 - Pin
19 - Ball
22 - Pin
23 - Cover
24 - O-Ring
25 - Ring
26 - Set of springs

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve
L4 - Primary valve
L5 - Check valve
L6 - Priority valve

T1 - Tank

Steering valve (L2)

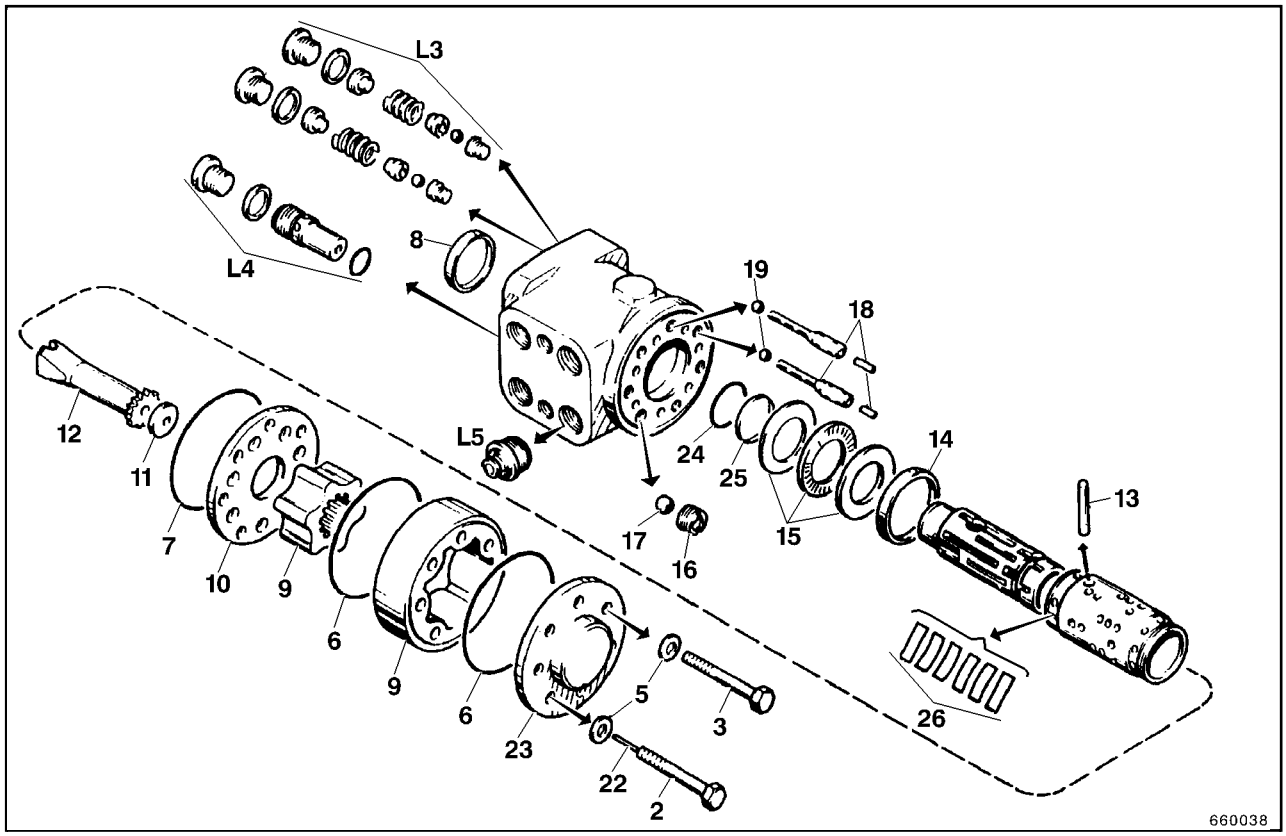

Fig. 8

Steering valve (L2)

Positions Fig. 8

1 - Inside thread M 10 x 1,5
2 - Bolt
3 - Bolt
4 - Date of manufacture Week/Year
5 - Washer
6 - O-Ring
7 - O-Ring
8 - Oil seal
9 - Wheel assembly
10 - Cover
11 - Washer
12 - Shaft
13 - Pin
14 - Ring
15 - Washer
16 - Plug
17 - Ball
18 - Pin
19 - Ball
22 - Pin
23 - Cover
24 - O-Ring
25 - Ring
26 - Set of springs

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve
L4 - Primary valve
L5 - Check valve
L6 - Priority valve

T1 - Tank

□

Installing the steering system

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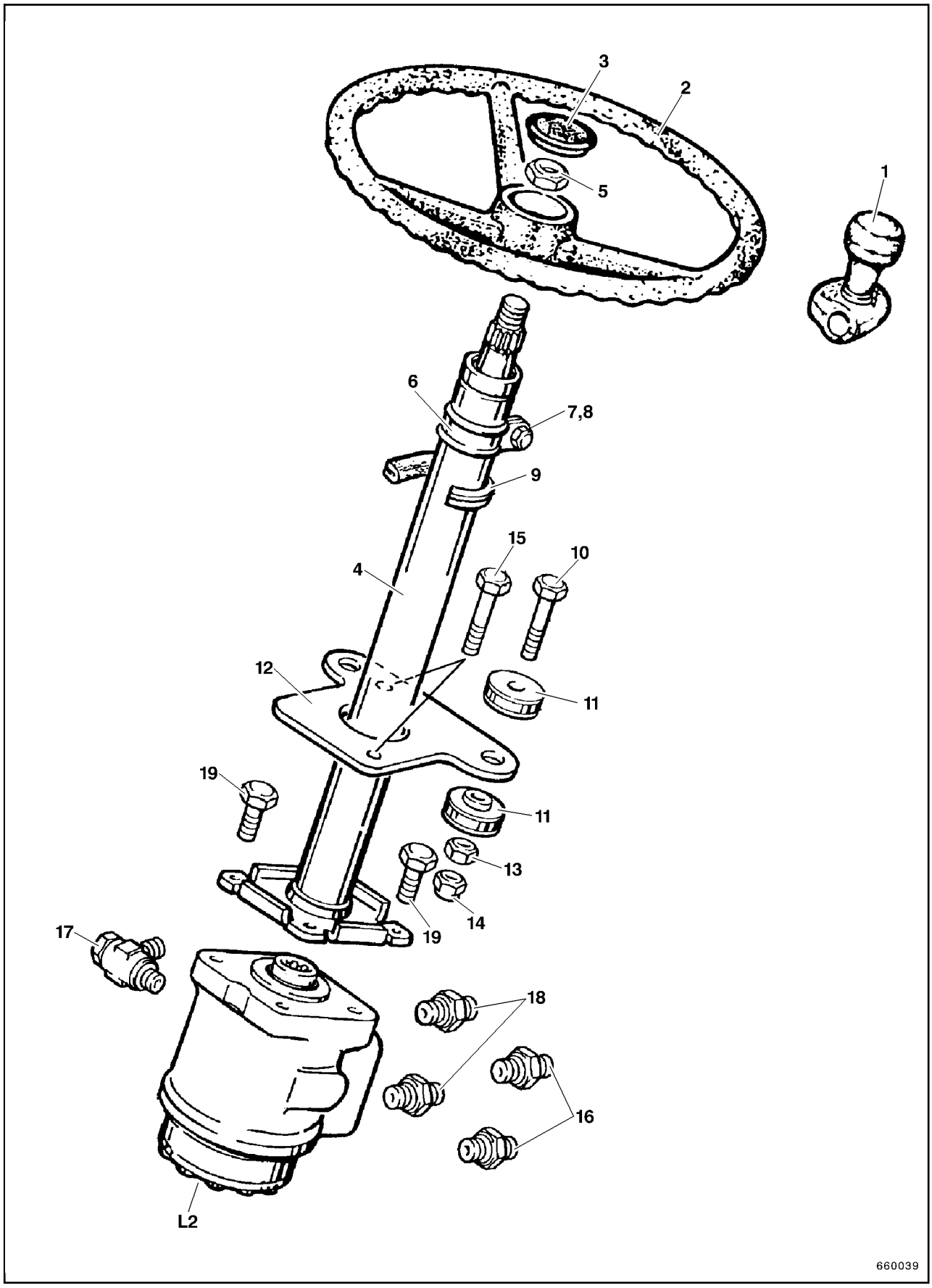

Fig. 9

Installing the steering system

Parts Fig. 9

1 - Handle
2 - Steering wheel
3 - Cover
4 - Steering column
5 - Hexagon nut; M_A = 40 Nm (29.5 lbft)
6 - Clip
7 - Hexagon nut M 6 x 25
8 - Lock nut M 6
9 - Edge protector
10 - Hexagon nut M 10 x 35 DIN 933
11 - Damper, slightly prestressed with Pos. 13 and locked with Pos. 14
12 - Plate
13 - Hexagon nut M 8 DIN 934
14 - Lock nut M 8 DIN 6925
15 - Hexagon bolt M 10 x 35 DIN 933; M_A = 40 Nm (29.5 lbft)
16 - Screw joint; M_A = 100 Nm (74 lbft)
17 - Rotatable screw joint; M_A = 40 Nm (29.5 lbft)
18 - Screw joint; M_A = 100 Nm (74 lbft)
19 - Hexagon bolt M 10 x 16 DIN 933; M_A = 40 Nm (29.5 lbft)

□

Testing and adjusting the steering system

2800937

- Primary pressure

  A pressure gauge must be connected to the measuring point (P_H). If the steering wheel is put to full lock, the pressure gauge reads the maximum value (approx. 175 bars / 2540 psi).

  If the primary pressure in the steering system is not reached, the condition of the pump must first be checked by measuring the primary pressure in the working hydraulics (see section "Working hydraulics"). If this pressure is attained, the primary valve (L4) of the steering system is probably defective.

- Secondary pressure

  Measuring the secondary pressure is a more complicated step. Steering cylinders that give way when the machine with the articulated joint in a collapsed state is being driven into a pile, indicate a defective secondary valve.

  Note:
  To check the secondary valves without removing them, a measuring point with a pressure gauge must be connected to the line, which leads to the steering cylinders. By turning the steering wheel against the limit stop, the maximum primary pressure can be generated.

  Higher pressure might be attained by driving into a pile while the articulated joint is in a collapsed state and without actuating the steering system.

  Nevertheless the secondary pressure of 240 bars (3480 psi) cannot be reached in this way. To measure the exact secondary pressure, an additional T-piece can be installed into the lines of the steering cylinders. Pressure can then be carefully introduced from outside, while the steering sytem is not actuated.

  The maximum pressure which can be attained, is the secondary pressure of the steering system.

Repairs

All repairs on the steering system which go further than checking the primary pressure must be carried out with great care.
Repairs on the steering valve must be performed by trained personnel only. □

Notes

2800145

07 BRAKES

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Safety instructions

⚠ DANGER

Personnel

Never do repair work on brakes unless you are qualified to work on brake systems.

Securing the machine

Never do repair work on brakes unless the machine is secured as described in the section "Securing the machine".

Block the articulated joint when carrying out work on the brake system.

Health protection

Always store hydraulic oil in the original containers.

Swallowing hydraulic oil is a severe health hazard.

If hydraulic oil is swallowed, induce vomiting immediately and go straight to a hospital.

Always keep hydraulic oil away from the eyes. If the eyes are splashed, rinse immediately with plenty of clear water and consult an ophthalmologist.

Never let hydraulic oil come into contact with the skin; wear rubber gloves.

If contact with the skin cannot be avoided, protect the skin with a barrier cream.

Contact with the skin must be as brief as possible. Afterwards, wash your hands thoroughly with soap and water. Then apply a barrier cream.

⚠ WARNING

Disposal

Never let hydraulic oil penetrate into the soil; it contaminates the ground water.

Catch any emerging hydraulic oil and dispose of it separately from other waste in the interests of environmental protection. Never mix with used oil.

Dispose of cloths saturated with hydraulic oil and removed parts separately from other waste in the interests of environmental protection

□

Explanations of circuit diagrams and illustrations

2800487

All circuit diagrams and illustrations in this Workshop Manual form one coherent system.

Each component has its own unique part number. In some cases a letter indicating the use is assigned to the digit for improved clarity.

Meanings:

A =	transmission drive,	z. B. **A7** =	servo-valve
B =	braking system,	z. B. **B1** =	brake fluid pump
L =	steering system,	z. B. **L1** =	steering cylinder
H =	working hydraulics,	z. B. **H8** =	primary valve
T =	tank, filter, cooling system	z. B. **T1** =	hydraulic tank

Part numbers without letters designate general components, e.g. Part **1** = diesel engine.

Encircled parts, e.g. ②, designate connections. They indicate the destination or the origin of the connection lines. Example ② indicates that the connection designated in this way is connected with the dual pump.

Measuring connections are specified with rectangular boxes.

X1 designates, for example, the measuring point for control pressure. □

Braking system, circuit diagram

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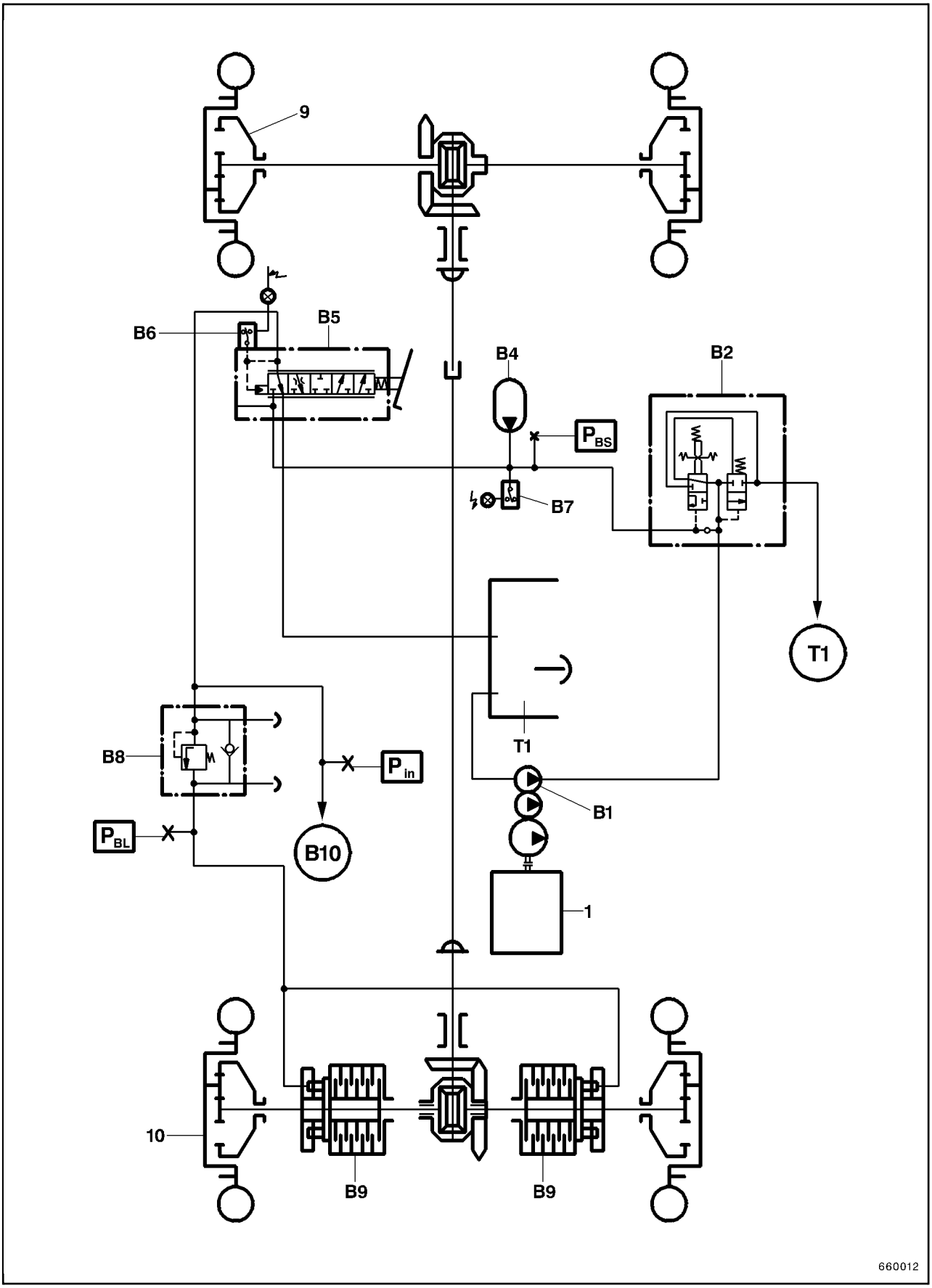

Fig. 1

Braking system, legend

1 - Diesel engine
2 - Triple pump, steering system / working hydraulics / braking system / fan drive
9 - Front axle
10 - Rear axle

T1 - Hydraulic tank
T2 - Hydraulic oil cooler
T3 - Hydraulic oil return-flow filter with by-pass
T4 - Check valve
T5 - Distributor

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve, steering system
L4 - Primary valve, steering system
L5 - Check valve
L6 - Priority valve

H1 - Lifting cylinder
H2 - Dumping cylinder
H3 - Quick-change locking cylinder
H4 - Hydraulic cylinder, 3rd function
H5 - Quick-change locking mechanism (multiway cock)
H6 - Control block, working hydraulics
H7 - Secondary valve "Rearward tilting" with replenishing valve
H8 - Secondary valve "Dumping" with replenishing valve
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve "Lifting/lowering"
H12 - Pressure-maintaining valve "Tilting"
H13 - Pressure-maintaining valve "3rd function"
H14 - Control piston "Lifting-lowering-floating" position
H15 - Control piston "Rearward tilting dumping"
H16 - Control piston "3rd function"
H17 - Hydraulic pump, steering and working hydraulics

B1 - Brake fluid pump
B2 - Accumulator charging valve
B5 - Pedal operated brake valve
B6 - Pressure switch, braking light
B7 - Pressure switch, accumulator warning
B8 - Sequence valve
B9 - Multiple-disc brake
B10 - Inching valve

A1 - Feed circuit filter
A2 - Feed pump
A3 - Variable displacement axial-piston pump A4VG-Da
A4 - High-pressure relief valves, deblockable
A5 - Replenishing valves
A6 - Soiling indicator, feed circuit filter
A7 - Servo-valve
A8 - Pressure cutout
A9 - Feed pressure relief valve
A10 - Restrictor
A11 - Electromagnetically activated switchover valve for forward and reverse travel
A12 - Scavenging needle
A13 - Adjusting cylinder forward/reverse/neutral
A14 - Bypass valve (feed circuit filter)
A15 - Axial-piston oil motor A6VM - HA 1U
A16 - Check valve
A17 - Electromagnetically activated switchover valve for slow travel (high displacement)
A18 - Adjusting cylinder for displacement change
A19 - Feed circuit filter

Pressure measuring points

P_H - Pump pressure for working and steering hydraulics

P_{SP} - Feed pressure

P_{HD} - High pressure at travelling

P_{HD*} - High pressure at travelling (at travel motor)

P_{BS} - Accumulator pressure

P_{in} - Actual braking pressure

P_{BL} - Braking pressure (for the multiple-disc brakes)

X_1 - Control pressure

X_2 - Control pressure

G - Regulation threshold (travel motor) □

Functional description of the braking system

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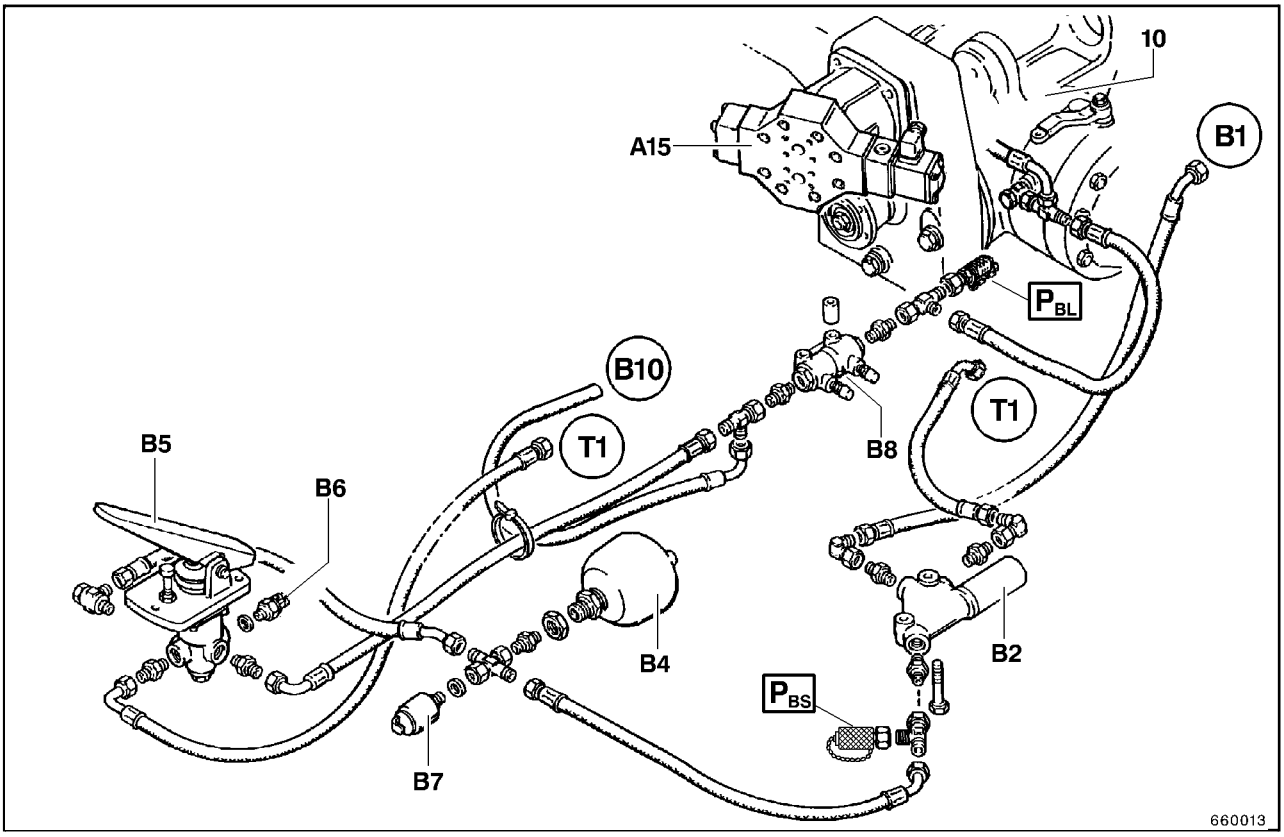

Fig. 2

Service brake (pump-storage brake)

The brake fluid pump (B1, Fig. 2) pumps brake fluid to the accumulator charging valve (B2).

When the pressure in the accumulator (B4) drops below 120 bars (1740 psi), the accumulator charging valve (B2) switches on the accumulator charging system.

At an accumulator pressure of 150 bars (2180 psi), the accumulator charging system is switched off and the fluid from the braking fluid pump flows back via the hydraulic motor housing to the hydraulic tank (T1).

If the accumulator pressure drops below 98 bars (1420 psi), the warning switch (B7) switches on the central warning lamp and the acoustic warning (buzzer) in the driver's cab.

When the pedal-type brake valve (B5) is activated, the pressure in the accumulator (B4) is directed into the brake line to the connecting valve (B8). The braking pressure is limited to max. 60 bars (870 psi) by the pedal-type brake valve (B5).

When a braking pressure above 3.5 bars (50 psi) is reached, the braking light switch (B6) responds.

If the reached braking pressure is less than 14 bars (200 psi), the braking pressure is **not** transmitted to the multiple disc brakes (B9) in the rear axle (10). Instead, the pressure is directed onto the inching valve (B10) and therefore activates only the auxiliary brake.

It is only when a higher pressure than the connecting pressure (14^{-3} bars / 200^{-40} psi) is reached that it can pass the connecting valve (B8) and then activates the multiple disc brakes (B9). The reached braking pressure minus the connecting pressure is now applied to the multiple-disc brakes.

The braking action is also transmitted to the front axle via the cardan shafts. If the pedal-type brake valve (B5) is now released, the pressure can now be released into the hydraulic tank (T1).

Auxiliary brake

If a pressure of less than 14 bars (200 psi) is reached with the pedal-type brake valve (B5), the braking pressure is transmitted only to the inching valve (B10), as the connecting valve (B8) transmits only the pressure in excess of 14 bars (200 psi) to the multiple-disc brakes (B9).

Depending on the level of the pressure reached, the inching valve (B10) opens a larger or smaller throttling channel which connects the control pressure of the driving pump (cf. Transmission Drive section) with the hydraulic tank (T1).

This results in the driving pump swivelling towards minimum pumping as a result of the brake being applied and the driving motion thus being reduced, i.e. the machine is braked.

One great advantage of this inching is that most of the engine output can be supplied to the operating hydraulics once the driving pump has swivelled back.

The functioning of the inching valve is shown in the hydraulic diagram Driving Operation.

Parking brake

The parking brake acts by cable control on the multiple disc brakes of the rear axle. The layout of the individual components is shown in Fig. 11.

Note that the drive is switched off by the handbrake switch (Fig. 3) when the handbrake lever is pulled.

a = position at rest max. 20,0 mm (0.8 inch)
b = switching point 13,3 ± 2,0 mm (0.52 ± 0.08 inch)

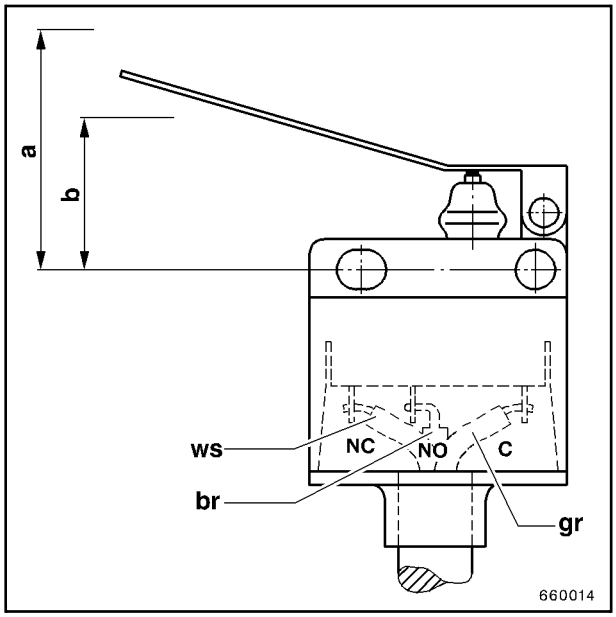

Fig. 3

Important:

The handbrake switch is located below the handbrake lever (1, Fig. 11).

- To check the lining thickness, see Multiple-disc Brakes.
- To replace the brake linings, see section on Axles. □

Accumulator charging valve (B2)

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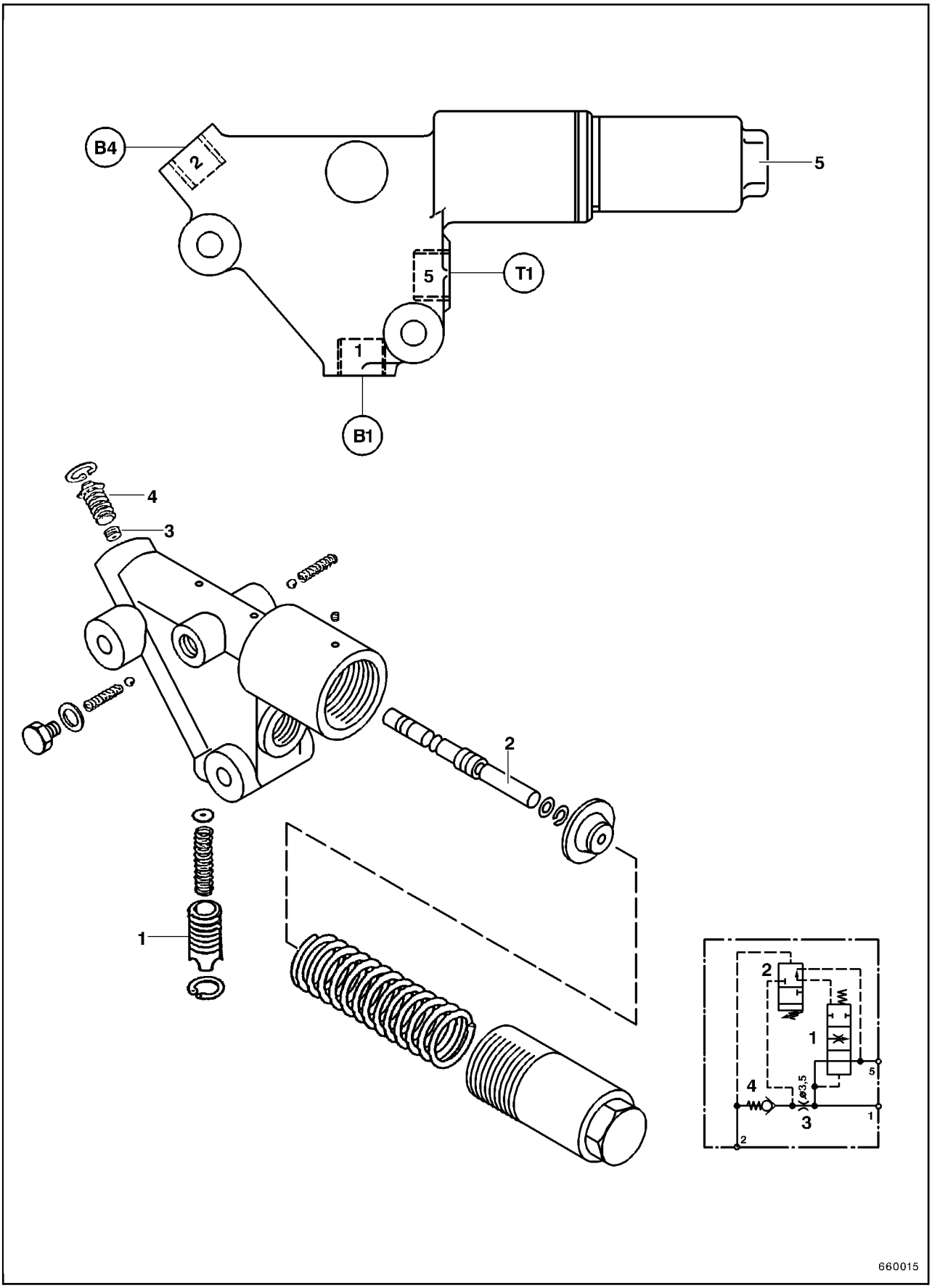

Fig. 4

Testing and adjusting the service brake

For all testing and adjusting operations on the braking system, the temperature of the hydraulic oil must be ca. 65˚C (150˚F).

Accumulator charging valve (B2)

When the engine is running, an accumulator pressure (cutout pressure) of 140 to 150 bars (2000 - 2180 psi) builds up. This pressure can be measured at measuring point (P_{BS}.

The accumulator is then lowered by repeated application of the service brake. When the pressure gauge (B3) indicates avalue of 120 - 130 bars (1740 - 1885 psi), accumulator recharching sets in and the accumulator is charged again until the the cutoff threshold is reached.

If connecting and cutout pressure are not correct, the cutout pressure can be set at the setscrew (B2.5) of the accumulator charging valve. The connecting pressure is then set automatically.

Connecting pressure: 120^{+10} bars (1740^{+145} psi)
Cutout pressure: 150_{-10} bars (2180_{-145} psi)

Parts Fig. 4

1 - Braking/flushing changeover piston
2 - Cutout piston
3 - Throttle
4 - Check valve
5 - Setting cutout pressure

T1 - M 16 x 1,5 / 40^{+5} Nm (29.5^{+3} lbft)
B1 - M 18 x 1,5 / 50^{+5} Nm (37^{+3} lbft)
B4 - M 16 x 1,5 / 40^{+5} Nm (29.5^{+3} lbft)

Accumulator (B4), Technical data

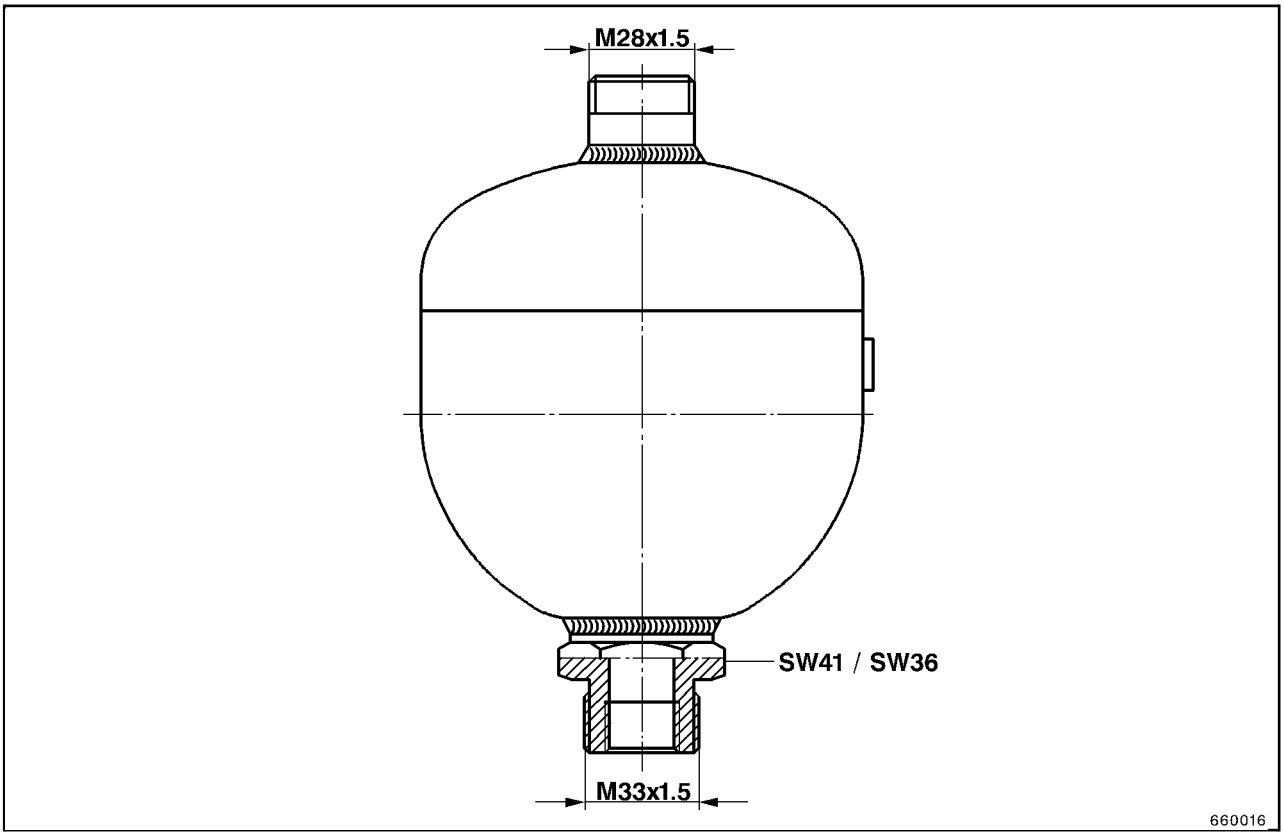

Fig. 5

Capacity:	0.75 l (0.2 gal)
Admissible operating pressure:	210 bars (3050 psi)
Filled gas:	Nitrogen
Filled-gas pressure:	50 bars (725 psi)
Weight:	2.8 kg (6.2 lb)

Accumulator (B4)

The accumulator (B4, Fig. 5) has a preliminary pressure of 50 bars (725 psi). To check the preliminary pressure, the diesel engine (1) is switched off and the accumulator emptied by operating the brake pedal.

The last pressure value indicated by the built-in pressure gauge (B3) before the accumulator pressure fails is the preliminary pressure of the accumulator.

If the preliminary pressure is too low, the accumulator can be brought to the correct pressure with an appropriate filling device. Older accumulators and those losing their pressure within a short time of being filled must be replaced.

Important:

If the braking system is working correctly, the machine can be braked at least 20 times with the engine stationary and the accumulator filled before the accumulator pressure fails. □

Accumulators, safety instructions

2800629

DANGER

Accumulators are installed in the hydraulic system. These accumulators contain nitrogen under high initial pressure.

Even when the hydraulic pressure in the system is reduced, the nitrogen remains in the accumulator.

The accumulators are completely safe in operation. If incorrectly handled, however, there is a risk of explosion.

So:

- **Never handle accumulator mechanically, never weld or solder it.**
- **Testing and servicing work must be carried out by experts only.**
- **Prior to any testing and servicing work, depressurize the hydraulic part of the system.**
- **To dismantle the accumulator, always wear goggles and working gloves.**
- **Fill accumulator with nitrogen only, never with compressed air or oxygen.**
- **Report any defects or damage to the machine owner without delay.**
- **Prior to recommissioning, an inspection by a specialist or expert is essential if the accumulator was damaged or if the admissible operating temperature or operating pressure was exceeded.**

Never remove or paint over warning and information plates, rating plates or type identification markings. Replace illegible or damaged plates immediately.

□

Pedal-type brake valve (B5)

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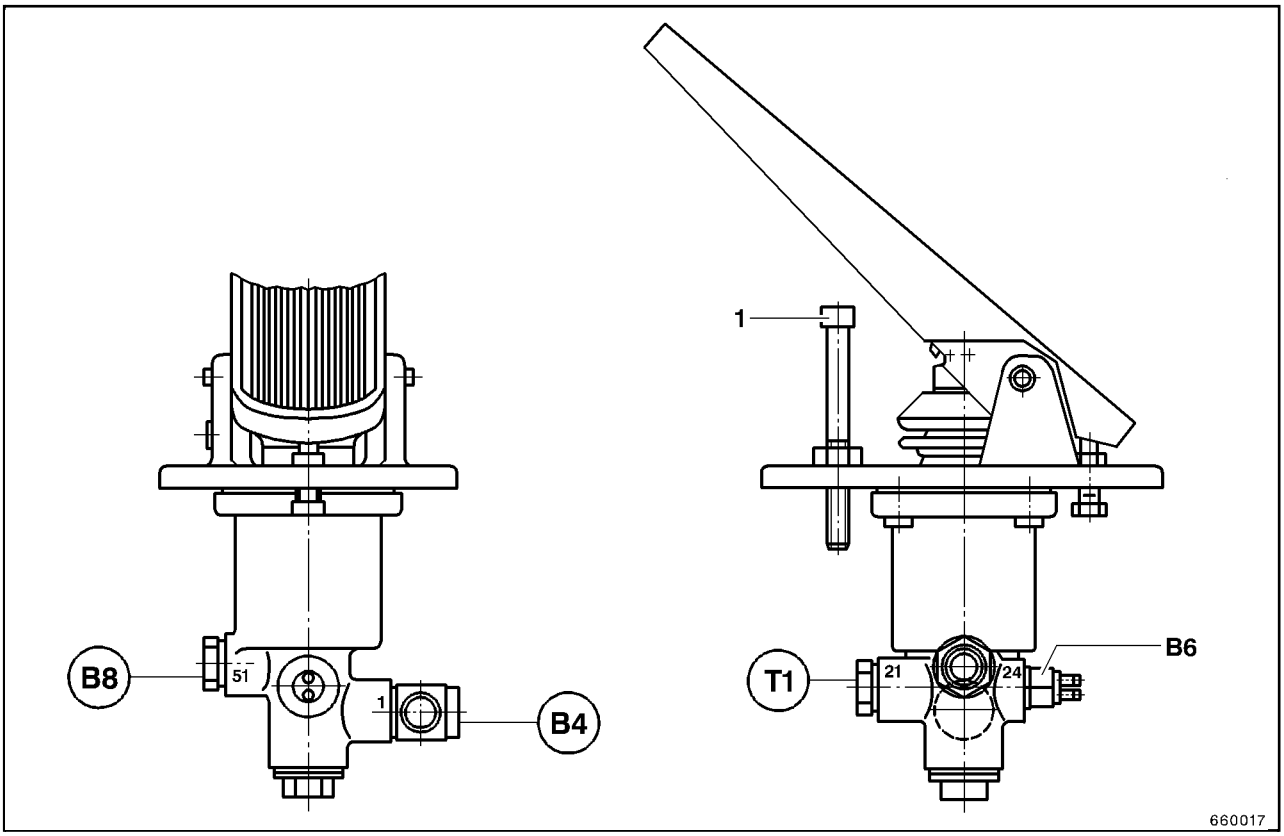

Fig. 6

To check the braking pressure, a pressure gauge must be connected at the measuring point (P_{in}). Depressing the brake pedal muct cause the indicated pressure to rise in proportion to pedal travel until a maximum of 60 bars (870 psi) is reached.

When testing the braking pressure, press the pedal down slowly, keeping an eye on the connected pressure gauge.

Important:

If the pedal type brake valve (Fig. 6) is incorrectly set, a 60-bar (870 psi) pressure gauge may be damaged by pressing the pedal down too far.

The maximum braking pressure is set at the stop screw of the pedal-type brake valve (B5, Part 1).

Parts Fig. 6

1 - Setscrew for braking pressure (set braking pressure = 60 bars / 870 psi)
B6 - Braking light switch

Connection designations on housing

1 - Power intake
21 - Service brake
24 - Braking light control
51 - Return flow connection

Connecting valve (B8)

Preliminary pressure 14_{-3} bars (200_{-40} psi)

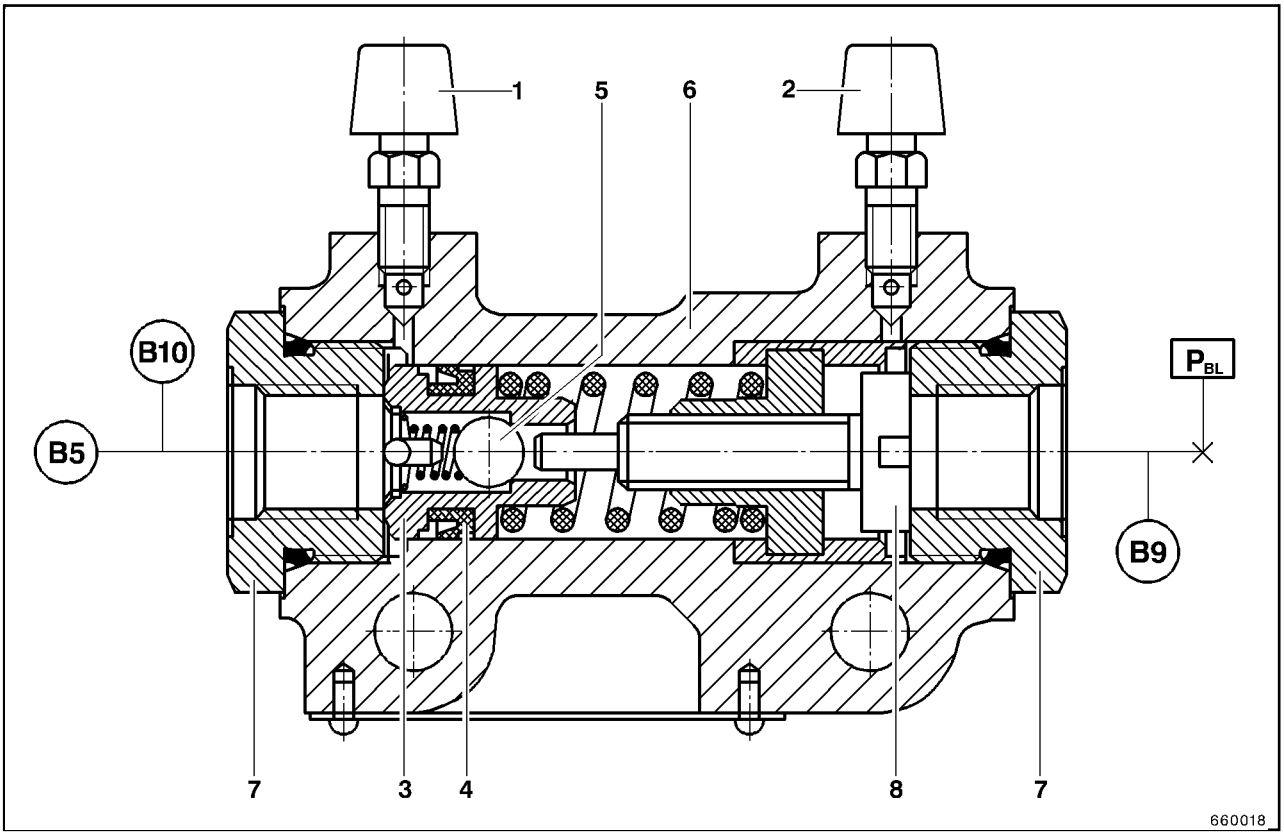

Fig. 7

To check that the connecting valve (B8, Fig. 7) is working properly, a further pressure gauge must be connected to the measuring connection (P_{BL}) in addition to the pressure gauge at the measuring connection (P_{in}).

On actuation of the brake pedal, no reaction must be recorded at the pressure gauge (P_{BL}) until the preliminary pressure of 14_{-3} bars (200_{-40} psi) is exceeded on the pressure gauge (P_{in}).

The maximum pressure attainable on the pressure gauge (P_{BL}) is calculated from the maximum braking pressure set at the pedal-type brake valve minus the actual value of the preliminary pressure at the connecting valve.

If the preliminary pressure is not correct, it can be re-adjusted with set screw (B8, Part 8). In case of valve replacement, the flow direction of the valve must be observed and the brake be bleed after installing the new component (see section on bleeding the braking system).

To correct the adjusted pressure proceed as follows:

- Remove the connection at the multiple-disk brake (B9) including measuring point and threaded connection piece.
- Adjust the setscrew (B8, Pos. 8) with a big screwdriver through the opening in the threaded conntion piece (B8, Pos.7)
  - turned clockwise = preliminary pressure lower
  - turned counter-clockwise = preliminary pressure higher
- Refit threaded connection piece, measuring point and hose and bleed brake system
- Check the preliminary pressure repeating the adjusting procedure if necessary.

Parts Fig. 7

1 - Vent, intake side
2 - Vent, discharge side
3 - Valve piston
4 - Gasket
5 - Ball
6 - Valve housing
7 - Socket
8 - Setscrew for preliminary

Inching valve (B10)

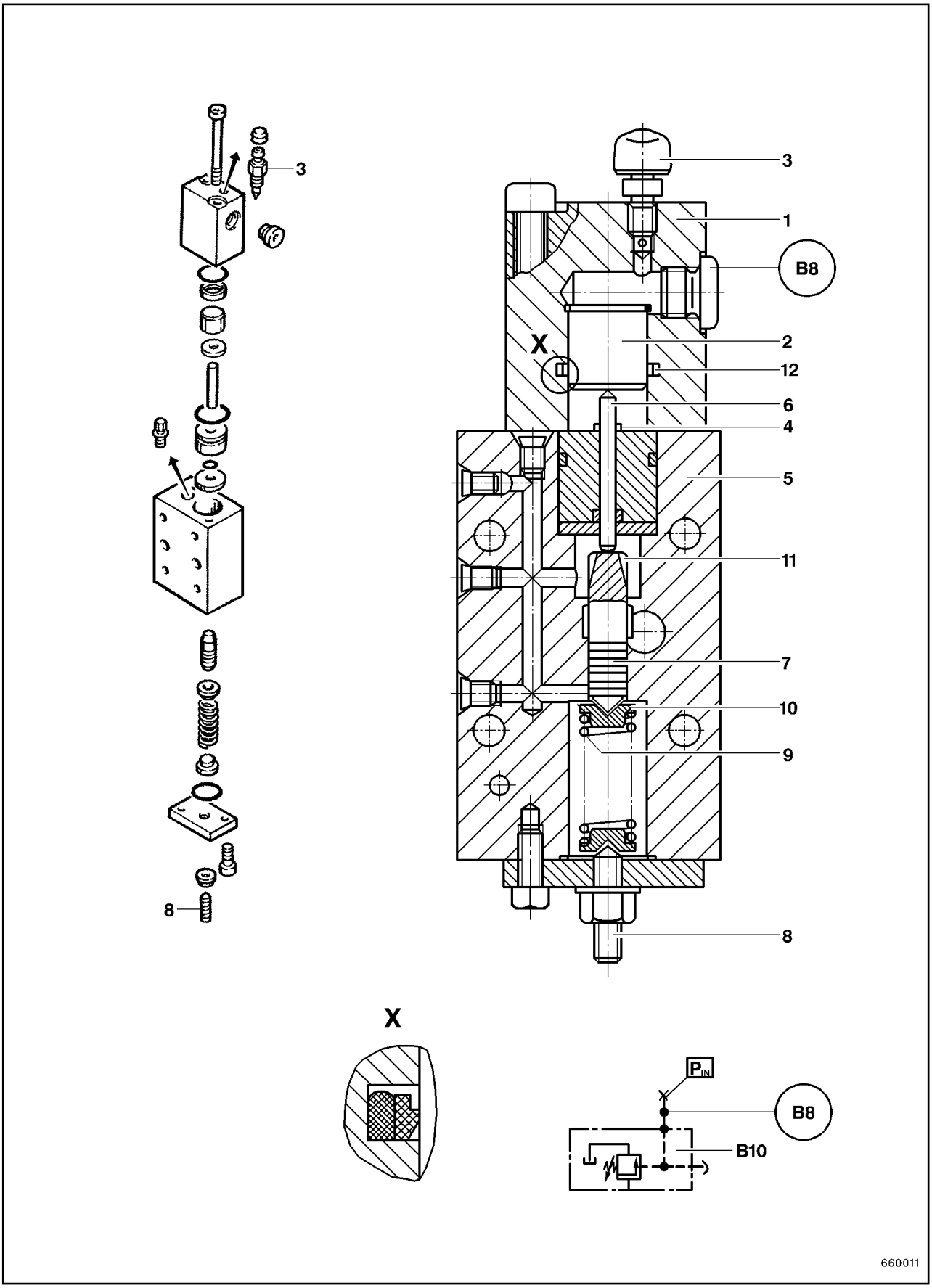

Fig. 8

Inching valve (B10)

Parts Fig. 8

1 - Slave cylinder
2 - Piston
3 - Vent valve
4 - Relief channels
5 - Valve chamber
6 - Tappet
7 - Control piston
8 - Setscrew
9 - Spring
10 - Spring plate
11 - Notch
12 - Gasket
B8 - Connecting valve

P_{in} - Actual braking pressure

For valve setting operations, see Section 04 - Hydraulic Travel Drive, subsection Adjusting Operations on the Travel Drive.

Manometric switches (B6, B7)

The braking light switch (B6) is mounted on the pedal-type brake valve (B5, Fig. 6).

Response pressure = 3.5 bars (51 psi)
Function = normally open contact
Connecting thread = M 12 x 1.5

The warning switch (B7, Fig. 2) for the accumulator pressure responds when the pressure drops below 100 bars (1450 psi)..

Response pressure = 98 bars (1422 psi)
Function = changeover contact
Connecting thread = M 10 x 1, tapered

For function checking, the accumulator is pumped empty by depressing the brake pedal. For monotoring purposes, a pressure gauge is attached to measuring port P_{BS}.

If the accumulator pressure drops below 100 bars (1450 psi), the central warning lamp must start flashing and thr buzzer sounding. Apart from the central warning lamp, no warning lamp lights up on the dashboard. Apart from the central warning lamp, no warning lamp lights up on the dashboard.

Important:

If the braking system is working correctly, the machine can be braked at least five times with the engine stationary and the accumulator filled before the central warning lamp responds. □

Multiple-disk brakes (B9) 2800493

During each rear-axle oil change check also the thickness of the disks in the multiple-disk brake.

- Park the machine as described under "Securing the machine".
- Turn out the screws (10.1, Fig. 9) when the gearbox oil has been removed.
- Apply the parking brake.

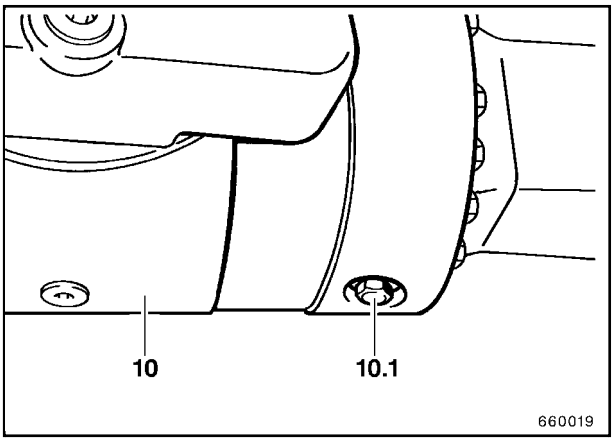

Fig. 9

- Check the brake for wear. The internal disks with friction layer must be replaced when they are worn down to the minimum thickness (S, Fig. 10) of 4.5 mm (0.18 inch).

  Contact the NEW HOLLAND CONSTRUCTION Dealer.

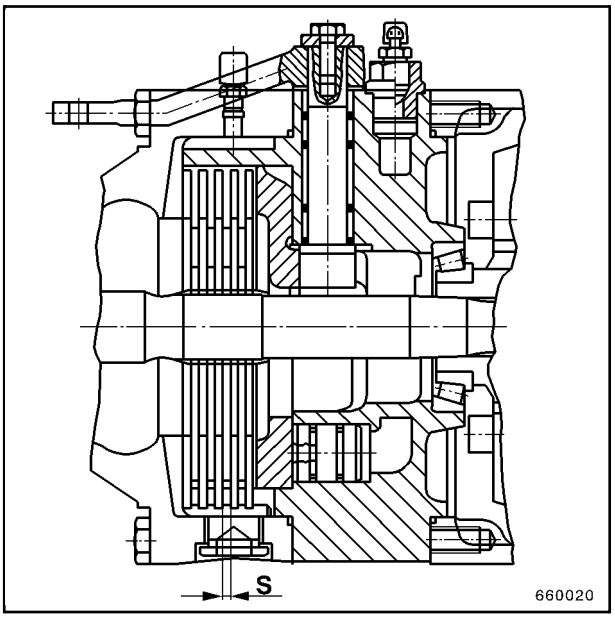

Fig. 10

Testing and adjusting operations on the auxilliary brake

These operations are described in the section Travel drive - Adjusting the inching threshold. □

Testing and adjusting operations on the parking brake

2800494

The parking brake must be set in such a way that it is fully applied after **four notches** of the handbrake lever (1, Fig. 11).

For this purpose it must first be ensured that both levers (2) are correctly mounted on the rear axle and are in reciprocally mirrored position both in released position and at the pressure points.

If this is not the case, the position of the levers (2) can be corrected after slackening the screws (3).

The length of the handbrake lever path is determined by shortening or extending the cable length between the levers (2). Corrections of up to one notch on the handbrake lever can also be made on the cable control to the handbrake lever at the setscrews (4) located there.

Major corrections must be made by adjusting the cable length between the levers (2). If adjustments on such a large scale are necessary, the thickness of the brake disc linings must also be checked in all events (see section on Multiple-disc Brakes).

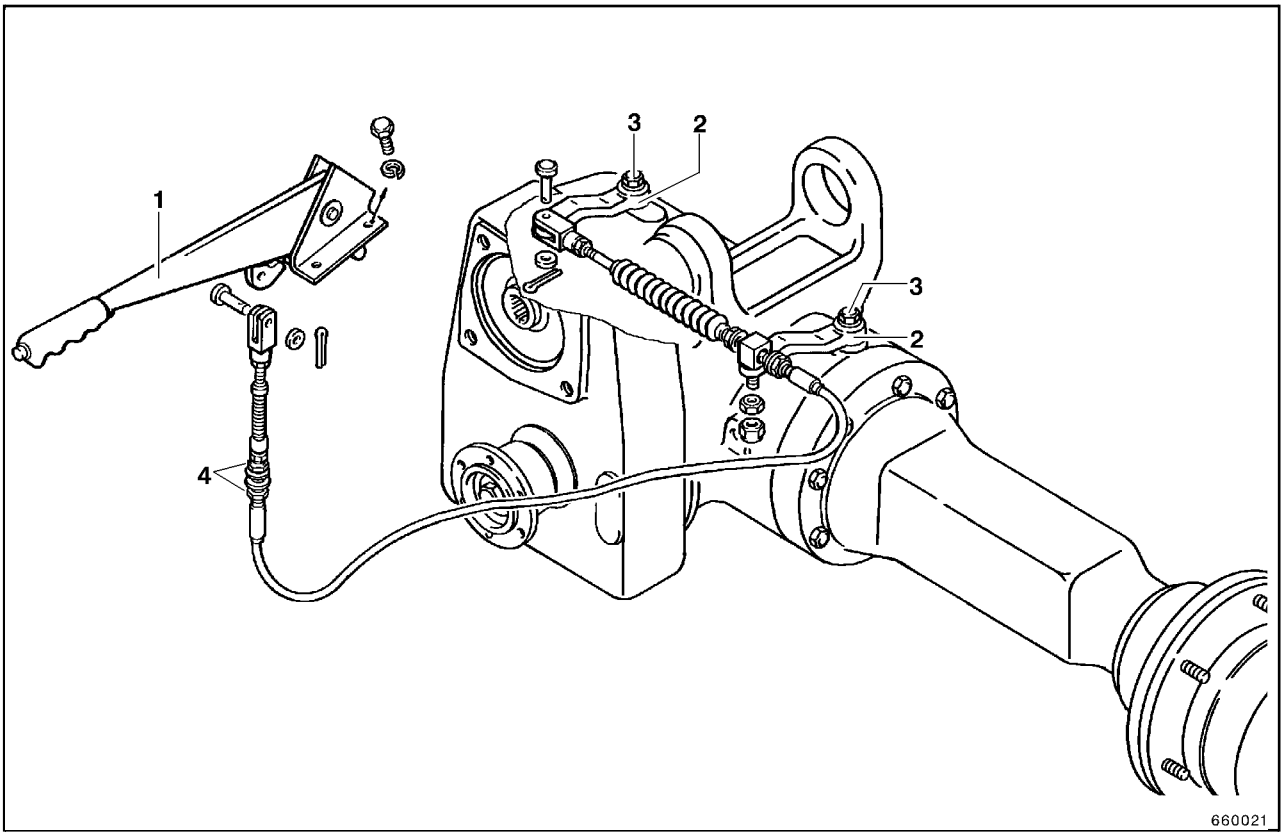

Fig. 11

Bleeding the braking system

2800495

The system must be bled when air has penetrated into the line system. This occurs when brake lines are loosened or parts of the braking system are replaced or dismantled.

Two persons are needed to bleed the braking system.

Bleeding must be done in the following sequence:

- Right vent valve (B9, Part 1, Fig. 12) at rear axle.

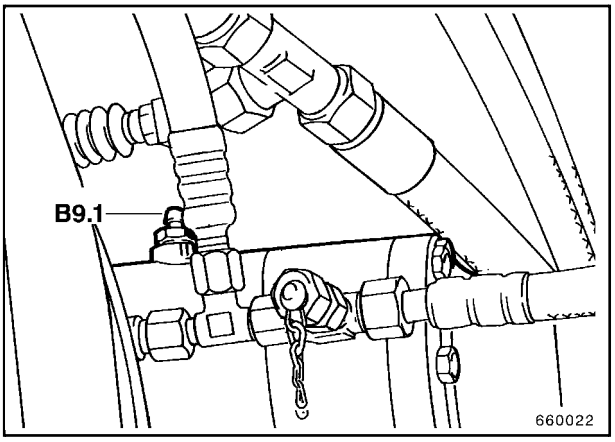

Fig. 12

- Left vent valve (B9, Part 2) at rear axle.
- Vent (B8, Part 2, Fig. 13) at connecting valve (on brake side).
- Vent (B8, Part 1) at connecting valve (on pedal side).

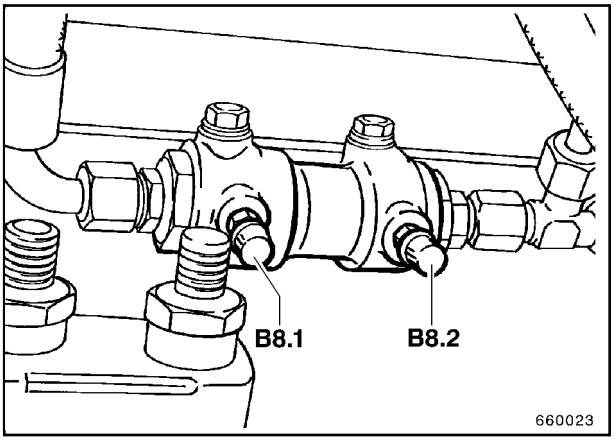

Fig. 13

- Vent (B10, Part 3, Fig. 14) at inching valve.

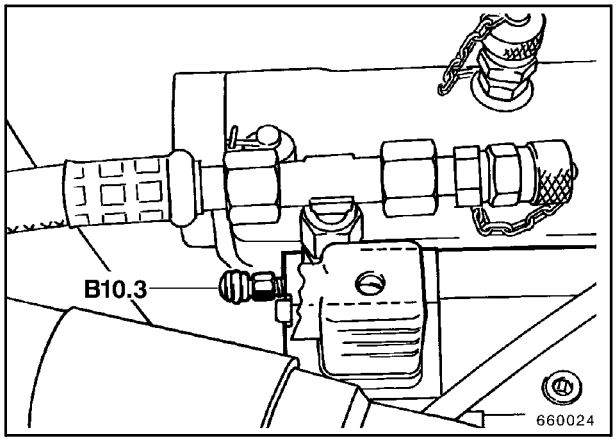

Fig. 14

Bleeding

For bleeding, a hose must be attached to the respective bleeding valve and the other end let into a suitable vessel filled with hydraulic oil (z. B. Fig. 15).

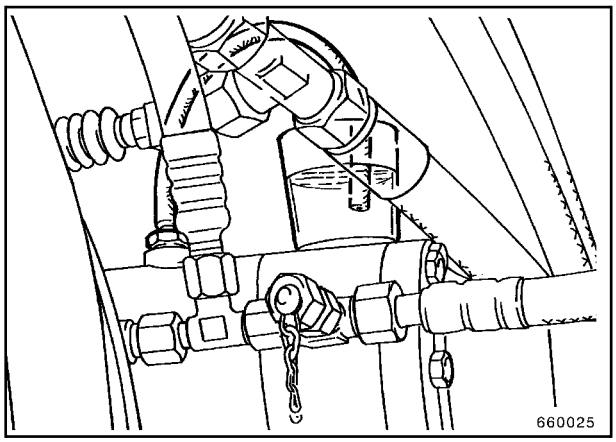

Fig. 15

While the first person now operates the brake pedal and keeps it pressed down with the engine running, the second person opens the vent by ca. 1/2 turn and closes it only when the hydraulic oil emerges bubble-free in the vessel. Only then does the first person release the brake again.

To ensure that all air is definitely removed from the system, this procedure must be carried out at least twice. □

Notes

2800145

08 HYDRAULIC SYSTEM

Hydraulic System, Safety Instructions

2800476

DANGER

Read and observe the operating instruction: "Inspection and Servicing, Safety Instructions".

Before working on the hydraulic system, ensure that the system is depressurized and that any residual pressure is discharged.

Engine off.

Secure the machine as described in the operating instruction: "Securing the machine".

Avoid skin contact with hydraulic oils. Wear gloves and firm working gear. Skin contact with hydraulic oils is a health risk.

□

Explanations of circuit diagrams and illustrations

2800487

All circuit diagrams and illustrations in this Workshop Manual form one coherent system.

Each component has its own unique part number. In some cases a letter indicating the use is assigned to the digit for improved clarity.

Meanings:

A = transmission drive,	z. B. **A7** =	servo-valve
B = braking system,	z. B. **B1** =	brake fluid pump
L = steering system,	z. B.**L1** =	steering cylinder
H = working hydraulics,	z. B.**H8** =	primary valve
T = tank, filter, cooling system	z. B. **T1** =	hydraulic tank

Part numbers without letters designate general components, e.g. Part **1** = diesel engine.

Encircled parts, e.g. (2), designate connections. They indicate the destination or the origin of the connection lines. Example (2) indicates that the connection designated in this way is connected with the dual pump.

Measuring connections are specified with rectangular boxes.

X1 designates, for example, the measuring point for control pressure. □

Depressurizing the hydraulic system

2800488

Before starting work, depressurize the hydraulic system:

- Secure the machine as described under "Securing the machine".
- Move control lever for operating equipment and 3rd function in all directions until the operating equipment makes no further movement.

The residual pressure in the operating equipment is then discharged. □

Hydraulic circuit diagram - working hydraulics

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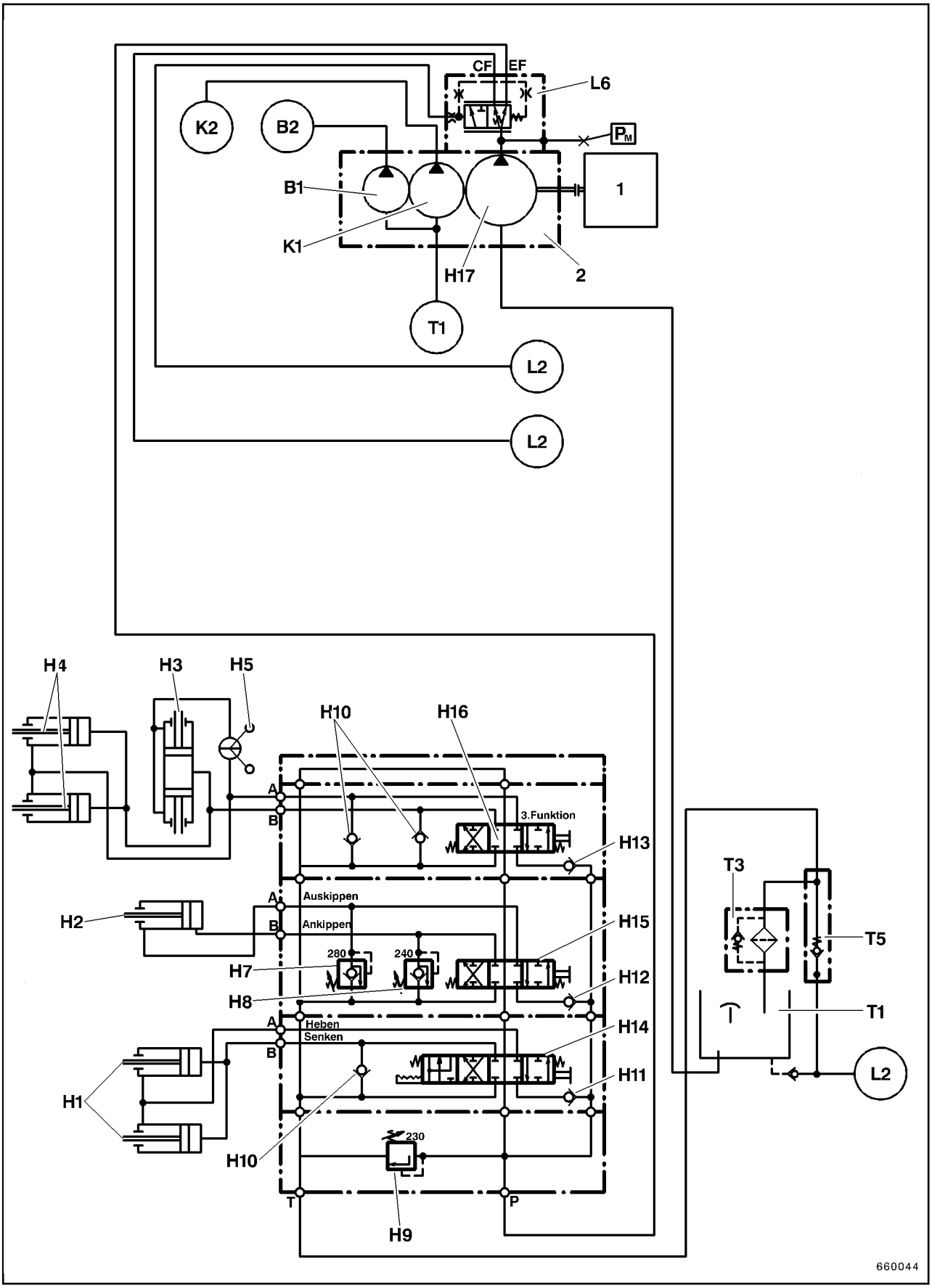

Fig. 1

Hydraulic circuit diagram, legend

1 - Diesel engine
2 - Triple pump, steering system / working hydraulics / braking system / Fan drive
9 - Front axle
10 - Rear axle

T1 - Hydraulic tank
T2 - Hydraulic oil cooler
T3 - Hydraulic oil return-flow filter with bypass
T4 - Check valve
T5 - Distributor

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve, steering system
L4 - Primary valve, steering system
L5 - Check valve
L6 - Priority valve

H1 - Lifting cylinder
H2 - Dumping cylinder
H3 - Quick-change locking cylinder
H4 - Hydraulic cylinder, 3rd function
H5 - Quick-change locking mechanism (multiway cock)
H6 - Control block, working hydraulics
H7 - Secondary valve "Rearward tilting" with replenishing valve
H8 - Secondary valve "Dumping" with replenishing valve
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve "Lifting/lowering"
H12 - Pressure-maintaining valve "Tilting"
H13 - Pressure-maintaining valve "3rd function "
H14 - Control piston "Lifting-lowering-floating" position
H15 - Control piston "Rearward tilting" dumping
H16 - Control piston "3rd function"
H17 - Hydraulic pump, steering and working hydraulics

B1 - Brake fluid pump
B2 - Accumulator charging valve
B4 - Brake accumulator
B5 - Pedal operated brake valve
B6 - Pressure switch, braking light
B7 - Pressure switch, accumulator warning
B8 - Sequence valve
B9 - Multiple-disc brake
B10 - Inching valve

K1 - Fan pump
K2 - Fan motor
K3 - Replenishing valve

A1 - Feed circuit filter
A2 - Feed pump
A3 - Variable displacement axial-piston pump A4VG-Da
A4 - High-pressure relief valves, deblockable
A5 - Replenishing valves
A6 - Soiling indicator, feed circuit filter
A7 - Servo-valve
A8 - Pressure cutout
A9 - Feed pressure relief valve
A10 - Restrictor
A11 - Electromagnetically activated switchover valve for forward and reverse travel
A12 - Scavenging needle
A13 - Adjusting cylinder forward/reverse/neutral
A14 - Bypass valve (feed circuit filter)
A15 - Axial-piston oil motor A6VM - HA 1U
A16 - Check valve
A17 - Electromagnetically activated switchover valve for slow travel (high displacement)
A18 - Adjusting cylinder for displacement change
A19 - Feed circuit filter

Pressure measuring points

P_H - Pump pressure for working and steering hydraulics

P_{SP} - Feed pressure

P_{HD} - High pressure at travelling

P_{HD*} - High pressure at travelling (at travel motor)

P_{BS} - Accumulator pressure

P_{in} - Actual braking pressure

P_{BL} - Braking pressure (for the multiple-disc brakes)

X_1 - Control pressure

X_2 - Control pressure

G - Regulation threshold (travel motor) □

Functional description, working hydraulics

2800943

The hydraulic oil pumped by the gear pump (H17) is fed to the working hydraulics and the steering system.

The priority valve (L6) gives the steering system oiling priority for safety reasons, so that the steering system is always supplied first when steering system and working hydraulics are activated simultaneously, and in this case only the residual oil goes to the working hydraulics (cf. section on Steering System).

The measuring connection at which the pumping pressure of the gear pump (H17) or the setting of the primary valve (H9) can be controlled is located direct at the priority valve (L6).

From the priority valve (L6) the oil goes into the control block (H6).
The maximum pumping pressure is limited here by the primary valve (H9) to 230 bars (3340 psi).

If no working hydraulics function is activated, the hydraulic oil flows back through the control block (H6) via the return-flow filter (T3) into the tank (T1).

If one of the control pistons (H14, H15, H16) is shifted, the hydraulic oil is directed into the corresponding hydraulic cylinder and the required function is executed.

The control piston (H14) controls the oil for the lifting and lowering function. If the operating lever is pressed beyond the lowering position, the piston engages into floating position.
In floating position, the hydraulic oil is returned unpressurized to the tank and the rod and piston ends of the lifting cylinder (H1) are interconnected via the control channels of the control piston (H14).
In this position, the bucket or the operating equipment is supported with its own weight on the ground.

To ensure that sufficient oil reaches the rod end of the lifting cylinder during rapid lowering movements, hydraulic oil is drawn in from the tank reflow when required by means of the replenishing valve (H10).

The rearward tilting and dumping function is controlled by means of the control rod (H15). To prevent damage due to excessive external forces, the rearward tilting line is secured by the secondary valve (H7) and the dumping line by the secondary valve (H8).

Both secondary valves also operate as replenishing valves and can draw oil from the tank reflow as required.

The control piston (H16) switches the 3rd function (H4) and the quick changer (H3).
When the multiway cock (H5) is opened, the changer cylinder is pressurized with the pressure oil (H3).

When the multiway cock (H5) is closed, the oil is available for the 3rd function and the changer cylinder (H3) is locked.

All three control pistons (H14, H15, H16) have an upstream pump-side check valve (H11, H12, H13) which acts as a pressure-retaining valve to prevent inadvertent movements (stalling of the lifting cylinder or emptying of the bucket).

After passing the control block (H6), the oil flows via the return-flow filter (T3) into the hydraulic tank (T1). □

Control block (H6)

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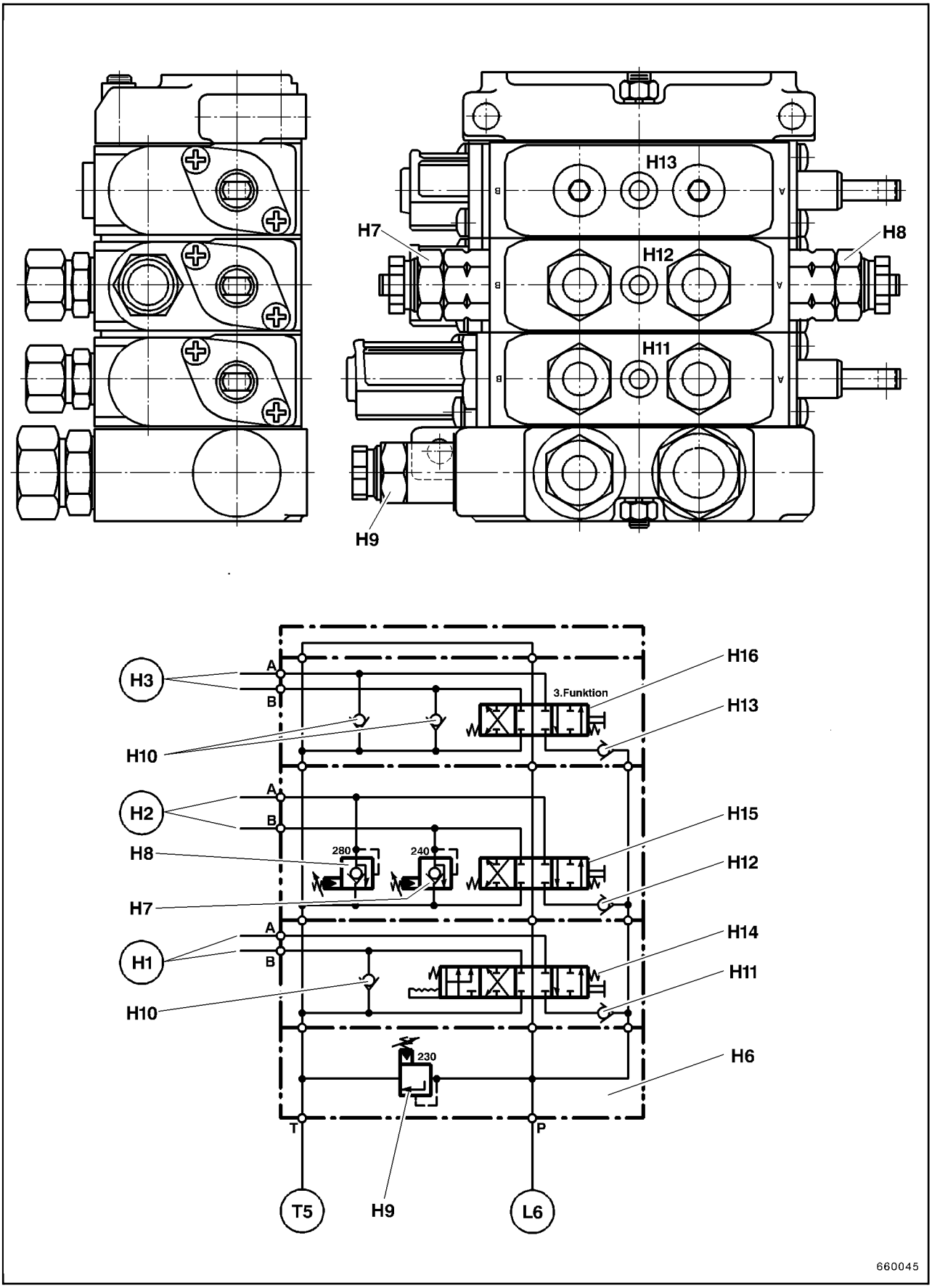

Fig. 2

Control block (H6)

Parts Fig. 2

H6 - Control block
H7 - Secondary valve, rearward tilting
H8 - Secondary valve, dumping
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve, lifting / lowering
H12 - Pressure-maintaining valve, rearward tilting / dumping
H13 - Pressure-maintaining valve, 3rd function
H14 - Control piston, lifting / lowering
H15 - Control piston, rearward tilting / dumping
H16 - Control piston, 3rd function

Connection designations

Designation at block	Use	Thread
A	Oil to operating equipment / cylinder	M 18 x 1.5
B	Oil to operating equipment / cylinder	M 18 x 1.5
P	Pressure oil from priority valve	M 22 x 1.5
T	Tank reflow via distributor (part T5)	M 26 x 1.5

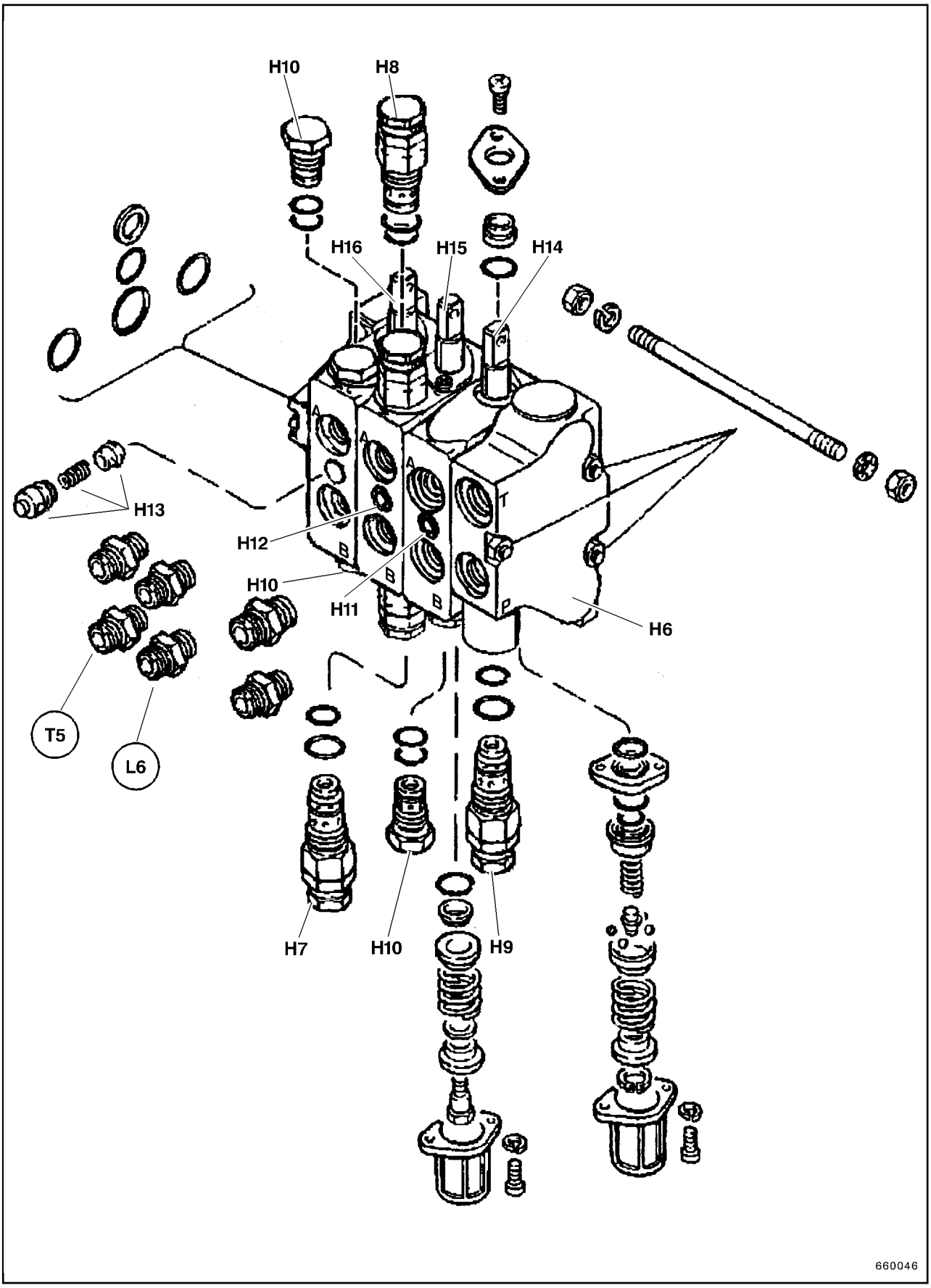

Fig. 3

Control block (H6)

Parts Fig. 3

H6 - Control block
H7 - Secondary valve, rearward tilting
H8 - Secondary valve, dumping
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve, lifting / lowering
H12 - Pressure-maintaining valve, rearward tilting / dumping
H13 - Pressure-maintaining valve, 3rd function
H14 - Control piston, lifting / lowering
H15 - Control piston, rearward tilting / dumping
H16 - Control piston, 3rd function

Connection designations

Designation at block	Use	Thread
A	Oil to operating equipment / cylinder	M 18 x 1.5
B	Oil to operating equipment / cylinder	M 18 x 1.5
P	Pressure oil from priority valve	M 22 x 1.5
T	Tank reflow via distributor (part T5)	M 26 x 1.5

□

Triple pump (2) of the steering and working hydraulics, the brake system and the fan drive

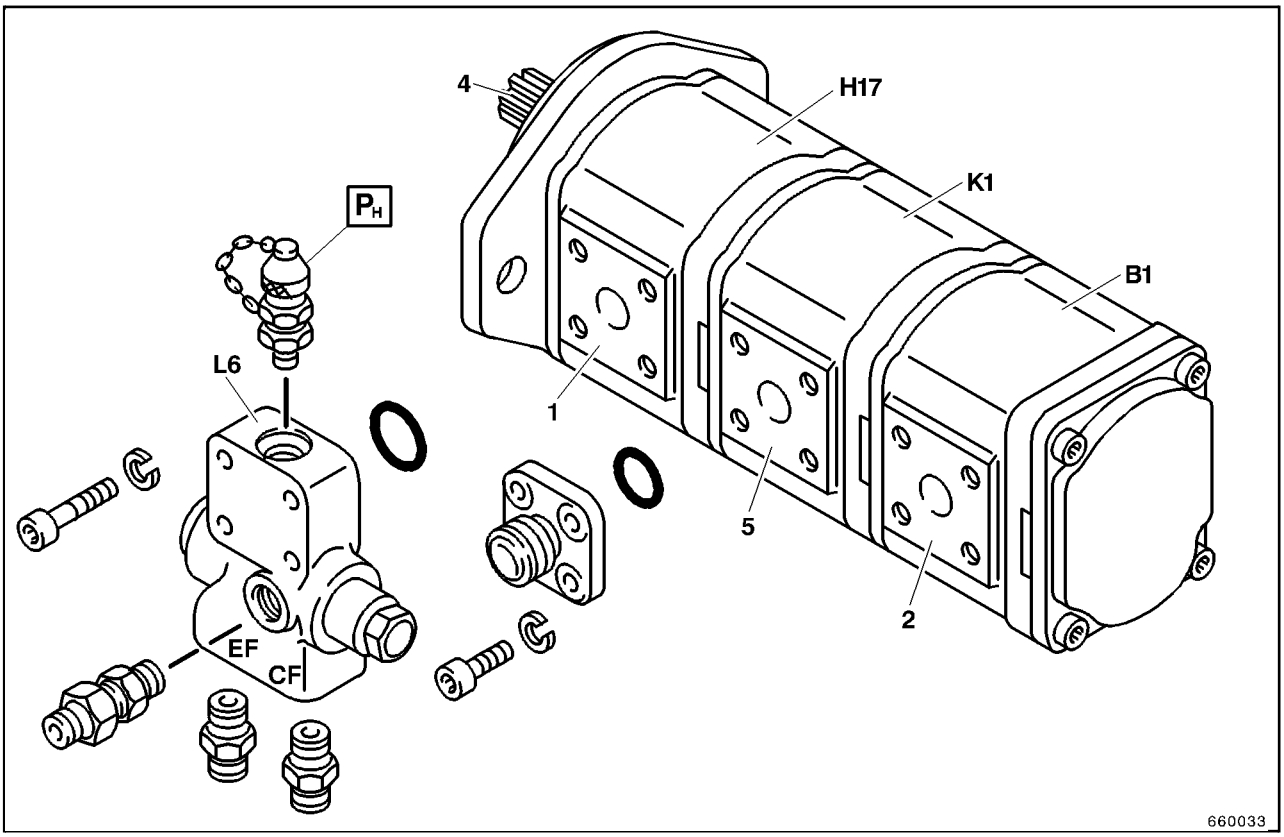

Fig. 4

Parts Fig. 3 and 4

1	-	Connection of the priority valve
2	-	Connection of the brake system
3	-	Connection of steering and working hydraulic
4	-	Drive shaft
5	-	Fan connection
6	-	Suck connection fan drive and braking system
B1	-	Brake pump
B2	-	Accumulator charging valve
H6	-	Control block
H17	-	Pump of the steering and working hydraulics
L2	-	Steering valve
L6	-	Priority valve
K1	-	Fan pump

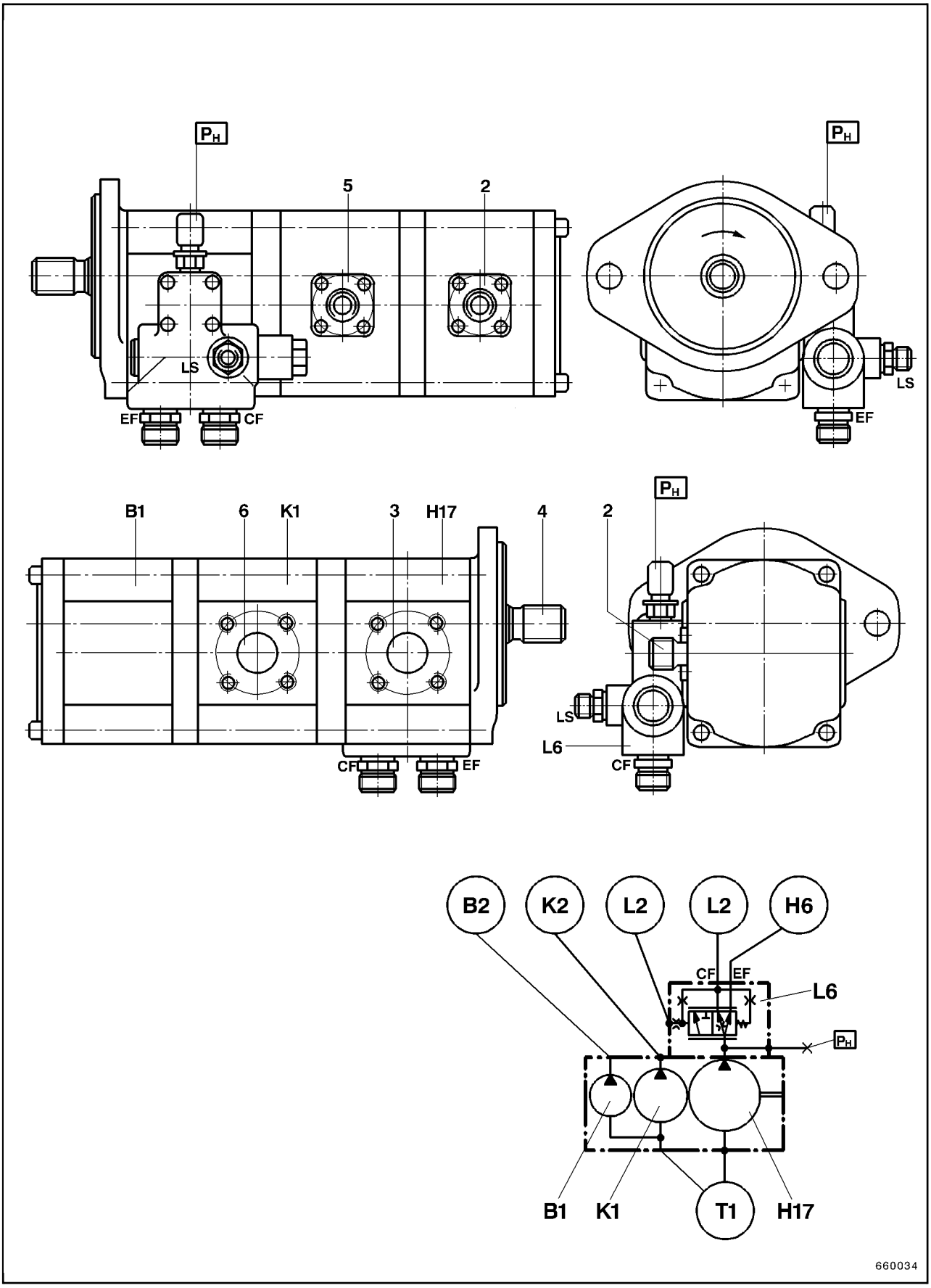
PH
5
2
LS
EF
CF
PH
LS
EF
B1
6
K1
3
H17
4
2
PH
LS
L6
CF
CF
EF
B2
K2
L2
L2
H6
CF
EF
L6
PH
B1
K1
T1
H17
660034

Fig. 5 □

Lifting cylinder (H1)

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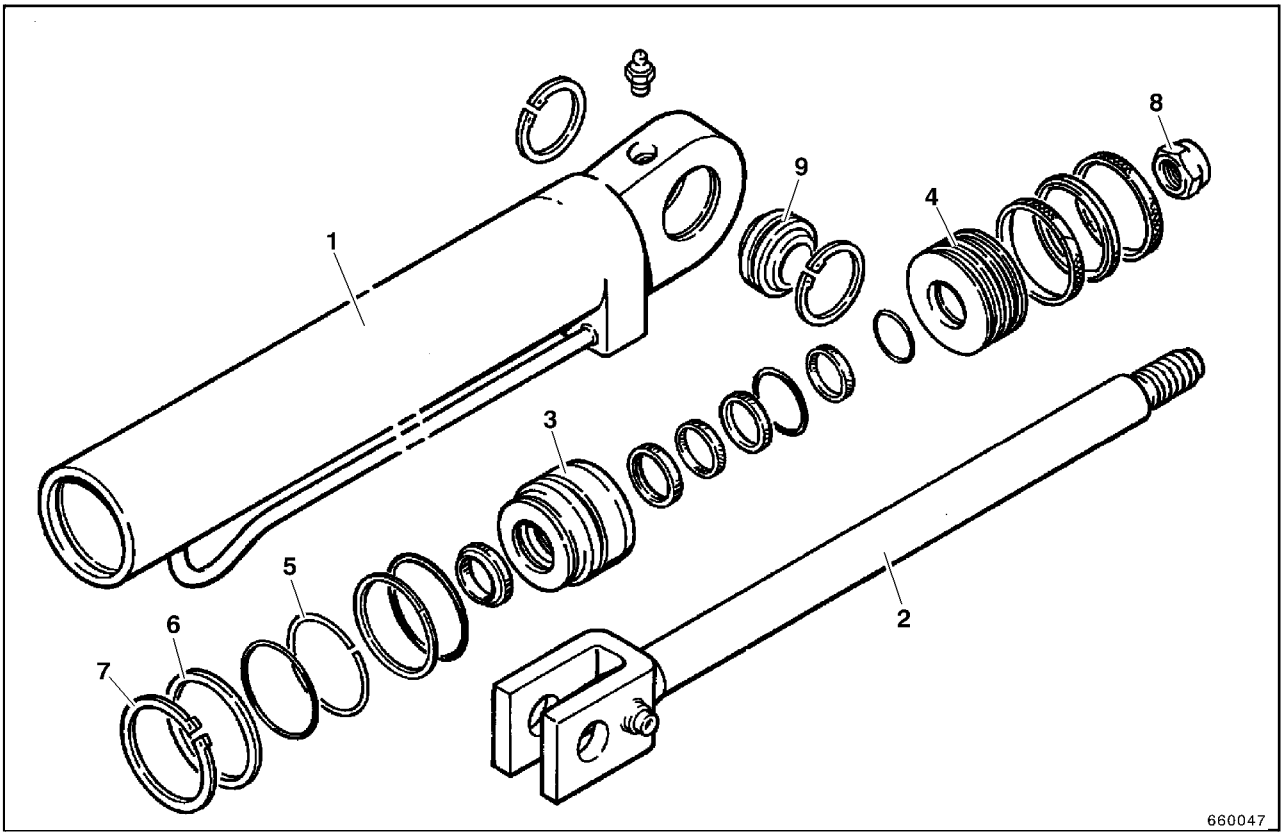

Fig. 6

Parts Fig. 6

1 - Cylinder
2 - Piston rod
3 - Guide
4 - Piston
5 - Round circlip
6 - Supporting plate
7 - Circlip
8 - Grooved nut M_A = 500 Nm (369 lbft), M 40 x 1.5 left-handed
9 - Pivot bearing

Technical data

Piston	:	85 mm (3.35 inch)
Rod	:	50 mm (1.97 inch)
Stroke	:	675 mm (26.58 inch)
Oil connections	:	L 15 W DIN 3853
Connection thread	:	M 22 x 1.5

Dumping cylinder (H2)

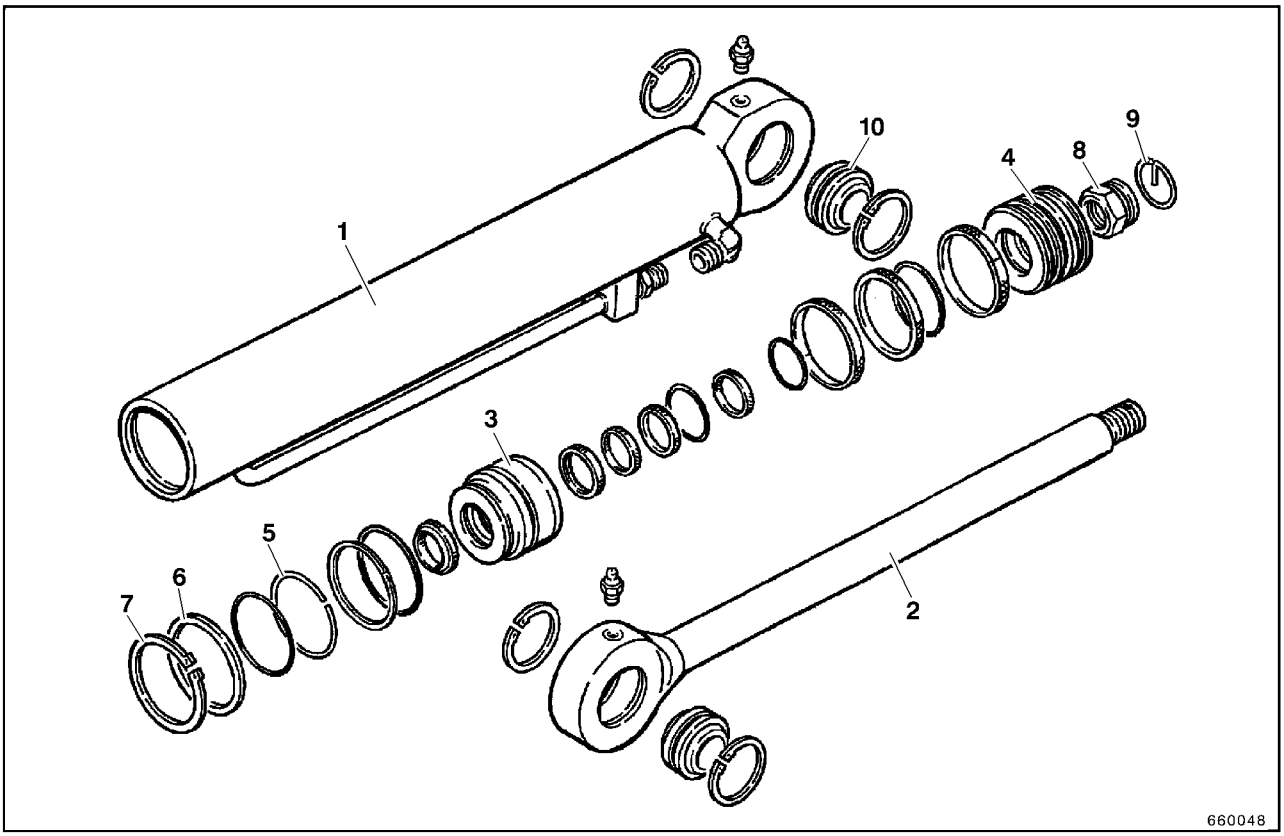

Fig. 7

Parts Fig. 7

1 - Cylinder
2 - Piston rod
3 - Guide
4 - Piston
5 - Round circlip
6 - Supporting plate
7 - Circlip
8 - Hexagon nut M_A = 1000 Nm (738 lbft), M 36 x 1.5
9 - Hooked circlip
10 - Pivot bearing

Technical data

Piston	:	100 mm (39.37 inch)
Rod	:	50 mm (1.97 inch)
Stroke	:	430 mm (16.93 inch)
Oil connections	:	ASW 15 L DIN 3853
Connection thread	:	M 22 x 1.5

Quick change locking cylinder (H3)

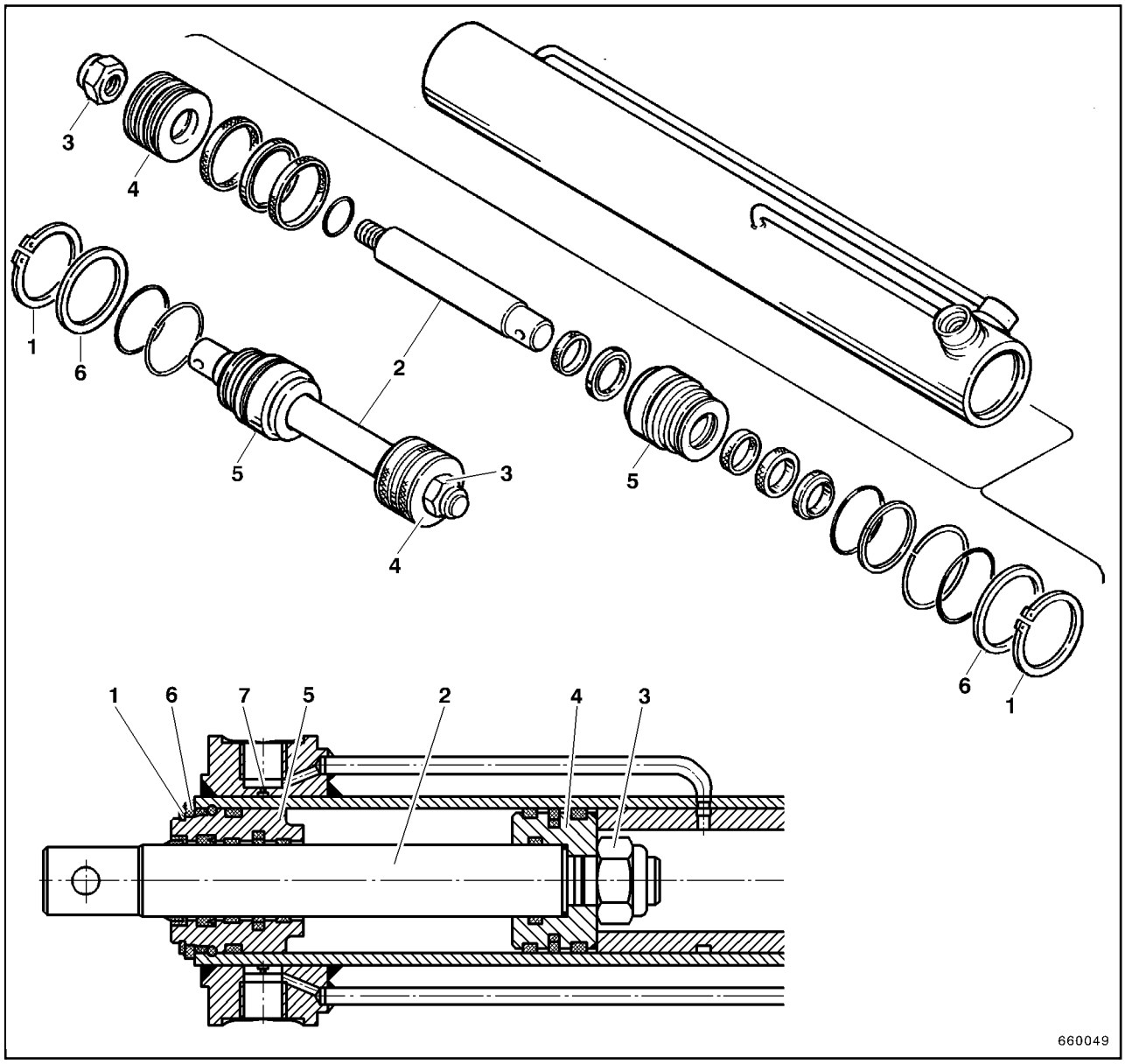

Fig. 8

Parts Fig. 8

1	-	Circlip
2	-	Piston rod
3	-	Hexagon nut M 18 x 1.5
4	-	Piston
5	-	Guide bushing
6	-	Washer
7	-	Compensating channel

Technical data

Stroke	:	75 mm (2.95 inch) (per side)
Piston	:	50 mm (1.97 inch)
Rod	:	25 mm (0.98 inch)
Service pressure	:	210 bars (3050 psi)
Compressive force	:	45.1 kN
Tractive force	:	33.8 kN

□

Hydraulic tank (T1) / Hydraulic filter (T3)

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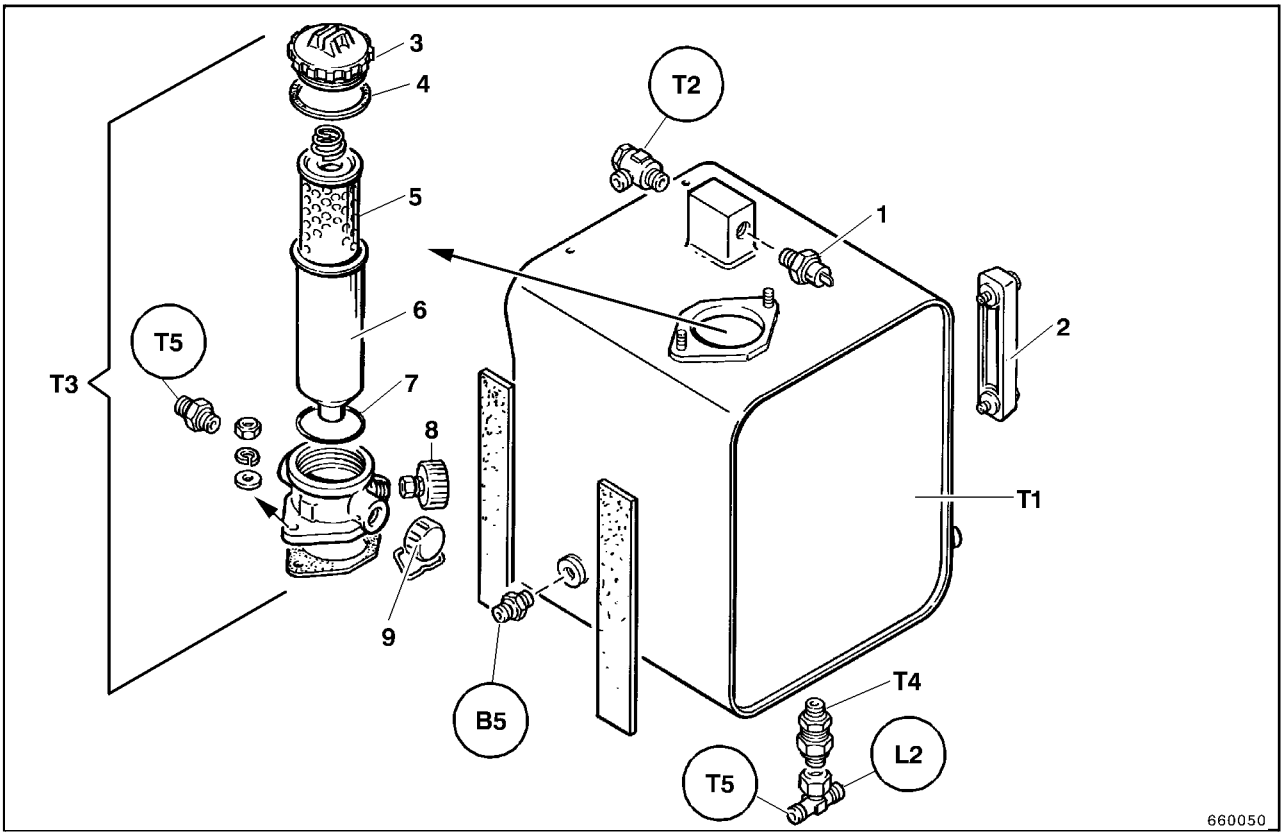

Fig. 9

Parts Fig. 9

T1 - Hydraulic tank
1 - Thermostat, hydraulic oil
2 - Oil gauge

T3 - Hydraulic filter
3 - Cap
4 - Gasket
5 - Filter cartridge
6 - Filter housing
7 - O-ring
8 - Pressure indicator (filter soiling)
9 - Venting filter

T4 - Check valve

Connections

B5 : Pedal-operated brake valve
L2 : Steering valve
T2 : Hydraulic oil cooler
T5 : Distributor

□

Distributor (T5)

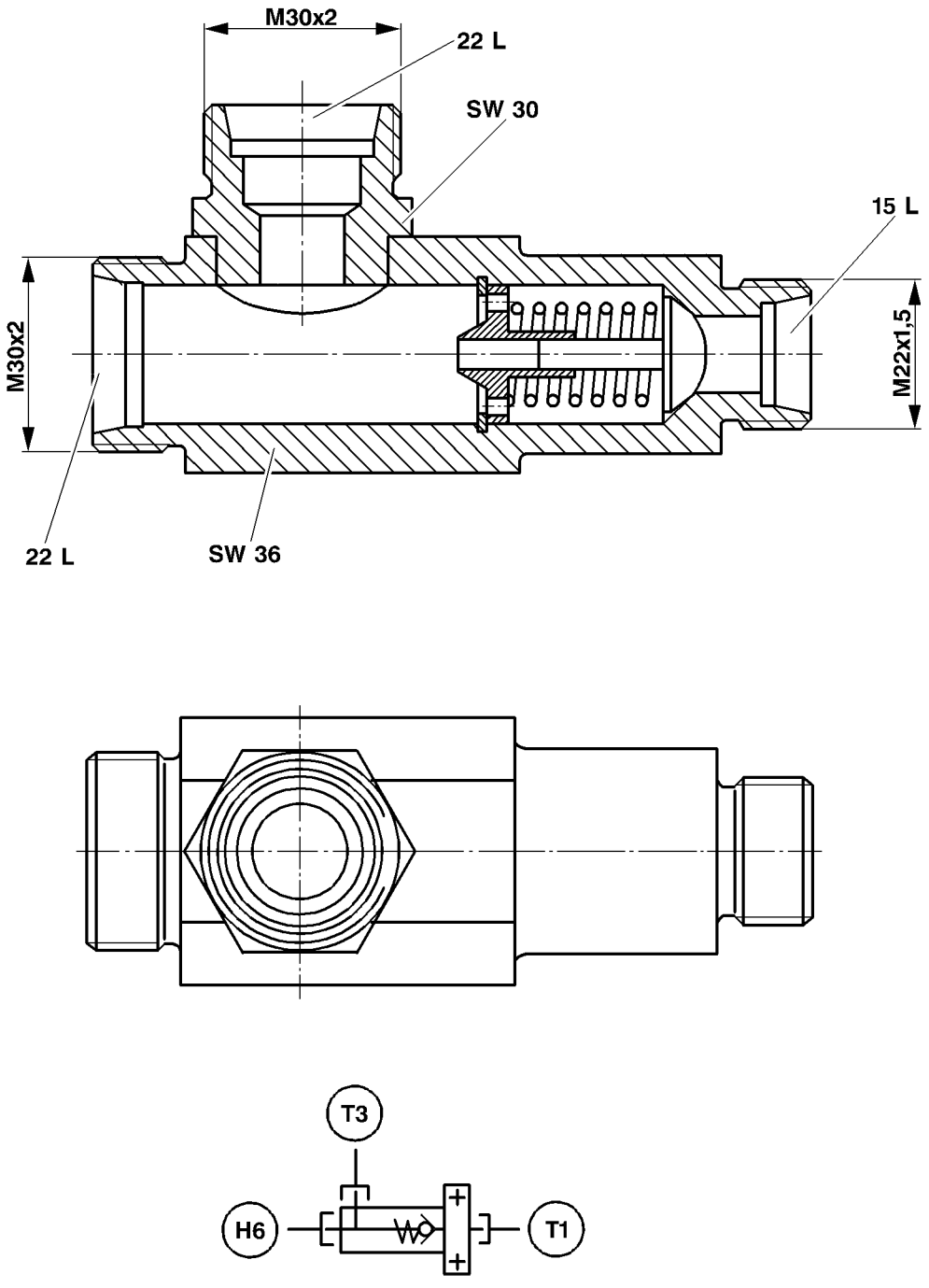

Fig. 10

Testing and adjustment work

2800948

For all testing and adjustment work at the hydraulic system, the temperature of the hydraulic oil must be ca. 60 - 70˚C (140 - 160˚F).

Pressure testing and adjustment

An appropriate pressure gauge must be connected at the measuring connection (P_H).
The working hydraulics are moved to the limit stop with the lifting function. The primary pressure of 230 bars (3340 psi) must not be read off at the pressure gauge.
The primary pressure is adjusted at the primary valve (H9).

The best way to check the secondary relief valves is the following procedure:

1. Correct a pressure gauge to the ring side of the dump cylinder.

2. Bring the lifting frame in horizontal position.

3. Dump the bucket against block.

4. Lift the lifting frame **without** using the dumping cylinder.
   Now you can read the pressure of the dump relief valve at the pressure gauge.

To check the roll back relief valve, the hoses at the dump cylinder have to be changed. Now the positions 2 - 4 of the procedure have to be done again.

Set what?	**How high?**	**Where?**
Primary pressure	230 bars (3340 psi)	Primary valve (H9)
Secondary valve, rearward tilting	240 bars (3480 psi)	Secondary valve (H7)
Secondary valve, dumping	280 bars (4065 psi)	Secondary valve (H8)

Practical testing

The correct setting of the primary and secondary pressure alone is not a confirmation that the hydraulic system is in order.
To be sure of this, the throughput must also be checked. As this is, however, a very complex measurement and the necessary measuring equipment is often not available, the stroke time can be determined as an option.
At top motor speed the stroke time should be ca. 6.3 seconds.

N.B.:

The precondition for this testing is that the drive motor is correctly set:

low idling: see techn. data

high idling: see techn. data

If the stroke time is clearly exceeded, this may indicate a defective priority valve (L6) or a defective hydraulic pump (H17).

Another test is measuring of the falling-off time. For this purpose the machine must be equipped with a standard bucket and the lifting arm and bucket must be positioned approximately horizontally.
The motor is then switched off.
In 15 minutes, the tip of the bucket may fall by ca. 60 mm (2.36 inch). If the falling rate is higher, check whether the fault is in the lifting or in the tilting function.
The lifting cylinders may yield by ca. 15 mm (0.6 inch)(measured at the piston rod) during this time.

Important:

During these measurements, suitable precautions must be taken to protect third parties and the mechanic taking the measurements from any lifting gear which may drop down.
The safety instructions must be observed.

Causes of a higher lowering rate may be:

Cause	Remedy
Lifting cylinder (H1) leaking	Seal cylinder
Dumping cylinder (H2) leaking	Seal cylinder
Control block (H6) leaking excessively	Replace control block or control piston
Fault in secondary valve for rearward tilting (H7)	Adjust, clean or replace secondary valve
Outward leakage	Seal

Summary:

Check what?	Where?	Setpoint?
Stroke time at max. engine speed	--	6.3 seconds
Lowering rate of working hydraulics	Bucket tip	60 mm/15 min. (2.36 inch/15min)

□

Hydraulic circuit diagram - cooling

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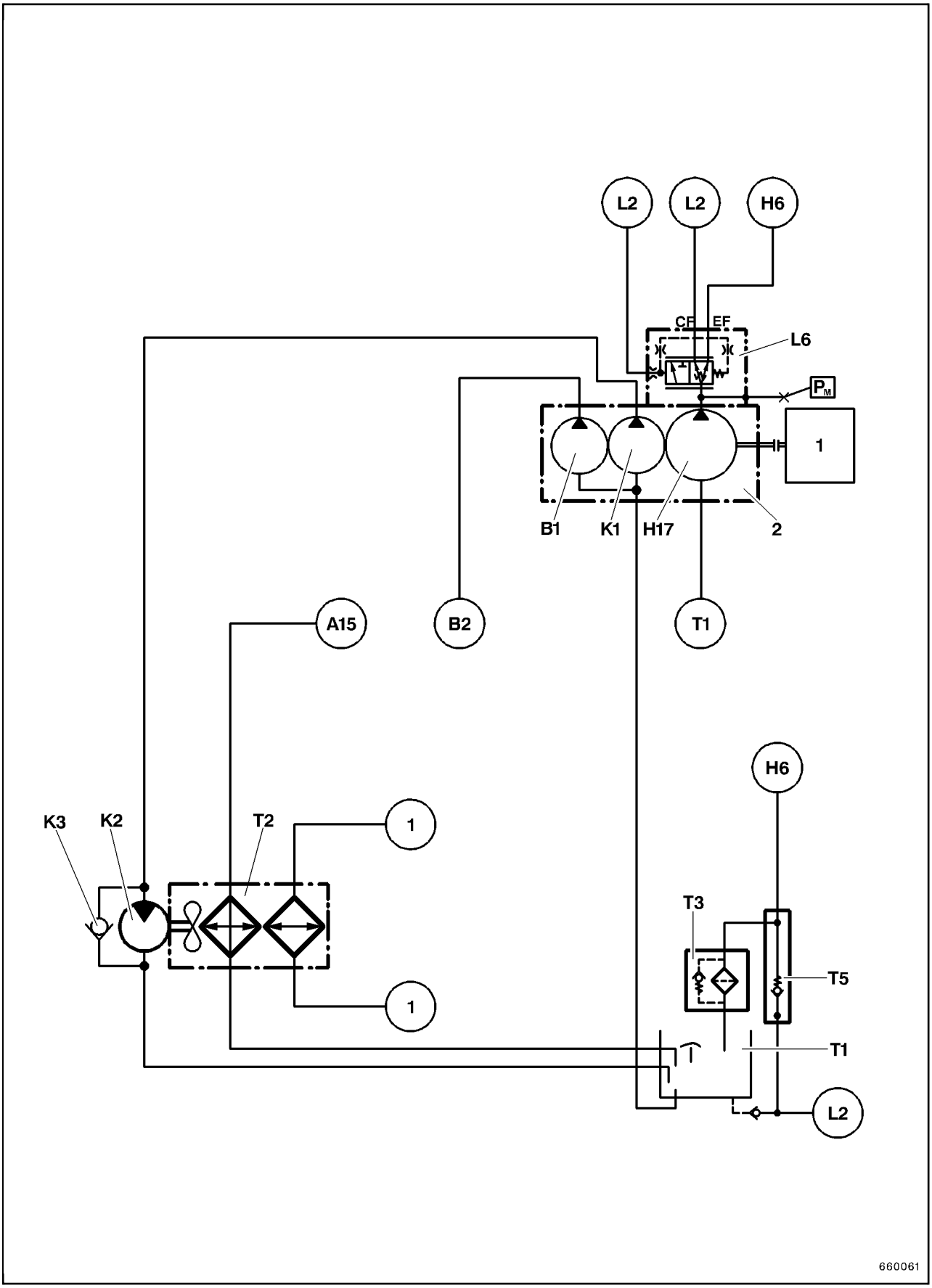

Fig. 11

Hydraulic circuit diagram, legend

1 - Diesel engine
2 - Triple pump, steering system / working hydraulics / braking system / Fan drive
9 - Front axle
10 - Rear axle

T1 - Hydraulic tank
T2 - Hydraulic oil cooler
T3 - Hydraulic oil return-flow filter with bypass
T4 - Check valve
T5 - Distributor

L1 - Steering cylinder
L2 - Steering valve
L3 - Secondary valve, steering system
L4 - Primary valve, steering system
L5 - Check valve
L6 - Priority valve

H1 - Lifting cylinder
H2 - Dumping cylinder
H3 - Quick-change locking cylinder
H4 - Hydraulic cylinder, 3rd function
H5 - Quick-change locking mechanism (multiway cock)
H6 - Control block, working hydraulics
H7 - Secondary valve "Rearward tilting" with replenishing valve
H8 - Secondary valve "Dumping" with replenishing valve
H9 - Primary valve
H10 - Replenishing valve
H11 - Pressure-maintaining valve "Lifting/lowering"
H12 - Pressure-maintaining valve "Tilting"
H13 - Pressure-maintaining valve "3rd function "
H14 - Control piston "Lifting-lowering-floating" position
H15 - Control piston "Rearward tilting" dumping
H16 - Control piston "3rd function"
H17 - Hydraulic pump, steering and working hydraulics

B1 - Brake fluid pump
B2 - Accumulator charging valve
B4 - Brake accumulator
B5 - Pedal operated brake valve
B6 - Pressure switch, braking light
B7 - Pressure switch, accumulator warning
B8 - Sequence valve
B9 - Multiple-disc brake
B10 - Inching valve

K1 - Fan pump
K2 - Fan motor
K3 - Replenishing valve

A1 - Feed circuit filter
A2 - Feed pump
A3 - Variable displacement axial-piston pump A4VG-Da
A4 - High-pressure relief valves, deblockable
A5 - Replenishing valves
A6 - Soiling indicator, feed circuit filter
A7 - Servo-valve
A8 - Pressure cutout
A9 - Feed pressure relief valve
A10 - Restrictor
A11 - Electromagnetically activated switchover valve for forward and reverse travel
A12 - Scavenging needle
A13 - Adjusting cylinder forward/reverse/neutral
A14 - Bypass valve (feed circuit filter)
A15 - Axial-piston oil motor A6VM - HA 1U
A16 - Check valve
A17 - Electromagnetically activated switchover valve for slow travel (high displacement)
A18 - Adjusting cylinder for displacement change
A19 - Feed circuit filter

Pressure measuring points

P_H - Pump pressure for working and steering hydraulics

P_{SP} - Feed pressure

P_{HD} - High pressure at travelling

P_{HD*} - High pressure at travelling (at travel motor)

P_{BS} - Accumulator pressure

P_{in} - Actual braking pressure

P_{BL} - Braking pressure (for the multiple-disc brakes)

X_1 - Control pressure

X_2 - Control pressure

G - Regulation threshold (travel motor) □

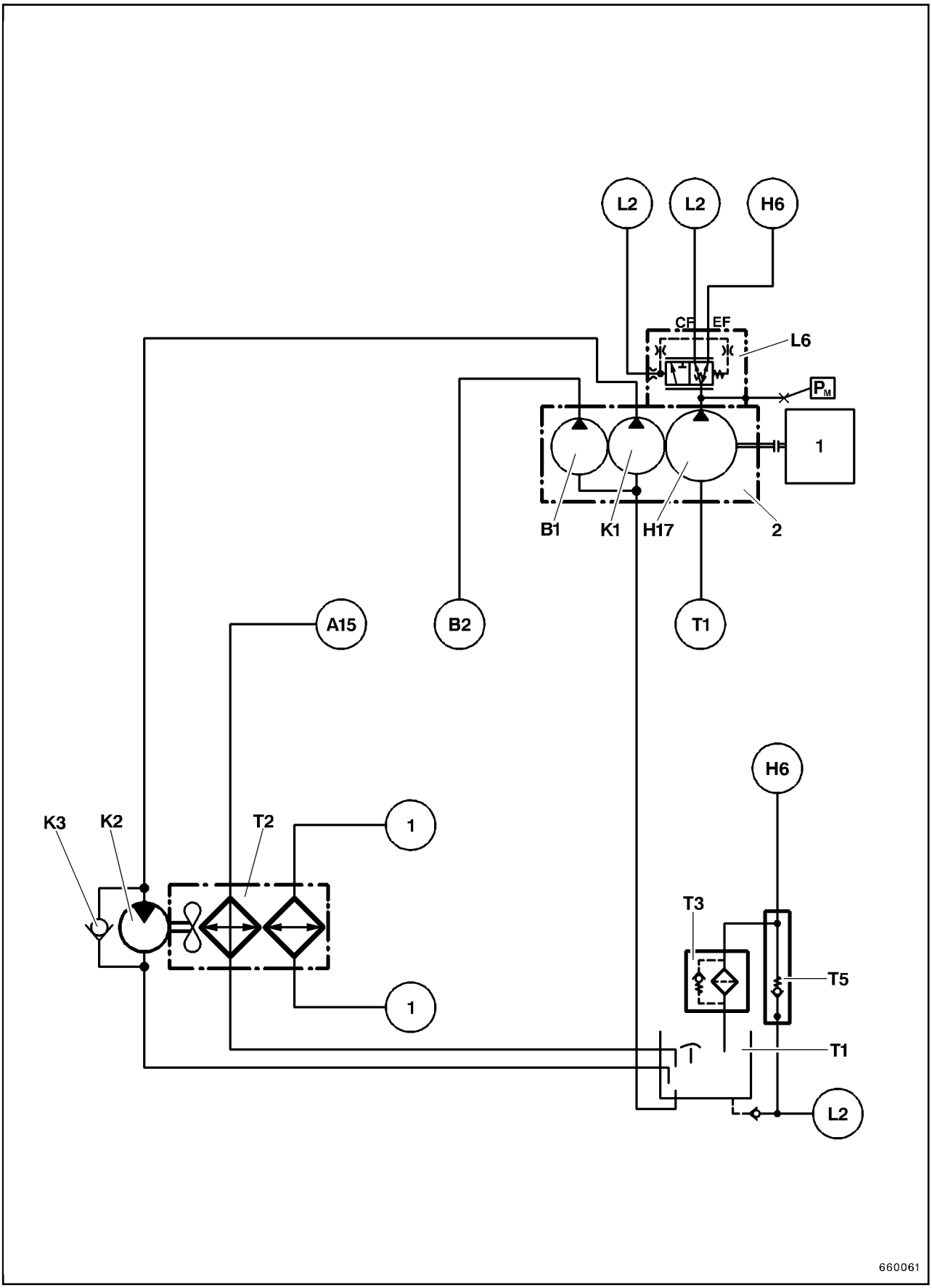
L2
L2
H6
CF
EF
L6
PM
1
B1
K1
H17
2
A15
B2
T1
H6
K3
K2
T2
1
T3
T5
1
T1
L2
660061

Fig. 12

Functional description of hydraulic system cooling

The wheel-loader W80H is equipped with an external cooling system for hydraulic-oil and engine-oil cooling.

The hydraulic system comprises a gear pump (K1) and a fan motor (K2) with replenishing valve (K3) connected in parallel.

Pump (K1) takes in oil from the hydraulic tank (T1) and directly drives the fan motor (K2) by means of an oil motor. The oil reflows to tank (T1).

If the Diesel engine (1) is stopped, gear pump (K1) stops, too, so that no oil is flowing.
To avoid cavitation damage to the fan motor (k2) when it is still turning, the system is equipped with a replenishing valve (K3).

Praktical checking

The hydraulic cooling system is a simple system requiring normally no special maintenance.

In the event of cooling problems, perform a functional check and a visual inspection of the oil and water cooler .

If the cooling performance remains insufficient even with a clean oil and water cooler, the speed of the fan must checked.

The fan speed is measured by means of an optical rev counter.

At maximum speed of the diesel engine, the measured speed of the fan must be at least 2750 min^{-1}. □

Pipe-burst protection (optional)

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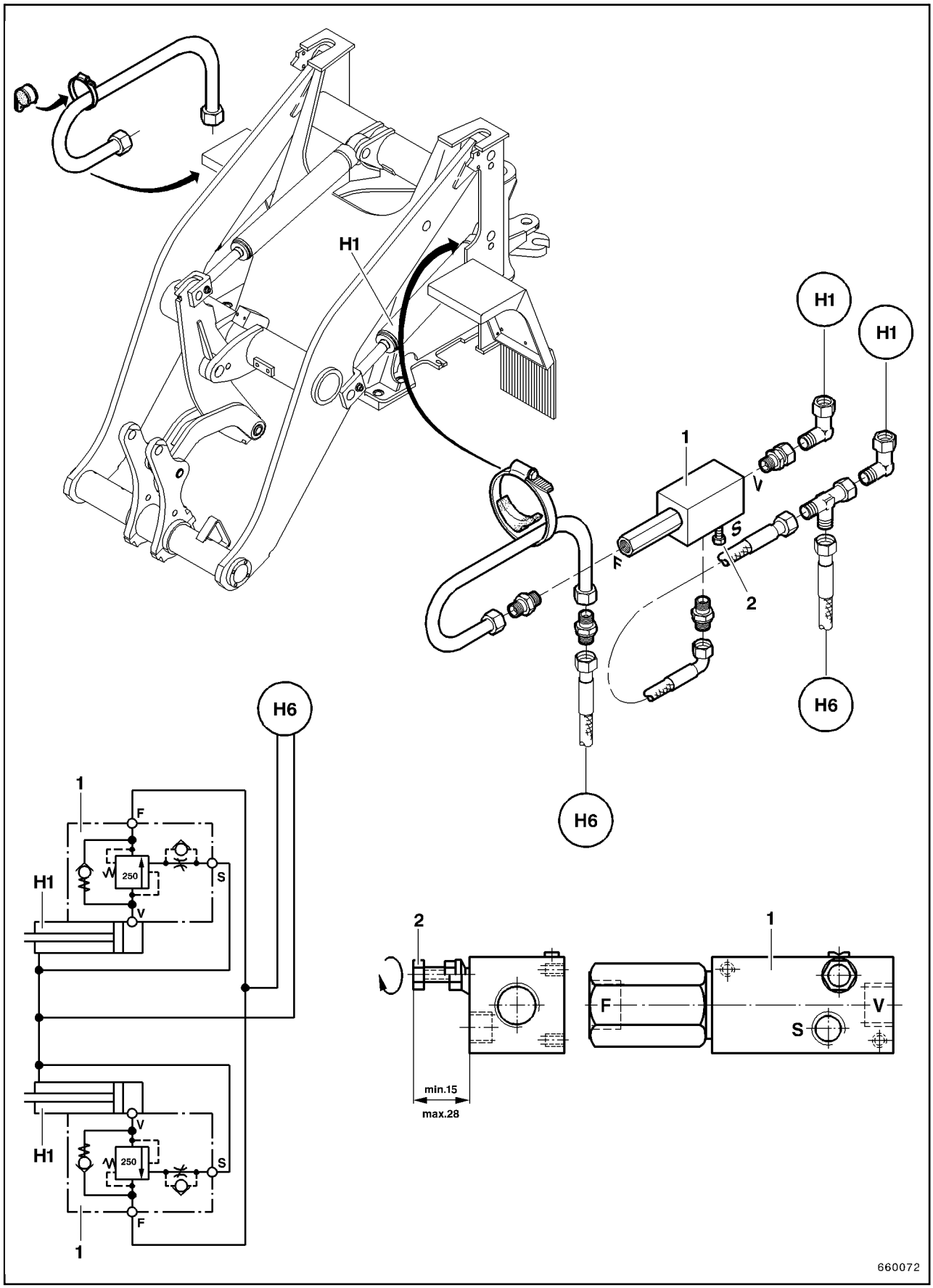

Fig. 13

Lifting cylinder load-holding valve (optional)

Items Fig. 13

1 - Load-holding valve, set pressure 250 bars (3630 psi)

2 - Throttle-screw size SW 10 for valve dampening
Do not turn throttle-screw beyond maximum. Before adjusting the screw, loosen the locknut by an appropriate amount to prevent the integrated sealing ring from being damaged by the thread.

H1 - Lifting cylinder

H6 - Working hydraulics control block

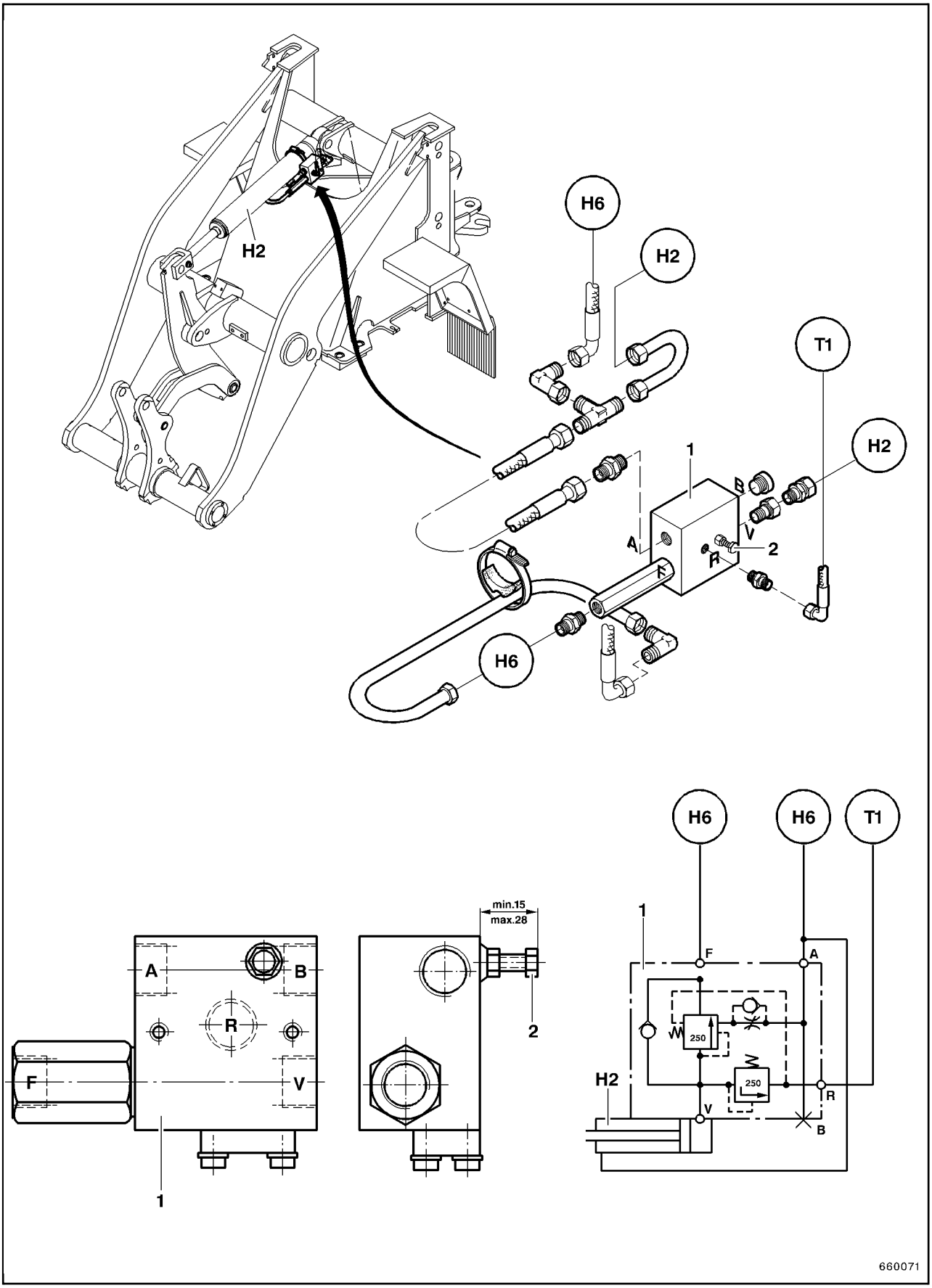
H6
H2
H2
T1
H2
1
B
V
A
R
2
H6
H6
H6
T1
min.15
max.28
A
B
R
F
V
2
1
1
F
A
250
250
H2
V
R
B
660071

Fig. 14

Dumping cylinder load-holding valve (optional)

Items Fig. 14

1 - Load-holding valve, set pressure 250 bars (3630 psi)

2 - Throttle screw size SW 10 for valve dampening
Do not turn throttle screw beyond maximum. Before adjusting the screw, loosen the locknut by an appropriate amount to prevent the integrated sealing ring from being damaged by the thread.

H2 - Dumping cylinder

H6 - Working hydraulics control block

□

Notes

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09 ELECTRICAL SYSTEM

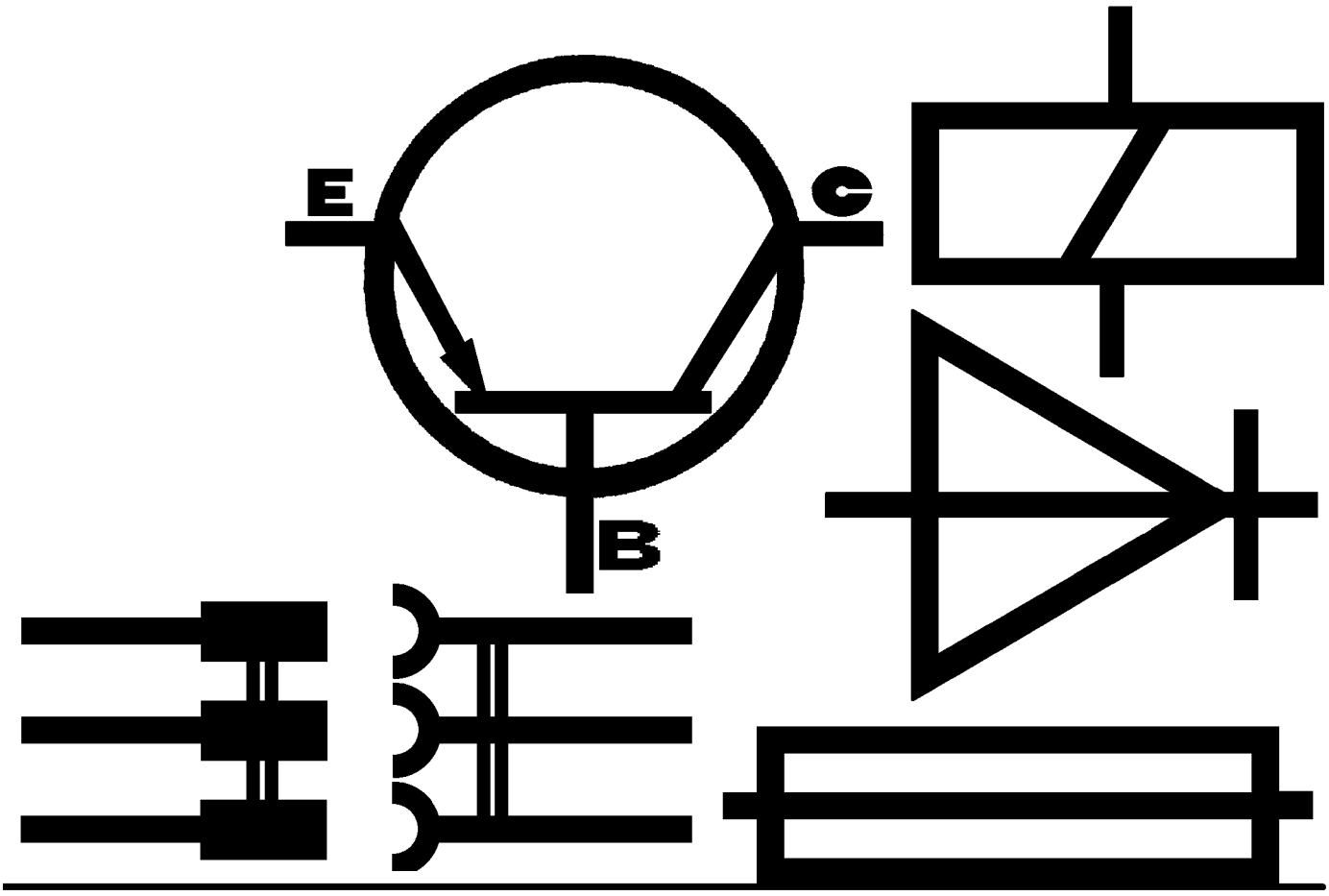
Electrical components in circuit diagram, P/No. 3 002 802

Technical handbook "Fundamentals of electrical engineering"

Technical handbook "Interpretation of wiring diagrams"

Technical Handbook

Fundamentals of electrical engineering



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PREFACE

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Electrical systems for construction machinery have developed far beyond their original applications as starting and lighting devices. The new tasks are essentially monitoring and control functions. This has entailed an inevitable increase in the number of circuits, so that the overall system appears complex and unclear to the non electrician.

This technical handbook applies to electrical systems for motor vehicles as well as to low-voltage and medium-voltage systems on construction machines. Attention must be paid in all events to the relevant accident prevention regulations, whose requirements vary with the different service voltages.

IMPORTANT INSTRUCTIONS

- Observe the accident prevention regulations.
- The personnel executing work must have the necessary expertise.
- Tools, lifting gear and other equipment must be in a secure, safe state.
- Prior to servicing or inspection work, secure the machine and equipment against unauthorized starting, e.g. chock the vehicle wheels and lower the working equipment to the ground.
- Protective devices of moving machine components must not be opened or removed except when the machine is stationary and secured against inadvertent starting.
- Metal objects such as rings, watches etc. must be removed prior to any work on automotive electrical systems.
- Direct current (d.c.) must be prevented from flowing through the human body.

ELECTRICAL SYSTEMS IN GENERAL

To make electrical systems comprehensible, we need a slight grasp of the physics of electrotechnology.

The atom

All substances are composed of atoms.

An atom consists of a positively charged nucleus. Negatively charged electrons orbit the nucleus at vast speed.

The nucleus itself is composed of positively charged protons and of neutrons with neutral charge.

The number of protons and neutrons depends on the structure of the atom.

If an atom possesses the same number of electrons and protons, the atom is electrically neutral.

All atoms are bound to their nucleus by magnetic forces. If an electron is missing for some reason, i.e. the nucleus has one proton too many in numerical terms, the atom is positive.

Structure of atoms

The number of protons corresponds to the number of electrons, i.e. it is electrically neutral.

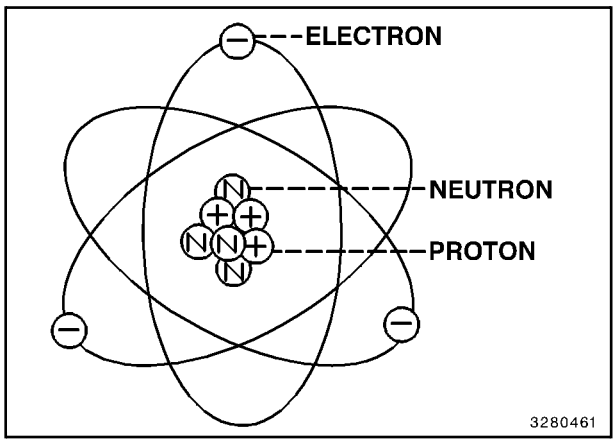


Fig. 1

The large quantity of atoms in the substances may well result in an electron being the same distance from another nucleus as from its own.

If this is the case, the magnetic force of attraction of the electron's own nucleus is eliminated. Such an electron is no longer bound to its own nucleus, i.e. it is free. We refer to such electrons as "free electrons".

Free electron

If an electron has left its path and is equally far from another nucleus as from its own, it is no longer bound to its nucleus - it is free.

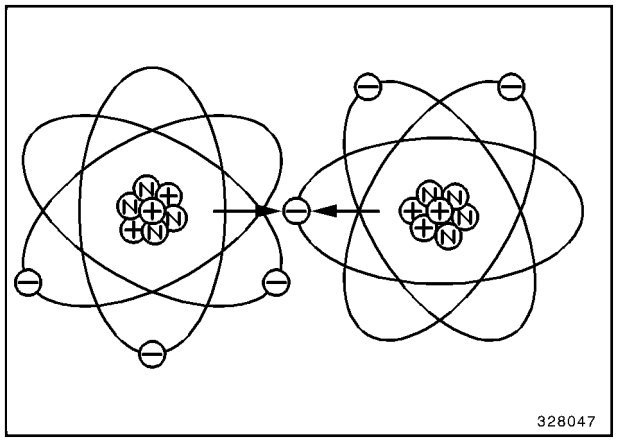


Fig. 2

The electron of nucleus A has entered a neutral path. As atom B is electrically neutral and atom C electrically non neutral (one electron is missing), the electron is attracted by nucleus C, and nucleus A thus becomes non-neutral.

It attracts another electron which has entered a neutral path. If an electron from nucleus C, which is now neutral, returns to a neutral path, it is also attracted by a non-neutral nucleus (etc.).

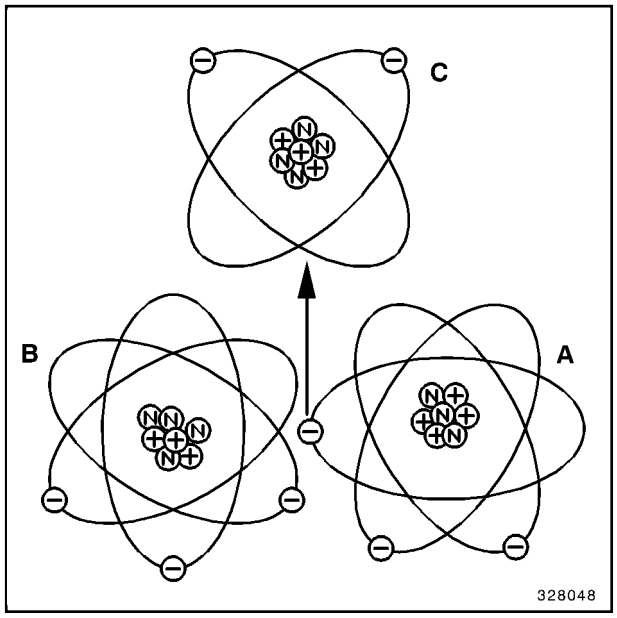


Fig. 3

A relatively large number of free electrons are present in noble metals and non-ferrous metals. If a conductor (e.g. a copper wire) is moved in a magnetic field, the free electrons are forced into one direction or another.

Electromagnetic field

When current is flowing in a conductor, a magnetic field is formed round the conductor as shown in the diagram below.

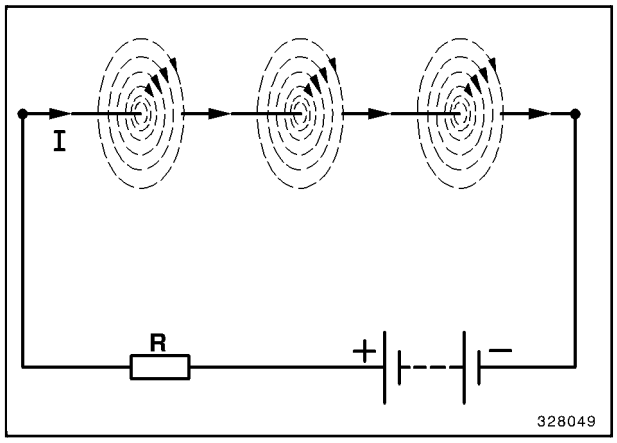


Fig. 4

Resistor "R" in the above diagram serves only to prevent a short circuit in the system.

If a conductor is shaped into a coil with several turns, a magnetic field will spread round the coil as shown in the diagram below. The strength of the magnetic field depends on the current flowing through the coil and on the number of turns.

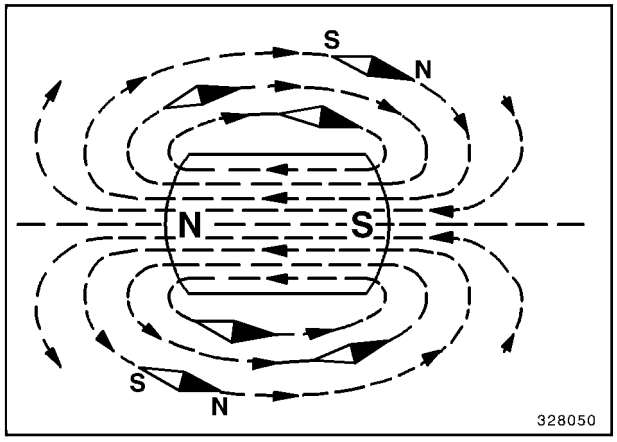


Fig. 5

To strengthen the magnetic field, an iron core with a preferred direction of magnetization is normally used as a winding support. The electromagnetic force is thus sufficient to attract a hydraulic switching piston, for example.

The outcome is that an electric potential is built up alternately at the ends of the conductor. This is known as electric voltage and is measured in volts (V). If this conductor is now formed as a closed circuit, the electron flow moving through the conductor can be measured. This electron flow, known as electric current, is measured in amperes (A).

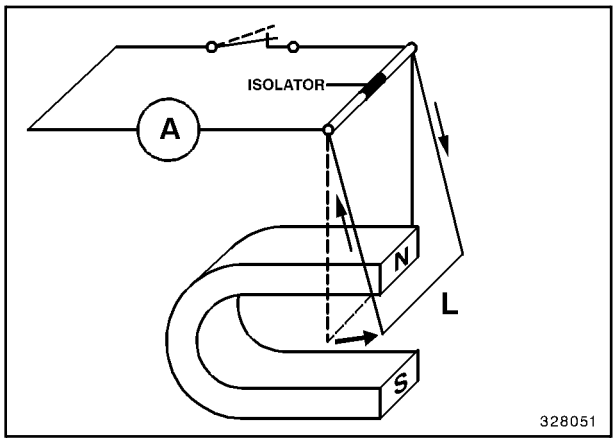


Fig. 6

N.B.: The build-up of a constantly changing potential in a conductor is known as alternating voltage, and the current flowing in the process as alternating current (a.c.), i.e. the current is continuously changing its direction and strength.

The alternating current or alternating voltage can be visualized by means of a visual display unit.
Current and voltage are normally isochronous. The term used when current is not isochronous with voltage is phase shift.

Alternating current diagram

T = Duration of one full cycle (period) in s

¤ = frequency in Hz (¤ = 1/T)

î = Peak value (amplitude) of the current,

û = Peak value (amplitude) of the voltage,

omega = Radian frequency in 1/s (omega = 2pi ˙ ¤)

phi = Phase shift angle (phase shift means: current and voltage attain their peak value or their zero crossing at different times) between current and voltage.

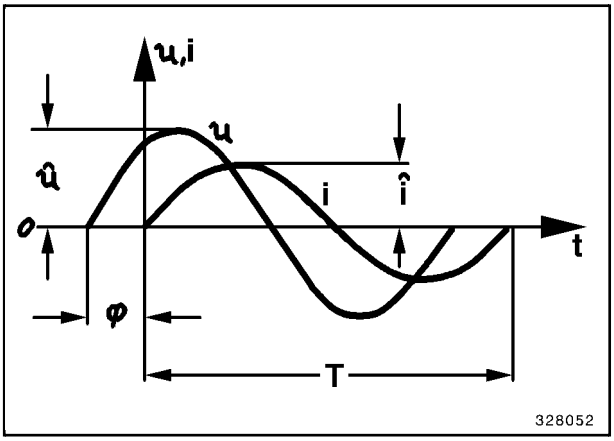


Fig. 7

The type of curve characterising alternating or direct current is known as a sine curve. If current and voltage are in phase, both reach their peak value at the same time. The oscillations in one second are referred to as frequency (¤). The number of oscillations per second are stated in Hertz (Hz).

POWER GENERATION

If the fact is exploited that a magnetic field is formed round a conductor when a current flows through it, it is relatively easy to build an electric generator. The principle is shown in the diagram below. Windings (2) supplied with direct current (3) are mounted on a rotor (1), resulting in a magnetic field (4). The windings (6) mounted on the stator (5) of our theoretical generator are cut by the magnetic field (4) of the rotor as the rotor is turned. This generates electric voltage in the stator winding.

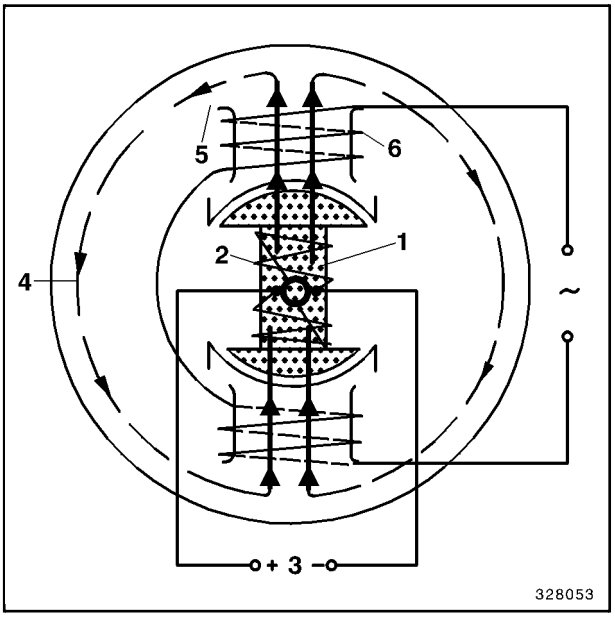


Fig. 1

Power generation in motor vehicles

Some years ago, so-called d.c. generators were installed in motor vehicles. Because of their size and output, they were replaced by a.c. generators.

In an a.c. generator, three alternating currents, each phase-shifted by 120˚, are generated. This alternating current is rectified in the vehicle by means of diodes, and we have direct current. The direct current is regulated to the required charging current with a regulator. The resulting direct current is needed to recharge the battery, i.e. the battery is recharged while the engine is running.

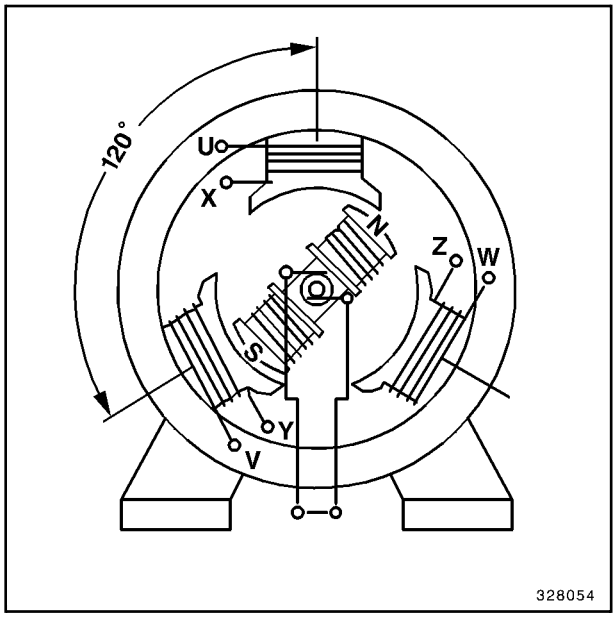


Fig. 2

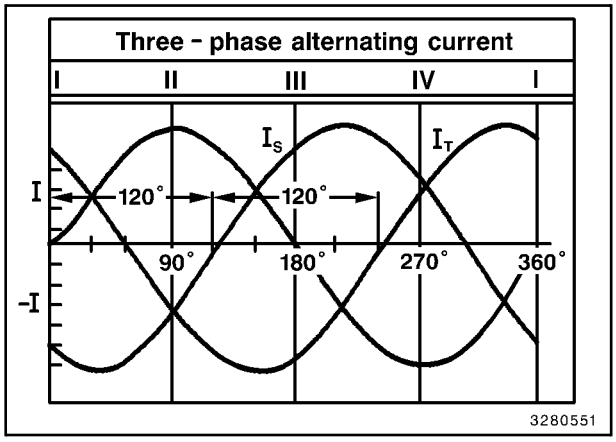


Fig. 3

If voltage is applied to the field winding mounted on the rotor, the current flows. This current induces a magnetic field large enough to cut the stator windings as the rotor turns.

As the rotor turns, alternating current is generated in each coil. Three equally large voltages are formed in the three coils. These voltages are, however, out of phase by 1/3 period, i.e. the phase shift is 120°. If the coils are uniformly loaded, the phase angle between the currents is also 120°.

Three alternating currents, each phase-shifted by 120° are known as three-phase alternating current or rotary current.

Battery charging

As the generator is used in the motor vehicle to recharge the battery, the alternating current must be converted into direct current. This is done with rectifier diodes as shown in the circuit diagram below.

1 Field diodes
2 Main diodes
3 Regulator

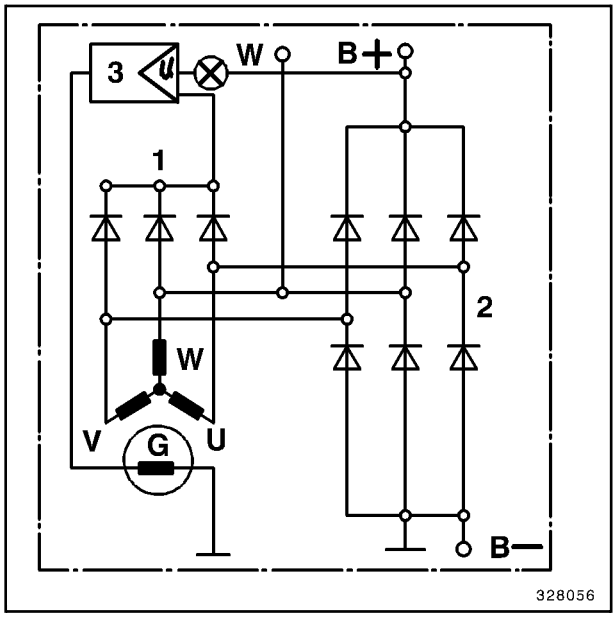


Fig. 4

The field diodes have the task of converting the alternating current into direct current. This direct current is then conducted via the regulator to the field winding, which ensures that the field current is limited or cut out when the charging voltage is reached. The main diodes are interconnected to form a so-called bridge. The output terminal (B+) of this diode bridge is firmly connected with the battery pole (+).

Claw-pole alternator

1 - Slip-ring end shield
2 - Rectifier heat-sink
3 - Power diode
4 - Exciter diode
5 - Transistorized regulator in hybrid technique
6 - Stator with three-phase winding
7 - Stator with claw poles
8 - Fan
9 - Pulley
10 - Drive end shield with mounting flanges

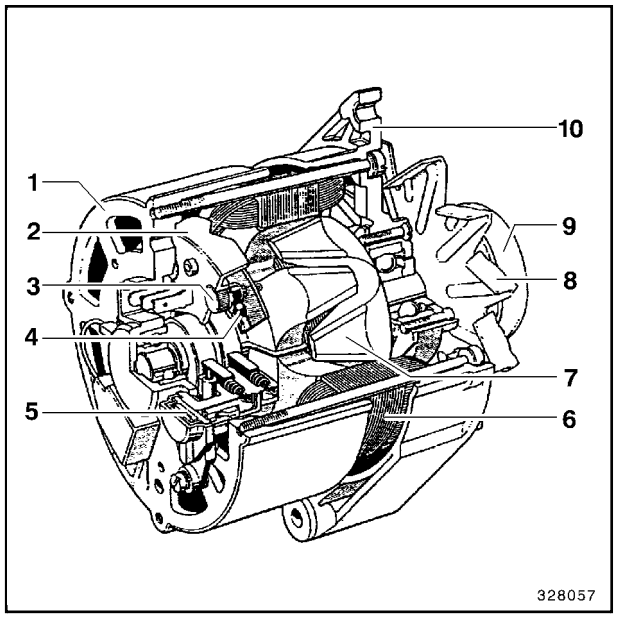


Fig. 5

Important:

The battery must not be disconnected from the alternator when the alternator is running.

Circuit with fault indication on interruption in the exciter circuit

1 = Alternator
2 = Charge monitoring lamp
3 = Resistor R
4 = Ignition switch
5 = Battery

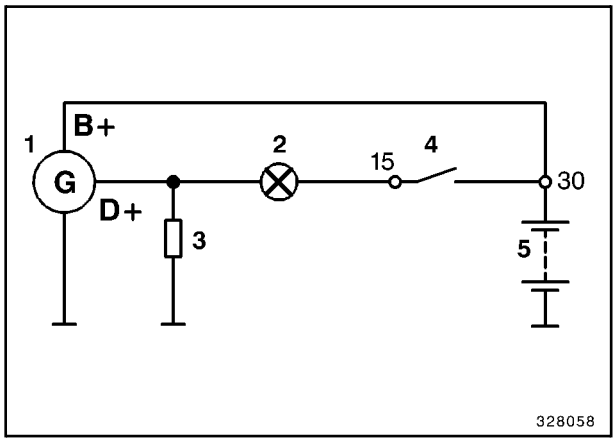


Fig. 6

The sole functions of the charging control lamp are to ensure that the alternator is pre-magnetized and to monitor the exciter circuit. If the charging control lamp lights up while the alternator is running, it means that no exciter current is present and thus that no battery charging is being executed.

Important:

The charging control lamp must not be replaced except with an equivalent one, in general 1.2 W with 12 V systems and 2 W with 24 V systems.

The functions of the charging control are based on the system shown in Fig. 6. If the ignition switch (4) is closed, current flows from the battery (5) through the lamp (2) via a resistor to ground. The resistor (3) has such a resistance value that the lamp lights up. If the diesel engine is then started and the alternator thus driven, a positive voltage will result at terminal (D +) of the alternator. When there is a positive voltage on both sides of the lamp, the charging control lamp will be extinguished. The resistor must be mounted immediately adjacent to the lamp.

Testing the charging system

To test the charging system, the voltmeter must be connected direct to the battery. The engine must then be run up to top speed. After ca. 2 minutes, the required charging voltage must be attained. This is between 13 and 14.5 V for a 12 V system, and 26 to 29 V for a 24 V system.

If the voltmeter indicates a higher value, the regulator is defective. If the measured value is lower, however, the fault is in the charging system.

Important: The voltmeter must be switched to the d.c. voltage measuring range.

MAIN COMPONENTS OF AUTOMOTIVE ELECTRICAL SYSTEM

Battery

The battery is basically needed only for starting and lighting of the parked machine.

In operation, power is supplied by the alternator which charges at the same time the battery.

The most commonly used batteries in motor vehicles are 12-volt batteries. By connecting 6 cells (with 2 volts each) in series, we obtain the nominal voltage of 12 volts.

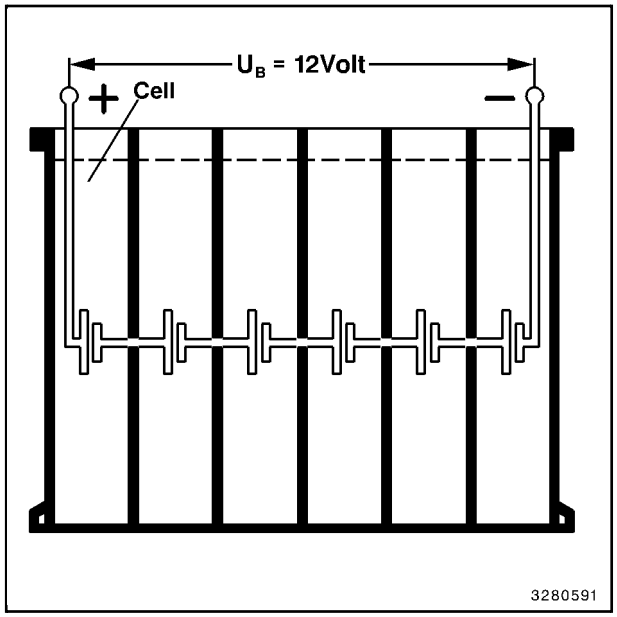


Fig. 1

The battery nominal voltage depends on the number of cells connected in series.

$$U_B = n \cdot U_Z$$

n = number of cells
U_B = nominal voltage of battery
U_Z = nominal voltage of cell

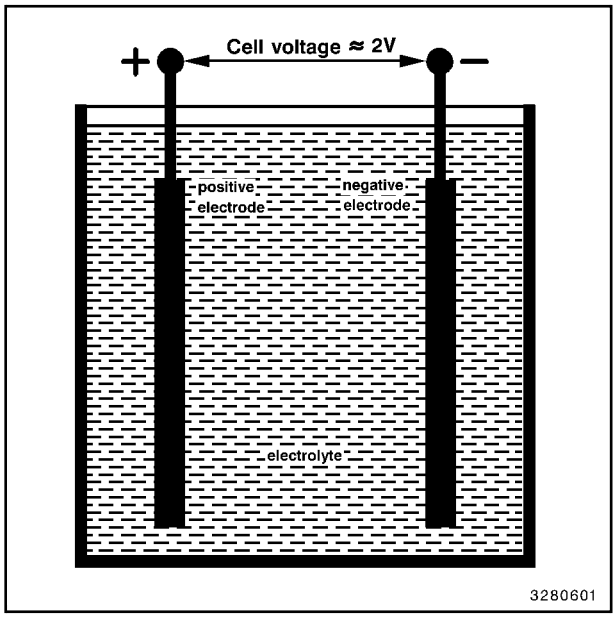


Fig. 2

Basic design of a lead-acid cell.

Types of batteries

Batteries used today are mostly maintenance-free. On account of metallurgical improvements, the water decomposition under normal operating conditions of the vehicle electrical system (U = constant) has been reduced to such an extent that the electrolyte reserve above the plates should be sufficient for the whole service life of the battery.

If such a battery is to be recharged after it has been disconnected from the electrical system, it must be ensured that the charging voltage per cell is limited to 2.4 volts max. (2.3 to 2.4 volts).

Maintenance-free starter battery

1 - One-piece cover
2 - Terminal post cover
3 - Direct cell strap
4 - Terminal post
5 - Frit
6 - Plate strap
7 - Battery case
8 - Base frame
9 - Positive electrodes in separating foils
10 - Negatives electrodes

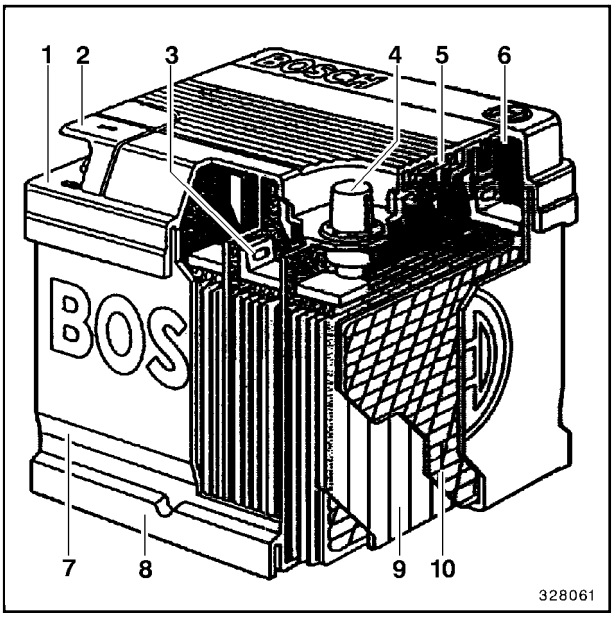


Fig. 3

Important:

The designation "maintenance-free in accordance with DIN" only means that a battery does not exceed certain limits concerning water consumption. It is by no means a guarantee that refilling with water can be dispensed with during the service life of the battery. Moreover, this definition does not concern other aspects of maintenance. For these reasons, both the DIN designation and also certain publicity statements with regard to freedom from maintenance are misleading.

Low-maintenance batteries

The electrolyte level of low-maintenance batteries should be checked at least once a year. If the electrolyte level drops below the "min" mark, the cells must be topped up with distilled water.

If the battery is disconnected from the vehicle electrical system for recharging, it must be charged with a current corresponding to 1/10 of the nominal capacity of the battery.

Important:
During the charging process, batteries give off highly explosive gases. Batteries must only be charged in well ventilated rooms provided for this purpose. Fire, unshielded light and smoking are prohibited.
The safety regulations pertaining to battery handling must always be observed.

Checking the battery

1) Acid density is the most important indicator of battery charge. The degree to which a battery is charged can therefore be determined by measuring the acid density. The acid density is measured with a hydrometer. The density can be read on the scale of this hydrometer.

Density values of diluted sulphuric acid

Charge condition	Type of battery	Acid density kg/l[1])	Freezing point °C
charged	normal type	1.28	- 68
	tropicalized type	1.23	- 40
half charged	normal type	1.16 / 1.20	- 17 ... - 27
	tropicalized type	1.13 / 1.16	- 13 ... - 17
discharged	normal type	1.04 / 1.12	- 3 ... - 11
	tropicalized type	1.03 / 1.08	- 2 ... - 8

2) Starting test
Starting tests are carried out by measuring the battery voltage under load conditions with a battery tester.

For batteries of the one-piece cover type, battery testers for 12 volts are used. The battery tester measures the voltage by applying a load resistor across the battery terminals, so that a current of 300 A flows for abt. 5 seconds through this resistor. The voltage is an approximate measure of the battery's starting capability. The admissible minimum voltage limit is fixed at 8 V = 1.33 V/cell. When the voltage is measured with the battery tester, it is important that the measuring probes and the terminal posts are in good contact.

3) Measuring results
If the acid density is insufficient, but if the starting test is satisfactory, the battery will in most cases only need recharging.
If the acid density and the starting test are unsatisfactory, the battery must only be charged with a low current of 6 A.
If the acid density is sufficient (e.g. after successful charging), but if the starting test is unsatisfactory, the battery is in most cases no longer useful.
If the acid densities of the cells or the battery voltages during the starting test differ considerably when the batteries are charged, or if they are even unsatisfactory, it is recommended to discard the battery.

Mixing fresh battery acid

Important:
When mixing new battery acid, care must be taken that concentrated sulphuric acid is always poured into the distilled water and never the other way round to avoid back-splashing of sulphuric acid. Wear goggles and protective clothes and observe the accident prevention rules.

The volumetric ratio of concentrated sulphuric acid (96 %) to distilled water is set out in the table below.

Mixing instructions

Desired acid density kg/l	Volumetric ratio of concentrated sulphuric acid (96 %) to distilled water
1.23	1 : 3,8
1.26	1 : 3,2
1.28	1 : 2,8
1.30	1 : 2,6
1.34	1 : 2,3

Maintenance

The term "maintenance" encompasses all measures of battery care required for an optimal function of the battery over its whole lifetime.

- Topping up the electrolyte level
- Periodic recharging during storage
- Immediate recharging after discharges
- Avoiding overcharging
- Avoiding exhaustive discharging

Troubleshooting

Trouble	Cause	Remedy
1. Acid level too low	Overcharging, evaporation (particularly during the summer months)	Top up with distilled or demineralized water (when the battery is charged)
2. Acid leaks out of the vent plug	1. Charging voltage too high	Check and adjust voltage regulator or have it replaced
	2. Acid level too high	Draw off excessive acid with the hydrometer
3. Acid density too low	1. Battery discharged	Charge the battery
	2. Alternator malfunction	Have alternator checked
	3. Short-circuit in wiring	Have electrical system checked
	4. Too much water in acid due to incorrect servicing	Have acid density re-adjusted
4. Acid density too high	Too much acid	Have acid density adjusted
5. Battery output power insufficient. Heavy voltage drop	1. Battery discharged	Recharge battery
	2. Charging voltage too low	Re-adjust or replace voltage regulator
	3. Connection terminals loose or corroded	Clean terminals and apply a thin layer of acid-protection grease Ft 40 v 1 on the underside; tighten terminal screws
	4. Battery capacity insufficient (too many consumers)	Use greater battery. If required, install also stronger alternator; consult specialized workshops
	5. Excessive self-discharge of the batteries due to impurities in the battery acid	Replace the battery
	6. Battery "sulphated" (grey-white layer on the positive and negative plates)	Charge battery with low current to induce decomposition of the layer. If the output is still insufficient after repeated charging and discharging, replace the battery
	7. Battery used up, plate substance no longer active	Replace the battery
	8. Acid level below upper edge of plates	Top up with distilled or de-mineralized water to the prescribed level

Trouble	Cause	Remedy
6. Insufficient service life of the battery	1. Battery too often and exhaustively discharged	Use battery with greater capacity considering using special "S" type batteries
	2. Battery gets too warm	Install at a better suited loacation
	3. Battery vibrations too heavy	Install at a better suited location
	4. Battery possibly "sulphated"	cf. 5.6
	5. Battery acid containing impurities	Replace the battery
7. Battery charge permanently insufficient	1. Defective alternator, voltage regulator or line connections	Increase alternator capacity or repair resp. replace alternator and voltage regulator; fasten connections properly
	2. V-belt loose	Retension the belt or replace
	3. Too many consumers connected to the battery	Install bigger battery. Consider using a stronger alternator; consult specialized workshops
8. Permanent overcharge	Voltage regulator and possibly alternator defective	Replace voltage regulator or change regulator setting; check alternator
9. Switch contacts in voltage regulator burnt (in case of d.c. generators)	Battery incorrectly connected (wrong polarity)	Connect battery with correct polarity. Replace voltage regulator
10. Rectifier diodes destroyed (in case of alternators)	Battery incorrectly connected (wrong polarity)	Connect battery with correct polarity. Replace rectifier diodes

Function of the alternator

The alternator has the function to meet the energy demands of the electrical consumers. Moreover, it has to ensure that the batteries are being charged when power is at the same time supplied to permanent consumers, and even when the engine is running at low speed (idling). The alternator has to supply a constant voltage under all operating and loading conditions.
In doing so, the alternator is assisted by the regulator which maintains the voltage between 13 and 14.5 volts independent of alternator load and alternator speed.

Alternator

1 - Housing
2 - Diode carrier
3 - Power diode
4 - Excitation winding (rotor)
5 - Regulator
6 - Stator winding (stator)
7 - Rotor

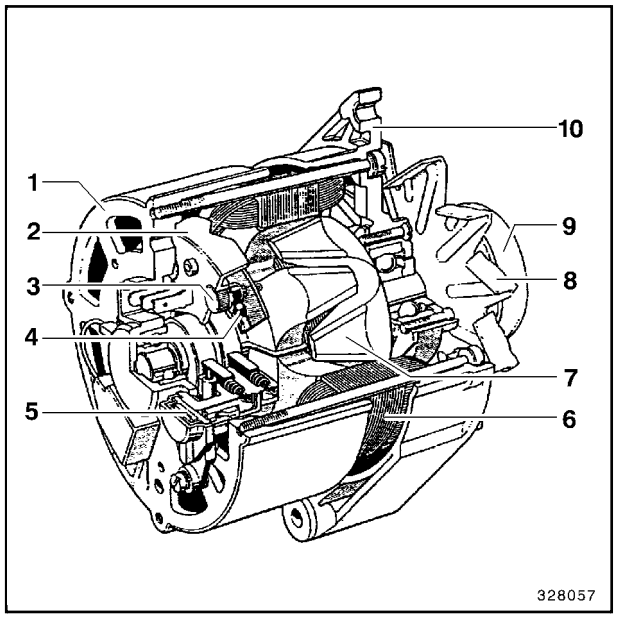
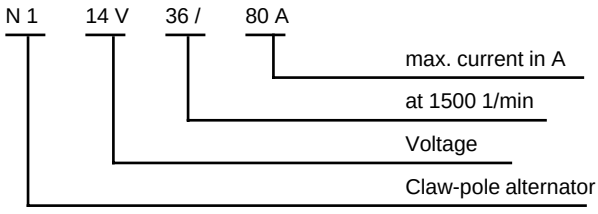


Fig. 4

Type designation



Important:
Depending on type, our machines are equipped with alternators for 12 volts resp. 28 volts.

Alternator

The alternator is a self-excited 12-pole synchronous claw-pole alternator with incorporated silicon rectifier diodes. The three-phase winding is in the stator and the exciter winding in the rotor.

The exciter current is supplied from the rectifier via D+, the regulator, two brushes and the slip rings to the exciter winding in the rotor. The stator winding is connected to the silicon rectifier diodes by means of a three-phase bridge circuit.

The rectified current is supplied to the consumers and the battery via the B+ terminal. The D+ terminal must only be loaded with the regulator current, the charging monitor and an additional current of 0.5 A (e.g. start inhibit relay).
In 24 V systems the charge monitoring lamp must be a 2 W type to ensure the appropriate excitation of the alternator. The voltage is regulated by the incorporated electronic field rheostat.

Claw-pole alternator

1 - Slip ring end shield
2 - Rectifier heat-sink
3 - Power diode
4 - Excitation winding (rotor)
5 - Transistor regulator with incorporated carbon brushes
6 Stator with three-phase winding
7 - Rotor with claw poles
8 - Fan
9 - Pulley
10 - Drive end shield with mounting flanges

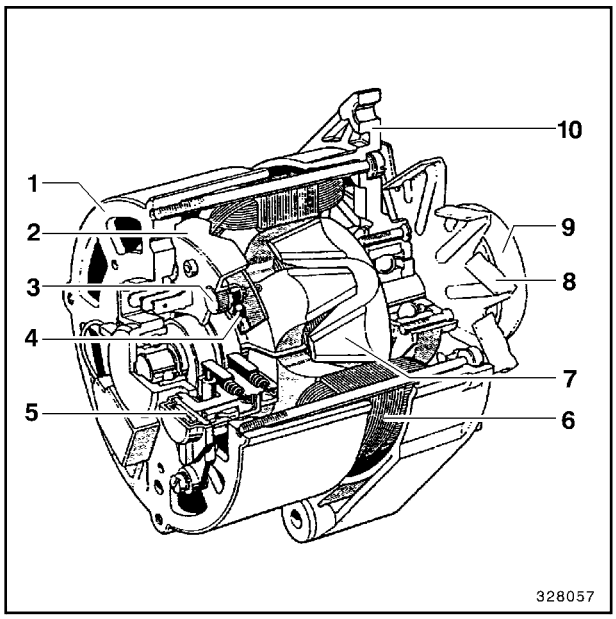


Fig. 5

Maintenance

Alternators installed in modern vehicles are largely maintenance-free. The V-belt tension should be checked once every month depending on the use of the machine.

The carbon brushes should be checked once every year. The slip-rings must also be visually inspected and polished with ultra-fine polishing cloth.

Electric motors

In motor vehicles, d.c. motors (starter motors, windscreen-wiper motors, fan motors, etc.) are used almost exclusively. The principle of these motors will therefore be discussed in greater detail.

Principle of the electric motor

An electric motor is a device that converts electrical energy (voltage times current) into mechanical energy (speed times torque). This is based on the fact that a current-carrying conductor in a magnetic field experiences a force. The force is proportional to the strength of the magnetic field and the magnitude of the current, and is greatest when the magnetic field and the conductor plane are in alignment.

For practical purposes, the conductor has the form of a rotating loop of wire (Fig. 6). The magnetic field lines extend from pole to pole (pole-shoe to pole-shoe).

If the conductors are under the pole-shoes, i.e. inside the magnetic field, the torque imparted to the loop of wire is constant and has a certain direction. After a half turn, when each conductor comes under the influence of the opposite magnetic field, the torque remains the same but its direction is reversed. If the loop is perpendicular to the pole shoe, the torque becomes zero (Fig. 7).

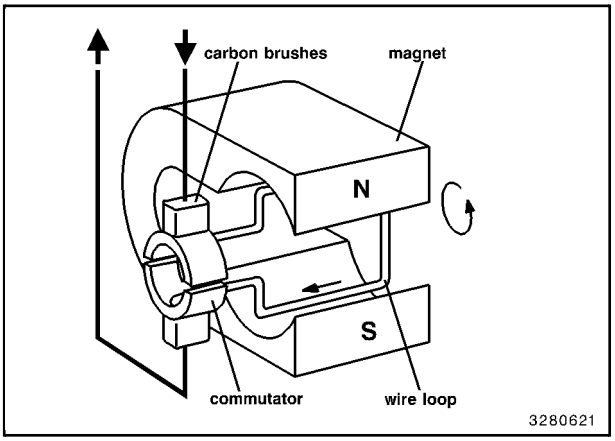


Fig. 6

Fig. 6 = Schematic diagram of an electric motor with a loop of wire

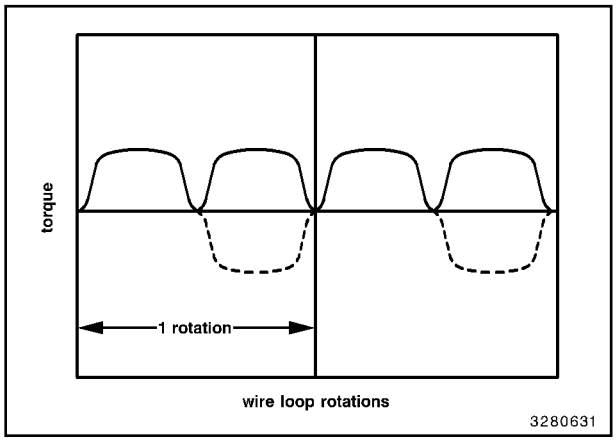


Fig. 7

Fig. 7 = Torque imparted to a loop of wire

If it can be ensured that the flow of current is reversed in the loop of wire after every half turn, the torque has always the same sense of rotation and can therefore cause the loop to turn continuously.

The current is reversed by means of a commutator consisting of two separate halves of a split-ring to which two ends of the wire loop are connected. Two collectors, called carbon brushes, are connected to the current source and slide on the split-ring segments (Figs. 6 and 8).

In order to obtain a uniform torque, an electric motor makes use of many wire loops (Fig. 8). Fig. 9 shows the individual torques for three symmetrically arranged loops and the resulting overall torque. In this case, the commutator has six individual segments, which are also called laminations. In reality, the number of loops is even higher since the torque increases with the number of wire loops installed.

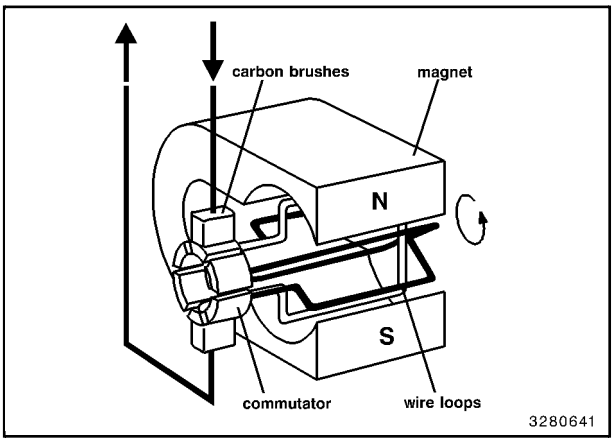


Fig. 8

Fig. 8 = Schematic diagram of an electric motor with three wire loops

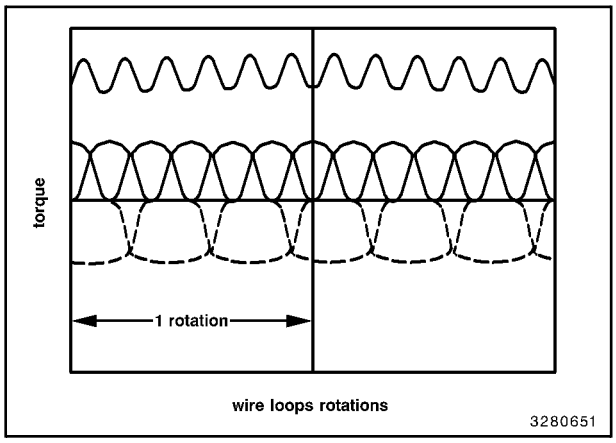


Fig. 9

Fig. 9 = Torque of three wire loops

Starting motor (starter)

Function of the starter

When the starter switch is operated, the starting motor solenoid and the engaging lever push the pinion along the spiral spline into the ring gear (Fig. 10).

When the starting motor solenoid reaches its end position, the main current contact is closed (Fig. 11).

The pull-in winding is now without current and the pinion kept in engagement by the hold-in winding.

When the motor starts, the pinion is pushed back into its original position by the armature-return spring when the starting switch is released.

Engaging

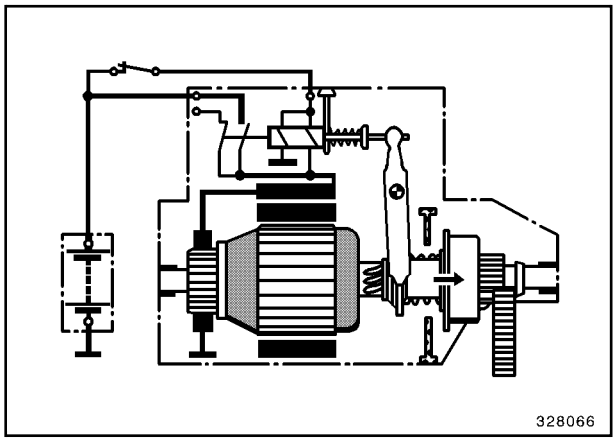


Fig. 10

Engaged

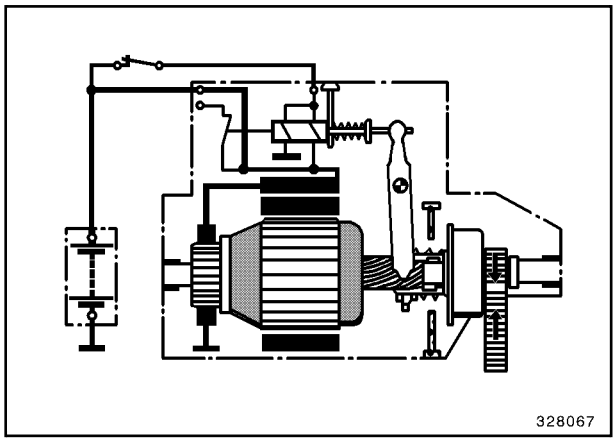


Fig. 11

Checking the vehicle starter system

Checking the battery (cf. under "Battery").
Checking the battery cables and connections for proper contact.
Measuring the voltage drop (0.5 V).
Measuring the minimum pull-in voltage at solenoid switch terminal 50 (8.0 V).

Starter

1 - Armature-return spring
2 - Hold-in winding
3 - Pull-in winding
4 - Starting motor solenoid
5 - Contact
6 - Mounting stud
7 - Contact bridge
8 - Collector bearing
9 - Brush spring
10 - Collector
11 - Carbon brush
12 - Pole housing
13 - Pole shoe
14 - Armature
15 - Exciter winding
16 - Armature winding
17 - Guide ring
18 - Stop
19 - Roller-type overrunning clutch
20 - Armature shaft
21 - Pinion
22 - Driver
23 - Brake disk
24 - Engaging spring
25 - Engaging lever

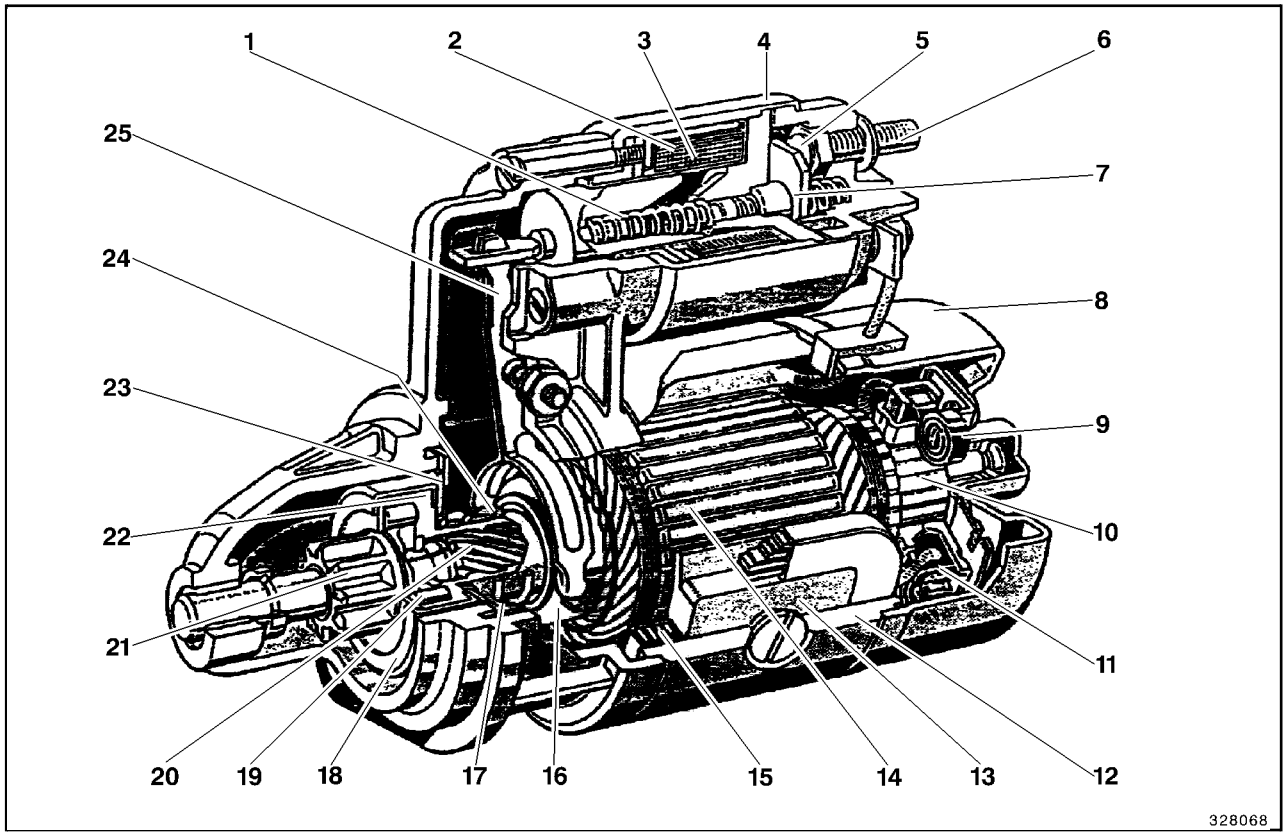


Fig. 12

Maintenance

1) Basic rules

   Working on the electrical part of the starting motor involves the risk of short-circuits. It is therefore recommended to disconnect the ground terminal from the battery before undertaking such work. Do not place tools on the battery.

2) Carbon brushes

   The carbon brushes must be checked from time to time for condition (cf. figure). After removing the end cover, the spring pressing the carbon brush against the collector is lifted with a hook. Do not bend spring sideways and do not lift more than necessary before checking whether the carbon brushes move easily in the brush-holder guide.

3) Collector

   The collector should present a uniform and smooth surface of greyish black colour and must be free from oil and grease. Contaminated collectors must be cleaned with a clean and petrol-stained cloth (do not use cleaning wool) and properly dried. Collectors presenting scoring and out-of-roundness due to wear must be repaired by turning off on a lathe in a specialized workshop. Under no circumstances must collectors be treated with emery-paper or a file.

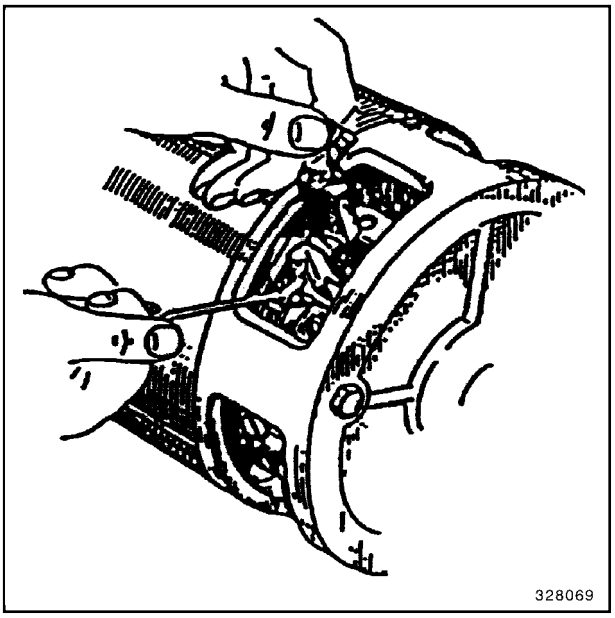


Fig. 13

Lubrication

Both bearings of pre-engaged-drive starting motors are self-lubricating. This means that they must not be lubricated. This type of bearing must not be treated with fat-dissolving detergents.

Carbon brushes and brush holders must be free from oil and grease. If these parts are contaminated or jamming, they must be cleaned with a clean and petrol-stained cloth (do not use cleaning wool because it is not lint-free) and well dried. Do not treat the bright metal sliding surface of the carbon brushes with emery-paper, files or knives. Brush holders must be blown clean. If a carbon brush is broken, unsoldered or worn out to such an extent that the spring or the stranded wire soldered into the brush threatens to contact the brush holder, the carbon brush must be replaced. When inserting the carbon brush, care must be taken that the spring does not tap on the brush

Carbon brushes should always be replaced during general repairs of the motor.

The collector should be repaired by turning off on a lathe whenever the carbon brushes are replaced.

FUNDAMENTALES OF AUTOMOTIVE ELECTRICAL SYSTEMS

Current, voltage, resistance and power

Current (I)

Electric current is the flow of free electrons in a conductor. The current is measured with an ammeter which must be connected in series with the consumer. The quantity of electric current is designated by "I" and the unit of current is symbolized by "A" (ampere).

Voltage (U)

Voltage is the potential difference existing between two conductors. Voltage is measured with a voltmeter which must be connected in parallel with the consumer or across the two points of different potential. The quantity of electric voltage is designated by "U" and the unit of voltage is symbolized by "V" (volt).

Resistance (R)

Electric resistance is the resistance offered to the electric current. The electric resistance depends on the material of the resistor and its dimensions. The quantity of electric resistance is designated by "R" and the unit of resistance is symbolized by " " (ohm).

Power (W)

Electric power is the current flowing through a consumer at a constant voltage. Power is symbolized by "P" and the unit of measure is symbolized by "W" (watt).

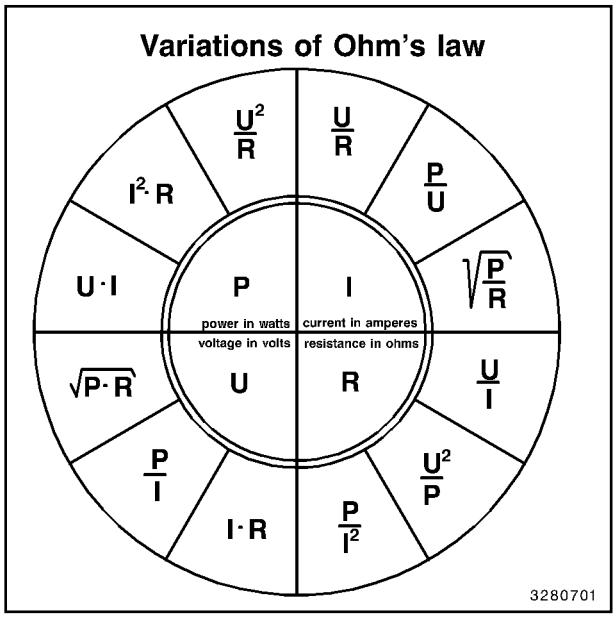


Fig. 1

MEASUREMENTS WITH THE MULTIMETER

Adjustment of the multimeter

Before connecting the meter to a circuit the following steps must be taken:

1) Set the meter to d.c. current or to a.c. current, resp. voltage.

2) Select the highest measuring range.

3) Connect the instrument and switch down to the measuring range offering the greatest possible scale reading for the measurement in question.

Measuring voltage

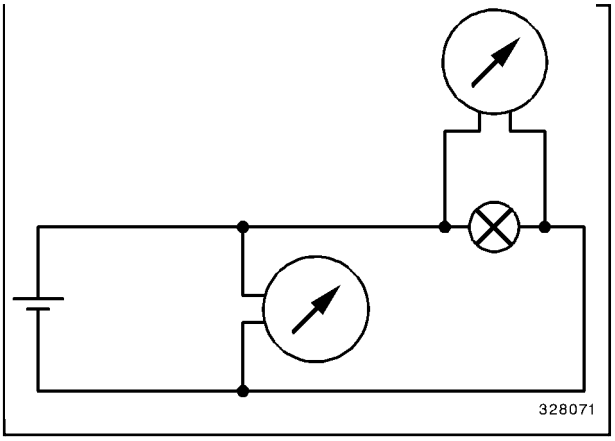


Fig. 1

Important:
A voltmeter is always connected in parallel with the consumers resp. across the voltage source.

Measuring current

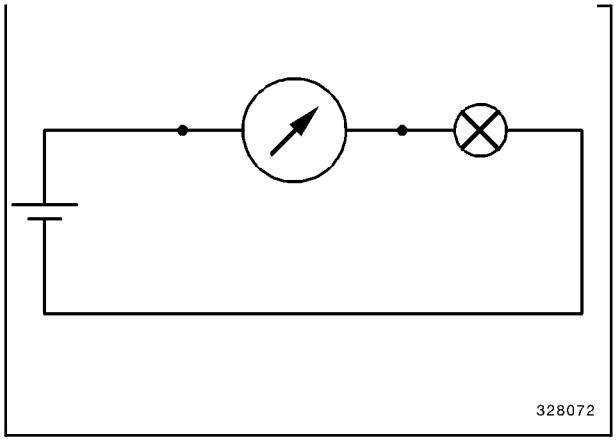


Fig. 2

Important:
If current is to be measured, the current-carrying conductor must be separated and the instrument connected in series, so that the current flows through the measuring instrument.

Measuring resistance

Ohmmeter

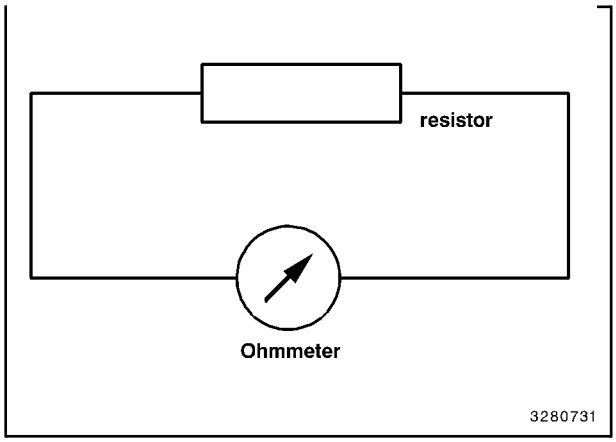


Fig. 3

Important:
If resistance is to be measured, the component to be measured must always be free from any voltage. Components in a circuit can only be measured after removing them from the circuit.

SERIES AND PARALLEL CONNECTION OF ELECTRICAL COMPONENTS

Batteries

If two or more batteries are connected in series, the voltages of the individual batteries add up to give the total voltage.

If two or more batteries are connected in parallel (the batteries having the same voltage rating, of course), the total voltage remains the same. The battery capacity, however, is the sum of the individual capacities.

Important:
Observe the polarity when connecting batteries to each other.

Resistors

Series connection

If two or more resistors are connected in series, the total resistance (R_{tot}) is the sum of the individual resistances.

Parallel connection

If two or more resistors are connected in parallel, the total resistance (R_{tot}) is less than the smallest of the individual resistances. When connecting two resistors with the same resistance together, the total resistance is half that of the individual resistor.

Capacitors

Series connection

If capacitors are connected in series, the total capacitance (C_{tot}) is less than the smallest individual capacitance.

Parallel connection

If capacitors are connected in parallel, the capacitances add, i.e. the total capacitance (C_{tot}) is the sum of the individual capacitances.

Important:
The results obtained for series or parallel connection are just the opposite of those found for resistors.

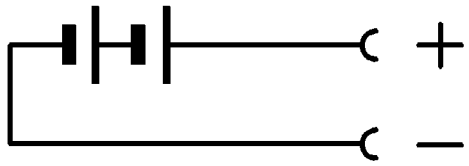
Electrolytic capacitors

Electrolytic capacitors have the same behaviour as the above-mentioned capacitors with the exception, however, that their polarity is of importance. The polarity is marked on the capacitor.

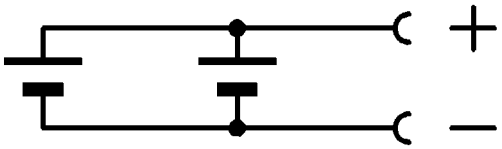
Important:
Electrolytic capacitors must never be used with wrong polarity. **Risk of accident.**

Remarks:
Further components or their schematic symbols can be found in section "symbols used in electrical engineering".

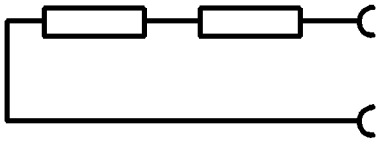
Battery series connection



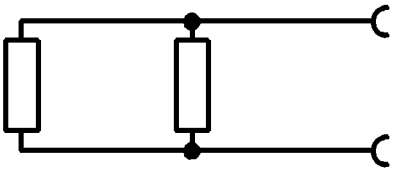
Battery parallel connection



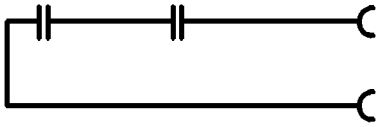
Resistor series connection



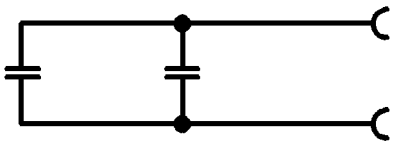
Resistor parallel connection



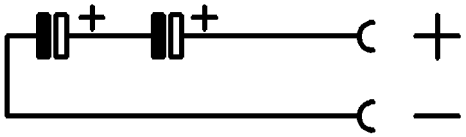
Capacitor series connection



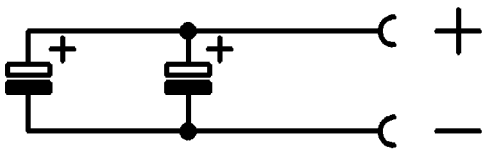
Capacitor parallel connection



Electrolytic capacitor
series connection



Electrolytic capacitor
parallel connection



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VOLTAGE LOSSES AND CABLES

The values for U_{vl} set out in table 1 can be used for computing positive leads. The voltage loss in the return lead to ground is not considered here. If the ground lead is insulated, however, the line length to be considered is equal to the total length of the positive and the return lines.

The U_{vg} values indicated are check values which cannot be used for line calculations, as they take into account - beside the lines themselves - also the contact resistance of switches, fuses, etc.

Table 1 - Admissible loss of voltage

Type of line	Adm. voltage drop in positive lead U_{vl}	Adm. voltage drop in overall circuit U_{vg}	Remarks
Lighting lines from lighting switch terminal 30 to lamps > 15 W to trailer receptacle from trailer receptacle to lamps	0.1 V	0.6 V	Current at nominal voltage and nominal power
from lighting switch terminal 30 to lamps > 15 W to trailer receptacle	0.5 V	0,9 V	---
from lighting switch terminal 30 to head lamps	0.3 V	0.6 V	---
Charging line from alternator terminal B to battery	 0.4 V at 12 V 0.8 V at 24 V	 --- ---	 - current at nominal voltage - and nominal power
Control lines from alternator to regulator (terminals D+, D-, DF)	0.1 V at 12 V 0,2 V at 24 V	--- ---	- At maximum - exciter current (remark 1)
Starter main line	0.5 V at 12 V 1.0 V at 24 V	--- ---	- Starter short-circuit current at +20˚C (68˚F) (remarks 2 and 3)
Starter control line from starter switch to starter terminal 50 Engaging relay with simple winding Engaging relay with pull-in and hold-in winding	 1.4 V at 12 V 2.0 V at 24 V 1.5 V at 12 V 2.2 V at 24 V	 1.7 V at 12 V 2.5 V at 24 V 1.9 V at 12 V 2.8 V at 24 V	 Max. control current (remarks 4 and 5)
Other control lines from switches to relays, horn, etc.	0.5 V at 12 V 1.0 V at 24 V	1.5 V at 12 V 2.0 V at 24 V	Current at nominal voltage

Remarks:

1) All three control lines, if possible, of the same length and resistance.

2) In special cases and very long starter main lines, the U_{vl} value can be exceeded for reduced limit starting temperatures.

3) In case of an insulated return of the starter main line, the voltage drop in the return line must not exceed that of the positive line. Admissible values for each line are 4 % of nominal voltage, i.e. 8 % altogether.

4) The U_{vl} values are applicable to engaging relay temperatures between 50 and 80°C (122 and 176°F).

5) If required, the line from the starting switch must be accounted for.

Calculation of lines

Quantities and units

Quantity		Unit
I	Electric current	A
l	Line length	m
P	Power consumption of consumer	W
q	Line cross-section	mm^2
R	Resistance (consumer)	Ω
S	Current density in the line	A/mm^2
U_N	Nominal voltage	V
U_{vl}	Admissible voltage drop of insulated lines	V
U_{vg}	Admissible voltage drop in overall circuit	V
rho	Resistivity	$\Omega mm^2/m$

Computation

When determining the line cross-section, the voltage drop and the temperature rise must be taken into consideration.

1) Determine the electric current *I* flowing through the consumer

$$I = P/U_N = U_N/R$$

2) Calculate line cross-section *q* based on the U_{vl} values in table 2
(for copper = 0.0185 $\Omega mm^2/m$)

$$q = I \cdot \text{rho} \cdot l/U_{vl}$$

3) Round up *q* to the next higher line cross-section according to table 1. Individual lines below a cross-section of less than 1 mm^2 are not recommended because of insufficient mechanical resistance.

4) Compute the effective voltage drop U_{vl}.

$$U_{vl} = I \cdot \text{rho} \cdot l/q \text{ and}$$

5) check current density *S* to avoid inadmissible warming (for short-time operation $S < 30$ A/mm^2, values for permanent operation cf. table 1).

$$S = I/q$$

Lines and wires in automotive electrical systems

Table 2 - Electrical copper wires for motor vehicles

Single-conductor, untinned, PVC-insulated

Nominal cross-section	Resistance per meter	Diameter of conductor	Diameter of cable	Admissible permanent current (recommended value)		Admissible current density
	at 20˚C (68˚F)	Largest dimension	Largest dimension	at + 30˚C (86˚F)	at + 50˚C (122˚F)	Permanent operation
mm^2	mΩ/m	mm	mm	A	A	A/mm^2
0,5	37,1	1,0	2,3	11	7,8	10
0,75	24,7	1,2	2,5	15	10,6	10
1	18,5	1,4	2,7	19	13,5	10
1,5	12,7	1,6	3,0	24	17,0	10
2,5	7,6	2,1	3,7	32	22,7	10
4	4,71	2,7	4,5	42	29,8	10
6	3,14	3,4	5,2	54	38,3	6
10	1,82	4,3	6,6	73	51,8	6
16	1,16	6,0	8,1	98	69,6	6
25	0,743	7,5	10,2	129	91,6	4
35	0,527	8,8	11,5	158	112	4
50	0,368	10,3	13,2	198	140	4
70	0,259	12,0	15,5	245	174	3
95	0,196	14,7	18,0	292	207	3
120	0,153	16,5	19,8	344	244	3

Design example

If an electrical component is to be installed in addition to those existing, we must know the cross-section of the cable to be used.

Example:
Installation of a floodlamp (two bulbs)

The following characteristics must be known: operating voltage of the vehicle and power consumption of the floodlamp. In our example, we assume the operating voltage to be 24 volts (28 volts) and the power consumption of one floodlamp bulb to be 70 W.

The first step consists in calculating the current flowing through the bulb (cf. chapter 4 - variations of ohm's law).

$$J = \frac{P}{U} = \frac{70\ W}{24\ W} = 2.9\ A$$

The current flowing through one of the bulbs would be 3 A. As we are installing two lamps in our example, we have to take twice this current (6 Ampere).

With reference to table 2 and for an ambient temperature of 50˚C (122˚F) (always used for calculations, as it cannot be excluded that the cable crosses the engine compartment), we can use a cable having a conductor cross-section of 0.5 mm^2.

Important:
The cables should be laid in a flexible tubing to avoid chafing or squeezing.

When retrofitting electrical components, it must be ensured that only "brown" cables are used for ground connections or negative leads. It must not be forgotten to protect all circuits with suitable fuses. If switches are used, the contacts must be designed for the currents expected.

LIGHTING

Vehicle lighting is of particular importance for the operating safety of the vehicle. The vehicle's headlamps must be designed and installed in accordance with the Federal Motor-Vehicle Safety Standards.

The headlamps must be adjusted in accordance with the Motor-Vehicle Traffic Regulations. If they are incorrectly adjusted, oncoming traffic may be dazzled by the headlamps.

Headlamps adjustment hints

1) The vehicle must be parked on a level surface.

2) The tyre pressure must be checked.

Headlamps should only be adjusted with a headlight setter after the two above-mentioned requirements have been met.

Floodlamps

Floodlamps may only be switched on for working. They are mostly installed on a mobile mount and can be turned to the required direction.

Bulbs

Light bulbs exist for electrical systems having 6, 12 and 24 volts. To avoid confusion, the bulbs are equipped with different bases. Voltage and wattage are marked on the bulb. Halogen bulbs are designated by the symbols H 1 .... H 4. Compared to conventional bulbs, the light efficiency of halogen bulbs has been improved by 70 % on average.

Important:
Bulbs must only be replaced by those stated in the circuit diagram.

Malfunctions of the lighting system and their causes

Important:
Always remember that the lighting installation is part of the vehicle's operating safety. The operating safety must be checked before using the vehicle.

One of the most frequent deficiencies of headlamps is that their light is "yellowish" and not white as it usually should be. If the power supply is o.k., the main cause of this deficiency is an inadmissibly high ground transition resistance, so that the allowed voltage drop is exceeded (cf. chapter "VOLTAGE LOSSES AND CABLES").

Transition resistance in electrical circuits

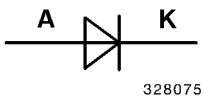
Transition resistances are most often found in cable connections, ground connections and defective switches. A transition resistance in a circuit causes a loss of voltage.
The admissible voltage losses are set out in the table of chapter "VOLTAGE LOSSES AND CABLES".

SPECIAL CIRCUITS IN AUTOMOTIVE ELECTRICAL SYSTEMS

The diode

Diodes are mainly made of germanium or silicon (both semi-conductors). They are mainly used in electronics and in automotive electrical systems.

Diodes are components permit the current to flow only in one direction, comparable to the non-return valves in hydraulics. The two connections are designated as the anode and the cathode.



If a positive voltage is applied to the cathode of such a diode, the current cannot flow to the anode because the diode is in a non-conducting state (operation in reverse direction). In the opposite case, the anode is connected to the positive supply, so that the current can flow to the cathode (operation in forward direction). For a negative voltage, the diode's behaviour is just the opposite of that with a positive voltage.

N.B.:
Positive voltage at the cathode - diode in non-conducting state.

Negative voltage at the cathode - diode in conducting state.

Positive voltage at the anode - diode in conducting state.

Negative voltage at the anode - diode in non-conducting state.

The "free-wheeling" diode

The term "free-wheeling" used in connection with a diode, only makes sense if considered in conjunction with a circuit including wire coils as inductors.

Electrical circuit with a diode used as a "free-wheeling" diode.

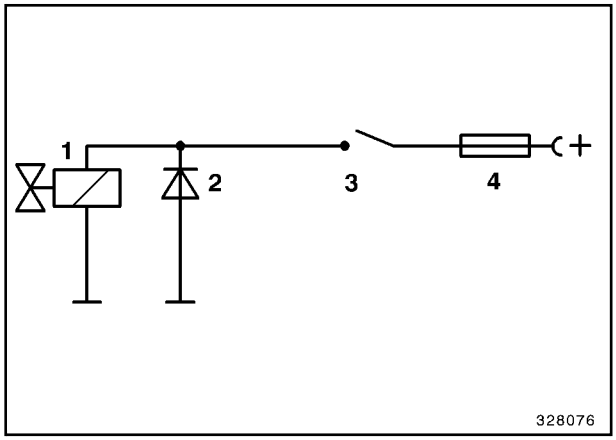


Fig. 1

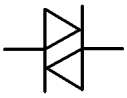
1 = Solenoid valve
2 = Free-wheeling diode
3 = Switch
4 = Fuse

When the solenoid valve is switched off, the coil produces an inductive voltage with a polarity opposite to that of the supply voltage. This voltage is so high that - when a switch is opened - an electric arc is struck which is capable of welding the switch contacts together.

As the induced voltage is negative at switch-off and as this voltage is applied to the cathode, the diode is in a conducting state for this voltage. The inductive voltage is short-circuited to ground which is an efficient protection against melting of the switch contacts.

Varistors

A varistor is a voltage-dependent resistor which fulfils on principle the same function as a free-wheeling diode and which is used in circuits in the same way.



Basic behaviour of a varistor: the higher the voltage the smaller the resistance.

Voltage rectification in three-phase bridge circuits

Since the alternator in a motor vehicle generates a three-phase alternating current, this current must be rectified if it is to be used for charging the battery.

If the three-phase alternating voltage generated by the alternator is displayed on an oscilloscope, we obtain 3 sine curves phase-shifted by 120° each. This is dependent on generator design.

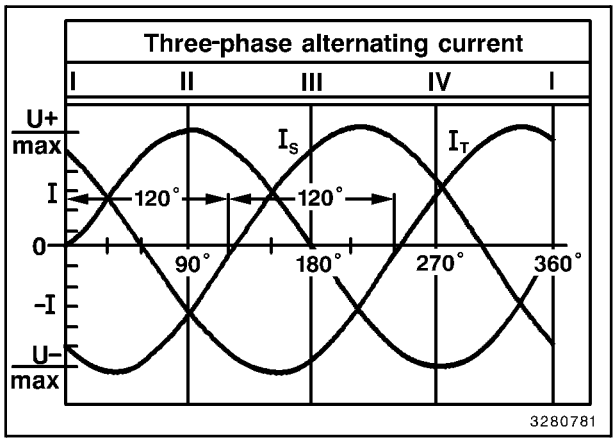
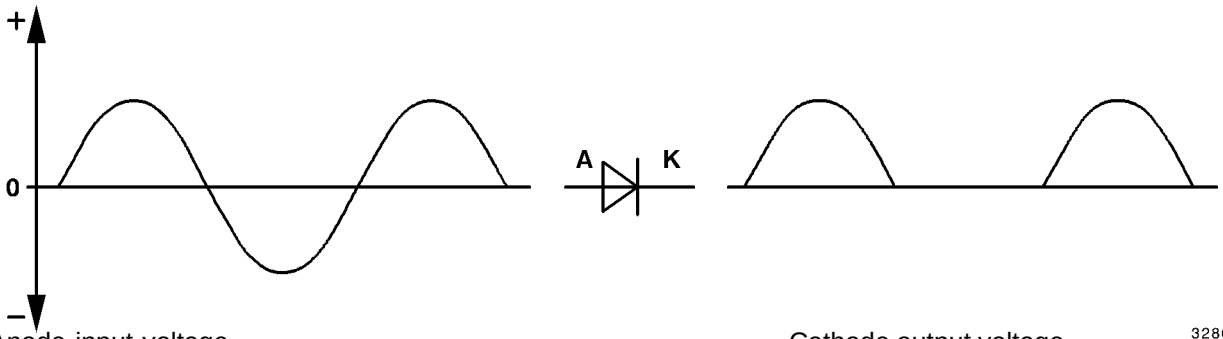


Fig. 2

Let us first consider one of the curves. The curve rises to the highest voltage value U+ max (plus) and then drops to the lowest voltage value U- max (minus) after crossing the "0" line.

If we now apply this alternating voltage to the anode of a diode, the negative half-wave is blocked and the positive one is allowed to pass.



Anode input voltage

Cathode output voltage

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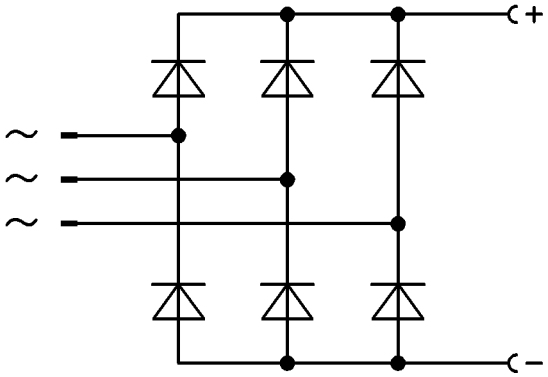
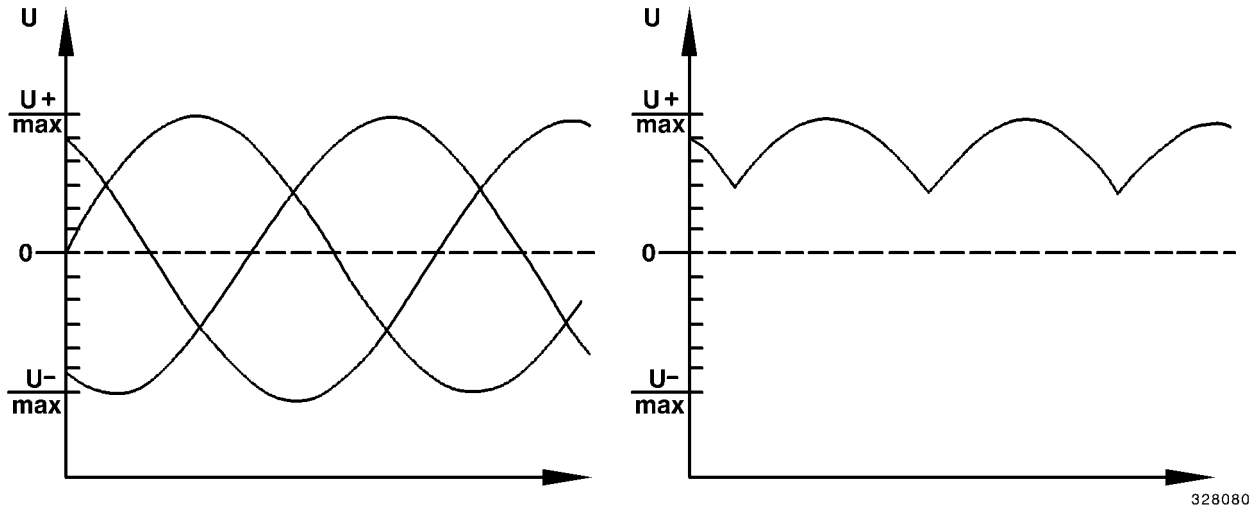
As we see from the diagram, only the positive (plus) voltage is left at the cathode.

If we consider the principle of rectifying three-phase currents, we see that several diodes are connected to form a bridge, as can be seen from the diagram below.

Three-phase current





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Three-phase current - Input into the bridge circuit

Direct current - Output from bridge circuit

As we have seen from the above diagrams, only positive half-waves are left at the rectifier bridge output, which means that the output carries only d.c. currents or d.c. voltages.

This d.c. current is used to buffer the battery.

Important:
The individual diodes of this bridge are designated by the term of "main diodes".

Alternator regulator

The alternator regulator regulates the current from the field windings of the alternator in such a way that in spite of varying alternator speeds there is always a constant voltage for charging the battery depending on battery condition. The field current is produced by the main windings of the alternator (4) and converted to direct current by means of the so-called field diodes. This d.c. voltage passes to the regulator (1) which controls the field current of the alternator.

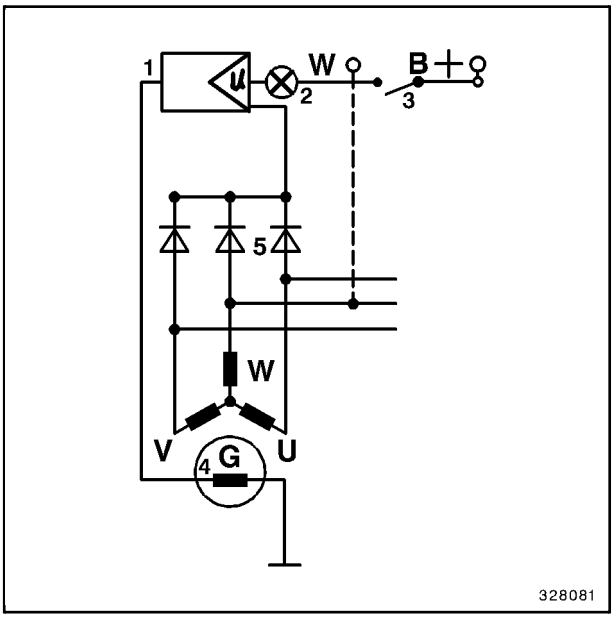


Fig. 3

1 Voltage regulator
2 - Charge monitoring lamp
3 - Ignition switch
4 - Alternator
5 - Field diode

The charge monitoring lamp (2) serves the purpose of pre-magnetizing the alternator. If the ignition switch is closed, the current flows from the battery through the regulator and the field winding to ground. The lamp circuit is now closed and the lamp lights up.

The current causes a weak magnetic field to build up in the field winding. When the alternator starts to turn, the main winding produces three-phase alternating current which is rectified in the field diodes (5). This direct current is then returned in a controlled state to the field winding where it generates a greater magnetic field depending on battery condition. At the same time, the field voltage is present at the regulator and charge monitoring lamp.

As the voltage on both sides of the lamp is now positive, the lamp goes out. Terminal "W" carries an alternating voltage which can be used for control purposes. The winding terminals of the alternator (4) are designated by U, V and W.

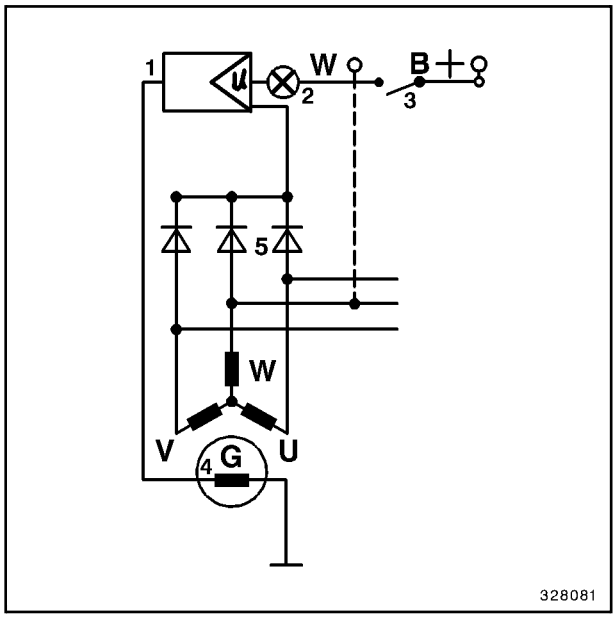


Fig. 4

FUSES IN MOTOR VEHICLES

Type	Nominal current A	Colour coding
Round fuses	5 8 8	yellow black white
	16 25	red blue
	25	white
Strip fuses	25	white
	30, 50, 100	grey
	125, 150, 250	
	35, 60, 100	grey
Plug-in type fuses	3 4 5 7,5 10 15 20 25 30	violet pink beige / transparent brown red blue yellow neutral / white green
Glas fuses	5 10 15 20 25	red yellow blue green silver
Radio fuses	2	transparent

DESIGNATION OF INDIVIDUAL COMPONENTS

Extract from DIN 40 719

Letter	Designation	Examples
A	Assembly, sub-assemblies	Amplifiers, magnetic amplifiers, assembly combinations
B	Conversion of non-electrical to electrical quantities (and vice versa)	Measuring transducers, thermo-electric probes, thermo cells, photo-electric cells, dynamometers, quartz cristals, phase-sequence transmitters, phase-angle sensors
C	Capacitors	---
D	Time-delay elements, storage devices, binary elements	logic elements, bi-stable elements, mono-stable elements
E	Miscellaneous	Lighting devices, heating devices
F	Protective devices	Fuses, surge voltage protectors, blocking devices, isolated fuses, protective relays, tripping elements
G	Alternators Power supply	Rotating alternators, rotating frequency converters, battery, power supply units, oscillators
H	Signalling equipment	Optical and acoustical signalling equipment
I	---	
K	Relays, contactors	Power contactors, auxiliary contactors, auxiliary relays, flasher relays, timer relays
L	Inductors	Chokes
M	Motors	---
P	Measuring instruments, testers	Indicating, recording and counting meters, pulse transmitters, clocks
Q	Power-current switching relays	Power switches, disconnectors, protective switches, motor protection switches, circuit breakers, fuse switches
R	Resistors	Variable resistors, potentiometers, rheostats
S	Switches, selectors	Pushbuttons, limit switches, control switches, signal transmitters
T	Transformers	voltage transformers, current transformers
U	Modulators, converters	Frequency converters, transducers, invertors, changers, d.c. inverters, power inverters
W	Transmission lines, wave-guides	Wires, cables, bus bars
X	Terminals, plugs, receptacles	Plugs and receptacles, test connectors, terminal strips, soldering strips
Y	Electrically operated mechanical devices	Brakes, couplings, valves
Z	Terminations, Equalizers, filters, limiters, Y-terminations	Cable equivalents

STANDARDIZED DESIGNATIONS OF TERMINALS

Terminal designation
(extract from DIN 72 552)

Designations of terminals are not identical to cable designations as appliances with different terminal designations can be connected to both ends of a line. If the terminal designations are insufficient (multi-pole connectors), the terminals are designated by running numbers or letters for which no function is standardized.

Terminal	Designation
1	**Ignition coil, ignition distributor** Low voltage
1 a 1 b	Ignition distributor with two separate circuits to contact breaker I to contact breaker II
2	Short-circuit terminal (magnetic ignition)
4	Ignition coil, ignition distributor high-voltage
4 a 4 b	Ignition distributor with two separate circuits from ignition coil I, terminal 4 from ignition coil II, terminal 4
15	Switched positive behind battery, (output ignition switch)
15 a	Output at ballast resistor to ignition coil and starter
17 19	**Glow-starting switch** Starting Preheating
30	**Battery** Input from battery Plus, direct
30 a	Battery change-over relay 12/24 V Input from battery II Plus
31 b	Return line to battery Minus or ground, via switch or relay (switched negative)
31 a 31 c	Battery change-over relay 12/24 V Return line to battery II Minus Return line to battery I Minus

Terminal	Designation
32 33 33 a 33 b 33 f 33 g 33 h 33 L 33 R	**Electric motors** Return line [1)] Main connection [1)] Limit stop shut-off Shunt field for second lower speed for third lower speed for fourth lower speed Lefthand sense of rotation Righthand sense of rotation
45	**Starter** Separate starter relay, output; starter, input (main current)
45 a 45 b	Double starter parallel operation Starter relay for engaging current Output starter I, input starters I and II Output starter II
48	Terminal at starter and at start repeat relay Start monitor
49 49 a 49 b 49 a	**Flasher relay** (pulse transmitter) Input Output Output, 2nd flasher relay Output, 3rd flasher relay
50	**Starter** Starter control (direct)
50 a	Battery change-over relay Output for starter control
50 b	Starter control for parallel operation of two starters with sequential control
50 a 50 d	Starter relay for sequential control of enganging current in parallel operation of two starters Input to starter relay for starter I Input to starter relay for starter II

Terminal	Designation
	Start inhibit relay
50 e	Input
50 h	Output
	Alternator
51	D.c. voltage at rectifier
51 e	D.c. voltage at rectifier with choke
	Trailer signals
52	General signalling from trailer to tractor vehicle
53	**Wiper motor** Input (+)
53 a	Wiper (+), limit stop
53 b	Wiper (shunt winding)
53 c	Electrical washer pump
53 e	Wiper (Brake winding)
53 i	Wiper motor with permanent magnet and third brush (for higher speed)
	Stoplight
54	for lamp clusters and trailer connectors **Trailer signal**
54 g	Compressed-air valve for permanent brake, electro-magnetically operated
55	**Fog lamp**
56	**Headlamps**
56 a	Main beam and main beam warning
56 b	Dipped beam
56 d	Flasher contact
57	**Position lamp** for motor-cycles (in foreign countries also for cars, trucks, etc.)
57 a	**Parking lamp**
57 L	Parking lamp, left
57 R	Parking lamp, right
58	**Position, tail, licence plate and instrument-panel lamps**
58 b	Tail lamp change-over for single-axle trailers
58 c	Trailer connectors for tail lamp connected with single-conductor cable, fuse-protected in trailer
58 d	Adjustable instrument panel illumination, tail and position lamp
58 L	left
58 R	right, licence-plate lamp

Terminal	Designation
	Alternator (Magnetic ignition alternator)
59	Alternating voltage, output, rectifier, input
59 a	Charging armature, output
59 b	Tail-lamp armature, output
59 c	Stop-lamp armature, output
61	**Alternator monitor**
	Tone-sequence switch
71	Input
71 a	Output to horn 1 + 2 low-tones
71 b	Output to horn 1 + 2 high-tones
72	**Alarm switch** (Rotary beacon)
75	**Radio, cigarette lighter**
76	Loudspeaker
77	**Door-valve control**
	Switch normally closed and change-over contacts
81	Input
81 a	1st output, break contact
81 b	2nd output, break contact
	Make contact
82	Input
82 a	1st output
82 b	2nd output
82 z	1st input
82 y	2nd input
	Multi-point switch
83	Input
83 a	Output, position 1
83 b	Output, position 2
83 L	Output, position left
83 R	Output, position right
	Current relay input
84	Input, drive and relay contact
84 a	Output, drive
84 b	Output, relay contact
	Switching relay
85	Output, drive (end of winding minus and ground) Input, drive
86	Beginning of winding
86 a	Beginning of winding or 1st winding
86 b	Winding tap or 2nd winding

Terminal	Designation
	Relay contact for normally closed and change-over contacts
87	Input
87 a	1st output (break contact side)
87 b	2nd output
87 c	3rd output
87 z	1st input
87 y	2nd input
87 x	3rd input
	Relay contact for normally open operation
88	Input
	Relay contact for normally open and change-over operation (break contact side)
88 a	1st input
88 b	2nd output
88 c	3rd output
	Relay contact for normally open operation
88 z	1st input
88 y	2nd input
88 x	3rd input

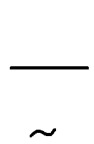
[1)] Polarity change terminal 32 - 33 possible

Generator and generator regulator	
B +	Battery plus
B -	Battery minus
D +	Dynamo plus
D -	Dynamo minus
DF	Dynamo field
DF 1	Dynamo field 1
DF 2	Dynamo field 2
	Alternator
U, V, W	Alternator terminals

Turn-signal indicator (flasher relay)	
C	First monitoring lamp
C 0	Main connection for control circuits separated from flasher
C 2	Second monitoring lamp
C 3	Third monitoring lamp (e.g. for double-trailer operation)
L	Turn-signal lamp, left
R	Turn-signal lamp, right

Symbols used in electrical engineering

Extract from DIN 40 900.



Direct current

Alternating current

3-phase alternating current

Ground, general

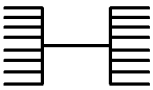
Lines, variable line thickness for emphasized elements

Grounding N, formerly Mp

Protective earth PE, formerly SL

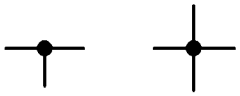
Assembly

Loose cable end



Grouping of lines for simplified representation in circuit diagrams.
Lines in arbitrary order, lines must be identified

Line crossings without connection



Crossings and branches with connection

Connection, firm (soldered)

Connection, detachable, general (terminal or plug)

Male plug

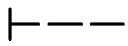
Female plug

320082

Plug-in type connector with male plug and female plug.

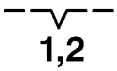
Switching element, two-way make contact with three switch positions

Mechanical link

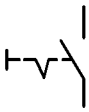


Driven by human force, generally hand-driven

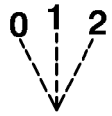
Notch



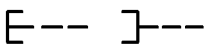
Notch with number of notch position



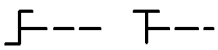
Example: hand-operated make contact with notch



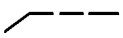
Identification of positions with numbers. The ground position can be identified as "0"
Application cf. under "Switches"



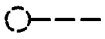
Hand operation, pushing, pulling



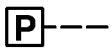
Hand operation, turning, toggling



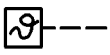
Foot operation



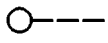
Removable hand-operated element, e.g. key



Driven by pressure

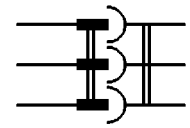


Driven by temperature

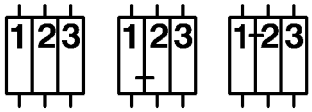


Indirect drive, e.g. limit switch

328083

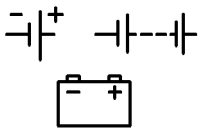


Multi-pole connector (terminal strips)



Modular terminals (terminal strips, lamp-wire connectors), also with firm or detachable connection

Sliding contact



Primary element. Battery in general; battery with several cells (if required)

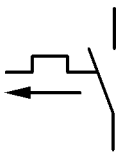
Fuse, general

Voltage surge protector
(lightning arrester)

Switch make contact

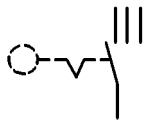
Switch break contact

Switch change-over contact

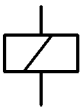


Fuse with thermally operated tripping (automatic)

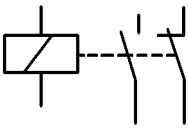
328084



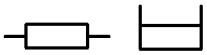
Example: ignition switch
(notched in Pos. 0 and 1)



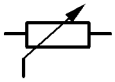
Electromechanical drive, e.g. with indication of an effective coil



Example: relay with make and break contacts



Resistor, general; also symbol for glow-plugs and heating resistors



Variable resistor, e.g. potentiometer

Capacitor, general

Electrolytic capacitor

Light bulb

Bulb with two filaments, e,g. Bilux

V = Voltmeter
A = Ammeter
Ω = Ohmmeter
W = Wattmeter
etc.

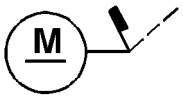
D.C. Generator

Alternator, general

328085

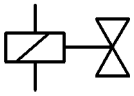
Alternator with rectifier set (3-phase alternating current generator)

Symbol for motors, starters (motor vehicles)

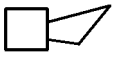


Windscreen wiper with motor drive

A.c. motor



Solenoid valve



Horn

Electrical fan

Buzzer

Operating-hours meter

Electrical clock

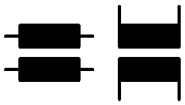
Spark gap, e.g. spark plug

328086

Ground, general

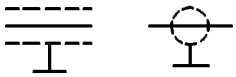
Winding, inductor, general (e.g. chokes)

Winding with magnetic core (choke with core)

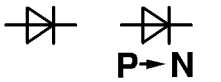


Transformer, converter, general

Symbol for 3-phase motor with squirrel cage



Shield with ground connection

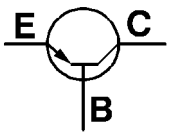


Diode rectifier, forward bias for positive current in the direction of the arrow point

Z diode (suitable for operation at breakdown voltage)

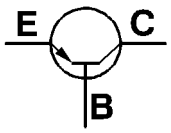
Thyristor

Light-ermitting diode



PNP transistor
E = Ermitter
C = Collector
} Switching resp. regulating connections
B = Base (control connection)

328087



NPN transistor

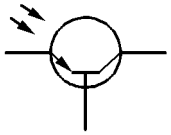
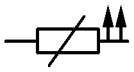
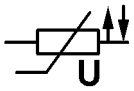


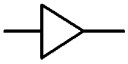
Photo-transistor



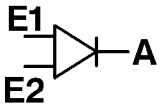
Temperature-dependent resistor



Voltage-dependent resistor, e.g. NTC



Electronic amplifier

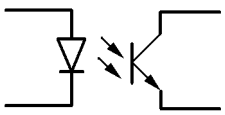


Operational amplifier (amplifies the voltage between E1 and E2)

D.c. converter

Voltage converter (24 to 15 volts)

Initiator



Optocoupler

320088

Symbols for directions of motion

Linear motion, e.g. to the right

Linear motion, in both directions

Rotary motion, e.g. to the left

Rotary motion, in both directions

3280891

□

Notes

2800145

A

B

C

D

E

F

G

H

I

L

M

O

P

R

S

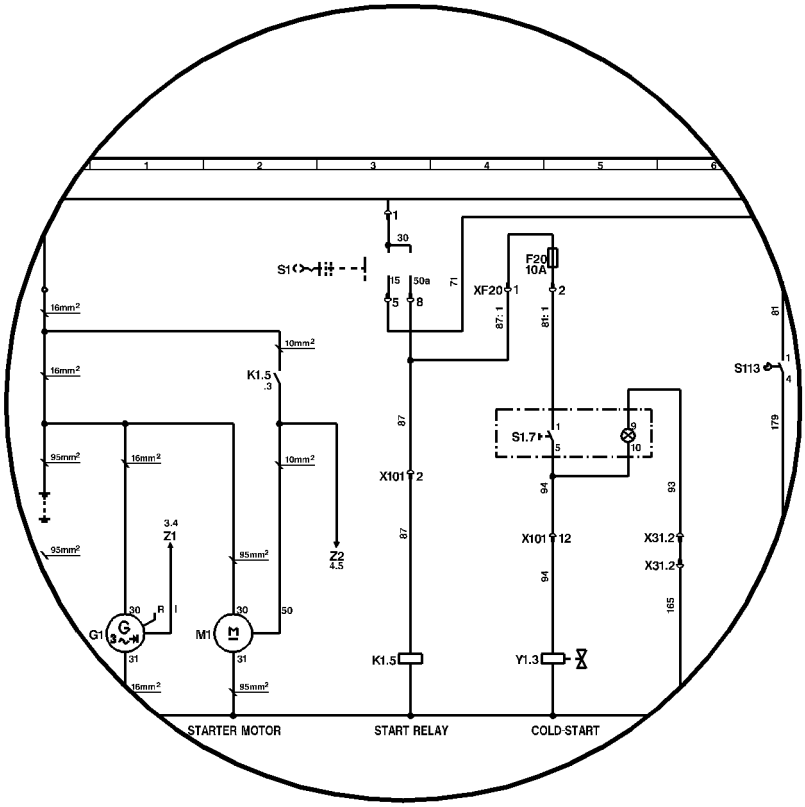
T

V

Technical Handbook

Automotive electrical systems in construction machinery

Interpretation of wiring diagrams Troubleshooting



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PREFACE

2732947

Electrical systems for construction machinery have developed far beyond their original applications as starting and lighting devices. The new tasks are essentially monitoring and control functions. This has entailed an inevitable increase in the number of circuits, so that the overall system appears complex and unclear to the non-electrician.

This impression was reinforced by the schematic block diagrams used in the past.

For this reason our company, like the automobile industry, has opted for another type of diagram, the circuit diagram.

This new type of diagram has proved very successful. Our company has now taken a further step in this direction with the decision to establish its documentation by means of a specially developed CAD system.

This has led to some differences between the old and the new circuit diagrams.

The interpretation of these new CAD circuit diagrams and their accompanying documents will be explained in the following description.

The present Technical Handbook applies to automotive electrical systems in construction machinery. The relevant accident prevention rules and the different requirements depending on various operating voltages must always be observed. These rules are not part of the handbook. □

NOTES ON SAFETY

2732948

⚠ WARNING

Before working on the electrical system

The repair personnel must have knowledge and experience in the repair of electrical systems of this or similar machines.

In case of insufficient knowledge, the candidates must be thoroughly instructed by experienced repair personnel.

Before undertaking any maintenance and repair work, the machine must be secured as follows:

- **Park the machine on level and stable ground.**
- **Stand working equipment on the ground.**
- **Block the articulated joint.**
- **Shut off the engine.**
- **Withdraw the key from the electrical system key-switch.**
- **Protect the machine against rolling away by placing chocks under the wheels.**
- **Disconnect the battery before undertaking work on the electrical system or before carrying out welding work.**

Disconnect the negative terminal and then the positive terminal.

After the work:

Connect first the positive and then the negative terminal.

Battery handling

Batteries give off explosive gases.

Avoid fire and unshielded light in the vicinity of batteries and do not smoke.

Battery acid is toxic and caustic.

Avoid contact of battery acid with the skin, the mouth, the eyes and the clothes. Do not spill battery acid and do not inhale the gases.

Wear gloves, firm working clothing and goggles when working on batteries.

If the skin has come into contact with acid, rinse thoroughly with water and consult a doctor.

⚠ WARNING

When acid has splashed into the eyes, rinse thoroughly with large amounts of water and go immediately to a doctor.

Do not place tools on the battery. They may produce a short-circuit destroying the battery and causing injury.

Do not wear necklaces, bracelets or watch straps of metal when working on the battery. Metal parts can cause short-circuits with the risk of resulting burns.

Dispose of used batteries separately from other waste and without polluting the environment.

Alternator - Handling instructions

Never disconnect electrical cables from alternators, regulators and battery when the engine is running to avoid damage to the alternator and regulator.

Do not mix up cables when connecting the batteries (observe polarity).

Always use measuring instrument for voltage and continuity testing.

Never use a "test lamp".

Never "tap against ground".

This causes a short circuit with consequent damage to the alternator and regulator.

When the engine is started, the alternator is pre-excited by an electronic circuit.
This circuit ensures that the alternator can supply power.
The circuit is part of the Central Electronic System in the control panel.

An LED in the control panel (charge control) indicates the correct functioning of the alternator. This LED must light up when the keyswitch is turned to the "ON" position. It goes out when the engine is running. If this is not the case, either the alternator circuit or the control panel are defective.

To prevent further damage, the causes of the fault must be located and rectified as fast as possible.
Contact your nearest dealer service.

⚠ WARNING

Fuses

Working on the fuse holder involves the risk of sparking and short-circuits. Therefore:

Remove fuses only after the circuit has been de-energized:

Shut off the engine and turn the key-switch of the electrical system to 0.

For machines with main battery switch:

Switch off main battery switch.

Replace defective fuses only by those of the same current rating.

□

ELECTRICAL SYSTEM DOCUMENTATION

2732949

For organizational reasons, the documentation for the electrical system of the machine has been annexed to the spare-parts list. The documentation includes:

- the circuit diagram
- the circuit diagram legend with the electrical components.

The components are identified in accordance with DIN 40 719 by letters. An extract of this standard is given in the ANNEX.

With the help of the above-mentioned documents and the present Technical Handbook, a qualified electrician should be able to rectify faults in the electrical system.

Simple works on the electrical system, e.g.

- the replacement of bulbs,
- of fuses and
- of relays

are described in the operating instructions of the machine. □

THE WIRING DIAGRAM

2732950

The wiring diagram is a schematic representation of the electrical system and its detailed components. The diagram shows the interconnection of electrical components and the operation of an electrical system.

The wiring diagram consists of several individual sheets (see lower right corner of the sheet shown in fig. 1) representing functional groups.

All components are shown in a no-voltage resp. no-current state and with none of the elements being actuated.

The representation makes use of symbols in acc. with DIN 40 900.

All components are identified by capital letters in acc. with DIN 40 719.

Extracts of these DIN standards can be found at the end of the present Technical Handbook.

The wiring layout plan shows the location of components and connectors of the machine.

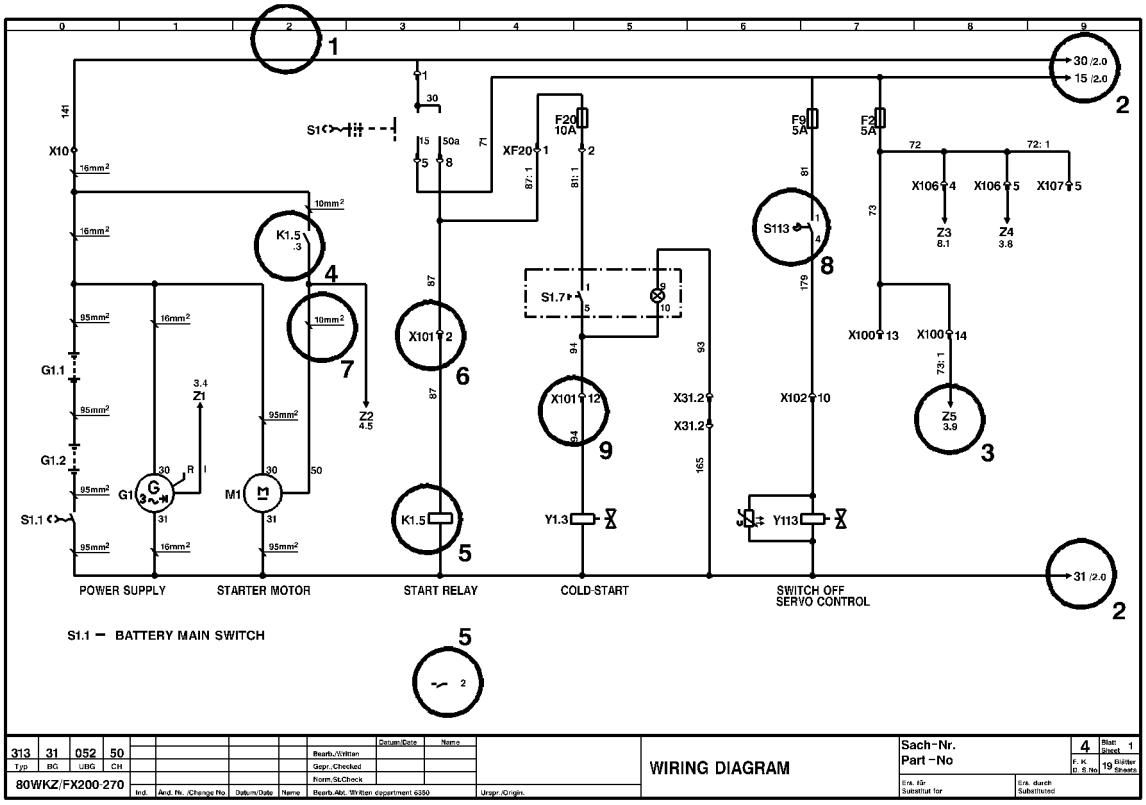

Fig. 1

Explanation of the wiring diagram

2732951

(sample page shown in fig. 1 is sheet 1 of 19 sheets)

1. Current paths

The current-path numbers are given at the upper margin of the path diagram sheet. They apparently subdivide the sheet into ten vertical columns (0 to 9).

Reference to the sheet number and the current-path number facilitates the search of components and the orientation in the wiring diagram.

2. Main circuits

The main circuits are shown as horizontal lines at the top and the bottom of the wiring diagram.
Positive potential main circuits are shown at the top and negative potential circuits are shown at the bottom.

Example:

30/2.0 = Plus (switched). The main circuit continues on sheet 2 of the circuit diagram with current path 0.

15/2.0 = Plus (switched). The main circuit continues on sheet 2 of the circuit diagram with current path 0.

31/2.0 = Minus (ground). The main circuit continues on sheet 2 of the circuit diagram with current path 0.

3. Branches

Current-path branches together with the letters and numbers indicate the additional connection of current paths on other sheets of the wiring diagram.

Example:

Label **Z5** **3.9** means:

This branch is connected to point Z5 in current path 9 on page 3 of the wiring diagram.

4. Relay contacts

Numbers on the relay contacts indicate the sheet number of the wiring diagram and the current path where the exciter coil for this contact can be found.

Example:

Label **K5** **.3** means:

The exciter coil for this make contact can be found in current path 3 on the same sheet of the current diagram.

5. Cross reference to other current paths

Relays whose make, break or change-over contacts are located in other current paths have numbers under the current path of the exciter coil indicating in which current paths these contacts are located.

Example:

The wiring diagram lable indicates that the relay **K 1.5** on the same sheet of the current wiring diagram in current circuit path has a make contact at circuit path **2**.

6. Contacts of plug-in connectors

Plug-in connectors are identified by the number of the connector and the number of the plug-in contact.

Example:

Label **X101/2** refers to:

contact 2 in connector X101.

▷

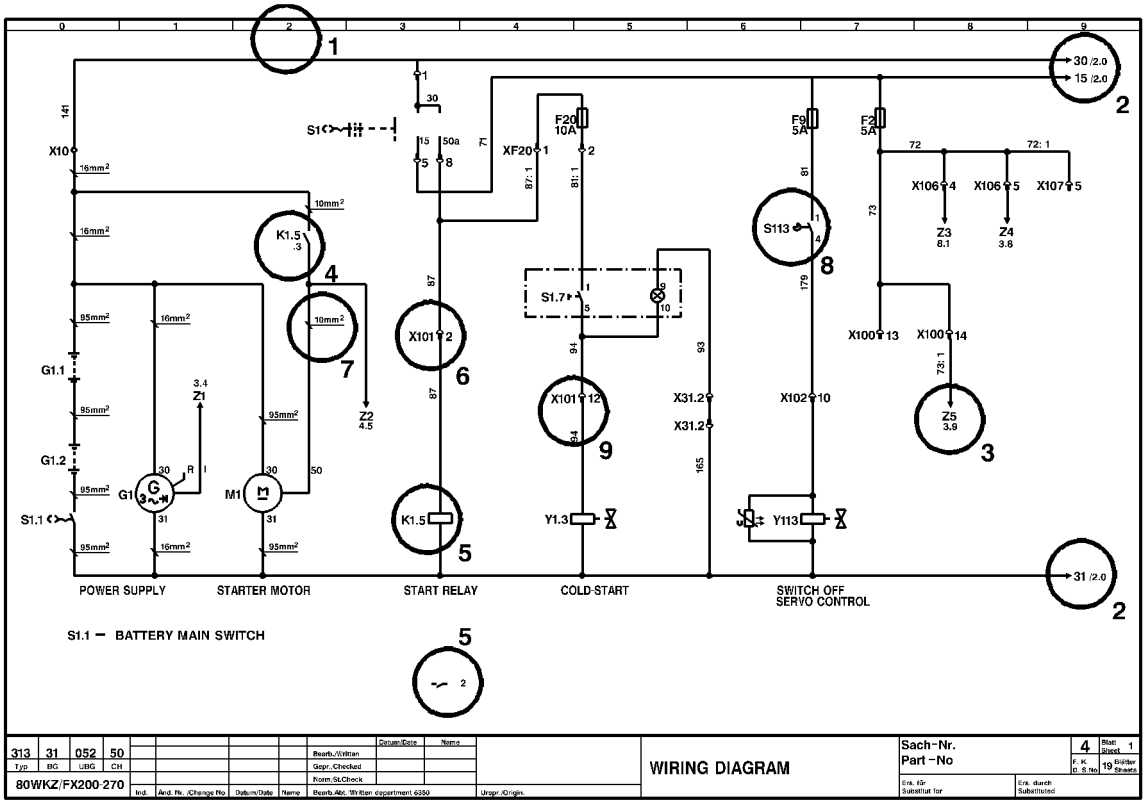
POWER SUPPLY
STARTER MOTOR
START RELAY
COLD-START
SWITCH OFF SERVO CONTROL
S1.1 – BATTERY MAIN SWITCH
WIRING DIAGRAM
80WKZ/FX200-270
Sach-Nr. Part-No
3283331

Fig. 2

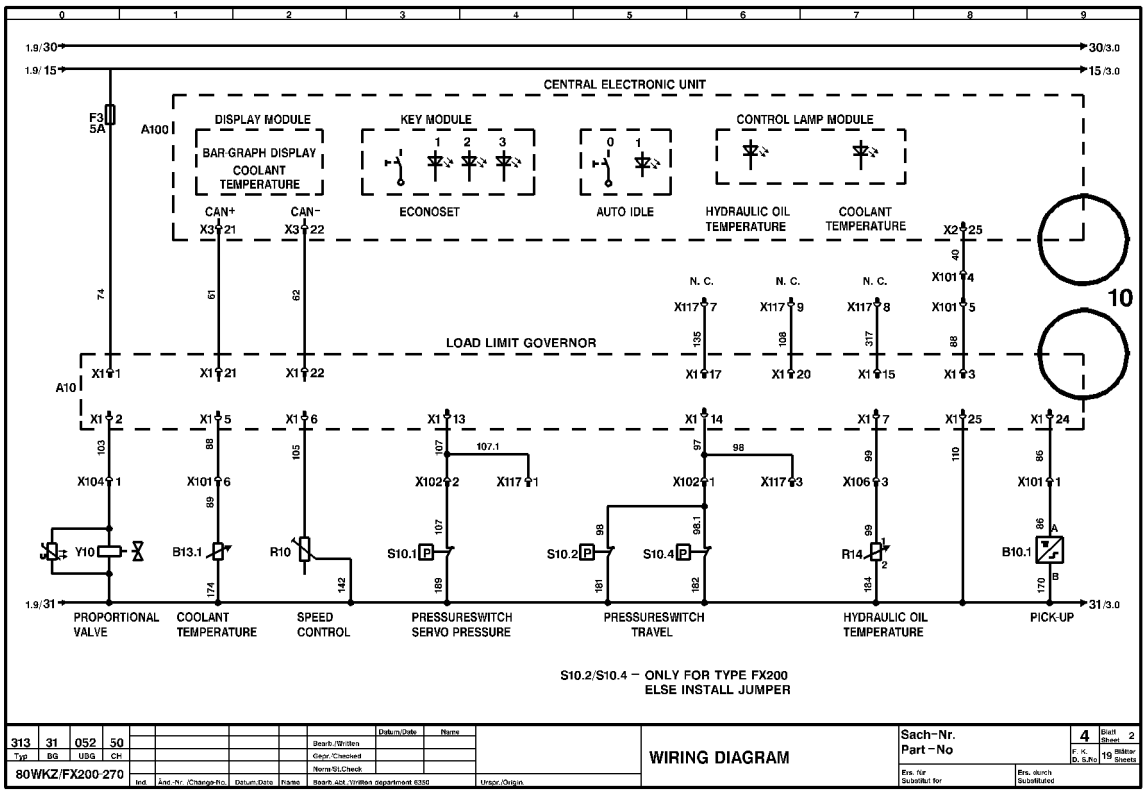
CENTRAL ELECTRONIC UNIT
DISPLAY MODULE
KEY MODULE
CONTROL LAMP MODULE
BAR-GRAPH DISPLAY COOLANT TEMPERATURE
ECONOSET
AUTO IDLE
HYDRAULIC OIL TEMPERATURE
COOLANT TEMPERATURE
LOAD LIMIT GOVERNOR
PROPORTIONAL VALVE
COOLANT TEMPERATURE
SPEED CONTROL
PRESSURESWITCH SERVO PRESSURE
PRESSURESWITCH TRAVEL
HYDRAULIC OIL TEMPERATURE
PICK-UP
S10.2/S10.4 – ONLY FOR TYPE FX200 ELSE INSTALL JUMPER
WIRING DIAGRAM
80WKZ/FX200-270
Sach-Nr. Part-No
3283321

Fig. 3

7. Cable cross-section

The following number refers to the cross-section of the cable **10** meaning that this cable has a conductor cross-section of 10 mm^2.

8. Identification of contacts

The numbers at relay contacts or at switch connections at contacts are identical with the numbers found on the components themselves.

Example:

Label **S113, 1,4** means:

The switch is the S113 with connections at contacts 1 and 4.

9. Cable number

The cable number (**94** in this case) is printed on the insulation at intervals of several centimeters.
This number together with number of the connector permits easy identifaction of a cable even in a cable harness or by the connector (e.g. for continuity checking). The connectors are also marked with their specific number (e.g **X101**). The connection tables showing the pin assignment of each connector can be found after the wiring diagram (e.g. **X101**, Fig. 4).
If a cable is defective and if you don't know which components are linked by this specific cable, then this can be determined from the connection tables.

The example (Fig. 2 and 4) shows how to identify cable **94** in connector **X 101:**
One end is connected to terminal **5** of switch **S 1.7** (cable cross-section 1.5 mm^2) and the other end to solenoid valve **Y 1.3** (cable cross-section 2.5 mm^2). The cable is connected to pin **12** of the connector which is part of the "engine cable harness". The exact location of the connector at the machine and the corresponding order number are set out in the "WIRING DIAGRAM LEGEND".

END POINT	CABLE NO.	C mm²	NO	■ mm²	CABLE NO.	END POINT
A10x1: 24	86	0.5	1	1	86	B10.1: A
S1: 8(50a)/FX20: 1	87/87.1	2.5	2	2.5	87	K1: 5
A100X2: 11/X117: 12	26/26.1	0.5	3			S13: 1 (OPTIONAL)
A100X2: 25	40	0.5	4	1		X101: 5
A10X1: 3	88	0.5	5	1		X101: 4
A10X1: 5	89	0.5	6	1	89	B13: 1
N. C.			7			
A100X2: 24	39	0.5	8			N. C.
A100X2: 16	31	0.5	9			N. C.
			10			
K7: 30 (OPTIONAL)	341	0.5	11	1	341	H7.1 (OPTIONAL)
S1.7: 5	94	1.5	12	2.5	94	Y1: 3
X115: 2	95	0.5	13			N. C.
			14			ENCODING PIN
X13: 1	96	0.5	15			N. C.
CONNECTION TABLE PLUG/SOCKET		X101				CABLE MOTOR

328331

Fig. 4

10. Electronic units (Fig. 3)

Electronic units (e.g. Central Electronic Unit, Load Limit Governor) are displayed in the wiring diagram as black boxes. □

WIRING DIAGRAM LEGEND

2732952

The legend "Electrical components in wiring diagram" (Fig. 1) gives a systematic overview which supplements the circuit diagram. The legend permits to find electrical components in the circuit diagram and on the machine. The legend also contains the part numbers of the components.

	Electrical components in wiring diagram				**31.050 -**
	FX 270	Wiring diagram No. **2459343**			**T 2459344 - 000** B 2459343 - 010
Part	Quantity	Description and Function	Curr. Path	Location	Part-No
A10	1,000	LOAD LIMIT GOVERNOR	2 - 0/61 -	CONTROL PANEL	
A10X4	1,000	DIAGNOSTIC UNIT CONNECTOR	4 - 2/18 -	CONTROL PANEL	73172588
A10X4	1,000	FLANGE	4 - 2/18 -	CONTROL PANEL	73172589
A100	1,000		2 - 1/16 -	CAB	73172003
B10	1,000	PRESSURE SENSOR - TRAVEL	8 - 0/84 -	SUPERSTRUCTRURE	73172592
B10.1	1,000	SPEED SENSOR	2 - 9/92 -	ENGINE	
B13.1	1,000	COOLING-WATER TEMPERATURE SENSOR	2 - 1/94 -	ENGINE	73172594
E1	1,000	LH HEADLIGHT	6 - 0/87 -	SUPERSTRUCTURE	73172595
E1	1,000	BULB	6 - 0/87 -	SUPERSTRUCTURE	73172596
E1	1,000	HOUSING	6 - 0/87 -	SUPERSTRUCTURE	73172597
E1	1,000	PLUG	6 - 0/87 -	SUPERSTRUCTURE	73172598
E1	2,000	COUNTER-SUNK SCREW	6 - 0/87 -	SUPERSTRUCTURE	73172599
E1	2,000	LOCKING NUT	6 - 0/87 -	SUPERSTRUCTURE	73172600
E2	1,000	RH HEDADLIGHT	6 - 1/87 -	SUPERSTRUCTURE	73172595
E2	1,000	BULB	6 - 1/87 -	SUPERSTRUCTURE	73172596
E2	1,000	HOUSING	6 - 1/87 -	SUPERSTRUCTURE	73172597
E2	1,000	PLUG	6 - 1/87 -	SUPERSTRUCTURE	73172598
E2	2,000	COUNTER-SUNK SCREW	6 - 1/87 -	SUPERSTRUCTURE	73172599
E2	2,000	LOCKING NUT	6 - 1/87 -	SUPERSTRUCTURE	73172600
E3	1,000	WORKING LIGHT, BOOM LEFT	6 - 2/87 -	BOOM	73172602
E3	1,000	BULB	6 - 2/87 -	BOOM	73172510
E4	1,000	WORKING LIGHT, BOOM LEFT	6 - 3/87 -	BOOM	73172602
E4	1,000	BULB	6 - 3/87 -	BOOM	73172510
E9	1,000	INTERIOR LIGHT	4 - 1/74 -	CAB	73171604
E9	1,000	BULB	4 - 1/74 -	CAB	73172605
F1	1,000	FUSE BOX, GREEN	4 - 1/16 -	CONTROL PANEL	73172606
F2	1,000	FUSE BOX, BLACK	1 - 7/16 -	CONTROL PANEL	73172606
F3	1,000		2 - 0/18 -	CONTROL PANEL	73172606
F4	1,000	FUSE BOX, BLACK	5 - 1/16 -	CONTROL PANEL	73172607
F5	1,000	FUSE BOX, NATURAL	5 - 5/16 -	CONTROL PANEL	73172608
F9	1,000	FUSE BOX, GREEN	1 - 4/16 -	CONTROL PANEL	73172607
F10	1,000	FUSE BOX, BLACK	6 - 6/16 -	CONTROL PANEL	73172606
F11	1,000	FUSE BOX, NATURAL	4 - 0/16 -	CONTROL PANEL	73172606

Fig. 1 □

Explanation of legend (Fig. 1)

2732953

Part

The part column lists all components of the electrical system in alphabetical order. The letters represent the type of component installed in acc. with DIN 40 719.
(Extracts of DIN 40 719 cf. "ANNEX").

Quantity

Indicates how many of the components are installed in the machine.

Description and function

Refer to the kind of component and to its function (e.g. cooling-water temperature sensor).

Current path

The current-paths numbers are indicated at the upper margin of the wiring diagram sheets. These numbers permit to find electrical components in the wiring diagrams.

Example:

Load limit governor
In the "Current path" column, we have: **2-0/61.**
This means that the load limit governor can be found on wiring diagram sheet **2** in current path **0**.
Figure **61** is an internal CAD system coordinate which is of no importance for the interpretation of the documentation.

Location

The "Location" column indicates the place of installation of the component in the machine.

This information facilitates the location of components in the machine, e.g. when searching for faults.

Part number

Order numbers for spare parts
If no part number is indicated, the component is connected to the electrical system, but part of another assembly. The part number for this component can then be found in the corresponding spare-parts sheet.

Example:

Part numbers for solenoid valves can be found in the "Hydraulic system" section of the spare-parts list. □

CHECKING AND TESTING EQUIPMENT

2732954

All methods of fault detection described in the present Technical Handbook can be carried out with simple measuring instruments and testers.

The use of these devices is explained in this handbook by means of the step-by-step method (cf. section "Basic measuring and testing procedures").

The present handbook will not deal with technically more complicated testing devices for automotive electrical systems. These devices have their own operating instructions with detailed information about how to handle them. The operating instructions must therefore be read before using such equipment.

Depending on the manufacturer, the testing equipment used in the field can differ from the instruments shown in this handbook. Due to the large number of commercially available types it is impossible to show all the types in this handbook. For this reason, the handbook dispenses with brand names and names of manufacturers.

Solenoid-valve tester

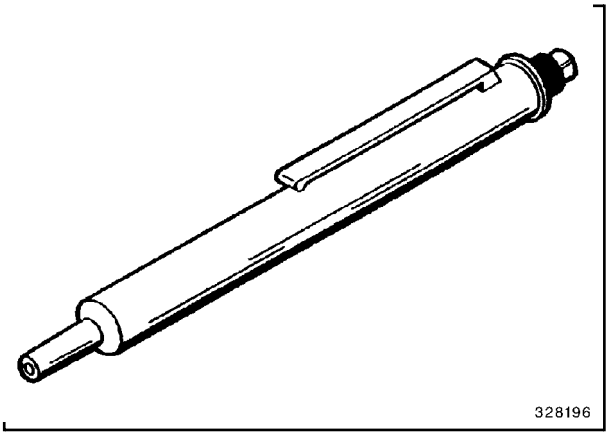

Fig. 1

The solenoid-valve tester indicates whether the coil of a solenoid valve or a relay produces a magnetic field.

The magnetic field is generated when current flows through the coil.

Operation of the solenoid tester shown requires two batteries (1.5 V, type AAA).

Test lamp

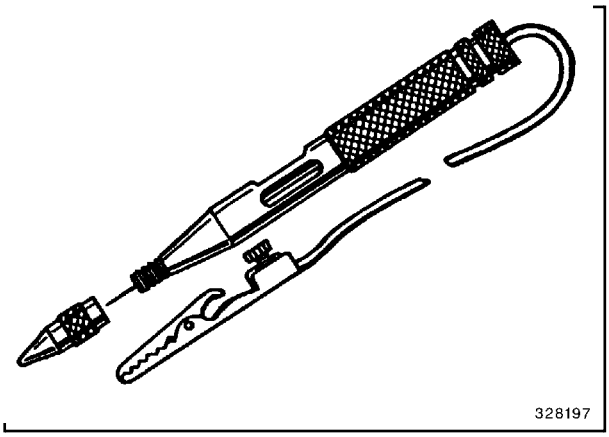

Fig. 2

Important:

Never use the test lamp for testing on circuit boards equipped with electronic components. Sensitive electronic components may be damaged by the strong current flowing through the test lamp. The housing of the test lamp is metallic and therefore conducts electric currents. The housing may therefore cause a short-circuit between two adjacent components on the board.

The test lamp lights up when the tested component is under tension.

Test lamps are manufactured for different system voltages. The test lamp must be designed for the voltage of the electrical system, as a 12-volt test lamp will be damaged if it is used in 24-volt systems.

Multimeter

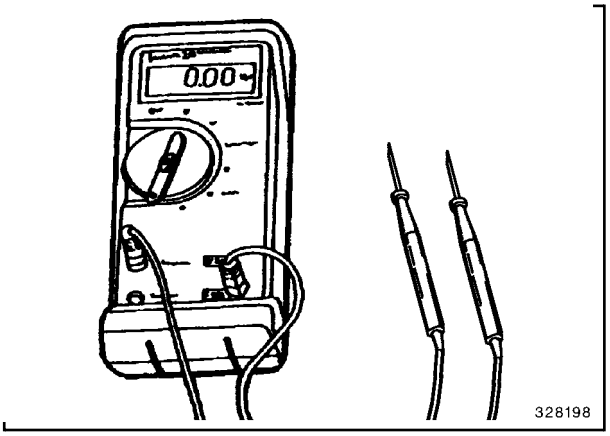

Fig. 3

The following quantities can be measured with multimeters:

- voltage,
- current,
- resistance.

Many multimeters have additional functions, e.g.:

- capacitance measurement,
- diode and transistor testing,
- testing facilities (continuity check).

Measuring instruments display the measured value in two ways:

- as analogue devices with pointer-type instruments and
- as digital devices with numerical read-out (Fig. 3).

Read the operating instructions before using the instruments. These measuring instruments are highly precise but also very sensitive devices which may be damaged if operated incorrectly.

Testers

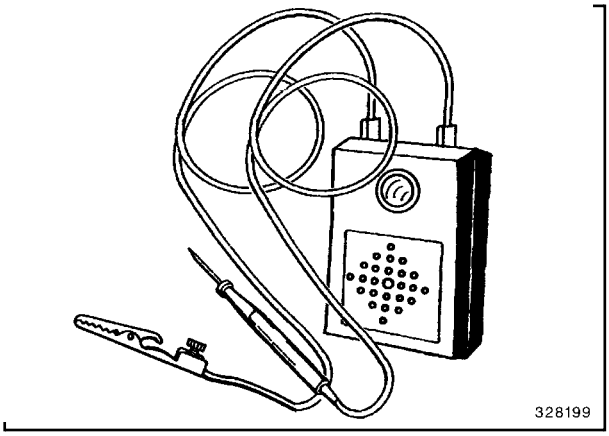

Fig. 4

Important:

Never use the test buzzer for testing on circuit boards equipped with electronic components. Sensitive electronic components may be damaged by the strong current flowing through the test buzzer.

Testers indicate by means of

- optical signals (lamp) and
- acoustical signals (buzzer)

whether a current flows through a component (e.g. cable, fuse, bulb). In this case, we say that the component "lets the current pass".

Acoustical continuity checks have the advantage that the person carrying out the test can concentrate on the test prods. It is not necessary to watch a lamp, so that incorrect measurements due to a displaced testing prod are excluded.

The continuity tester requires batteries for operation (number and type of the battery depend on the type of tester used). □

BASIC MEASURING AND TESTING PROCEDURES

2732955

⚠ WARNING

Risk of injury

Some testing procedures must be carried out with the electrical system under tension.

Therefore protect the machine against inadvertent movements before carrying out work on electrical systems under tension.

Close the door of the driver's cab or place a warning sign at an easily visible place inside the cab.

Voltage checks

In the present example we are going to check whether the coil of solenoid (Y 1.3) for the flame-glow pre-heating system of an diesel - engine is under tension.

1. Checking with the test lamp (Fig. 1)

- Select a suitable test lamp (12 V or 24 V).
- Connect the ground terminal of the test lamp to vehicle ground.
- Press the tip of test lamp against the live component terminal (positive terminal).
  The test lamp lights up if the component is under tension.

If the test lamp has a needle tip, it is possible to penetrate the insulation of the connecting cable. If the test lamp lights up, the connection cable is under tension.

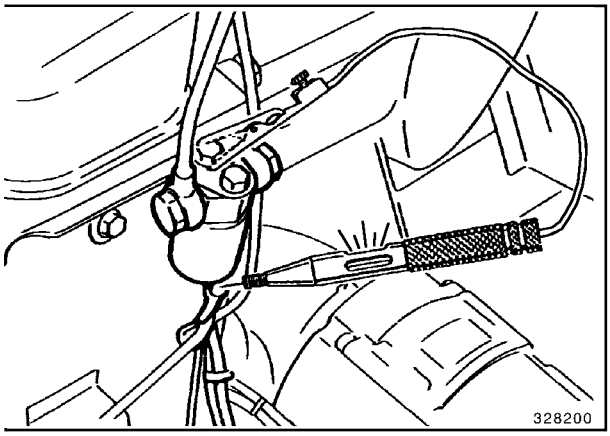

Fig. 1

2. Checking with the multimeter (Fig. 2)

- Switch multimeter to the "voltage mode" and select the suitable measuring range.
- Connect the ground terminal to vehicle ground.
- Press the positive test prod against the positive component terminal (plus +).
  The instrument indicates the magnitude of the voltage present.

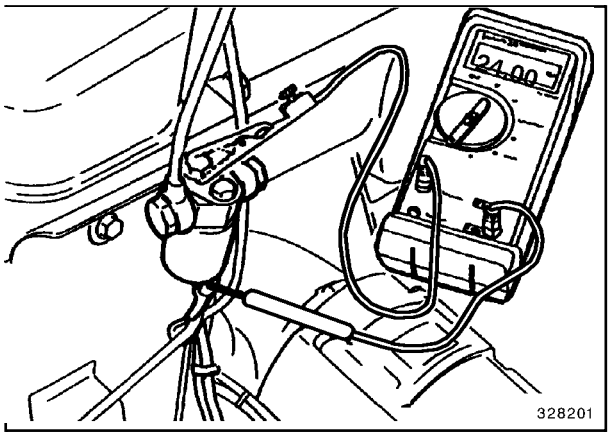

Fig. 2

Checking the continuity

⚠ WARNING

Risk of short-circuit

Never carry out continuity checks on components under tension. Checking may cause short-circuits or overloading with resulting damage to the component or test equipment.

The component to be tested must therefore be de-energized. To do so, disconnect all electrical connections from the component.

Continuity checks permit show whether a current flows through a component.
This check is always recommended if invisible interruptions of conductors inside a component are suspected as the cause of trouble (e.g. in cables, coils, contacts, bulbs).

In the present example we will check whether the conductors of a cable allow current to pass or whether they are interrupted.

1. Checking with the tester (Fig. 3)

- Connect the ground terminal of the continuity tester to one end of the conductor.
- Hold the test prod against the other end of the same conductor (observe insulation colour coding).

In this example, the continuity tester and the component under test form a closed current circuit.

The continuity tester checks the conductor with low voltage. If the conductor is continuous, the current circuit is closed. The lamp lights up and the buzzer sounds.

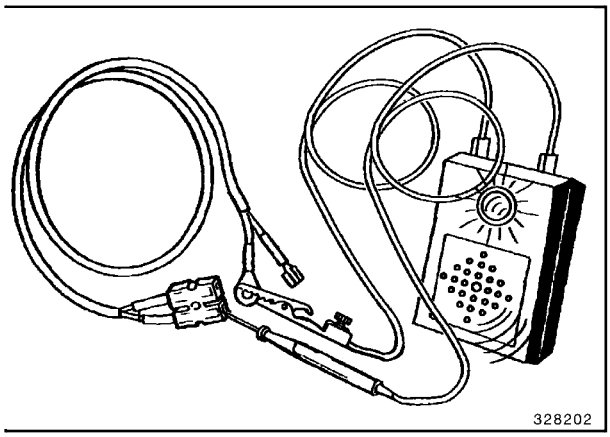

Fig. 3

2. Checking with the multimeter (Fig. 4)

- Switch the multimeter to the "resistance mode".
- Attach the ground connector to one end of the conductor.
- Hold the test prod to the other end of the conductor (observe insulation colour coding).

The instrument now shows the resistance of the conductor in ohms.

If nothing is indicated, the conductor is interrupted.

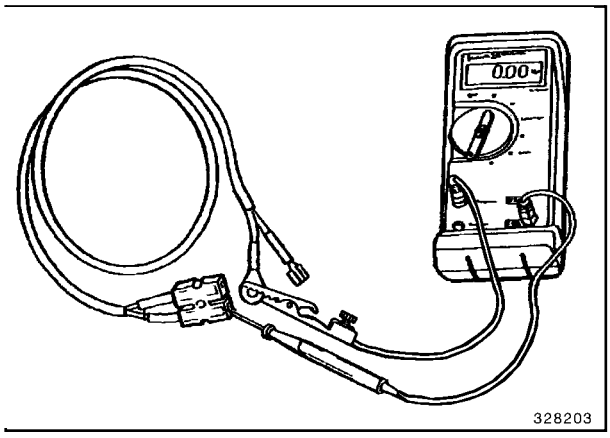

Fig. 4

Checking the coil of a solenoid

In this case we will check whether the coil of the switching magnet of the "start boost system" (Y 1.1) generates a magnetic field when under tension.

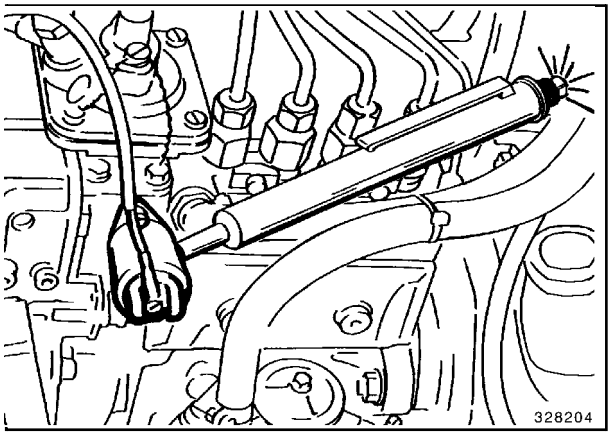

Fig. 5

Using the solenoid valve tester (Fig. 5)

- Hold the test prod of the solenoid valve tester to the coil.

The signal lamp of the tester lights up if a magnetic field is generated by the coil.

This test does not permit a statement about the mechanical function of the component. It is still possible that the switching pin jams although the coil itself is o.k. □

PRACTICAL TROUBLESHOOTING

2732956

Notes on troubleshooting in automotive electrical systems

In order to rectify faults fast and safely, it is important to proceed systematically when searching for faults.
Beside the technical qualification of the electrician, knowledge of the following facts is required for successful troubleshooting:

- Which assembly is defective?
- Which is the location of the assembly in the machine?
- Which is the correct function of the assembly?
- Which components are interacting?
- In which way do the components interact?
- Where are the components located in the machine?
- Under which conditions and in which operational state is the fault present?

Questions to the operator of the machine:

- Which warning signs have preceded the fault?
- Which maintenance or repair works have been carried out beforehand?
- Has the fault already been observed before?
- Can the fault be rectified with the troubleshooting tables in the operating instructions?
- Has the machine been wrongly operated?

Required documents:

- operating instructions,
- wiring diagram with legend and
- spare-parts list.

Measuring and testing devices

Recommended measuring and testing devices are described in the "Measuring and testing devices" section.

Measuring and testing procedures

How to carry out testing with simple means is described in the "Basic measuring and testing procedures" section.

Wiring diagrams

Knowledge and understanding of the wiring diagrams and the symbols used in these diagrams are an essential prerequisite for successful troubleshooting in automotive electrical systems. The symbols used in the wiring diagrams are listed in the annex.

Even more important than locating the defective component is the determination of the cause of trouble.
In many cases, faults and defects repeat themselves if the cause of the fault is not recognized and eliminated.

Example of systematic troubleshooting

Starting situation:

- batteries fully charged,
- system voltage normal,
- tank filled with fuel,
- starter turns the engine with start - speed.

Fault:

- engine does not fire.

▷

Fault-finding diagram (example)

The sequence of troubleshooting operations is represented by means of a diagram.
Faul finding is divided into individual steps making it clear and easy to follow.

How to work with the fault-finding diagram.
Such a diagram must basically be read from top to bottom. The top mentions the kind of fault. This is the starting point for further actions described in the following symbols.

Diamond-shaped symbols contain a request to check the situation. This check can be answered with "Yes" or "No". Depending on the result of the check, follow either the "Yes" or the "No" line.

If the answer is "Yes", the next testing step can be performed.
If the answer is "No", the line leads to a square-shaped symbol. This symbol indicates the repair work to be carried out.

If the fault has been rectified after such repair, fault-finding ends here. If the fault persists, fault detection must be continued with the next step.

Electrical connections between the components mentioned are set out in the circuit diagram (Fig. 1 and 3). Each testing step has a reference to the corresponding position in the wiring diagram.

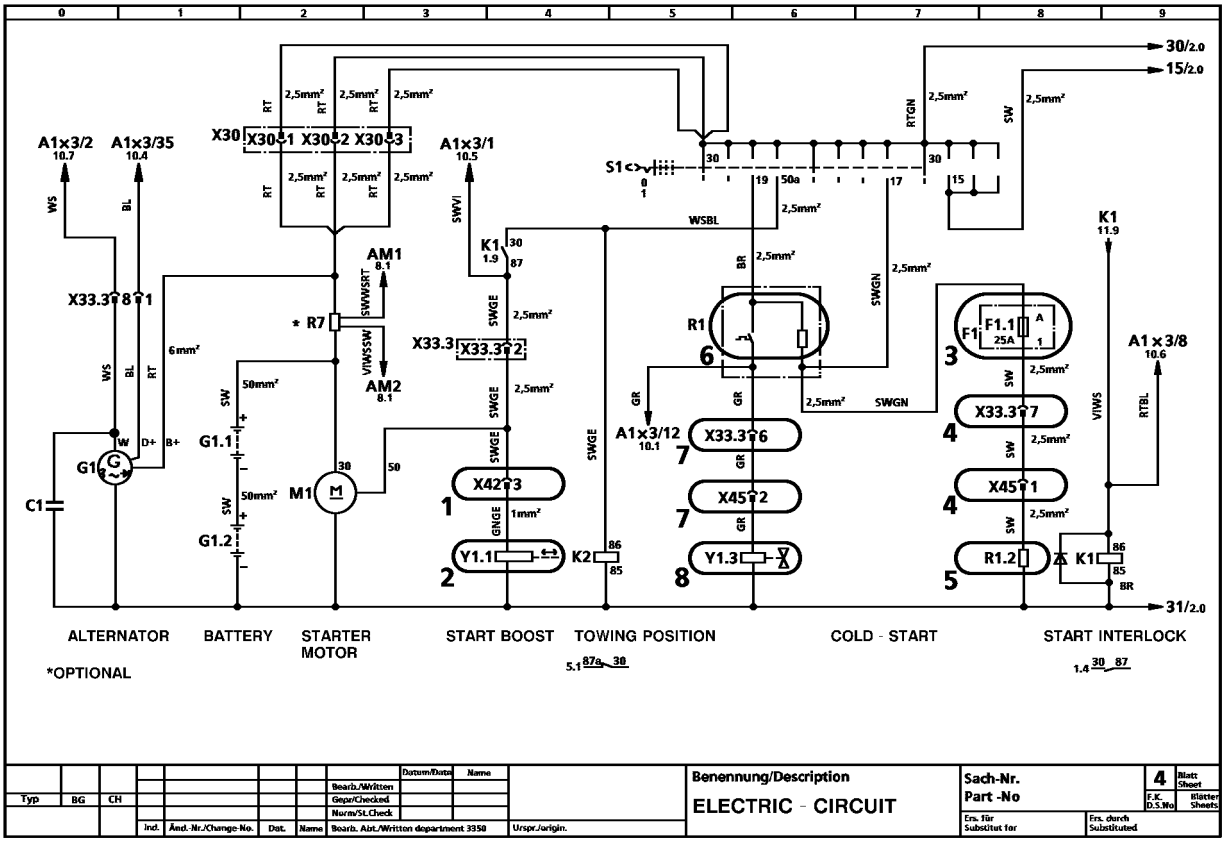

Fig. 1

3281861

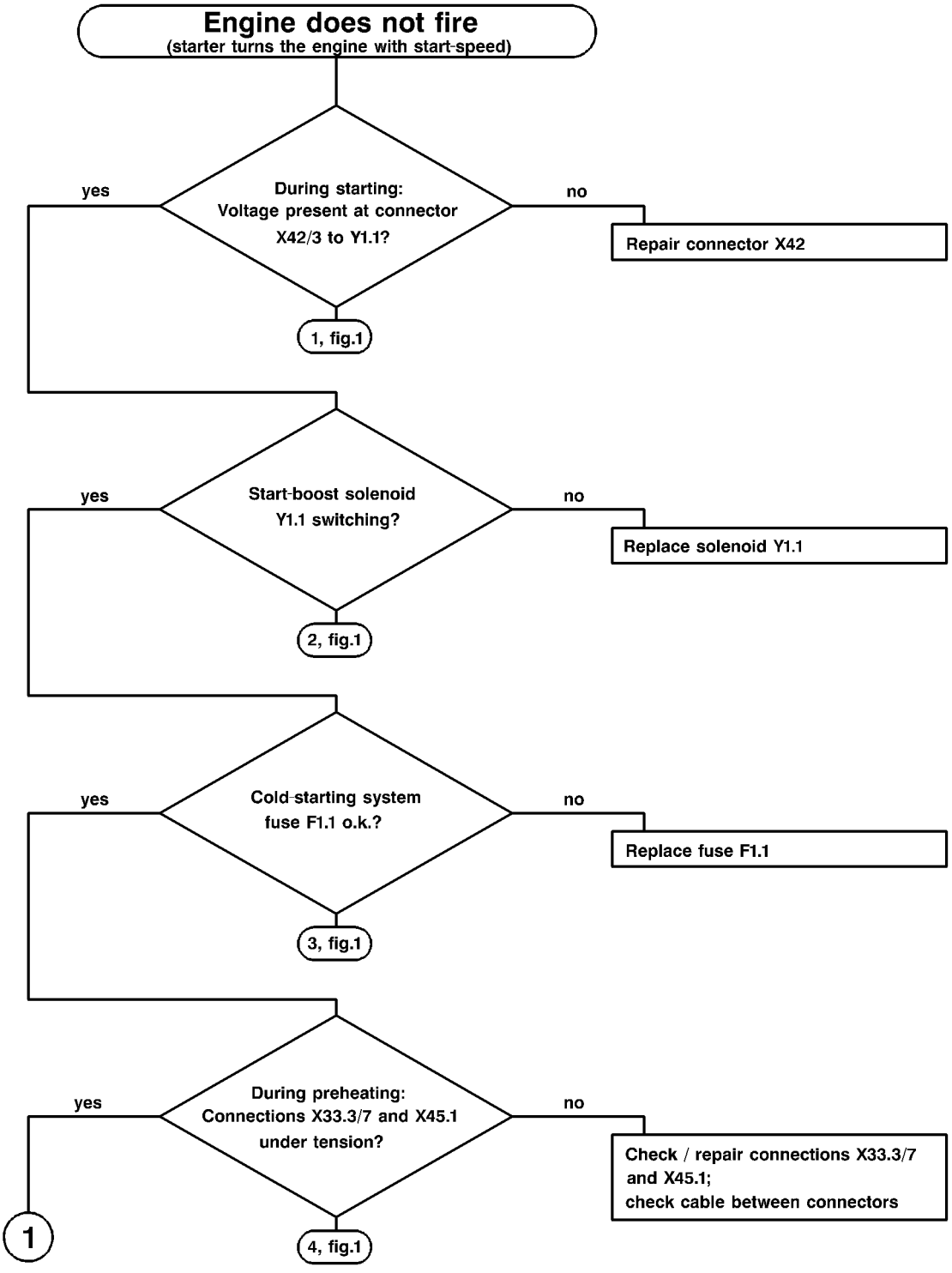

Fig. 2

3282051

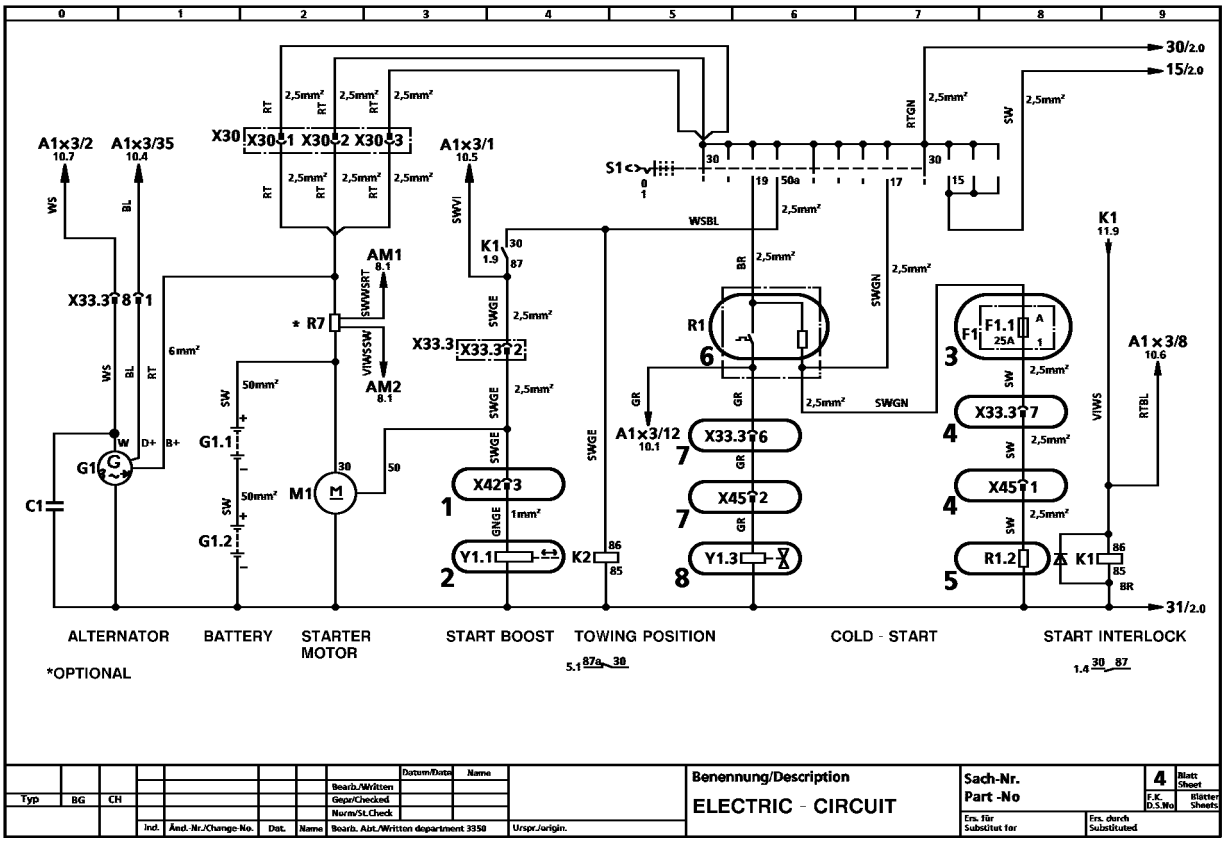

Fig. 3

3281861

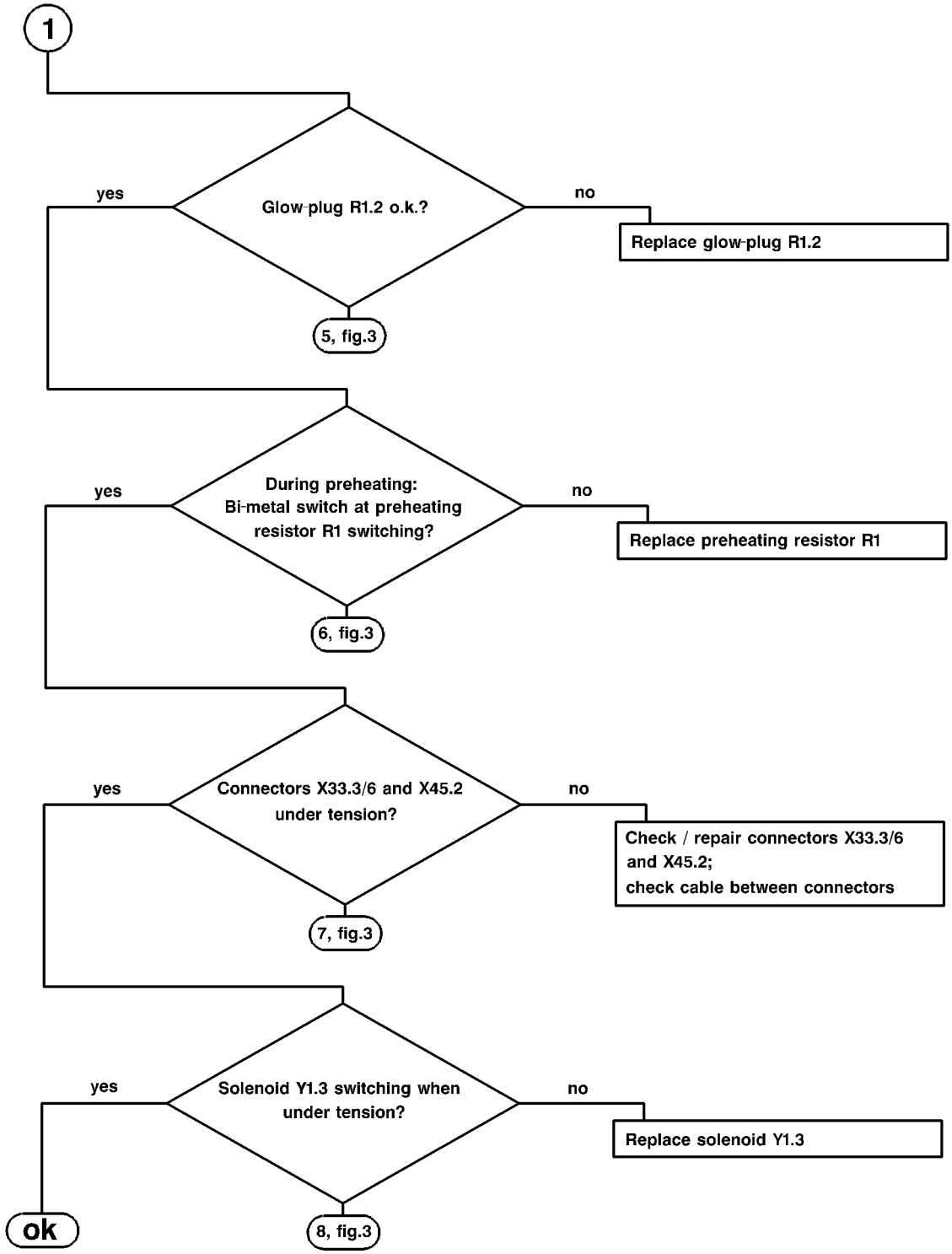

Fig. 4

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ANNEX

2732957

Identification of components

(Exerpt from DIN 40719)

Letter	Designation	Examples
A	Assembly group, parts of groups	Control unit, switch unit, magnetic amplifiers, combinations of devices
B	Transformation from non-electrical into electrical magnitudes (and vice versal)	Metering transformers: rev. transmitter, pressure sensor, pressure switch, thermic sensors, photo-electric cells, pulse generator, inclinometers
C	Capacitors	---
D	Binary elements, memories	Digital unit, integrated circuit, impulse counter
E	Miscellaneous	Lights, heaters
F	Safety devices	Fuses, overload guards, interlocks, circuit breakers, safety relays, releases
G	Generator Electrical supplies	Rotary generators, rotary frequency converters, batteries, power supplies, oscillators
H	Monitors	Monitoring lamp, buzzer
K	Relays, contactors	Power contactors, auxiliary contactors, auxiliary relays, blinker relays, time-lag relays
L	Inductive devices	Throttle coils, coils
M	Motors	Fan motor, wiper motor

Letter	Designation	Examples
P	Meters, testers	Indicating, recording and metering instruments, impulse initiators, clocks
R	Resistances	Pre-glow plug, flame-glow plug, shunt, potentiometer
S	Switches, selectors	Buttons, limit switches, control switches, signal ermitters
T	Transformers	Transformers, converters
U	Modulators, converters	Frequency converters, converters, inverters, tansverters, demodulators, reversing converters
V	Semiconductors	Cancelling diodes for solenoid valves, variode
W	Conductive paths, hollow conductors	Switch lines, cables, busbar, antenna
X	Terminals, plug, sockets	Isolating plugs/sockets, test sockets, terminal strips, solder strips
Y	Electrically actuated mechanical devices	Brakes, coupling, valves
Z	Filters	Interference suppression assembly

Schematic symbols (Exerpt from DIN 40900)

2732958

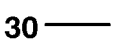
Electrical Connections

Direct current (DC)

Alternating current (AC)

3-phase AC

Ground, general

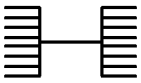


Positive, unswitched (connection No. 30)

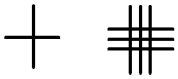
Positive, switched (connection No. 15)

Negative (ground)

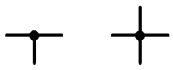
Moveable cable



Compilation of cables for easier illustration in circuit diagrams



Cables cross without connections



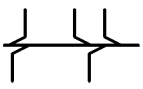
Junction and cross-over, with connection

Permanent connection (solder point)

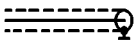
Non-permanent connection, general (terminal or plug)

Socket (female), pole of a socket

Plug (male), pole of a plug



Cable harness



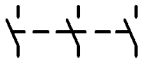
Shielded line with connection to ground

3282071

Switches, contacts


Closer


Opener


Main contact, 3 poles, closer


Alternating contact


Button, press to close


Button, press to open


Switch, turn to close / lock


Switch, turn to open / lock


Switch, press to close / lock


Switch, press to open / lock


Key switch, closer

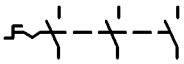

Key switch, opener


Foot switch, closer


Foot switch, opener


Carn switch, closer


Carn switch, opener


Main switch, 3 poles


Impact switch, Emergency OFF

3282081

Switches, contacts


Switch, general, opener with indent


Switch, general, closer with indent


Button, general, closer


Button, general, opener


Impact button, closer


Impact button, opener


Closer, time-lag closing


Opener, time-lag opening


Closer, time-lag opening


Opener, time-lag closing


Closer, advanced closing


Opener, delayed


Closer, thermal release


Opener, thermal release


Button, closed mechanically


Button, opened mechanically

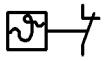
Pressure monitor, closer

Pressure monitor, opener

3282091

Switches, contacts

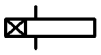

Temperature switch, closer

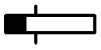

Temperature switch, opener


Float switch, closer


Float switch, opener

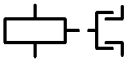

Coil, general (relay, solenoid)

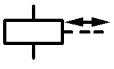

Electro-magnetic actuation, delayed


Electro-magnetic actuation, delayed return


Solenoid valve

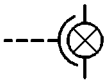

Solenoid-actuated brake


Solenoid actuated coupling


Solenoid with shift bar

3282101

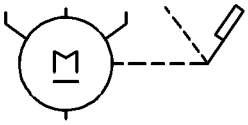
Indicators, measuring devices

	Horn
	Bell, alarmbell
	Clock
	Buzzer
	Blinker
	Giratory beacon
	Illuminated push button with lamp test
	Counter, meter
	Voltmeter
	Amperemeter
	Hourmeter
	Automobile instrument, generals
	Lamp, general
	Incandescent lamp with mechanical cover (e.g. in rocker switches : the cover opens when the rocker is actuated, the lamp is then visible to indicate that the switch has been actuated)

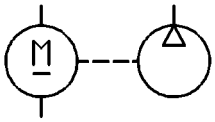
3282111

Motors, alternators

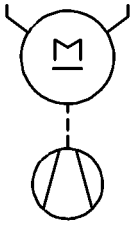
DC motor, general (f.ex. engine starter motor)



Windscreen wiper motor



DC motor with pump



Fan motor

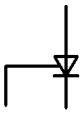
3-phase alternator with rectifier

3282121

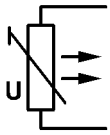
Semiconductors

Light emitting diode

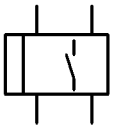
Diode



Thyristor



Voltage-dependent (semi-conductor) resistor
(resistance increases with higher voltage)



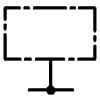
Electronic pulse generator

3283291

Miscellaneous

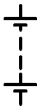

1-pole automotive plug


Assembly, unit


Shielded assembly with connection to ground


Cigarette lighter

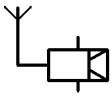

Fuse


Battery


Thermocouple (temperature probe)


Light beam


Heating element (f.ex. glow plug)


Radio / receiver


Speaker


Capacitor


Capacitor, polarized


Engine speed transducer with digital output signal (pick-up)

3283301

Symbols for directions of motion

Linear motion, e.g. to the right

Linear motion, in both directions

Rotary motion, e.g. to the left

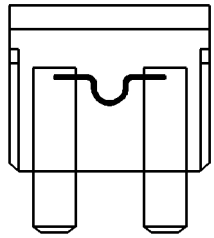
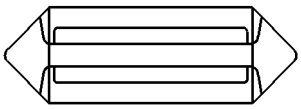
Rotary motion, in both directions

3280891

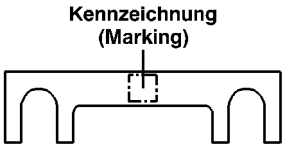
Fuses

2732959

Fuse links (DIN 72 581)

Type	Nominal current, amperes	Colour of fuse insulation
 Fuse link, flat type	3 4 5 7,5 10 15 20 25 30	violet pink lightbrown brown red lightblue yellow white (nature) lightgreen
 Fuse link, round type	5 8 16 25	yellow white red blue

Fuse strips (DIN 72 581)

	Nominal current, amperes
	30 50 80 100

Notes

2800145

T

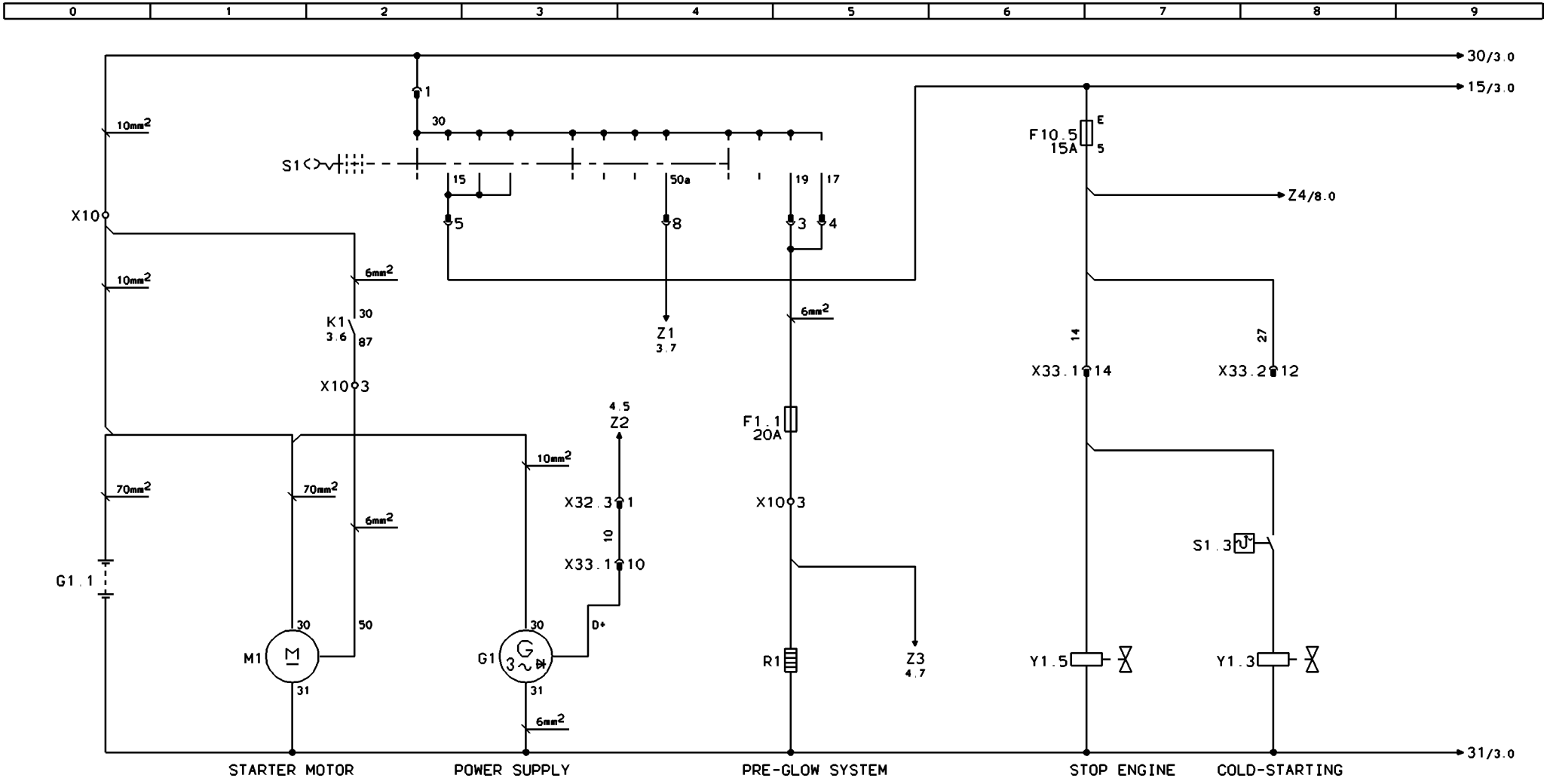
V

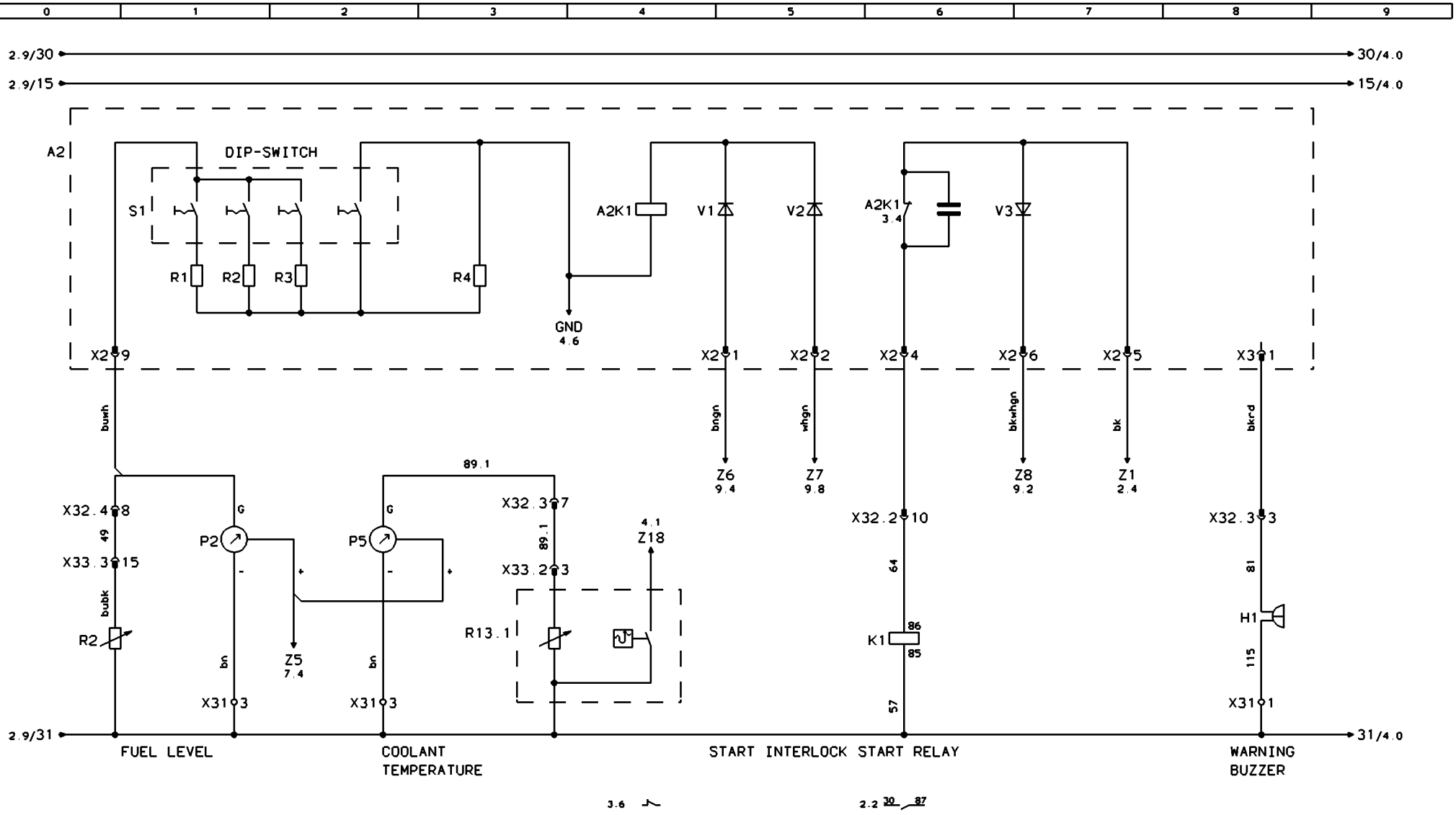
W

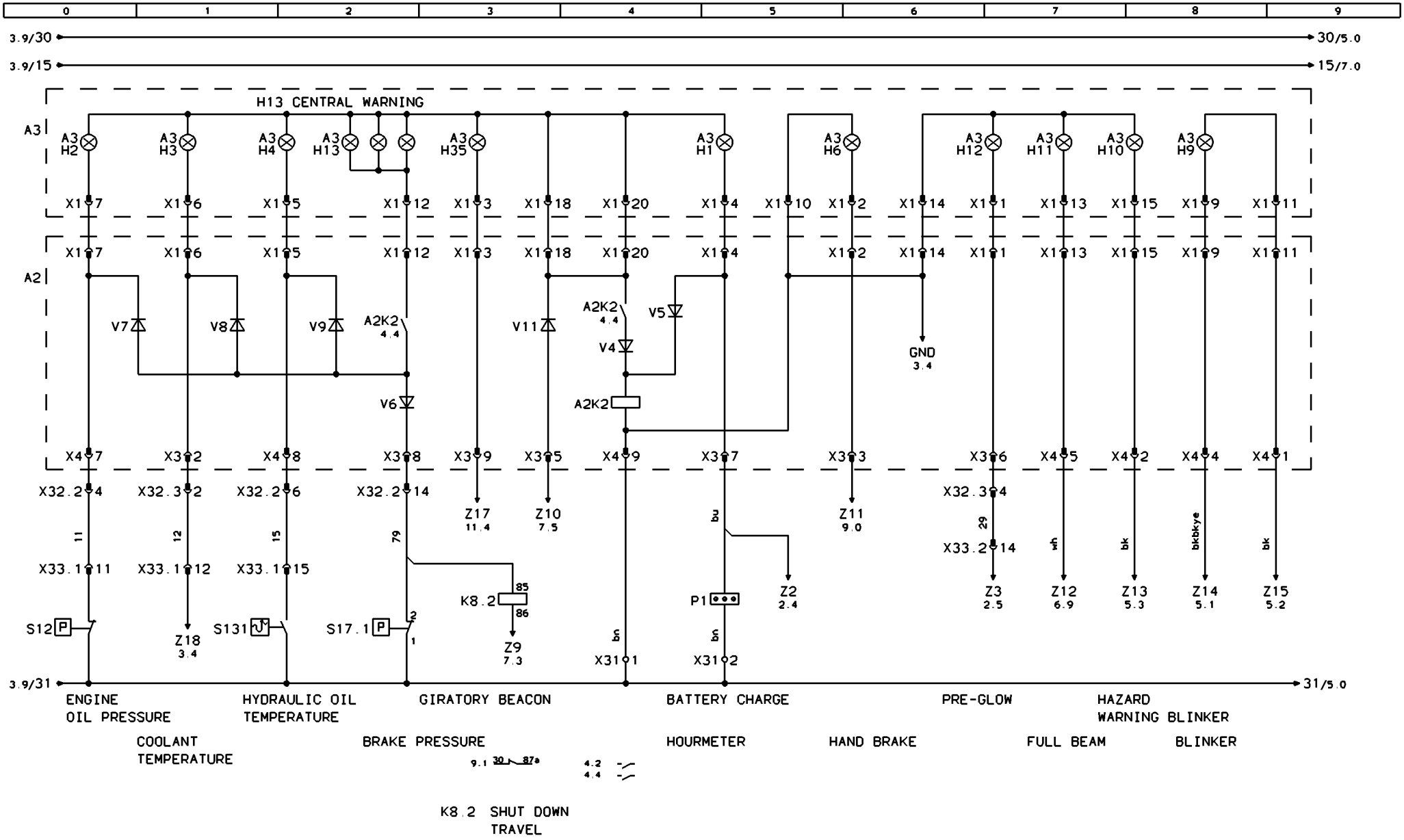
List of contents

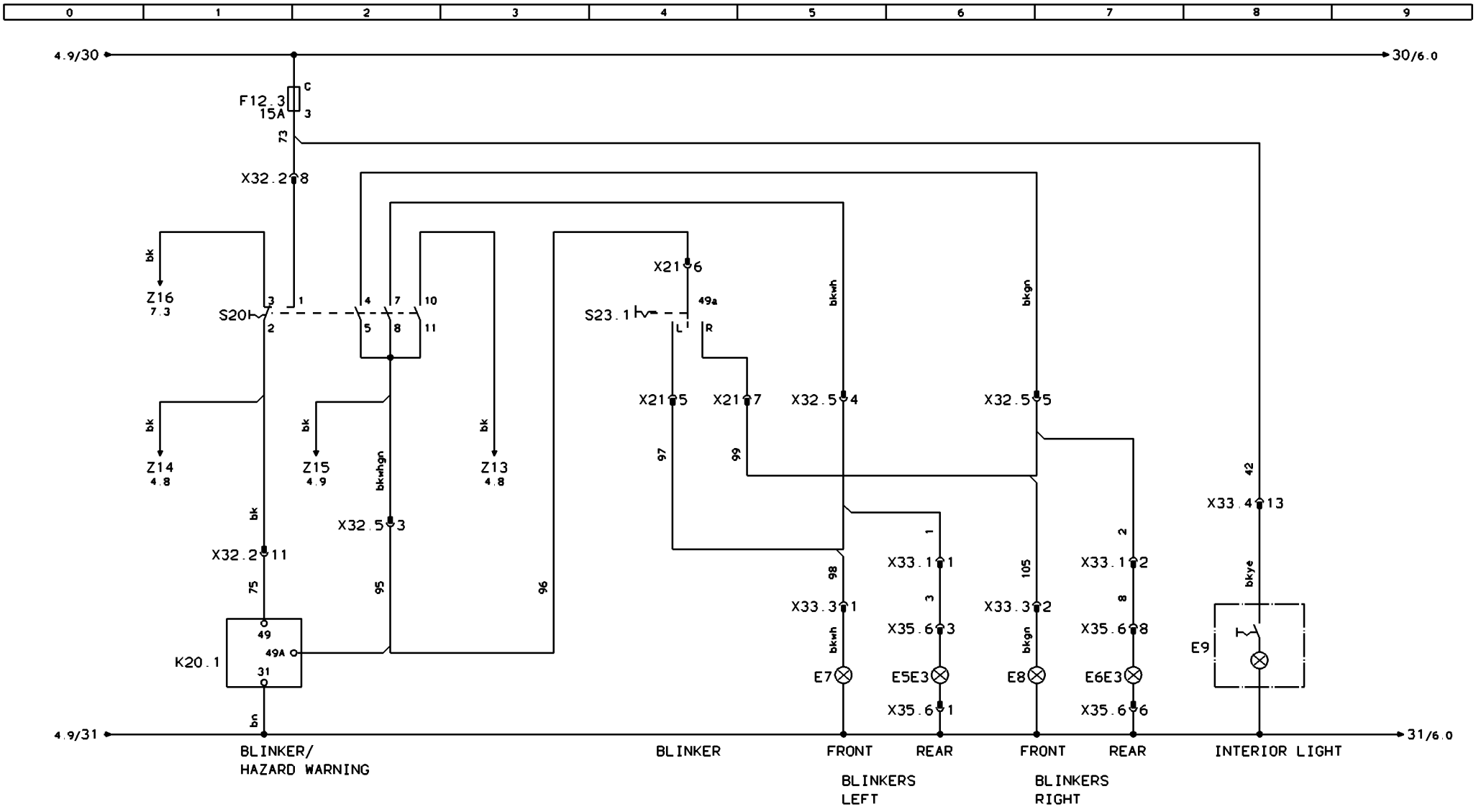
Spalte X: eine automatisch erzeugte Seite wurde manuell nachbearbeitet

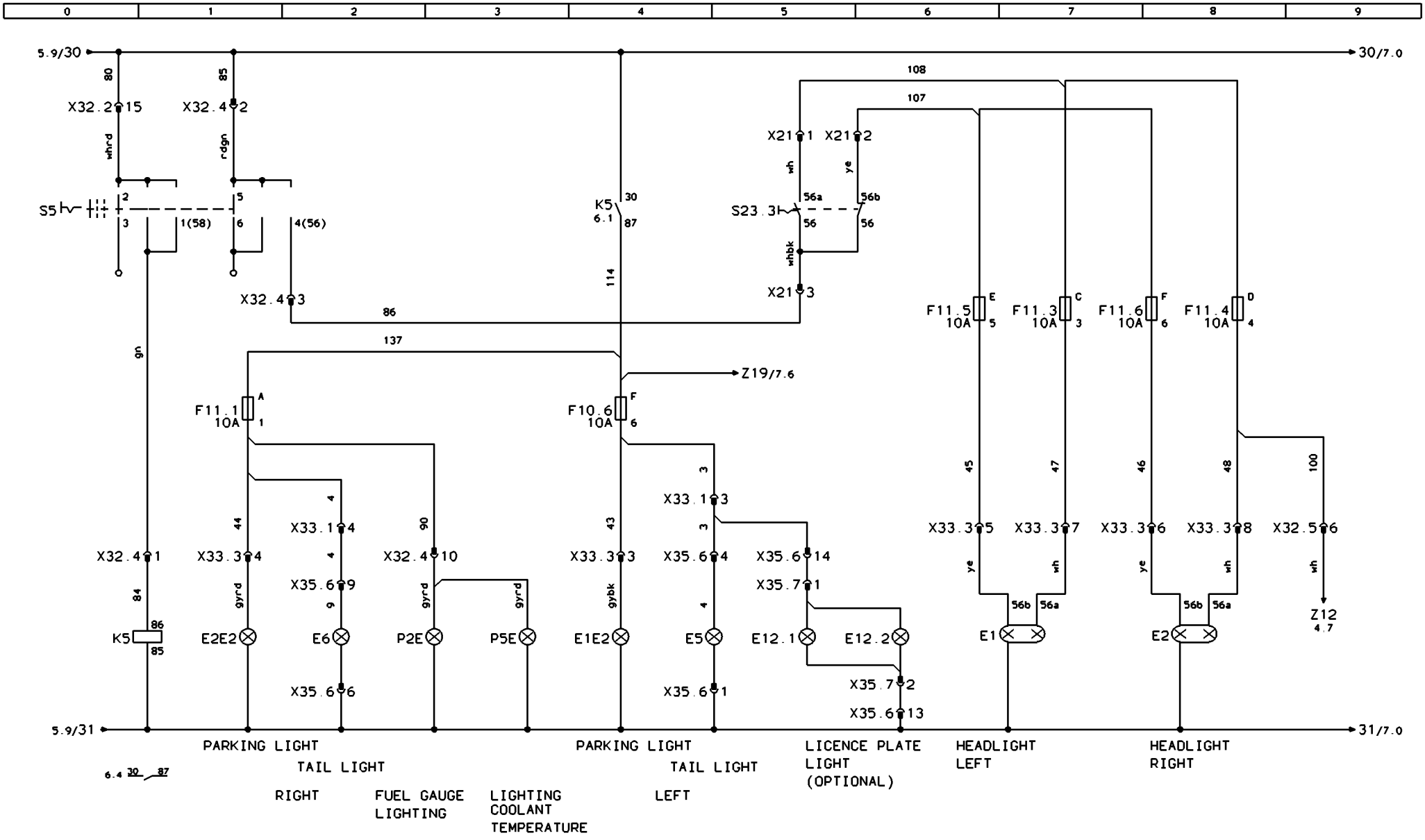
WUP1205D / 28.Mai.1993

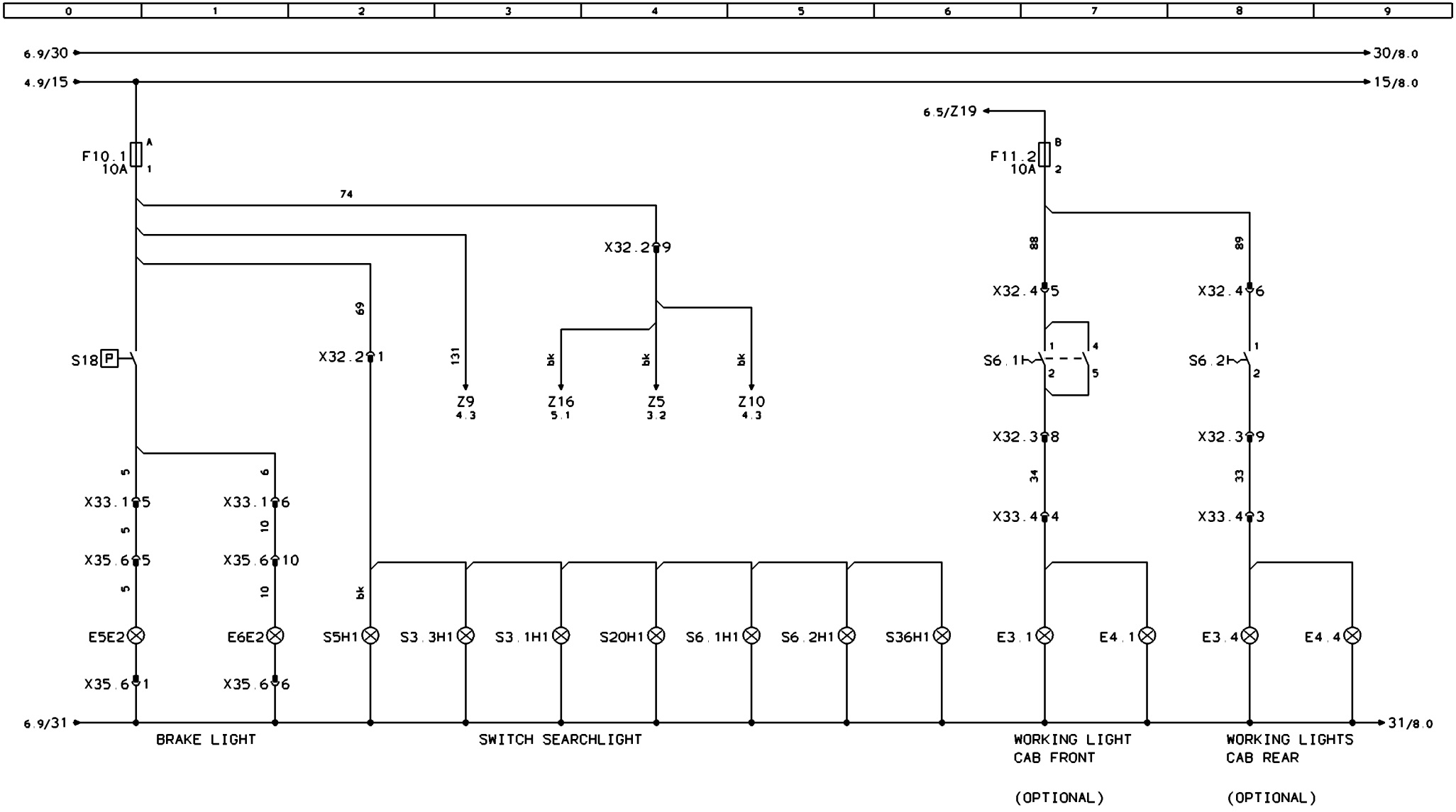

0
1
2
3
4
5
6
7
8
9
30/3.0
15/3.0
31/3.0
Z4/8.0
S1
1
30
15
50a
19
17
5
8
3
4
F10.5
15A
E
5
X10
10mm²
6mm²
K1
3.6
30
87
X10 3
Z1
3.7
4.5
Z2
F1.1
20A
70mm²
X32.3 1
10
X33.1 10
X10 3
G1.1
M1
30
50
31
G1
D+
R1
Z3
4.7
X33.1 14
X33.2 12
14
27
S1.3
Y1.5
Y1.3
STARTER MOTOR
POWER SUPPLY
PRE-GLOW SYSTEM
STOP ENGINE
COLD-STARTING

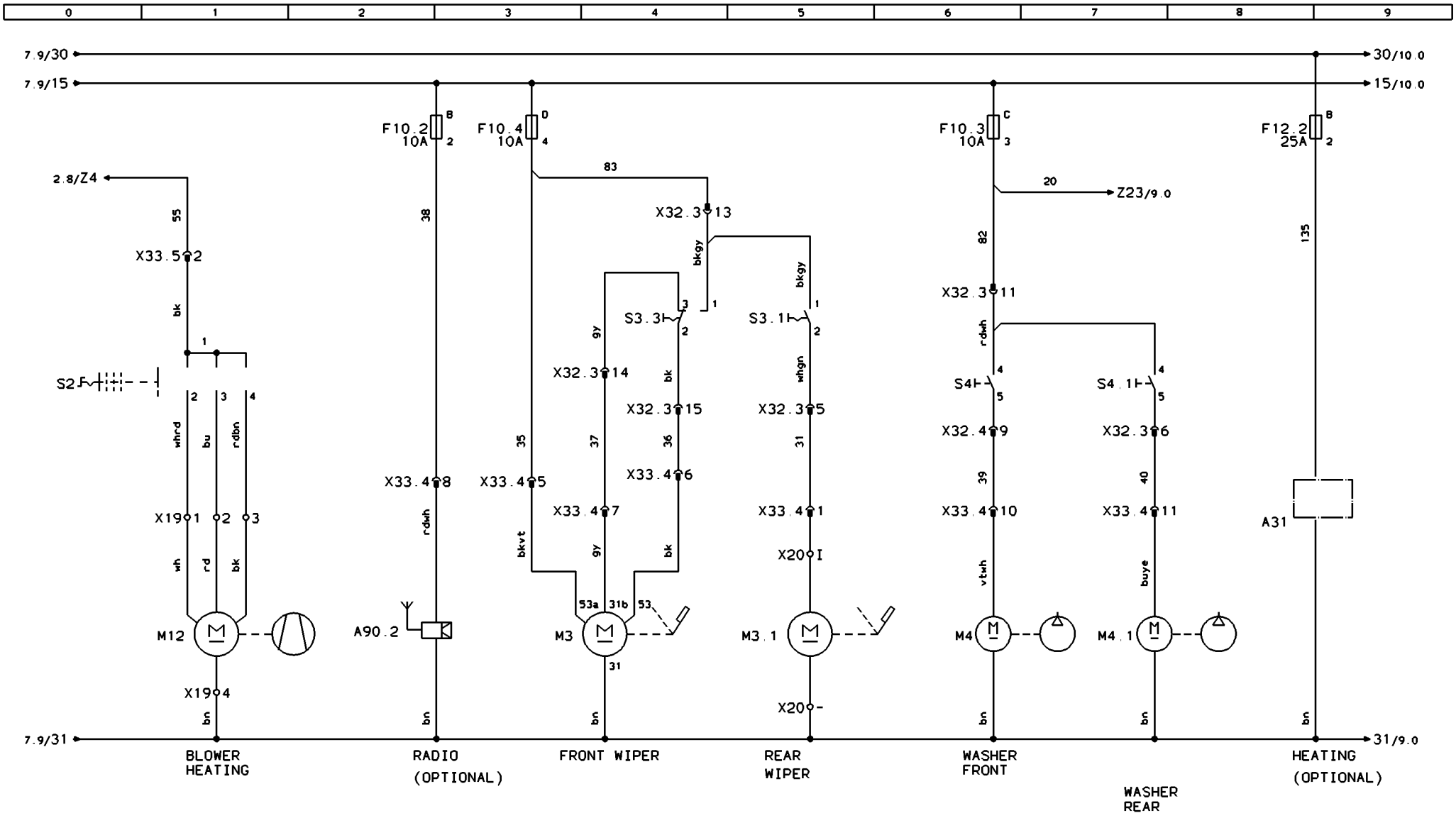

0
1
2
3
4
5
6
7
8
9
2.9/30
30/4.0
2.9/15
15/4.0
A2
DIP-SWITCH
S1
R1
R2
R3
R4
GND
4.6
A2K1
V1
V2
A2K1
3.4
V3
X2.9
X2.1
X2.2
X2.4
X2.6
X2.5
X3.1
buwh
bngn
whgn
bkwhgn
bk
bkrd
89.1
Z6
9.4
Z7
9.8
Z8
9.2
Z1
2.4
X32.4.8
X32.3.7
X32.2.10
X32.3.3
49
89.1
64
81
4.1
Z18
X33.3.15
X33.2.3
bubk
H1
R2
R13.1
K1
86
85
Z5
7.4
bn
bn
115
57
X3.1.3
X3.1.3
X3.1.1
2.9/31
31/4.0
FUEL LEVEL
COOLANT
TEMPERATURE
START INTERLOCK START RELAY
WARNING
BUZZER
3.6
2.2
30
87


0 1 2 3 4 5 6 7 8 9
3.9/30
30/5.0
3.9/15
15/7.0
H13 CENTRAL WARNING
A3
A3 H2
A3 H3
A3 H4
A3 H13
A3 H35
A3 H1
A3 H6
A3 H12
A3 H11
A3 H10
A3 H9
X1:7
X1:6
X1:5
X1:12
X1:3
X1:18
X1:20
X1:4
X1:10
X1:2
X1:14
X1:1
X1:13
X1:15
X1:9
X1:11
A2
V7
V8
V9
A2K2
4.4
V6
V11
A2K2
4.4
V5
V4
A2K2
GND
3.4
X4:7
X3:2
X4:8
X3:8
X3:9
X3:5
X4:9
X3:7
X3:3
X3:6
X4:5
X4:2
X4:4
X4:1
X32.2:4
X32.3:2
X32.2:6
X32.2:14
X32.3:4
11
12
15
79
29
X33.1:11
X33.1:12
X33.1:15
X33.2:14
Z17
11.4
Z10
7.5
Z11
9.0
bu
wh
bk
bkbkye
bk
S12
Z18
3.4
S131
S17.1
K8.2
85
86
Z9
7.3
P1
Z2
2.4
Z3
2.5
Z12
6.9
Z13
5.3
Z14
5.1
Z15
5.2
X31:1
X31:2
3.9/31
31/5.0
ENGINE OIL PRESSURE
HYDRAULIC OIL TEMPERATURE
GIRATORY BEACON
BATTERY CHARGE
PRE-GLOW
HAZARD WARNING BLINKER
COOLANT TEMPERATURE
BRAKE PRESSURE
HOURMETER
HAND BRAKE
FULL BEAM
BLINKER
9.1 30 87a
4.2
4.4
K8.2 SHUT DOWN TRAVEL


0
1
2
3
4
5
6
7
8
9
4.9/30
30/6.0
F12.3
15A
C
3
73
X32.2 8
Z16
7.3
bk
S20
3
1
2
4
7
10
5
8
11
Z14
4.8
Z15
4.9
bkwhgn
Z13
4.8
X32.5 3
X32.2 11
75
95
96
49
49A
31
K20.1
bk
4.9/31
X21 6
49a
S23.1
L
R
X21 5
X21 7
X32.5 4
X32.5 5
bkwh
bkgn
97
99
98
105
X33.3 1
X33.3 2
X33.1 1
X33.1 2
1
3
2
8
X35.6 3
X35.6 8
X35.6 1
X35.6 6
E7
E5E3
E8
E6E3
X33.4 13
42
bkye
E9
31/6.0
BLINKER/
HAZARD WARNING
BLINKER
FRONT
REAR
FRONT
REAR
INTERIOR LIGHT
BLINKERS
LEFT
BLINKERS
RIGHT


0
1
2
3
4
5
6
7
8
9
5.9/30
30/7.0
80
85
X32.2 15
X32.4 2
wh/rd
rdgn
S5
2
5
3
1(58)
6
4(56)
X32.4 3
86
108
107
X21 1
X21 2
wh
ye
S23.3
56a
56b
56
56
whbk
X21 3
K5
30
6.1
87
114
137
Z19/7.6
F11.1
10A
A
1
F10.6
10A
F
6
F11.5
10A
E
5
F11.3
10A
C
3
F11.6
10A
F
6
F11.4
10A
D
4
gn
X32.4 1
84
K5
86
85
44
X33.3 4
gyrd
E2E2
4
X33.1 4
4
X35.6 9
9
E6
X35.6 6
90
X32.4 10
gyrd
P2E
gyrd
P5E
43
X33.3 3
gybk
E1E2
3
X33.1 3
3
X35.6 4
4
E5
X35.6 1
X35.6 14
X35.7 1
E12.1
E12.2
X35.7 2
X35.6 13
45
X33.3 5
ye
47
X33.3 7
wh
56b
56a
E1
46
X33.3 6
ye
48
X33.3 8
wh
56b
56a
E2
100
X32.5 6
wh
Z12
4.7
5.9/31
31/7.0
PARKING LIGHT
TAIL LIGHT
RIGHT
FUEL GAUGE
LIGHTING
LIGHTING
COOLANT
TEMPERATURE
PARKING LIGHT
TAIL LIGHT
LEFT
LICENCE PLATE
LIGHT
(OPTIONAL)
HEADLIGHT
LEFT
HEADLIGHT
RIGHT
6.4 30 87


0
1
2
3
4
5
6
7
8
9
6.9/30
30/8.0
4.9/15
15/8.0
6.5/Z19
F10.1
10A
A
1
F11.2
10A
B
2
74
88
89
69
131
X32.2 9
X32.4 5
X32.4 6
S18
P
X32.2 1
S6.1
S6.2
1
4
2
5
Z9
4.3
Z16
5.1
Z5
3.2
Z10
4.3
bk
X32.3 8
X32.3 9
34
33
X33.4 4
X33.4 3
5
6
X33.1 5
X33.1 6
10
X35.6 5
X35.6 10
E5E2
E6E2
S5H1
S3.3H1
S3.1H1
S20H1
S6.1H1
S6.2H1
S36H1
E3.1
E4.1
E3.4
E4.4
X35.6 1
X35.6 6
6.9/31
31/8.0
BRAKE LIGHT
SWITCH SEARCHLIGHT
WORKING LIGHT
CAB FRONT
(OPTIONAL)
WORKING LIGHTS
CAB REAR
(OPTIONAL)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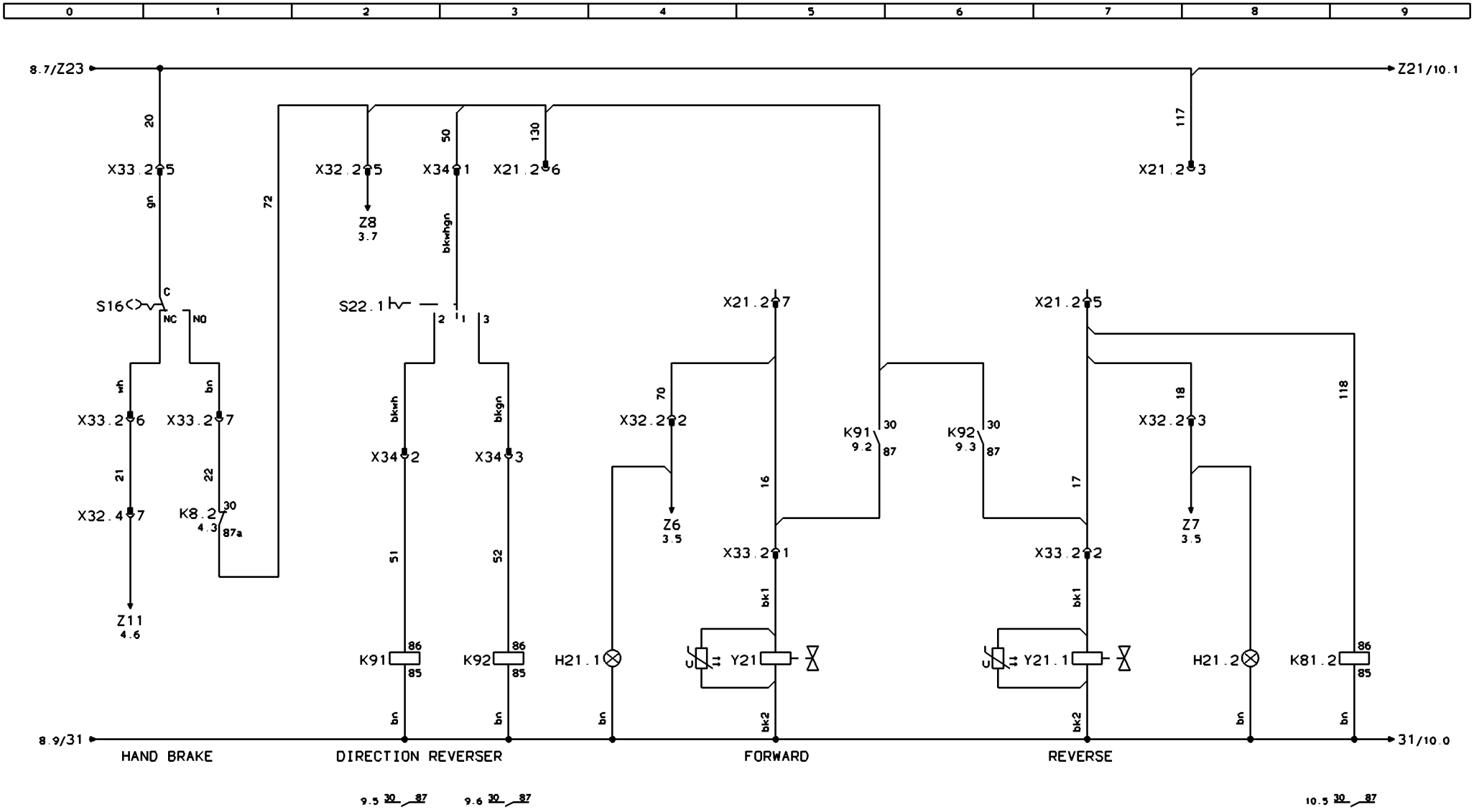
7.9/30
7.9/15
7.9/31
30/10.0
15/10.0
31/9.0
F10.2 10A
F10.4 10A
F10.3 10A
F12.2 25A
2.8/Z4
Z23/9.0
X33.5
X32.3
X19
X33.4
X32.4
X20
S2
S3.3
S3.1
S4
S4.1
M12
M3
M3.1
M4
M4.1
A90.2
A31
BLOWER HEATING
RADIO (OPTIONAL)
FRONT WIPER
REAR WIPER
WASHER FRONT
WASHER REAR
HEATING (OPTIONAL)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8.7/Z23
Z21/10.1
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X33.2 5
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72
X32.2 5
Z8
3.7
50
X34 1
bkwhgn
130
X21.2 6
117
X21.2 3
S16
C
NC
NO
S22.1
2
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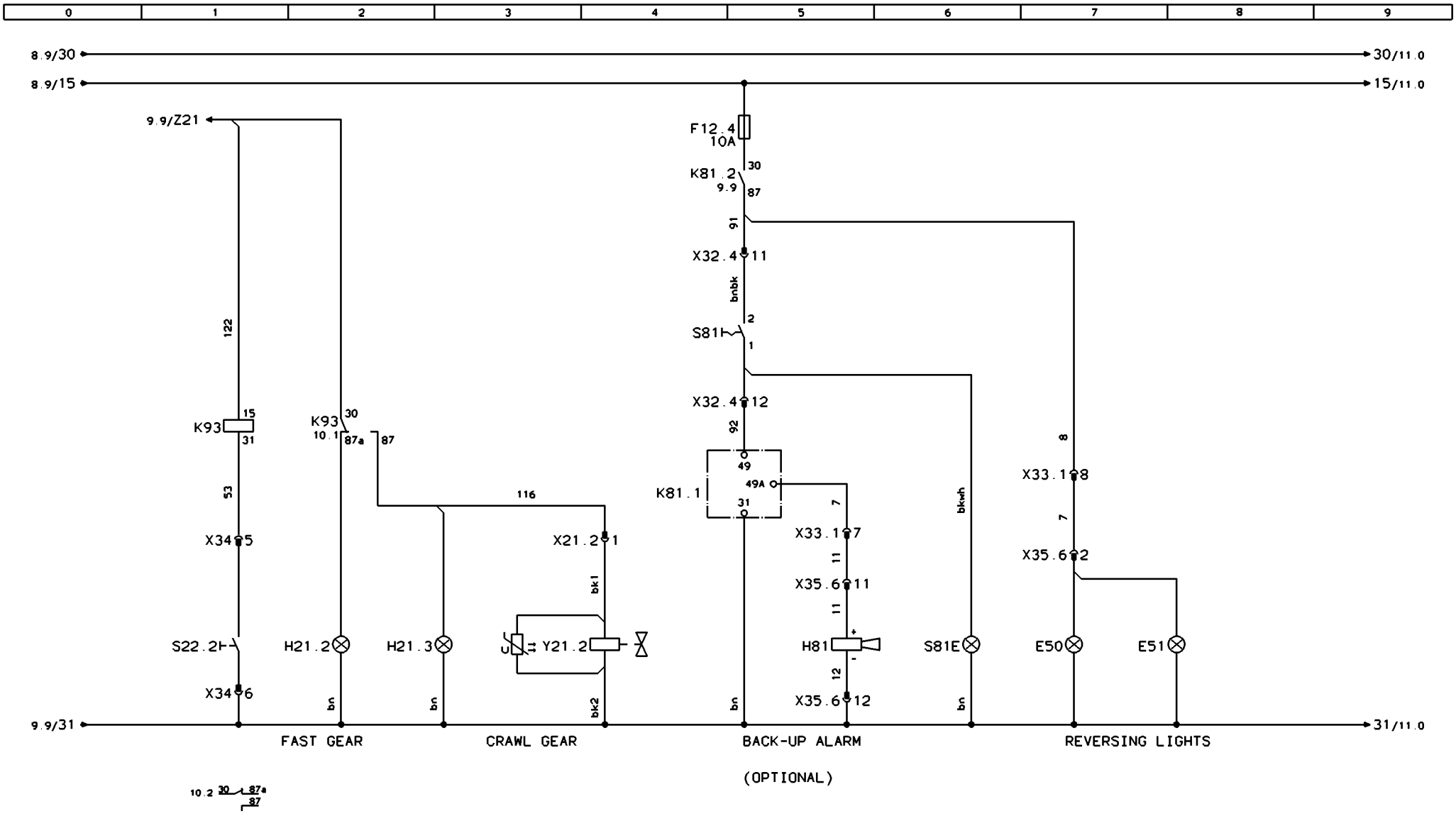
3
X21.2 7
X21.2 5
wh
bn
bkwh
bkgn
70
X32.2 2
18
X32.2 3
118
X33.2 6
X33.2 7
X34 2
X34 3
K91
30
9.2
87
K92
30
9.3
87
21
22
16
17
X32.4 7
K8.2
30
4.3
87a
Z6
3.5
Z7
3.5
X33.2 1
X33.2 2
bk1
Z11
4.6
51
52
K91
86
85
K92
86
85
H21.1
Y21
Y21.1
H21.2
K81.2
bn
bk2
8.9/31
31/10.0
HAND BRAKE
DIRECTION REVERSER
FORWARD
REVERSE
9.5 30 87
9.6 30 87
10.5 30 87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9.9/Z21
F12.4
10A
K81.2
9.9
30
87
91
X32.4 11
bnbk
2
S81
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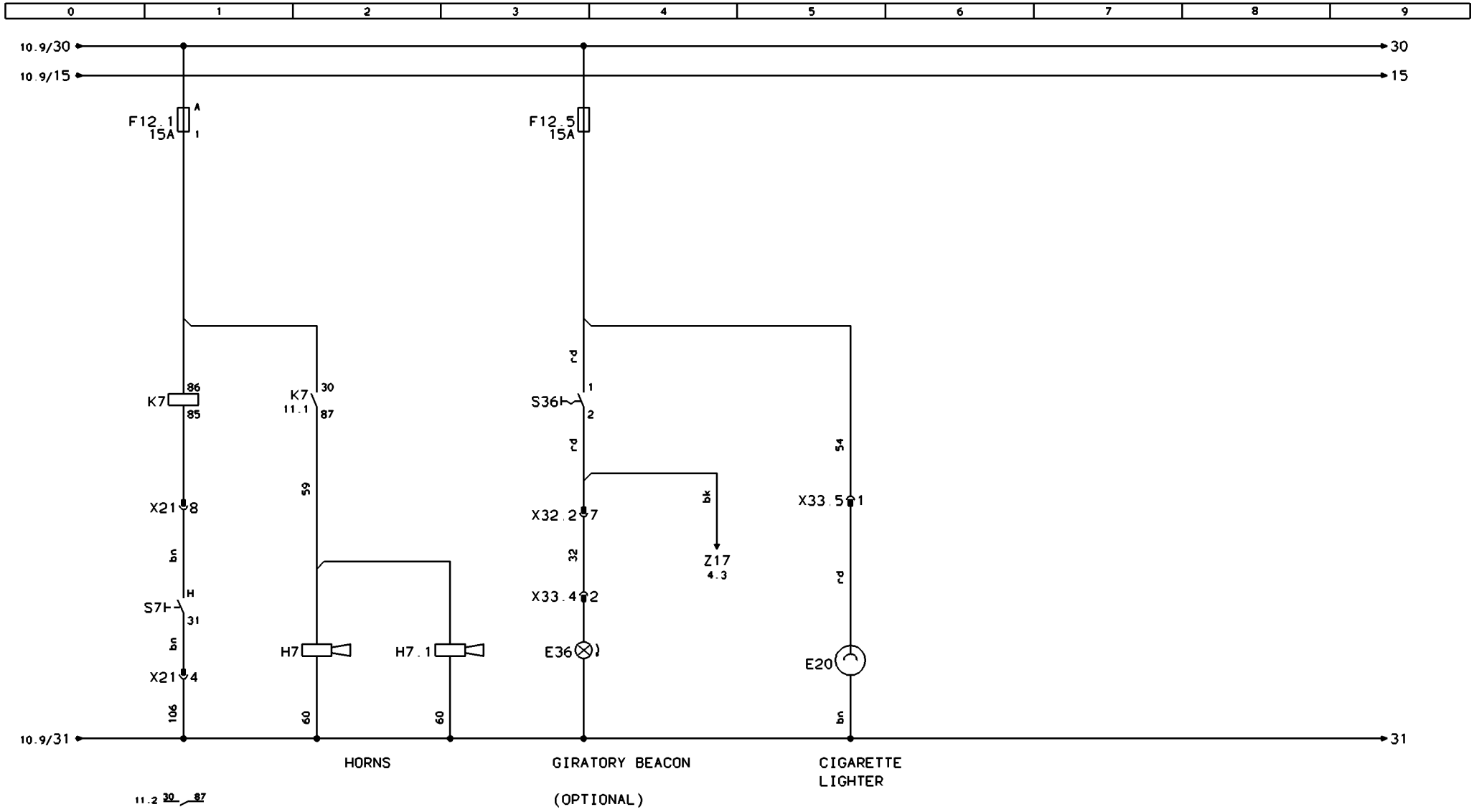
X32.4 12
92
49
49A
K81.1
31
X33.1 7
11
X35.6 11
11
H81
12
X35.6 12
bn
bkwh
X33.1 8
8
7
X35.6 2
S81E
E50
E51
K93
15
31
53
X34 5
X34 6
S22.2
K93
30
10.1
87a
87
116
X21.2 1
bk1
bk2
H21.2
H21.3
Y21.2
9.9/31
31/11.0
FAST GEAR
CRAWL GEAR
BACK-UP ALARM
REVERSING LIGHTS
(OPTIONAL)
10.2
30
87a
87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10.9/30
30
10.9/15
15
F12.1
15A
A
1
F12.5
15A
K7
86
85
K7
11.1
30
87
S36
1
2
rd
rd
54
X21
8
59
X32.2
7
bk
X33.5
1
Z17
4.3
bn
32
rd
S7
H
31
X33.4
2
bn
X21
4
106
H7
H7.1
E36
E20
60
60
bn
10.9/31
31
HORNS
GIRATORY BEACON
(OPTIONAL)
CIGARETTE
LIGHTER
11.2 30 87

END POINT	CABLE NO.	⌒ mm²	NO.	■ mm²	CABLE NO.	END POINT
F10.1	69	1	1	1		S5H1 / S3.3H1 / S3.1H1
X21.2.7	70	1	2	1	bngn	H21 / A2X2.1
X21.2.5	18	1	3	1	whgn	H21.1 / A2X2.2
X33.1.11	11	1	4	1		A2X4.7
K8.2.87a	72	1,5	5	1,5	bkwhgn	A2X2.6
X33.1.15	15	1	6	1		A2X4.6
X33.4.2	32	1,5	7	1,5		S36/2 / S17.1
F12.3	73	1	8	1		S36/1 / S20/1
F10.1	74	1,5	9	1,5		S20/3 / P2/+ / A2X3.5
K1.86		64	10	1		A2X2.4
K20.1.49	75	1	11	1		S20/2 / A2X4.4
			12			
			13			
K8.2.85 / S17.1	79	1	14	1		A2X3.8
B+ (30)	80	1	15	1		S5/2

CONNECTION TABLE PLUG/SOCKET
PANEL X32.2 DEVICE

END POINT	CABLE NO.	⌒ mm²	NO.	■ mm²	CABLE NO.	END POINT
A2X3.7 / P1	bu	1	1	1	10	X33.1.10
A2X3.2		1	2	1	12	X33.1.12
H1	81	1	3	1	bkrd	A2X3.1
A2X3.6		1,5	4	1,5	29	X33.2.14
S3.1/2	whgn	1,5	5	1,5	31	X33.4.1
S4.1/5		1,5	6	1,5	40	X33.4.11
P5/G	89.1	1	7	1	89.1	X33.2.3
S6.1/2/5		1,5	8	1,5	34	X33.4.4
S6.2/2		1,5	9	1,5	33	X33.4.3
			10			
S4/4	rdwh	1,5	11	1,5	82	F10.3
			12			
S3.3/1	bkgy	1,5	13	1,5	83	F10.4
S3.3/3	gy	1	14	1	37	X33.4.7
S3.3/2	bk	1	15	1	36	X33.4.6

CONNECTION TABLE PLUG/SOCKET
PANEL X32.3 DEVICE

END POINT	CABLE NO.	(mm²	NO.	■ mm²	CABLE NO.	END POINT
S5/1/3	gn	1	1	1	84	K5.86
S5/5	rdgn	1,5	2	1,5	85	30 (B+)
S5/4		1,5	3	1,5	86	X21.3
			4			
S6.1/1/4		1,5	5	88	1,5	F11.2
S6.2/1		1,5	6	1,5	89	F11.2
A2X3.3		1	7	1	21	X33.2.6
P2/G	buwh	1	8	1	49	X33.3.15
S4/5		1,5	9	1,5	39	X33.4.10
P2E	gyrd	1,5	10	1,5	90	F11.1
S81/2	bnbk	1,5	11	1,5	91	K81.2 (87)
S81/1		1,5	12	1,5	92	K81.1 (49)

CONNECTION TABLE PLUG/SOCKET
PANEL X32.4 DEVICE

END POINT	CABLE NO.	(mm²	NO.	■ mm²	CABLE NO.	END POINT
			1			
			2			
K20.1 (48a) / X21.6	95/96	1,5	3	1,5	bkwhgn	S20/5/8/11
X21.5/X33.3.1/X33.1.1	97/98	1,5	4	1,5	bkwh	S20/7
X21.7/X33.3.2/X33.1.2	2/105	1,5	5	1,5	bkgn	S20/4
			6			
			7			
			8			
			9			

CONNECTION TABLE PLUG/SOCKET
PANEL X32.5 DEVICE

END POINT	CABLE NO.	(mm²	NO.	■ mm²	CABLE NO.	END POINT
X32.5.4	1	1	1	1	3	E5E3
X32.5.5	2	1	2	1	8	E6E3
F10.6	3	1	3	1	4	E5E1
F11.1	4	1	4	1	9	E6E1
S18	5	1	5	1	5	E5E2
S18	6	1	6	1	10	E6E2
K81.1 (49a)	7	1,5	7	1,5	11	H81 (OPTIONAL)
K81.2 (87)	8	1	8	1	7	E50 / E51 (OPTIONAL)
X.1	9		9	1,5		RESERVE BEL. RECHTS
X32.3.1	10	1	10	1		G1 (D+)
X32.2.4	11	1	11	1		S12
X32.3.2	12	1	12	1		S13
X10.3	13	2,5	13	2,5	30	X11.B
F10.5	14	2,5	14	2,5	15	X11.A
X32.2.6	15	1	15	1		S131
CONNECTION TABLE PLUG/SOCKET PANEL			X33.1			DEVICE

END POINT	CABLE NO.	(mm²	NO.	■ mm²	CABLE NO.	END POINT
X21.2.7 / K91 (87)	16	1	1	1	bk 1	Y21
X21.2.5 / K92 (87)	17	1	2	1	bk 1	Y21.1
			3			
			4			
			5			
			6			
X32.3.7	89.1	1	7	1	89.1	R13.1
			8			
			9			
GROUND (-)	25	1	10	1,5	B1	K1.3.1
			11	1,5	B2	K1.3.2
F10.5	27	1	12	1,5	B3	K1.3.3
X10.3		1	13	1,5	B4	K1.3.4
X32.3.4	29	1	14	1,5	B5	K1.3.5
X.2	30	1,5	15	1,5	X	RESERVE BEL. LINKS
CONNECTION TABLE PLUG/SOCKET PANEL			X33.2			DEVICE

END POINT	CABLE NO.	⏜ mm²	NO.	■ mm²	CABLE NO.	END POINT
X21.5	98	1,5	1	1,5	bkwh	E7
X21.7	105	1,5	2	1,5	bkgn	E8
F10.6	43	1,5	3	1,5	gybk	E1E2
F11.1	44	1,5	4	1,5	gyrd	E2E2
F11.5	45	1,5	5	1,5	ye	E1 (56b)
F11.6	46	1,5	6	1,5	ye	E2 (56b)
F11.3	47	1,5	7	1,5	wh	E1 (56a)
F11.4	48	1,5	8	1,5	wh	E1 (56a)
			9			
			10			
			11			
			12			
			13			
			14			
X32.4.8	48	1	15	1	bubk	R2

CONNECTION TABLE PLUG/SOCKET
PANEL X33.3 DEVICE

END POINT	CABLE NO.	⏜ mm²	NO.	■ mm²	CABLE NO.	END POINT
X32.3.5	31	1,5	1	1,5		X20/I
X32.2.7	32	1,5	2			E36 (OPTIONAL)
X32.3.9	33	1,5	3			E3.4 / E4.4 (OPTIONAL)
X32.3.8	34	1,5	4			E3.1 / E4.1 (OPTIONAL)
F10.4	35	1,5	5	1,5	bkvt	M3 (53a)
X32.3.15	36	1,5	6	1,5	bk	M3 (53)
X32.3.14	37	1,5	7	1,5	gy	M3 (31b)
F10.2	38	1,5	8	1,5	rdwh	A90.2 (OPTIONAL)
			9			
X32.4.9	39	1,5	10	1,5	vtwh	M4
X32.3.6	40	1,5	11	1,5	buye	M4.1
			12			
F12.3	42	1,5	13	1,5	bkye	E9
			14			
			15			

CONNECTION TABLE PLUG/SOCKET
PANEL X33.4 DEVICE

END POINT	CABLE NO.	⌒ mm²	NO.	■ mm²	CABLE NO.	END POINT
X21.2.6	50	1,5	1	1,5	bkwhgn	S22.1/1
K91 (86)	51	1,5	2	1,5	bkwh	S22.1/2
K92 (86)	52	1,5	3	1,5	bkgn	S22.1/3
			4			
K90 (31)	53	1,5	5	1,5		S22.2
GROUND (-)		1,5	6	1,5		S22.2
CONNECTION TABLE PLUG/SOCKET PANEL X34 DEVICE						

END POINT	CABLE NO.	⌒ mm²	NO.	■ mm²	CABLE NO.	END POINT
X33.1.1	9	1,5	1			
X33.2.15	30	1,5	2			
CONNECTION TABLE PLUG/SOCKET PANEL X DEVICE						

END POINT	CABLE NO.	☾ mm²	NO.	■ mm²	CABLE NO.	END POINT
GROUND (-)	1	1,5	1	1	1,5	E5E3 / E5 / E5E2
X33.1.8	2	1	2	1	2	E50 / E51
X33.1.1	3	1	3	1	3	E5E3
X33.1.3	4	1	4	1	4	E5
X33.1.5	5	1	5	1	5	E5E2
GROUND (-)	6	1,5	6	1,5	6	E6 / E6E3 / E6E2
			7			
X33.1.2	8	1	8	1	8	E6E3
X33.1.4	9	1	9	1	9	E6
X33.1.6	10	1	10	1	10	E6E2
X33.1.7	11	1	11	1	11	H81 (OPTIONAL)
GROUND (-)	12	1	12	1	12	H81 (OPTIONAL)
GROUND (-)	13	1	13	1	13	X35.7.2
X33.1.3	14	1	14	1	14	X35.7.1
			15			

CONNECTION TABLE PLUG/SOCKET
TAIL LIGHTS X35.6 DEVICE

END POINT	CABLE NO.	■ mm²	NO.	☾ mm²	CABLE NO.	END POINT
X35.6.14	14	1	1	1	14	E12.1 / E12.2 (OPTIONAL)
X35.6.13	13	1	2	1	14	E12.1 / E12.2 (OPTIONAL)

CONNECTION TABLE PLUG/SOCKET
LICENCE PLATE LIGHT X35.7 DEVICE

END POINT	CABLE NO.	■ mm²	NO.	☾ mm²	CABLE NO.	END POINT
F11.4	108	1,5	1	1,5	wh	S23.3/56a
F11.6	107	1,5	2	1,5	ye	S23.3/56b
X32.4.3	86	1,5	3	1,5	whbk	S23.3/56
GROUND (-)		1,5	4	1,5	bn	S7/31
X33.3.1	97	1,5	5	1,5	bkwh	S23.1/L
X32.5.3	96	1,5	6	1,5	bkwhgn	S23.1/49a
X33.1.1	99	1,5	7	1,5	bkgn	S23.1/R
H7	60	1,5	8	1,5	bnwh	S7/H

CONNECTION TABLE PLUG/SOCKET
PANEL X21 DEVICE

END POINT	CABLE NO.	■ mm²	NO.	☾ mm²	CABLE NO.	END POINT
K90 (87)	116	1,5	1	1,5	bk1	Y21.2
			2			
F10.3	117	1,5	3			
			4			
X32.2.3 / K81.2 (86)	118	1,5	5			
X34.1 / K91 (30)	130	1,5	6			
X32.2.2 / X33.3.1	70/16	1,5	7			
			8			

CONNECTION TABLE PLUG/SOCKET
PANEL X21.2 DEVICE

OVERVIEW-CABLE HARNESSES

W1 → CABLE HARNESS CONTROL PANEL	W11 → CABLE LIGHTS	W21 →
W2 → CABLE LIGHTING	W12 →	W22 →
W3 → CABLE SET MOTOR	W13 →	W23 → ENGINE EARTH
W4 →	W14 →	Z24 →
W5 → MAIN CABLE SET	W15 →	Z25 →
W6 →	W16 →	W26 →
W7 →	W17 →	W27 →
W8 → CABLE STARTER	W18 → EARTH CABLE HEADLIGHTS	W28 →
W9 → CABLE SET CAB	W19 →	W31 → WIRING CPL. PARKING BRAKESWITCH
W10 →	W20 →	W41 → CABLESET HEATING

Electrical components in circuit diagram

Circuit diagram No. **T 72183406 - 00**

B 3002802 - 800

Part	Quantity	Description and function	Curr. Path	Location	Part no.
A2	1,000	PCB LAMP TEST	4 - 0/34	CONTROL PANEL	72180829
A3	1,000	LAMP MODULE	4 - 0/13	CONTROL PANEL	72180830
A3H2	1,000	WARNING - OIL PRESSURE	4 - 0/19	CONTROL PANEL	72181912
A3H3	1,000	WARNING - OIL TEMPERATURE	4 - 1/19	CONTROL PANEL	72181912
A3H4	1,000	WARNING - HYDRAULIC TEMPERATURE	4 - 2/19	CONTROL PANEL	72181912
A3H13	3,000	COMBI WARNING	4 - 2/19	CONTROL PANEL	72181912
A3H35	1,000	TELL-TALE - BEACON	4 - 3/19	CONTROL PANEL	72181912
A3H1	1,000	WARNING - BATTERY CHARGE	4 - 5/19	CONTROL PANEL	72181912
A3H6	1,000	TELL-TALE - PARKING BRAKE	4 - 6/19	CONTROL PANEL	72181912
A3H12	1,000	PREHEATING MONITORING LAMP	4 - 7/19	CONTROL PANEL	72181912
A3H11	1,000	MAIN BEAM MONITORING LAMP	4 - 7/19	CONTROL PANEL	72181912
A3H10	1,000	TELL-TALE - HAZARD WARNING	4 - 8/19	CONTROL PANEL	72181912
A3H9	1,000	TELL-TALE - BLINKER	4 - 8/19	CONTROL PANEL	72181912
A31	0,000	STAND HEATER	8 - 8/66	CAB	
A90.2	1,000	RADIO	8 - 3/85	CAB	
E1E2	1,000	LAMP - PARKING LIGHT	6 - 4/88		72181706
E1	1,000	LH HEADLIGHT	6 - 7/86	WORKING LIGHT, LEFT	72181695
E1	1,000	BULB	6 - 7/86	WORKING LIGHT, LEFT	72181697
E2E2	1,000	LAMP - PARKING LIGHT	6 - 1/88		72181706
E2	1,000	RH HEADLIGHT	6 - 8/86	WORKING LIGHT,RH	72181699
E2	1,000	BULB	6 - 8/86	WORKING LIGHT,RH	72181697
E3.1	1,000	WORKING LIGHT DRIVERS CAB LEFT	7 - 7/86	CAB	
E3.1	1,000	WORKING HEADLIGHT	7 - 7/86	CAB	73172509
E3.1	1,000	BULB	7 - 7/86	CAB	72181210
E3.4	1,000	WORKING LIGHT CAB L.H.(UP-AND DOWN)	7 - 8/86		
E3.4	1,000	WORKING HEADLIGHT	7 - 8/86		73172509
E3.4	1,000	BULB	7 - 8/86		72181210
E4.1	1,000	WORKING LIGHT DRIVERS CAB RIGHT	7 - 7/86	CAB	
E4.1	1,000	WORKING HEADLIGHT	7 - 7/86	CAB	73172509
E4.1	1,000	BULB	7 - 7/86	CAB	72181210
E4.4	1,000	WORKING LIGHT CAB R.H.(UP-AND-DOWN)	7 - 9/86		
E4.4	1,000	WORKING HEADLIGHT	7 - 9/86		73172509
E4.4	1,000	BULB	7 - 9/86		72181210

Electrical components in circuit diagram

Circuit diagram No. **T 72183406 - 00**

B 3002802 - 800

Part	Quantity	Description and function	Curr. Path	Location	Part no.
E5E3	1,000	LAMP - DIRECTION INDICATOR	5 - 6/90		72181703
E5	1,000	TAIL LIGHT, LEFT	6 - 5/88		73177935
E5	1,000	BULB	6 - 5/88		72181707
E5E2	1,000	LAMP - STOP LIGHT	7 - 0/86		72181703
E6E3	1,000	LAMPE - DIRECTION INDICATOR	5 - 7/90		72181703
E6	1,000	TAIL LIGHT, RIGHT	6 - 2/88		73177935
E6	1,000	BULB	6 - 2/88		72181707
E6E2	1,000	LAMP - STOP LIGHT	7 - 1/86		72181703
E7	1,000	BLINKER LEFT	5 - 5/90		
E7	1,000	LAMP	5 - 5/90		72181907
E7	1,000	BULB	5 - 5/90		72181703
E8	1,000	BLINKER RIGHT	5 - 7/90		
E8	1,000	TURN SIGNAL LIGHT	5 - 7/90		72181909
E8	1,000	BULB	5 - 7/90		72181703
E9	1,000	INTERIOR LIGHT	5 - 8/82	CAB	
E9	1,000	INTERIOR LAMP	5 - 8/82	CAB	73172604
E9	2,000	BULB	5 - 8/82	CAB	72181188
E12.1	1,000	NUMBER PLATE LIGHT, LEFT	6 - 5/88		
E12.2	1,000	NUMBER PLATE LIGHT, RIGHT	6 - 6/88		
E20	1,000	CIGARETTE LIGHTER	11 - 5/87	CAB	72180647
E50	1,000	REVERSING LIGHT	10 - 7/87		
E50	1,000	REVERSING LIGHT	10 - 7/87		73177901
E50	1,000	BULB	10 - 7/87		72181703
E51	1,000	REVERSING LIGHT	10 - 8/87		
E51	1,000	REVERSING LIGHT	10 - 8/87		73177901
E51	1,000	BULB	10 - 8/87		72181703
F1.1	1,000	FUSE: PRE-GLOW	2 - 5/53	CAB	73175155
F1.1	1,000	FUSE HOLDER	2 - 5/53	CAB	73175154
F1.1	1,000	BRACKET PLATE	2 - 5/53	CAB	73172001
F1.1	1,000	FUSE INSERT	2 - 5/53	CAB	72182234
F10.1	1,000	FUSE: INSTRUMENTS AND MONITORS,BLINKER, BRAKE LIGHT ,SWITCHILLUMINATION	7 - 0/20	CONTROL PANEL	72180863
F10.2	1,000	FUSE: BLINKERS,CAB LIGHT,CIGARETTE LIGHTER	8 - 3/16	CONTROL PANEL	72180863

Electrical components in circuit diagram

Circuit diagram No. **T 72183406 - 00**

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Part	Quantity	Description and function	Curr. Path	Location	Part no.
F10.3	1,000	FUSE: W/S WASHER FRONT AND REAR,DIRECTION REVERSER	8 - 6/16	CONTROL PANEL	72180863
F10.4	1,000	FUSE: HEATER BLOWER,ENGINE STOP	8 - 3/16	CONTROL PANEL	72180863
F10.5	1,000	FUSE: W/S WIPERS FRONT AND REAR	2 - 7/16	CONTROL PANEL	73172608
F10.6	1,000	FUSE: LH PARKING LIGHT,LH TAIL LIGHT	6 - 4/56	CONTROL PANEL	72180863
F11.1	1,000	FUSE: RH PARKING LIGHT,RH TAIL LIGHT,FUEL GAUGE LIGHT	6 - 1/56	CONTROL PANEL	72180863
F11.2	1,000	FUSE: WORKING LIGHTS	7 - 7/20	CONTROL PANEL	72180863
F11.3	1,000	FUSE: FULL BEAM LEFT	6 - 7/42	CONTROL PANEL	72180863
F11.4	1,000	FUSE: FULL BEAM RIGHT	6 - 8/42	CONTROL PANEL	72180863
F11.5	1,000	FUSE: LH HEADLIGHT	6 - 6/42	CONTROL PANEL	72180863
F11.6	1,000	FUSE: RH HEADLIGHT	6 - 8/42	CONTROL PANEL	72180863
F12.1	1,000	FUSE: HORN	11 - 1/15	CONTROL PANEL	73172608
F12.2	1,000	FUSE: STAND HEATER	8 - 9/16	CONTROL PANEL	72180864
F12.3	1,000	FUSE: RADIO	5 - 2/12	CONTROL PANEL	73172608
F12.4	1,000	FUSE	10 - 5/16		73172608
F12.5	1,000	FUSE	11 - 3/15		73172608
G1	1,000	ALTERNATOR	2 - 3/82	ENGINE	
G1.1	1,000	BATTERY	2 - 0/72	ENGINE COMPART.	72181911
H1	1,000	WARNING BUZZER	3 - 8/82	CONTROL PANEL	73174164
H7	1,000	HORN	11 - 2/87	PLATFORM	72181427
H7.1	1,000	HORN	11 - 3/87	PLATFORM	72181427
H21.1	1,000	CONTROL LAMP DRIVE DIRECTION FORWARD	9 - 4/88	CONTROL PANEL	72180841
H21.1	1,000	SNAP-ON PANEL	9 - 4/88	CONTROL PANEL	72183341
H21.1	1,000	FRAME	9 - 4/88	CONTROL PANEL	72180846
H21.2	1,000	CONTROL LAMP DRIVE DIRECTION BACKWARDS	9 - 8/88	CONTROL PANEL	72180841
H21.2	1,000	SNAP-ON PANEL	9 - 8/88	CONTROL PANEL	72183341
H21.2	1,000	FRAME	9 - 8/88	CONTROL PANEL	72180846
H21.2	1,000	WARNING LAMP	10 - 2/87		72180841
H21.2	1,000	SNAP-ON PANEL	10 - 2/87		72180843
H21.2	1,000	FRAME	10 - 2/87		72180846
H21.3	1,000	INDICATION LAMP	10 - 3/87		72180841
H21.3	1,000	SNAP-ON PANEL	10 - 3/87		72180842

Electrical components in circuit diagram

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Part	Quantity	Description and function	Curr. Path	Location	Part no.
H21.3	1,000	FRAME	10 - 3/87		72180846
H81	1,000	HORN REVERSING ALARM	10 - 5/87		
H81	1,000		10 - 5/87		73177902
H81	1,000	CAP	10 - 5/87		73177903
K1	1,000	RELAY - START INHIBIT	3 - 6/85	CAB	72181714
K5	1,000	RELAY - LIGHTING	6 - 1/88	CONTROL PANEL	73175157
K5	1,000	SOCKET	6 - 1/88	CONTROL PANEL	72181913
K8.2	1,000	RELAY- SHUT-DOWN/TRAVEL	4 - 3/84	CAB	73175157
K8.2	1,000	SOCKET	4 - 3/84	CAB	72181913
K20.1	1,000	FLASHER RELAY	5 - 1/84	CONTROL PANEL	72180866
K81.1	1,000	IMPULSE GENERATOR-REVERSING ALARM	10 - 4/62		
K81.1	1,000	BLINKER UNIT	10 - 4/62		72180866
K81.1	1,000	SOCKET	10 - 4/62		72181913
K91	1,000	SWITCH-OVER RELAIS DRIVE DIRECTION	9 - 2/88	CAB	73175157
K91	1,000	SOCKET	9 - 2/88	CAB	72181913
K92	1,000	SWITCH-OVER RELAIS DRIVE DIRECTION	9 - 3/88	CAB	73175157
K92	1,000	SOCKET	9 - 3/88	CAB	72181913
K93	1,000	SWITCH-OVER RELAIS TRAVEL SPEED	10 - 1/57	CAB	72181454
M1	1,000	STARTER	2 - 1/82	ENGINE	
M3	1,000	WINDSCREEN WIPER MOTOR	8 - 3/84	CAB	72180687
M3.1	1,000	REAR WINDOW WIPER	8 - 5/84	CAB	72181914
M4	1,000	W/S WASHER PUMP	8 - 6/84	CAB	72180699
M4.1	1,000	WINDSCREEN WASHER PUMP	8 - 7/84	CAB	72180700
M12	1,000	HEATING BLOWER	8 - 1/84	CAB	72181915
P1	1,000	HOURMETER	4 - 5/84	CONTROL PANEL	73174177
P2	1,000	FUEL GAUGE	3 - 1/70	CONTROL PANEL	72180824
P2E	1,000	BULB INSTRUMENT LIGHTING	6 - 3/88	CONTROL PANEL	72181918
P5	1,000	OIL TEMPERATURE GAUGE	3 - 2/70	CONTROL PANEL	72182954
P5E	1,000	BULB-ENGINE OIL GAUGE	6 - 3/88	CONTROL PANEL	72181918
R1	1,000	HEATER PLUG RESISTOR	2 - 5/84	ENGINE	
R2	0,000	IMMERSED TUBE SENSOR	3 - 0/85	FUEL TANK	72180311
R13.1	1,000	TEMPERATURE SENSOR WITH WARNING SWITCH	3 - 3/80	ENGINE	72182939

Electrical components in circuit diagram

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Part	Quantity	Description and function	Curr. Path	Location	Part no.
S1	1,000	START BUTTON	2 - 2/20	CONTROL PANEL	72181450
S2	1,000	BLOWER SWITCH	8 - 0/51	CONTROL PANEL	73174186
S3.1H1	1,000	LIGHT IN WIPER SWITCH	7 - 3/86	CONTROL PANEL	73174147
S3.1	1,000	SWITCH - REAR WINDOW WIPER	8 - 5/42	CONTROL PANEL	73174195
S3.1	1,000	PLATE	8 - 5/42	CONTROL PANEL	73174187
S3.1	1,000	LID	8 - 5/42	CONTROL PANEL	73174196
S3.1	1,000	BELLOWS	8 - 5/42	CONTROL PANEL	73174197
S3.1	1,000	CAP	8 - 5/42	CONTROL PANEL	73174191
S3.1	1,000	GASKET	8 - 5/42	CONTROL PANEL	73174188
S3.1	1,000	SOCKET	8 - 5/42	CONTROL PANEL	73174194
S3.1	1,000	BULB	8 - 5/42	CONTROL PANEL	73174147
S3.1	1,000	PLATE	8 - 5/42	CONTROL PANEL	73174198
S3.3H1	1,000	LIGHT IN WIPER SWITCH	7 - 3/86	CONTROL PANEL	73174147
S3.3	1,000	SWITCH - WINDSREEN WIPER	8 - 4/42	CONTROL PANEL	73174195
S3.3	1,000	PLATE	8 - 4/42	CONTROL PANEL	73174187
S3.3	1,000	LID	8 - 4/42	CONTROL PANEL	73174196
S3.3	1,000	BELLOWS	8 - 4/42	CONTROL PANEL	73174197
S3.3	1,000	CAP	8 - 4/42	CONTROL PANEL	73174191
S3.3	1,000	GASKET	8 - 4/42	CONTROL PANEL	73174188
S3.3	1,000	SOCKET	8 - 4/42	CONTROL PANEL	73174194
S3.3	1,000	BULB	8 - 4/42	CONTROL PANEL	73174147
S3.3	1,000	PLATE	8 - 4/42	CONTROL PANEL	73174198
S4	1,000	SWITCH - WINDSREEN WASHER	8 - 6/51	CONTROL PANEL	73174195
S4.1	1,000	BUTTON - W/S WASHER	8 - 7/51	CONTROL PANEL	73174195
S5	1,000	LIGHT SWITCH	6 - 0/28	CONTROL PANEL	72181204
S5	1,000	PLATE	6 - 0/28	CONTROL PANEL	73174187
S5	1,000	LID	6 - 0/28	CONTROL PANEL	73174196
S5	1,000	BELLOWS	6 - 0/28	CONTROL PANEL	73174197
S5	1,000	CAP	6 - 0/28	CONTROL PANEL	73174191
S5	1,000	GASKET	6 - 0/28	CONTROL PANEL	73174188
S5	1,000	SOCKET	6 - 0/28	CONTROL PANEL	73174194
S5	1,000	BULB	6 - 0/28	CONTROL PANEL	73174147
S5	1,000	FOIL	6 - 0/28	CONTROL PANEL	73174201

Electrical components in circuit diagram

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Part	Quantity	Description and function	Curr. Path	Location	Part no.
S5H1	1,000	LIGHT IN LIGHT SWITCH	7 - 2/86	CONTROL PANEL	73174147
S6.1H1	1,000	LIGHT IN WORKING LIGHT SWITCH	7 - 5/86	CONTROL PANEL	73174147
S6.1	1,000	SWITCH - WORKING LIGHT, FRONT	7 - 7/48	CONTROL PANEL	72181211
S6.1	1,000	PLATE	7 - 7/48	CONTROL PANEL	73174187
S6.1	1,000	LID	7 - 7/48	CONTROL PANEL	73174196
S6.1	1,000	BELLOWS	7 - 7/48	CONTROL PANEL	73174197
S6.1	1,000	CAP	7 - 7/48	CONTROL PANEL	73174191
S6.1	1,000	GASKET	7 - 7/48	CONTROL PANEL	73174188
S6.1	1,000	PLATE	7 - 7/48	CONTROL PANEL	73174236
S6.2H1	1,000	LIGHT IN WORKING LIGHT SWITCH	7 - 5/86	CONTROL PANEL	73174147
S6.2	1,000	SWITCH - WORKING LIGHT, REAR	7 - 8/48		
S6.2	1,000	SWITCH	7 - 8/48		72181211
S6.2	1,000	PLATE	7 - 8/48		73174187
S6.2	1,000	LID	7 - 8/48		73174196
S6.2	1,000	BELLOWS	7 - 8/48		73174197
S6.2	1,000	CAP	7 - 8/48		73174191
S6.2	1,000	GASKET	7 - 8/48		73174188
S6.2	1,000	PLATE	7 - 8/48		73174236
S7	1,000	HORN BUTTON	11 - 1/81	CONTROL PANEL	72181451
S12	1,000	OIL PRESSURE SWITCH	4 - 0/88	ENGINE	
S16	1,000	HANDBRAKE SWITCH	9 - 1/40	PLATFORM	72181919
S17.1	1,000	PUSHBUTTON SWITCH - BRAKE	4 - 2/88	PLATFORM	72180275
S18	1,000	BRAKE LIGHT SWITCH	7 - 0/48	PLATFORM	72181920
S20	1,000	HAZARD WARNING SWITCH	5 - 1/41	CONTROL PANEL	72181203
S20	1,000	PLATE	5 - 1/41	CONTROL PANEL	73174187
S20	1,000	LID	5 - 1/41	CONTROL PANEL	73174196
S20	1,000	BELLOWS	5 - 1/41	CONTROL PANEL	73174197
S20	1,000	CAP	5 - 1/41	CONTROL PANEL	73174191
S20	1,000	GASKET	5 - 1/41	CONTROL PANEL	73174188
S20	1,000	SOCKET	5 - 1/41	CONTROL PANEL	73174194
S20	1,000	BULB	5 - 1/41	CONTROL PANEL	73174147
S20	1,000	FOIL	5 - 1/41	CONTROL PANEL	72180828
S20H1	1,000	LIGHT IN HAZARD-WARNING SWITCH	7 - 4/86	CONTROL PANEL	73174147

Electrical components in circuit diagram

Circuit diagram No. **T 72183406 - 00**

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Part	Quantity	Description and function	Curr. Path	Location	Part no.
S22.1	1,000	TRAVEL DIRECTION SWITCH	9 - 2/40	CAB	72181451
S23.1	1,000	DIRECTION INDICATOR	5 - 4/41	CONTROL PANEL	72181451
S23.3	1,000	MOUNTING INSTRUCTIONS	6 - 5/28	CONTROL PANEL	72181451
S36H1	1,000	ILLUMINATION SWITCH ROTARY BEACON	7 - 6/86	CONTROL PANEL	73174147
S81	1,000	SWITCH TRAVEL-BACKWARDS ALARM	10 - 5/44		
S81	1,000	SWITCH	10 - 5/44		73174202
S81	1,000	PLATE	10 - 5/44		73174187
S81	1,000	LID	10 - 5/44		73174196
S81	1,000	BELLOWS	10 - 5/44		73174197
S81	1,000	CAP	10 - 5/44		73174191
S81	1,000	GASKET	10 - 5/44		73174188
S81	1,000	PLATE	10 - 5/44		73177904
S81E	1,000	INDICATION LAMP SWITCH BACKWARDS-A	10 - 6/87		72181912
S131	1,000	OIL COOLER TEMPERATURE SWITCH	4 - 2/88	ENGINE COMPART.	
W1	1,000	CABLE HARNESS, CONTROL PANEL	19 - 1/20		72181921
W2	1,000	CABLE HARNESS, LIGHTING	19 - 1/30		73177905
W3	1,000	CABLE HARNESS, ENGINE	19 - 1/40		72182145
W5	1,000	MAIN CABLE SET	19 - 1/60		72180868
W8	1,000	CABLE BATTERY PLUS	19 - 1/90		
W9	1,000	CABLE HARNESS, STANDARD CAB	19 - 1/10		72181922
W11	1,000	CABLE HARNESS, LIGHTING MODULE	19 - 4/20		72180837
W18	1,000	HEADLIGHT EARTH CABLE	19 - 4/90		72180815
W23	1,000	ENGINE EARTH	19 - 7/40		72180816
W31	1,000	CABLE SET PARKING BRAKE	19 - 7/10		73177906
W41	1,000	CABLE SET HEATER	19 - 7/11		72180859
X10	4,000	B+ DISTRIBUTOR	- 0/ 0		73170164
X10	2,000	CLIP	- 0/ 0		73172640
Y1.3	1,000	SOLENOID VALVE COLD START	2 - 8/84	ENGINE	
Y1.5	1,000	SOLONOID VALVE ENGINE STOP	2 - 7/84	ENGINE	
Y21	1,000	SOLENOID - TRAVEL DIRECTION FORWARDS	9 - 5/88	VALVE BLOCK	
Y21.1	1,000	SOLENOID VALVE - REVERSE	9 - 7/88	VALVE BLOCK	
Y21.2	1,000	SOLENOID VALVE - CRAWL GEAR	10 - 4/87	VALVE BLOCK	

10 FRAME

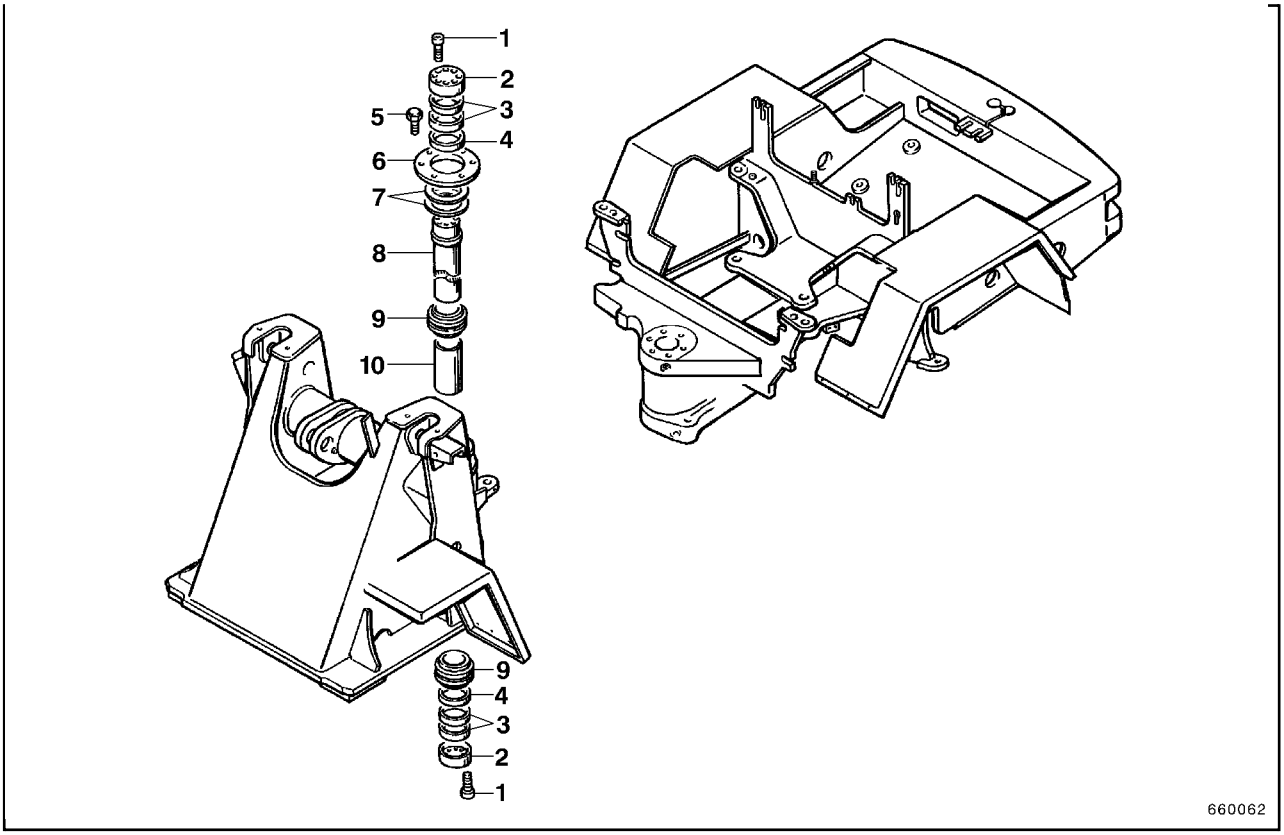

Fig. 1

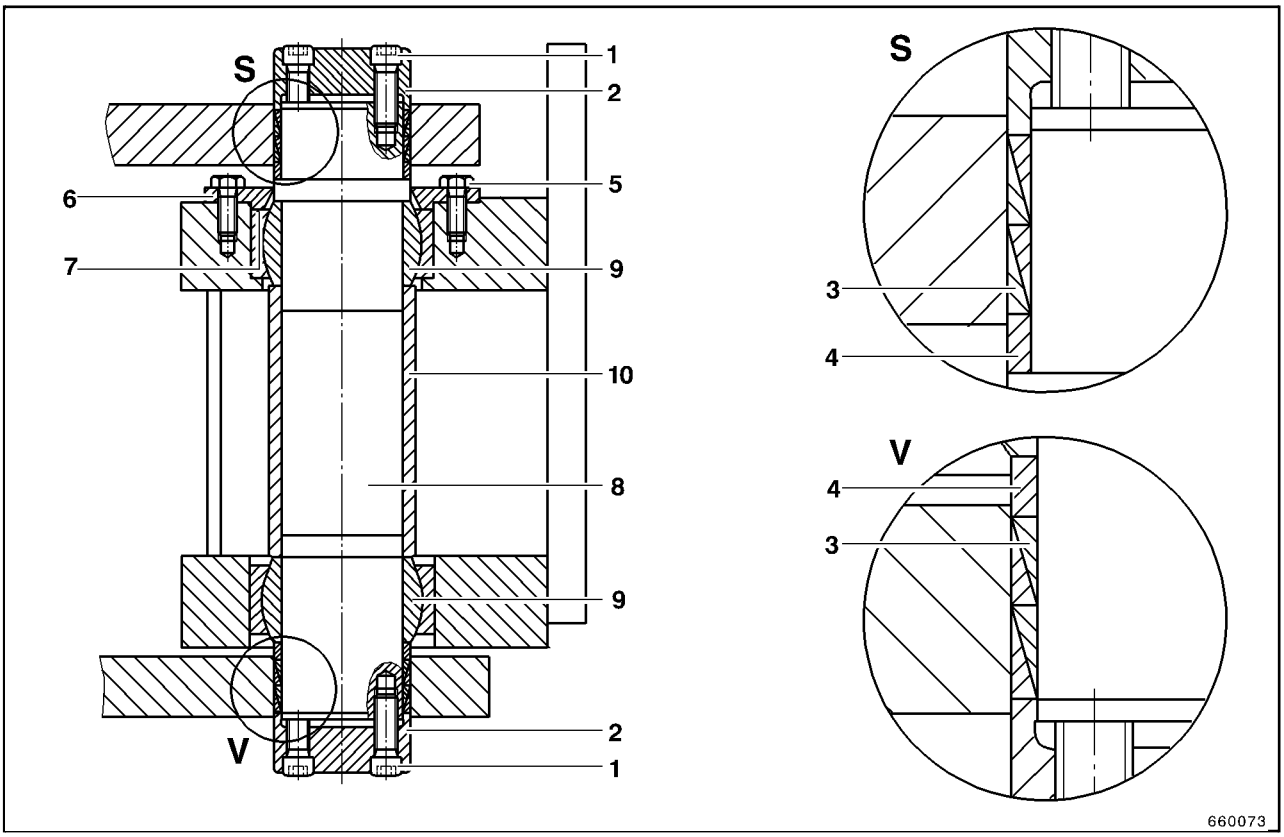

Fig. 2

Frame, Safety Instructions 2801917

DANGER

Read and observe the operating instruction: "Inspection and Servicing, Safety Instructions".

Secure the machine as described in the operating instruction: "Securing the machine".

□

Repairing the loader frame 2801061

Exchanging the main pivot parts

The articulated joint links the front frame with the rear frame of the chassis.

It consists of:

- pin (8)
- joint bearings (9)
- tapered split rings (3)
- rings (4)
- lids (2) and screws (1)

Dismantling

Note: For replacing the pivot pin parts separate the front frame section from the rear frame section.

- Place loader on solid and level ground. Relieve bucket from load burden.
- Separate both steering cylinders from front frame section by removing the pins. Remove hose holding brackets.

  Remove universal shaft from gear-box.
- Block up with wood under booth sides of oscillating axle.
- Block up under front frame section. Place mobile jack under rear frame section near the main pivot and take rear frame section at lift with a mobile crane and remove rear frame section.

  Attention: Before removing the pivot parts secure front and rear frame against tilting, articulating and rolling away.
- Remove screws (1, Fig. 2) and take off lids (2).
- Give the bottom of pin (8) a blow with a hammer to detach split rings (3).
  Remove lower split rings (3) and ring (4).
- Drive out pin (8) from the bottom using a hydraulic device fo this work.
- **Attention:** When pressing pivot pin out or in release rear section in the main pivot from load burden or center the main pivot.

  Make sure the front and rear frames do not jam when pressing the pin in or out. The pin bores must be in alignment.

  Note: Use pivot secure when the loader is transported by loading or shipping or in case of maintenance or resp. repairs.
- Separate front and rear frame and secure against inadvertent movements.
- Remove screws (5) and take off lid (6) and disk (7).
- Take a sleeve or a piece of pipe and hold against the outer ring of lower joint bearing (9). Drive bearing upwards with caution until an extractor can be applied between upper joint bearing (9) and sleeve (10).

  Note: Do not drive lower joint bearing out of its seat. The bearing can then no longer be removed from the frame.
- Withdraw upper joint bearing (9).
- Withdraw lower joint bearing and remove sleeve (10).

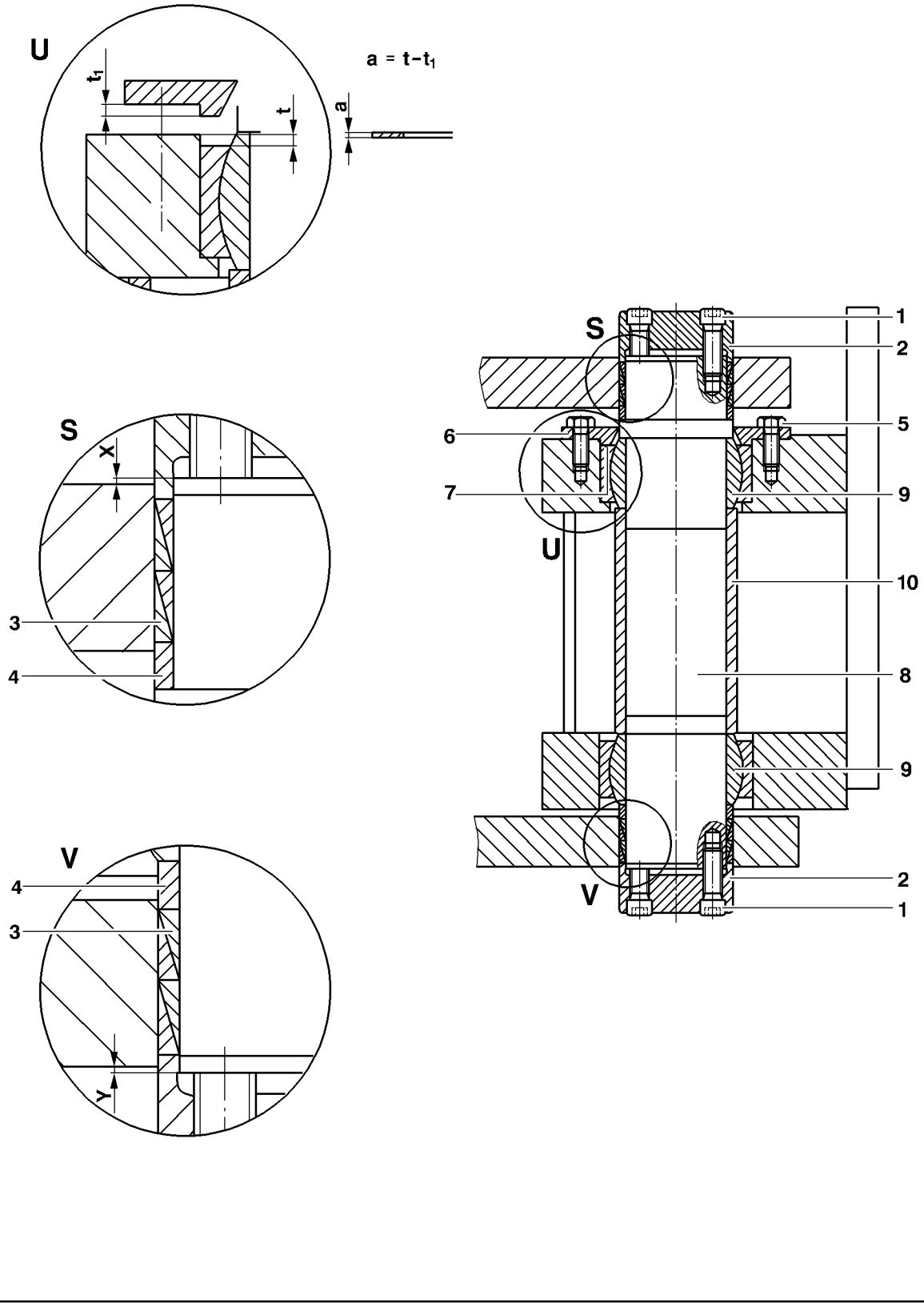

Fig. 3

Mounting

- For reassembly the disassembly should be reversed.

  Note: Clean all contact faces of component and oil slightly. Use oils without molybdenum disulphide (MoS_2) additive only.

- Drive upper joint bearing (9, Fig. 3) fully in.
- Measure dimensions "t" and "t1" (Detail U). Eliminate play "a" (a = t - t1) between joint bearing (9) and lid (6) by inserting spacer (7).
- Turn in screws (5) and tighten with a torque of M_A = 75 Nm (55 lbft).
- Install sleeve (10) and lower joint bearing (9).

  Note: Sleeve (10) must be centered and rest without play on the internal rings of both joint bearings (9).

- Push front and rear frame towards each other and align.
- Drive pin (8) fully down from above.
- Measure projection of pin (8) at the top (X, detail S) and at the bottom (Y, detail V). The measured length must be the same.
- Install rings (4) and split rings (3) in the position shown on the drawing.
- Fit lids (2) and tighten srews (1) uniformly and crosswise.
  Tightening torque M_A = 105 Nm (77 lbft).
- Grease the articulated joint.

Notes

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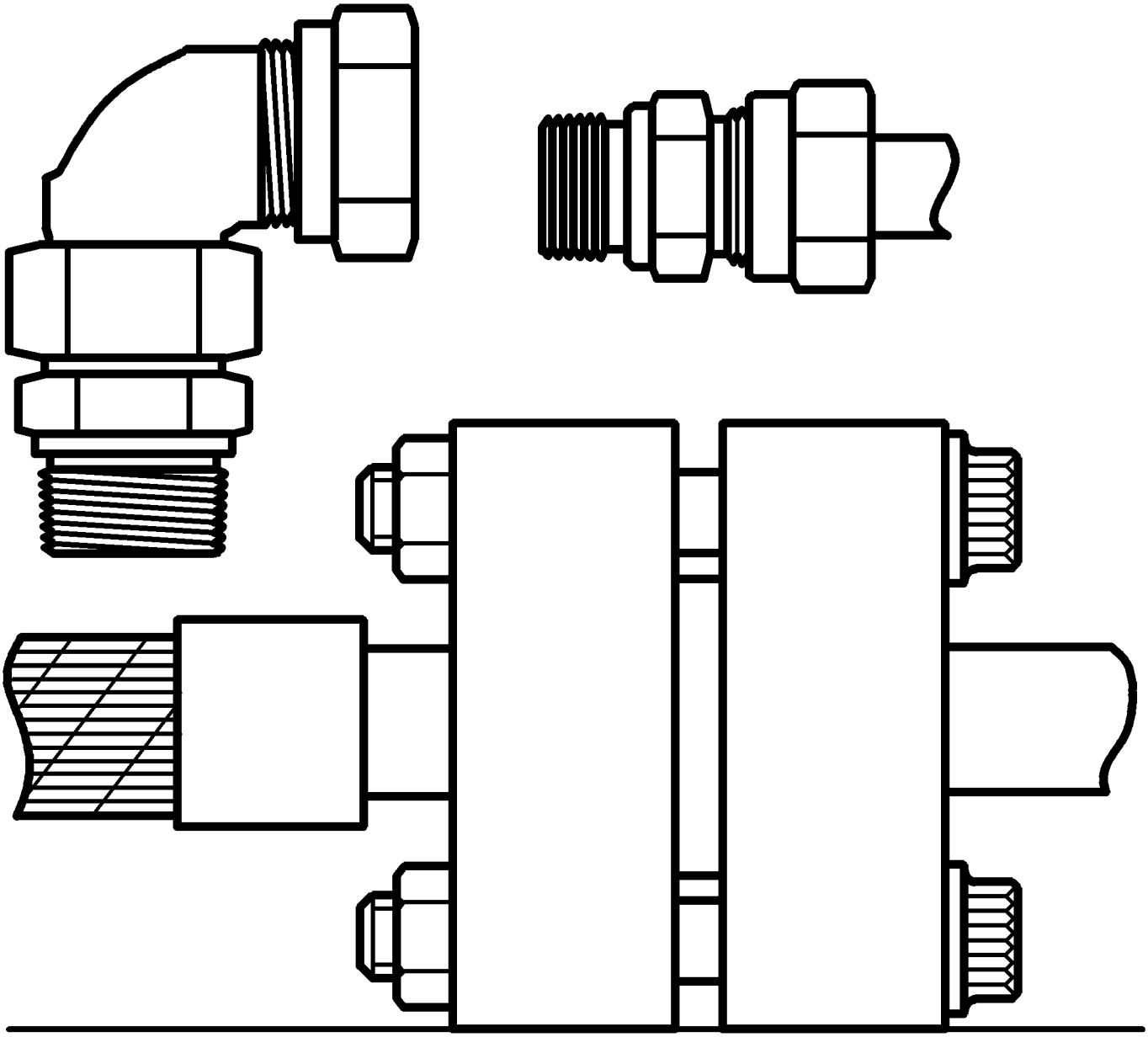
Technical Handbook

Fittings, pipes and hoses



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INTRODUCTION

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The various units of a machine are interconnected by pipe or hose lines so that the transfer of consumables, energy and control commands becomes possible. The hydraulic, brake and fuel supply systems of a machine are just such units.

Numerous line and coupling systems are available, especially in the spheres of hydraulics and pneumatics.

This handbook is intended to give an impression of the pipe and hose lines, as well as their coupling elements. Working directions are also included for servicing procedures which involve the re-routing or changing of such line and coupling systems.

FUNDAMENTAL SAFETY INSTRUCTIONS

Warnings and symbols

2800455

The following signs are used in the manual to designate instructions of particular importance:

WARNING

Precautionary rules and measures designed to protect the machine operator and other persons from life-threatening danger or injuries and to prevent extensive damage.

CAUTION

Information and precautionary measures designed to prevent damage to the machine or other property.

□

Organizational measures

2261965

The operating instructions must always be at hand at the place of use of the machine, e.g. by stowing them in the tool compartment or tool-box provided for such purpose.

In addition to the operating instructions, observe and instruct the user in all other generally applicable legal and other mandatory regulations relevant to accident prevention and environmental protection.

These compulsory regulations may also deal with the handling of hazardous substances, issuing and/or wearing of personal protective equipment or traffic regulations.

The operating instructions must be supplemented by instructions covering the duties involved in supervising and notifying special organizational features, such as job organization, working sequences or the personnel entrusted with the work.

Personnel entrusted with work on the machine must have read the operating instructions and in particular the chapter on safety before beginning work. Reading the instructions after work has begun is too late. This applies especially to persons working only occasionally on the machine, e.g. during setting up or maintenance.

Check - at least from time to time - whether the personnel is carrying out the work in compliance with the operating instructions and paying attention to risks and safety factors.

For reasons of security, long hair must be tied back or otherwise secured, garments must be close-fitting and no jewellery, such as rings, may be worn. Injury may result from being caught up in the machinery or from rings catching on moving parts.

Use protective equipment wherever required by the circumstances or by law.

Observe all safety instructions and warnings attached to the machine.

See to it that safety instructions and warnings attached to the machine are always complete and perfectly legible.

In the event of safety-relevant modifications or changes in the behaviour of the machine during operation, stop the machine immediately and report the malfunction to the competent authority/person.

Never make any modifications, additions or conversions which might affect safety without the supplier's approval. This also applies to the installation and adjustment of safety devices and valves as well as to welding work on load-bearing elements.

Spare parts must comply with the technical requirements specified by the manufacturer. Spare parts from original equipment manufacturers can be relied to do so.

Replace hydraulic hoses within stipulated and appropriate intervals, even if no safety-relevant defects have been detected.

Adhere to prescribed intervals or those specified in the operating instructions for routine checks and inspections.

For the execution of maintenance work, tools and workshop equipment adapted to the task on hand are absolutely indispensable.

The personnel must be familiar with the location and operation of fire extinguishers.

Observe all fire-warning and fire-fighting procedures.

Selection and qualification of personnel - basic responsibilities

Any work on and with the machine must be executed by reliable personnel only. Statutory minimum age limits must be observed.

Employ only trained or instructed staff and set out clearly the individual responsibilities of the personnel for operation, set-up, maintenance and repair.

Make sure that only authorized personnel works on or with the machine.

Define the machine operator's responsibilities - also with regard to observing traffic regulations - giving the operator the authority to refuse instructions by third parties that are contrary to safety.

Do not allow persons to be trained or instructed or persons taking part in a general training course to work on or with the machine without being permanently supervised by an experienced person.

Work on the electrical system and equipment of the machine must be carried out only by a skilled electrician or by instructed persons under the supervision and guidance of a skilled electrician and in accordance with electrical engineering rules and regulations.

Work on chassis, brake and steering systems must be performed by skilled personnel only, which has been specially trained for such work.

Work on the hydraulic system must be carried out only by personnel with special knowledge and experience of hydraulic equipment.

Safety instructions governing specific operational phases

Standard operation

Avoid any operational mode that might be prejudicial to safety.

Before beginning work, familiarize yourself with the surroundings and circumstances of the site, such as obstacles in the working and travelling area, the soil bearing capacity and any barriers separating the construction site from public roads.

Take the necessary precautions to ensure that the machine is used only when in a safe and reliable state.

Operate the machine only if all protective and safety-oriented devices, such as removable safety devices, emergency shut-off equipment, soundproofing elements and exhausters, are in place and fully functional.

Check the machine at least once per working shift for obvious damage and defects. Report any changes (incl. changes in the machine's working behaviour) to the competent organization/person immediately. If necessary, stop the machine immediately and lock it.

In the event of malfunctions, stop the machine immediately and lock it. Have any defects rectified immediately.

Start the machine from the driver's seat only.

During start-up and shut-down procedures always watch the indicators in accordance with the operating instructions.

Before setting the machine in motion, make sure that nobody is at risk.

Before starting work or travelling with the machine, check that the braking, steering, signalling and lighting systems are fully functional.

Before setting the machine in motion always check that the accessories have been safely stowed away.

When travelling on public roads, ways and places always observe the valid traffic regulations and, if necessary, make sure beforehand that the machine is in a condition compatible with these regulations.

In conditions of poor visibility and after dark always switch on the lighting system.

Persons accompanying the driver must be seated on the passenger seats provided for this purpose.

When crossing underpasses, bridges and tunnels or when passing under overhead lines always make sure that there is is sufficient clearance.

Always keep at a distance from the edges of building pits and slopes.

Avoid any operation that might be a risk to machine stability.

Never travel across slopes; always keep the working equipment and the load close to the ground, especially when travelling downhill.

On sloping terrain always adapt your travelling speed to the prevailing ground conditions. Never change to a lower gear on a slope but always before reaching it.

Before leaving the driver's seat always secure the machine against inadvertent movement and unauthorized use.

Special work in conjunction with utilization of the machine - maintenance and repairs during operation - disposal of parts and consumables

Observe the adjusting, maintenance and inspection activities and intervals set out in the operating instructions, including information on the replacement of parts and equipment. These activities may be executed by skilled personnel only.

Brief operating personnel before beginning special operations and maintenance work, and appoint a person to supervise the activities.

In any work concerning the operation, conversion or adjustment of the machine and its safety-oriented devices or any work related to maintenance, inspection and repair, always observe the start-up and shut-down procedures set out in the operating instructions and the information on maintenance work.

Ensure that the maintenance area is adequately secured.

If the machine is completely shut down for maintenance and repair work, it must be secured against inadvertent starting by:

- removing the ignition key and
- attaching a warning sign.

Carry out maintenance and repair work only if the machine is positioned on stable and level ground and has been secured against inadvertent movement and buckling.

To avoid the risk of accidents, individual parts and large assemblies being moved for replacement purposes should be carefully attached to lifting tackle and secured. Use only suitable and technically perfect lifting gear and suspension systems with adequate lifting capacity. Never work or stand under suspended loads.

The fastening of loads and the instructing of crane operators should be entrusted to experienced persons only. The marshaller giving the instructions must be within sight or sound of the operator.

For carrying out overhead assembly work always use specially designed or otherwise safety-oriented ladders and working platforms. Never use machine parts as a climbing aid.

Wear a safety harness when carrying out maintenance work at greater heights.

Keep all handles, steps, handrails, platforms, landings and ladders free from dirt, snow and ice.

Clean the machine, especially connections and threaded unions, of any traces of oil, fuel or preservatives before carrying out maintenance/repair. Never use aggressive detergents. Use lint-free cleaning rags.

Before cleaning the machine with water, steam jet (high-pressure cleaning) or detergents, cover or tape up all openings which - for safety and functional reasons - must be protected against water, steam or detergent penetration. Special care must be taken with electric motors and switchgear cabinets.

Ensure during cleaning of the machine that the temperature sensors of the fire-warning and fire-fighting systems do not come into contact with hot cleaning agents as this might activate the fire-fighting system.

After cleaning, remove all covers and tapes applied for that purpose.

After cleaning, examine all fuel, lubricant, and hydraulic fluid lines for leaks, loose connections, chafe marks and damage. Any defects found must be rectified without delay.

Always tighten any screwed connections that have been loosened during maintenance and repair.

Any safety devices removed for set-up, maintenance or repair purposes must be refitted and checked immediately upon completion of the maintenance and repair work.

Ensure that all consumables and replaced parts are disposed of safely and with minimum environmental impact.

Warning of special dangers

Electric energy

Use only original fuses with the specified current rating. Switch off the machine immediately if trouble occurs in the electrical system.

When working with the machine, maintain a safe distance from overhead electric lines. If work is to be carried out close to overhead lines, the working equipment must be kept well away from them. Caution, danger! Check out the prescribed safety distances.

If your machine comes into contact with a live wire

- do not leave the machine
- drive the machine out of the hazard zone
- warn others against approaching and touching the machine
- have the live wire de-energized
- do not leave the machine until the damaged line has been safely de-energized.

The electrical equipment of machines is to be inspected and checked at regular intervals. Defects such as loose connections or scorched cables must be rectified immediately.

Gas, dust, steam and smoke

Operate internal combustion engines and fuel-operated heating systems only on adequately ventilated premises. Before starting the machine on enclosed premises, make sure that there is sufficient ventilation.

Observe the regulations in force at the respective site.

Carry out welding, flame-cutting and grinding work on the machine only if this has been expressly authorized, as there may be a risk of explosion and fire.

Before carrying out welding, flame-cutting and grinding operations, clean the machine and its surroundings from dust and other inflammable substances and make sure that the premises are adequately ventilated (risk of explosion).

Hydraulic and pneumatic equipment

Check all lines, hoses and screwed connections regularly for leaks and obvious damage. Repair damage immediately. Splashed oil may cause injury and fire.

Depressurize all system sections and pressure pipes (hydraulic system, compressed-air system) to be removed in accordance with the specific instructions for the unit concerned before carrying out any repair work.

Hydraulic and compressed-air lines must be laid and fitted properly. Ensure that no connections are interchanged. The fittings, lengths and quality of the hoses must comply with the technical requirements.

Noise

During operation, all sound baffles of the machine must be closed.

Always wear the prescribed ear protectors.

Oil, grease and other chemical substances

When handling oil, grease and other chemical substances, observe the product-related safety regulations.

Be careful when handling hot consumables (risk of burning or scalding).

Transporting and towing - recommissioning

The machine must be towed, loaded and transported only in accordance with the operating instructions.

For towing the machine observe the prescribed transport position, admissible speed and itinerary.

Use only appropriate means of transport and lifting gear of adequate capacity.

The recommissioning procedure must be strictly in accordance with the operating instructions. □

WORKING EQUIPMENT

2732243

Assembling working equipment - safety instructions

⚠ WARNING

Personnel

Assembly work may be carried out only by operating or maintenance personnel who have the necessary know-how at their disposal.

If such know-how is lacking, meticulous instruction must be given by experienced personnel.

The operating manual, and in particular the section headed "Fundamental Safety Instructions", must have been read and understood.

Only such persons may start up the machine during assembly work in order to adjust the attachments.
Incorrect operation of the machine or the attachments may give rise to life-threatening situations.

Personal protective gear and working clothing

Wear closely fitting working clothing when working on the machine. Loose, wide garments may catch on machine parts and result in injury.

Wear a safety helmet, safety footwear and gloves.

Tools and auxiliaries

Tools, hoists, slings, chocks and other devices must be in a reliable, safe state.

Metal spinters may cause injury when accessory bolts are being driven in or out. A brass or copper mandrel should therefore be used for this purpose, and goggles must be worn.
Use steps and handrails when climbing onto or off the machine.
Always keep steps and platforms in a non-slip state. Remove any oil, grease, earth, clay, snow, ice and other foreign matter immediately.

⚠ WARNING

Securing working equipment

Stand working equipment on the ground in such a way that no movements can be made if mechanical or hydraulic connections become detached.

When working in jointed areas, block off the joints. Remove the blocks on finishing work.

Secure any equipment or component which is to be mounted or dismantled, or whose position is to be changed, with hoists or appropriate slinging/supporting devices to prevent them from moving, slipping or falling inadvertently.

Securing the machine

Carry out work on the attachment only if the machine is secured as decribed in the section "Securing the Machine".

Selecting the attachments

The machine can be equipped with various attachments. The components of the attachments are assembled with hydraulic cylinders and connectors. Components can be combined in various ways for optimum adaptation of the attachments to the specific application.

Operate the machine only with the equipment and component combinations expressly approved.

Protective roof against falling objects

If the machine is used in areas where there is a risk of heavy objects falling, e.g. for

- **work on earth or rock faces,**
- **demolition or forestry work,**

it can be equipped with a protective roof (FOPS) and with a front guard.
Consult your local dealer.

□

Repair work - safety instructions

2732233

⚠ WARNING

Operating instructions

Never carry out repair work without having read and understood the operating instructions.

Pay special attention to:

"Fundamental Safety Instructions", "Inspection and servicing - safety instructions" and all warnings and safety instructions attached to the machine.

The descriptions of job sequences provide only experienced personnel with the necessary instructions.

The operating manual must be kept with the machine at all times.

Repair personnel

Repair personnel must have know-how and experience relevant to repairing this or comparable machines.

Working at greater heights

Always wear safety harnesses when working at greater heights.

Wear an approved safety harness; it must be equipped with stabilizers and safety cables.

Pressurized or spring loaded units

Never open defective pressurized or spring loaded units but replace them as an entirety.

In exceptional cases, open only when the system and the operating sequence are precisely known and any special tools required are available.

The operating manual contains no information on this point.

⚠ WARNING

Dismantling components

Never dismantle while the machine is at operating temperature.

Oils, greases, brake fluid or coolants may have a high temperature and result in burning or scalding.

Leave time for the machine to cool down.

Before starting work, depressurize piping and hoses, cylinders, radiator, hydraulic tank, air-brake reservoir and other systems or units.

Replace defective components in good time to prevent major damage.

Clean the defective component carefully before dismantling it.

Mark the dismantled parts in the correct sequence to facilitate assembly.

When dismantling the component, close off exposed hose and piping connections, exposed drill holes and housing carefully to prevent any dust from penetrating.

Never remove lead seals

Never change rated pressure of pressure relief valves without the explicit authorization.

Never remove lead seals from pressure relief valves and accumulators.

After the repair work

To prevent corrosion, coat all bright metal machine parts with a grease film.

On completing the work, reassemble all protective devices, covers, and sound- and vibration-insulation material.

Never start up the driving motor while work is being done on the machine.

Check the repaired components and all machine functions with a trial run.

Never release the machine for recommissioning until it is fully functioning.

□

LINES FOR VARIOUS MEDIA

Depending upon the purpose for which they are intended, a distinction is made between lines for

hydraulic oil
brake fluid
compressed air
fuel
cooling water
combustion air
engine exhausts
lubricating oil
grease

Materials for pipes and hoses

The material used (copper, steel or plastic pipe, armoured rubber or plastic hoses) is chosen according to the structural and operational conditions intended, as well as with regard to easy installation in order to keep assembly and servicing costs to a minimum.

Pressure, return and intake lines in hydraulic systems are generally made up using seamless precision steel pipe according to DIN 2391 (annealed and scale-free).

Pressure hoses are generally made of oil-resistant, synthetic rubber.

Some types of hose have a steel wire spiral between the textile braiding in order to improve strength and bending resistance.

They are also often used as intake hoses in systems in which the pressure within the hose is lower than atmospheric pressure.

Depending upon the pressure range to which they are to be subjected, high-pressure hoses have a number of tear-resistant textile braid inlays to absorb bursting, tensional and pressure forces. Extra high-pressure hoses have, additional steel wire inlays vulcanised into their covering layers.
Practically all types of hose have an external covering of oil-resistant, synthetic rubber which makes them especially wear-resistant.

Conditions and deviations in the line system

The efficiency of a hydraulic system and the anticipated permanent operating temperature of the pressure fluid during continuous operation depend upon the line dimensions, the way the line is routed and the arrangement of bends and connection points in the system.

Any change of direction or cross section in a line or hose alters the flow resistance, and can therefore lead to eddy formation and pressure losses in the system. Every effort is therefore made to keep line and hose systems as simple and clearly arranged as possible, with a minimum of couplings.

The line system is, moreover, arranged in such a way that any components which require setting, servicing or regular changing, e.g. valves, pressure gauges, breathers and filters, are easily accessible.

Steel pipes

Pressure, return and intake lines are practically always made up of precision steel pipe according to DIN 2391 - annealed and scale-free.

Cold bending:

When cold bending with mechanical bending machines, or when using spindles for manual bending, certain minimum dimensions are to be observed. These minimum dimensions are given in Table 1 and illustrated in Figs. 1 - 3.

All dimensions in mm.
The maximum permissible bending angle is 180°

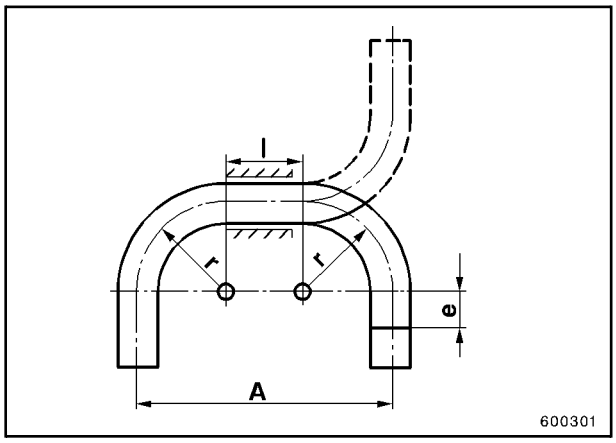


Fig. 2

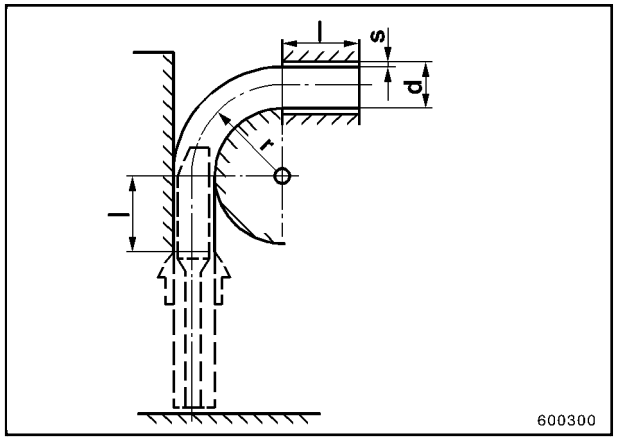


Fig. 1

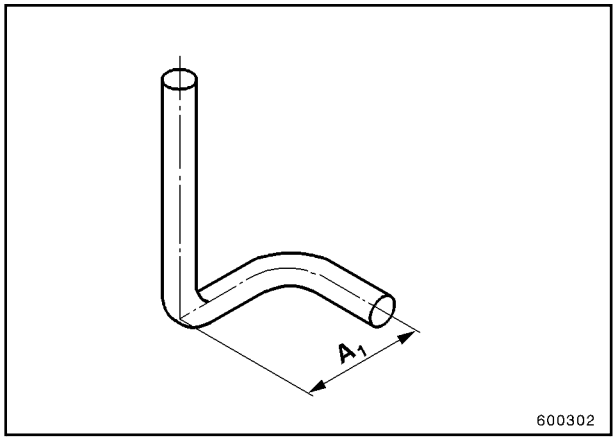


Fig. 3

Pipe outside Ø	Wall thickness s	Bending radius r	l min	A min	A_1 min	Minimum length e for couplings[1)]		
						LL	L	S
10	1.5	30	70	130	135	25	32	35
12	2.0	37,5	70	145	135	26	32	36
14	2.0	45	70	160	135	--	--	40
15	1.5	45	70	160	135	30	35	--
16	2.0	45	70	160	135	--	--	42
18	1.5	50	70	170	135	32	36	--
20	2.0	60	75	195	135	--	--	48
22	2.0	85	75	245	135	33	41	--
25	3.0	90	85	265	135	--	--	53
30	3.5	100	95	295	135	--	--	59
35	2.0	125	115	365	135	--	48	--
38	4.0	120	115	355	135	--	--	65
42	2.0	100	130	330	135	--	--	--
50	2.0	150	155	455	135	--	--	--
50	6.0	160	155	475	135	--	--	--

Table 1: Minimum dimensions for pipe bends

[1)] LL = extra light; L = light; S = heavy duty

Cutting pipes:

Pipes are always to be cut at right angles to their longitudinal axes (Figs. 4 & 5). A pipe cutting clamp, as shown in Fig. 3 (P/N 73171493) facilitates the cutting of pipes at right angles.

Pipe cutters are not to be used on account of the cold deformation of the pipe which occurs.

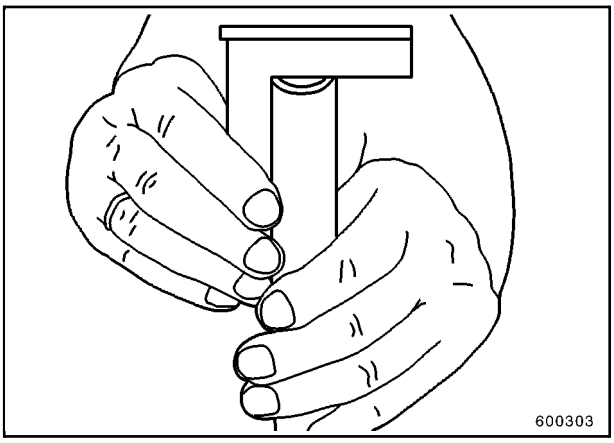


Fig. 4

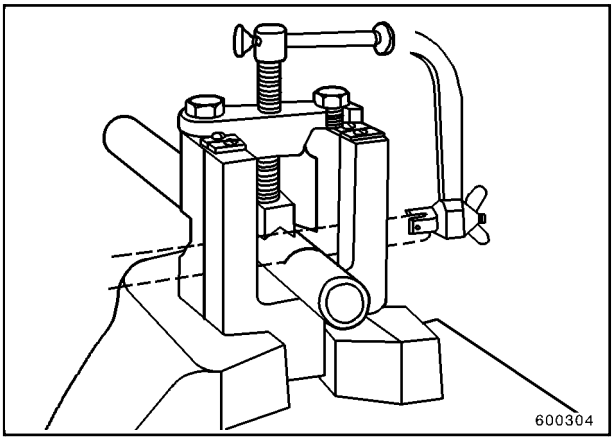


Fig. 5

After cutting, deburr the pipe inside and out (Figs. 6 and 7).

WARNING

Any metal particles inside the pipe must be removed.

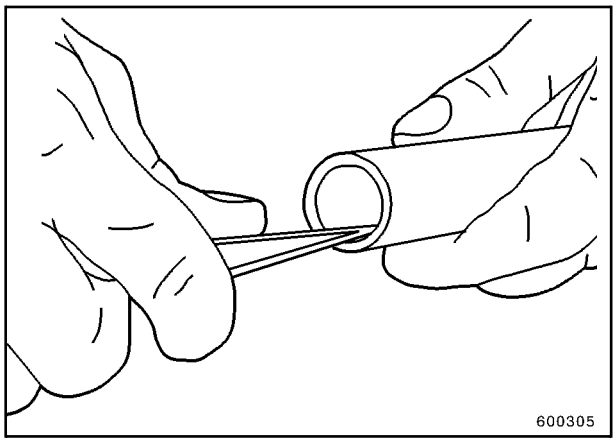


Fig. 6

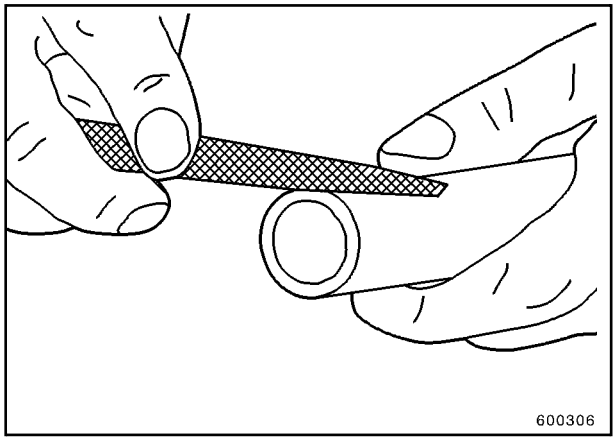


Fig. 7

Hoses

Hoses must be carefully chosen for the application to which they are to be put. Operating pressure, pressure peaks, fluid temperature, hose length, bend angles and radii must be taken into consideration. The hoses must be resistant to mineral oil, water and their emulsions, as well as to gas and air bubbles. Only the manufacturer of a machine is able to determine such demands exactly, e.g. as are made upon EHP hoses in a hydraulic system.

Hoses are delivered ready to be installed. They may have screw couplings (Fig. 1)

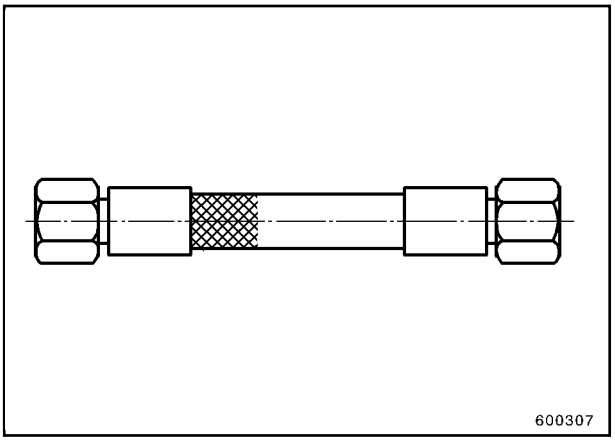


Fig. 1

or SAE flange fittings (Fig. 2) at each end,

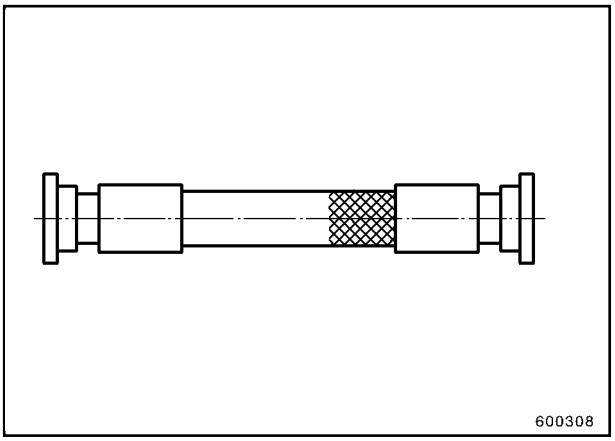


Fig. 2

or may have one screw coupling and one SAE flange fitting (Fig. 3).

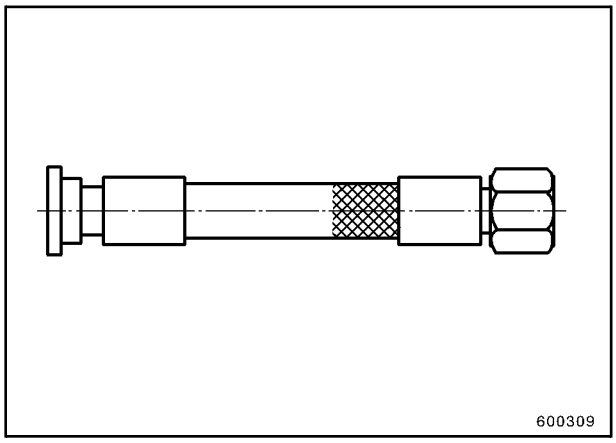


Fig. 3

Hoses may alter their length slightly when subjected to high pressure. Permissible tolerances range from -4 % to +2 %, based on nominal dimension.

Examples for fitting hoses

Hoses must be installed free of tension and kinks. Damage can otherwise occur to the hose itself and to its end couplings. What is more, the restoring torque of a hose installed incorrectly can lead to the coupling loosening and leaking.

Hoses installed in a straight line with both couplings lying at the same level must be allowed to "sag" slightly. Only then is it possible for fluctuations in length - due to pressure and temperature deviation - to be taken up by the hose itself.

Fig. 4 shows examples of correct hose installation.

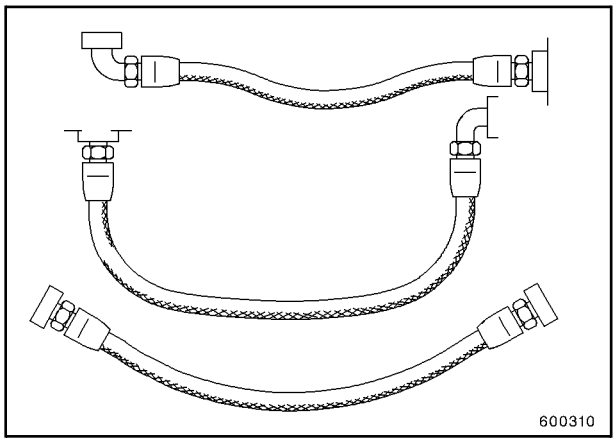


Fig. 4

Fig. 5 shows mistakes to be avoided.

Hoses subjected to alternating bending stress during operation must be installed in such a way that high stressing does not occur on couplings or to the hoses themselves. The following must therefore be considered:

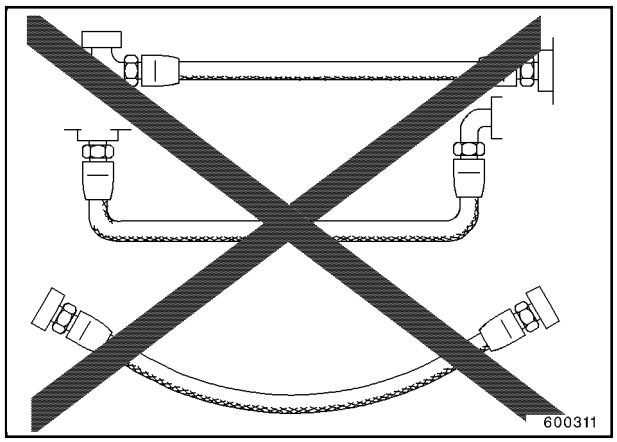


Fig. 5

- the hose bend radius must be large enough
- sufficient hose material must be available to take up the motion
- suitable couplings, e.g. angle couplings, must be used when sharp bends are required in the hose routing

Fig. 6 shows examples of good installation of hoses.

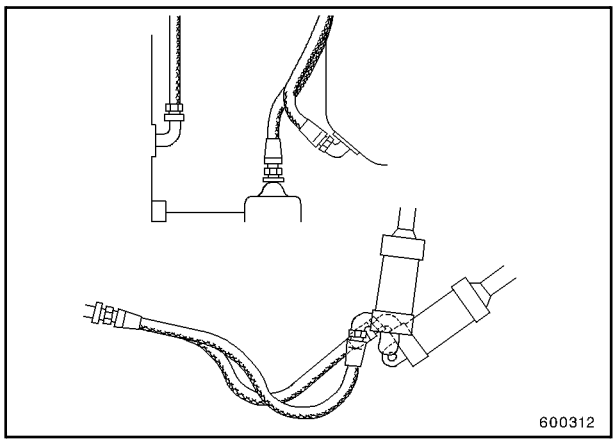


Fig. 6

Fig. 7 shows mistakes which must be avoided.

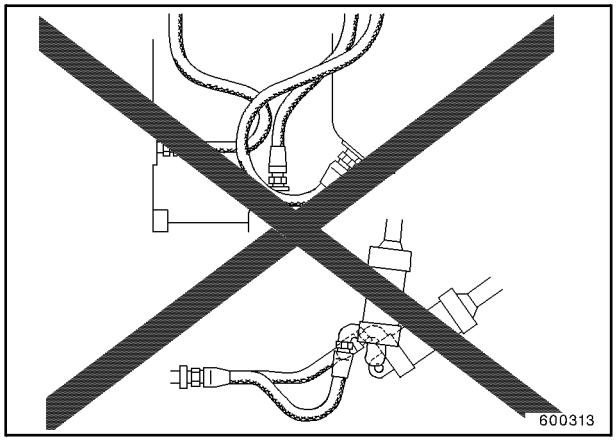


Fig. 7

Plastic pipes

Pipelines for compressed air, e.g. in brake systems, are often made up of plastic pipe sections.

Such plastic pipes can be used within the temperature range of -140˚F to +212˚F.
During repair work, make sure that the pipes are not exposed to excessive temperatures which might cause damage. When welding, the pipes are to be covered over to protect them against sparks, flames, welding spatter and welding slag. If extensive work is to be carried out, the plastic pipes should be removed beforehand.

WARNING

Damaged plastic pipes must be changed - even if they have only been slightly penetrated by welding spatter.

Plastic pipes must not be installed near exhaust pipes or other sources of heat.

Bending and straightening

During fitting, plastic pipes can be bent for installation at ambient temperatures of at least + 68˚F.

As plastic pipes are not permanently deformed during bending, and return to their original shape when released, they must be clamped in the required position.
Plastic pipes can be straightened again by being immersed in hot water (at least 158˚F). They then return automatically to their original, linear shape.

Cutting and installing

When installing new pipes, make sure that the cut edge is at right angles to the pipe's longitudinal axis. If a pipe cutter is not available, a sharp knife can be used to cut the plastic pipes.
Make sure that cut ends are de-burred before installation.

Installation

First push the union nut (1, Fig. 1) and then the clamping ring (2) onto the pipe. The shallow taper (3) of the clamping ring must be towards the end of the pipe. Push insert sleeve (4) fully into the pipe until edge (5) aligns with pipe end.

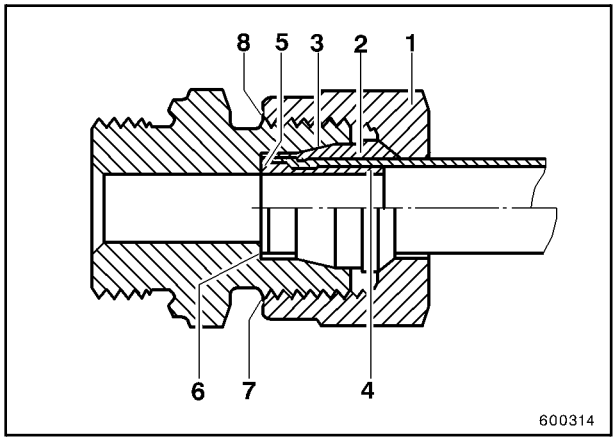


Fig. 1

WARNING

Push end of pipe, with insert sleeve, fully into the coupling until it is up against end stop (6).

Push clamping ring (2) into the coupling and tighten union nut (1) by hand. To avoid damaging the pipe, never tighten the union nut too hard. 1.5 to 1.75 turns are sufficient to tighten up the nut. After tightening, edge (7) of union nut must reach approximately to the thread run-out (8) of the coupling piece.

CONNECTIONS

Pipe and hose connections must meet the following requirements:

- They must be able to be disconnected and reconnected numerous times.
- They must not leak whatever the operating conditions.
- The through-flow cross sections must be as near as possible to that of the respective pipe or hose line.
- The strength of the connection must, on account of possible pressure peaks and vibrations, be at least as high as that of the pipe it connects.

Connections on machines:

1. Pipe couplings

2. Bulkhead couplings

3. Stud couplings and male nipples

4. Swivel couplings

5. Flange connections

Pipe couplings

The best-known of the detachable pipe couplings are those which make use of cutting rings. These are supplied as:

- straight couplings (Fig. 1),
- angle couplings (Fig. 2),
- "T" couplings (Fig. 3) and
- "X" or cross couplings (Fig. 4).

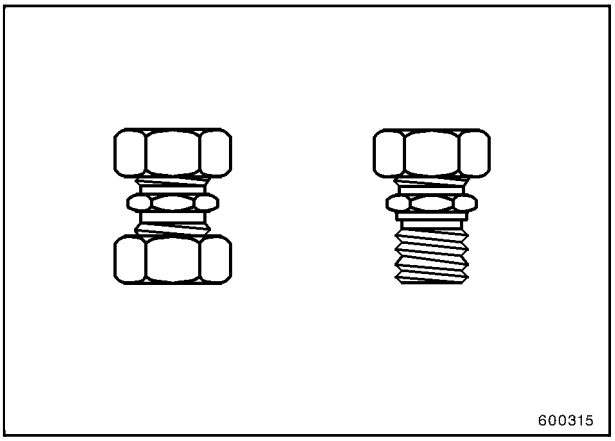


Fig. 1

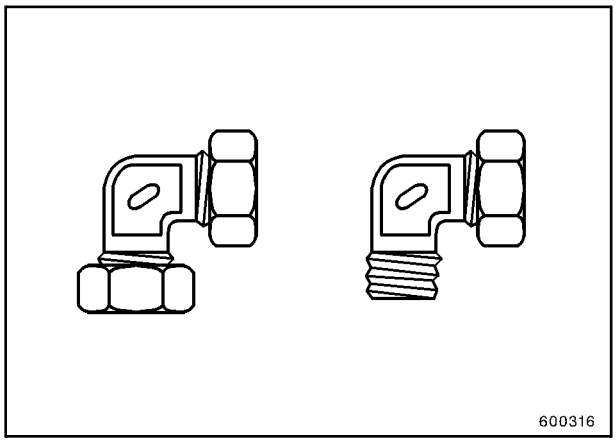


Fig. 2

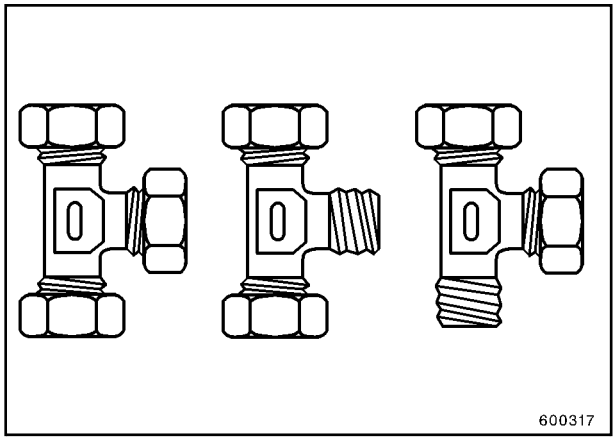


Fig. 3

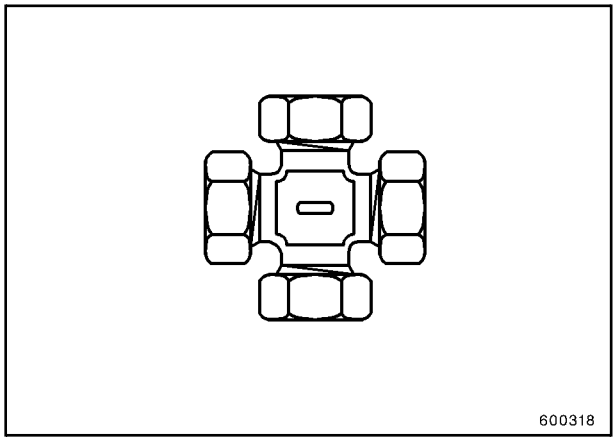


Fig. 4

DIN 2353 gives a summary of the shapes and dimensions of such couplings.
Besides different shapes, the couplings are also manufactured in three pressure categories, namely:

Series LL = extra light duty
Series L = light duty
Series S = heavy duty

The individual components of a cutting ring coupling (Figs. 1 - 7) are:

1 - Coupling body
2 - Cutting ring (DIN 3861)
3 - Union nut (DIN 3871)

Function

Fig. 5 shows a pipe connection prior to the union nut being tightened. When the nut (3) is tightened, the pre-formed, hardened cutting ring (2) is pushed into the internal cone of the coupling body (1) and thereby cuts its way into the pipe, at the same time throwing up a ridge of cut material. The pipe is held firmly against the end shoulder of the coupling body and cannot therefore move while cutting is taking place.

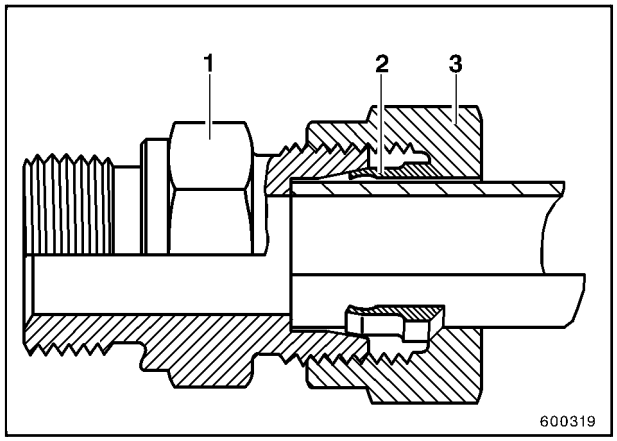


Fig. 5

It is absolutely essential that the pipe lie firmly against this shoulder in the coupling - cutting cannot otherwise take place.

The wedging of the cutting ring between pipe wall and inner cone prevents the cutting ring from being pushed too far into the pipe wall and possibly breaking off the end of the pipe. At the other end, underneath the nut, the pipe is wedged firmly in the cylindrical bore of the cutting ring. This provides additional strength and relieves the cut area of dynamic stress.

Fig. 6 shows the completed connection with the union nut tightened.

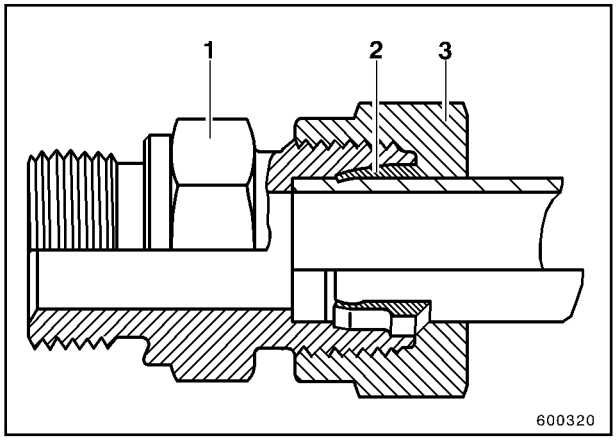


Fig. 6

DIN 3861 does not specify a particular shape of cutting edge for cutting rings. This is left open to the manufacturer. Minor fluctuations are therefore possible.

WARNING

Cutting ring and coupling body should always be of the same make.

A cutting ring coupling can be disconnected and re-connected several times.

Fitting instructions

Pipe couplings with large diameters should be assembled in a vice if possible. A wrench with a grip approximately 15 times longer than the jaw width should be used.

1. Cut pipe end at right angles and de-burr - see section "Steel pipes"
2. Lightly oil (do not grease):
   thread and internal cone (Figs. 1 + 2)
   cutting ring all round (Fig. 3)
   inside of union nut (Fig. 4)

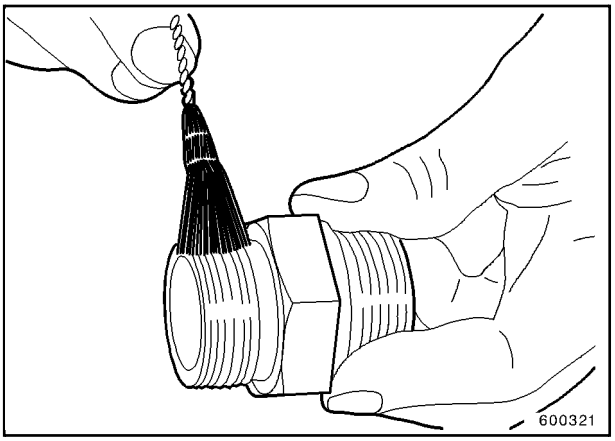


Fig. 1

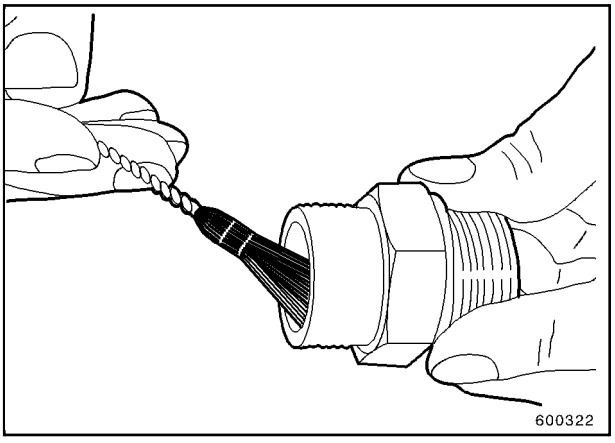


Fig. 2

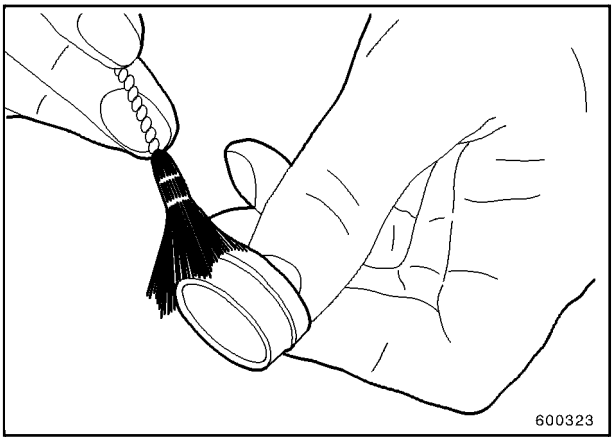


Fig. 3

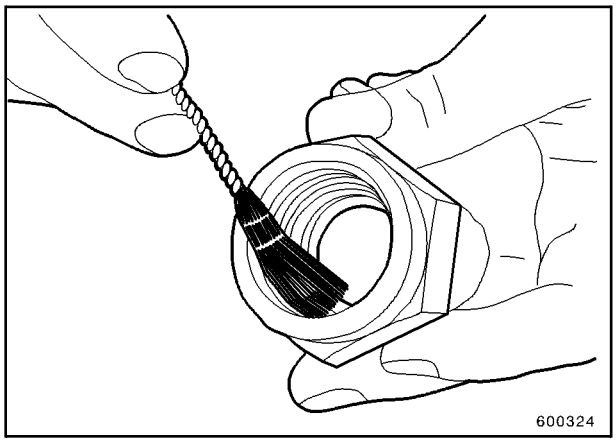


Fig. 4

3. First push union nut and then cutting ring onto the pipe (Fig. 5).
   The thicker shoulder of the cutting ring must point towards the union nut (Fig. 6).

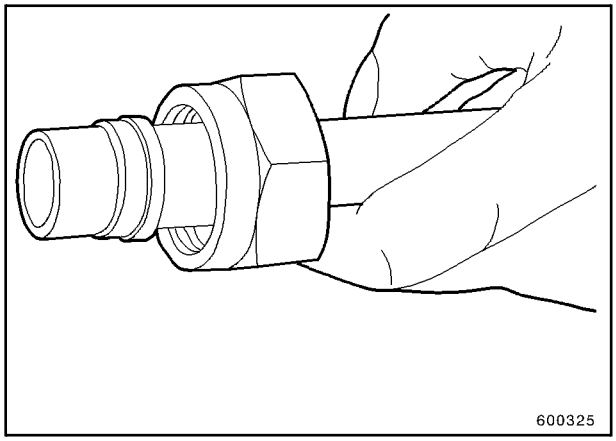


Fig. 5

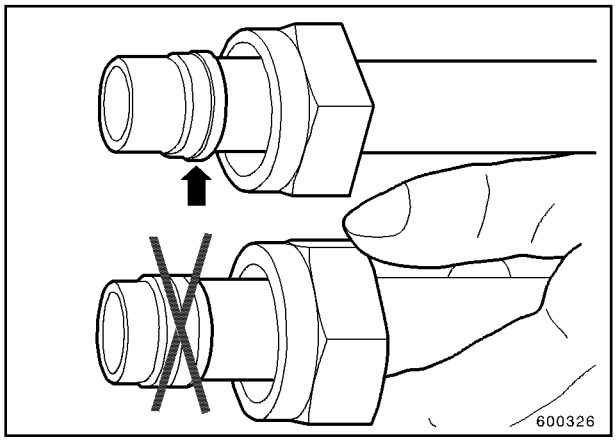


Fig. 6

4. Push pipe into inner cone of coupling body until it lies up against shoulder end stop (Fig. 7).

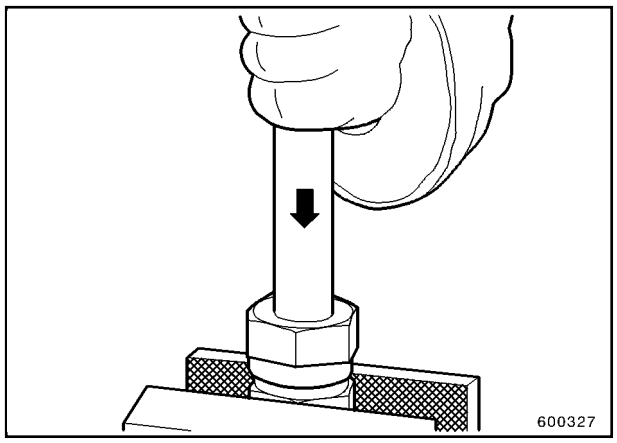


Fig. 7

5. Tighten union nut by hand until resistance is noticed (Fig. 8). The cutting ring must come firmly into its position between union nut and inner cone of the coupling body.

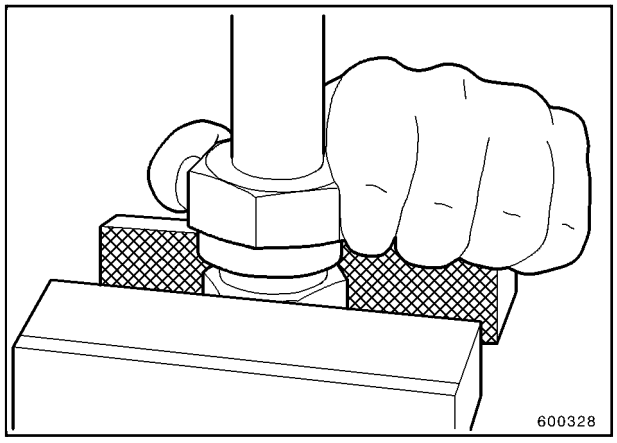


Fig. 8

6. Make chalk marks on union nut and pipe (Fig. 1) so that assembly can be checked more easily.

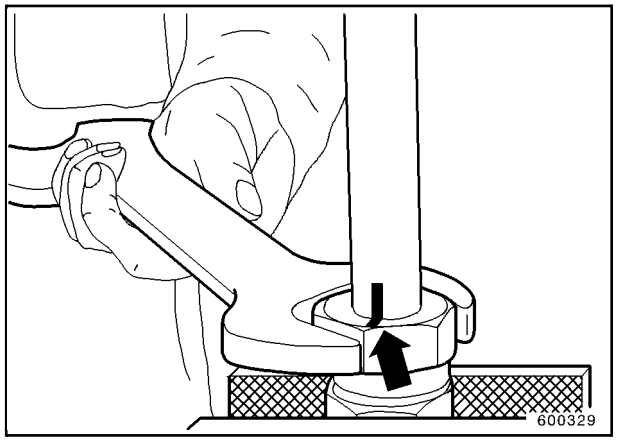


Fig. 9

Fig. 10 shows the coupling before tightening the union nut:

1 - Coupling body
2 - Cutting ring
3 - Union nut
4 - Pipe
A - End stop in inner cone
B - Inner cone

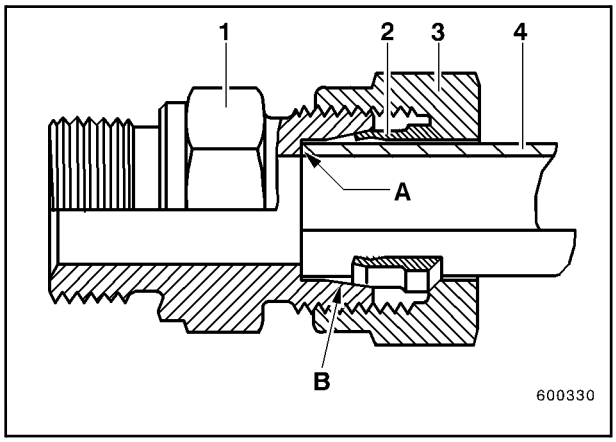


Fig. 10

7. Tighten union nut with a wrench / spanner (Fig. 11).

   Pipe outside diameter up to Ø 18 mm: 1 turn
   Pipe outside diameter over Ø 20 mm: 1 turn

   The edge of the cutting ring thereby cuts into the pipe wall and throws up a visible ridge of cut material.

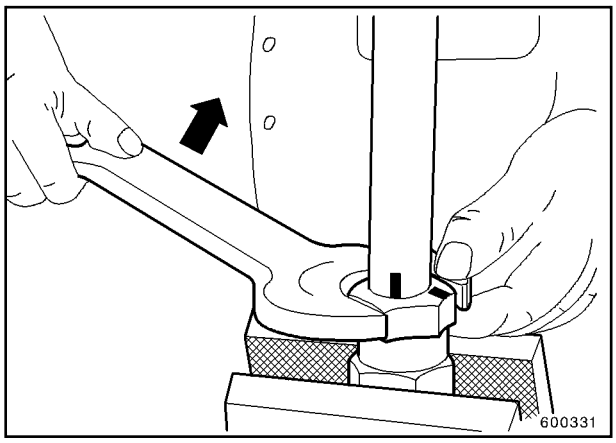


Fig. 11

Fig. 12 shows the coupling after tightening the union nut.

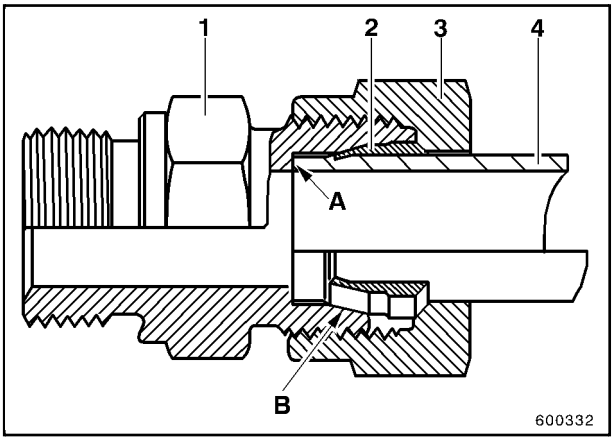


Fig. 12

8. Loosen union nut and check the cut of the cutting ring (Fig. 13).
   The ridge of material thrown up should cover 70 - 80 % of the cutting ring front edge. If this is not the case, tighten the union nut further. It does not matter if the ring can be rotated on the pipe.

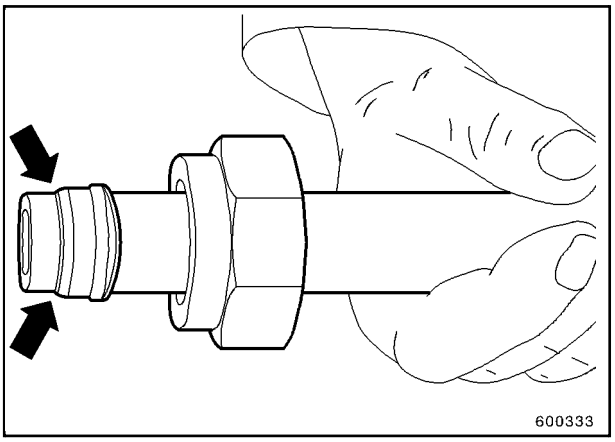


Fig. 13

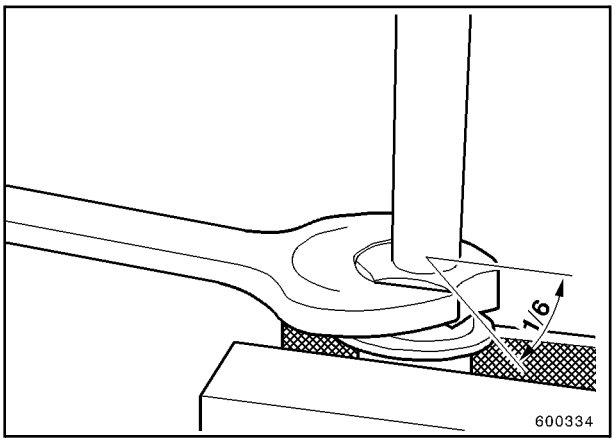


Fig. 14

9. Assemble the coupling again. Tighten union nut until resistance is noticed and then a further 1/6 of a turn (Fig. 14).

Sealing pipe couplings

If properly assembled, a leaking coupling can usually be sealed again by tightening the union nut by approx. 1/2 a turn further. If the leak cannot be stopped in this way, open up the coupling and check that the pipes are aligned, check whether couplings or pipes are distorted, scored or cracked, check whether the connecting surface of the other component is in order, check whether any seal element is in order.

If it is still not possible to stop the leakage, then the whole coupling is to be changed.

Bulkhead couplings

Straight bulkhead couplings (Fig. 1), angled bulkhead couplings (Fig. 2) and welded bulkhead couplings (Fig. 3) are used when lines are to be routed through the walls of structural components. The couplings are secured to the structural component by tightening the nuts 5 (Figs. 1 and 2), or by welding into place.

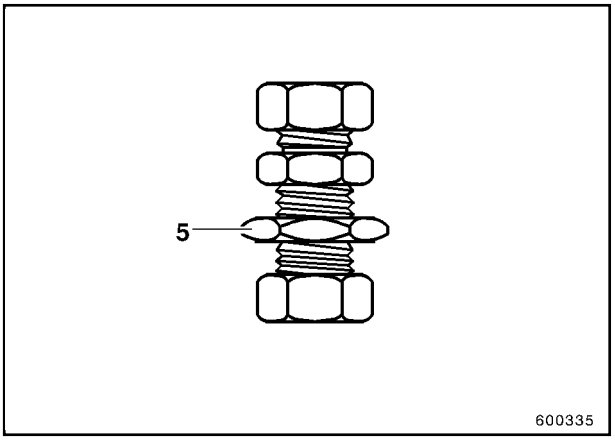


Fig. 1

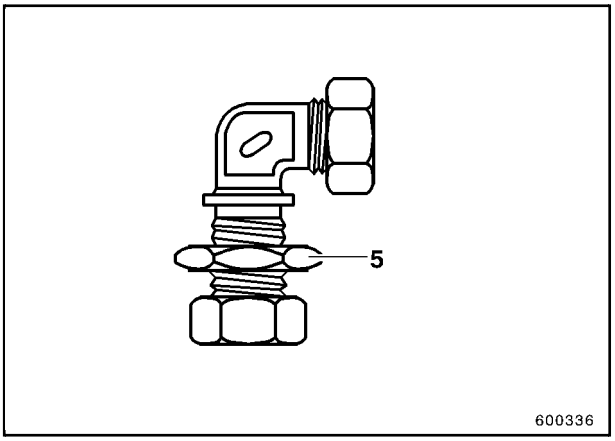


Fig. 2

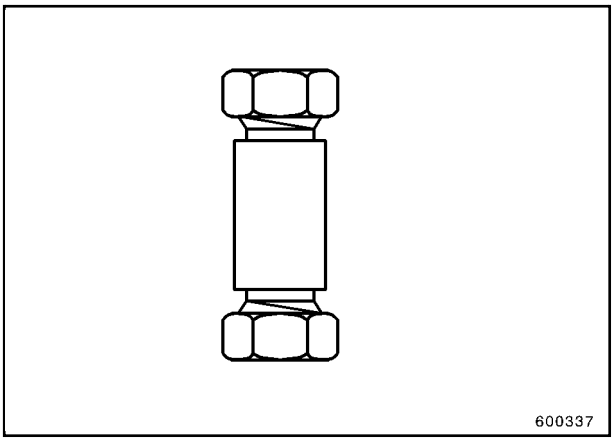


Fig. 3

The assembly of connecting lines (pipes, cutting rings, union nuts) is as described under "Pipe couplings".

Stud couplings and male nipples

Male thread and seals

Whitworth pipe thread (cylindrical) DIN 259

Metric ISO thread (cylindrical) DIN 13

Cylindrical male threads are generally sealed with a sealing edge according to DIN 3852, Form B (metal-to-metal, without seal disk). See Fig. 4.

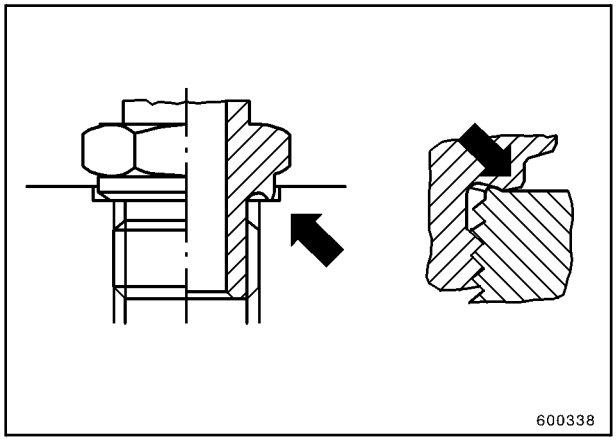


Fig. 4

In special cases, it is advantageous to seal the male thread with a soft seal (Fig. 5).

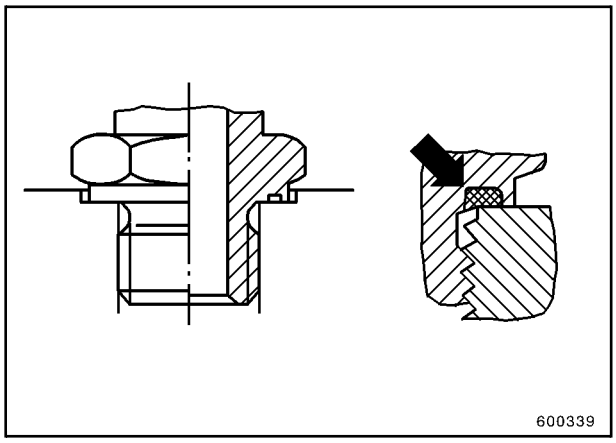


Fig. 5

Male nipples with metric or Imperial (inch) threads require a recess to accommodate the O-ring to seal the nipple (Fig. 6).

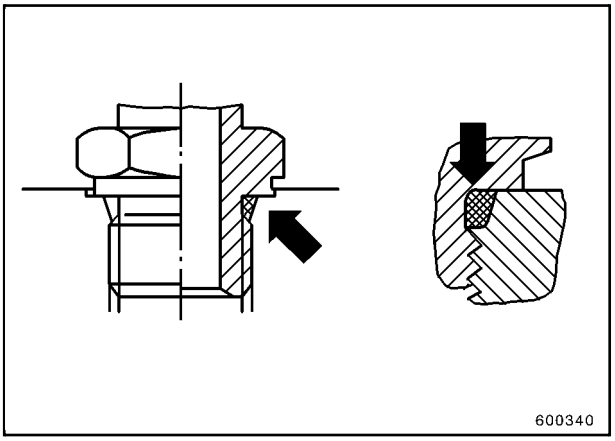


Fig. 6

In hydraulic systems, straight male nipples with sealing rings are often used. The ring is then rectangular in cross section (Stircomatic ring) or round (O-ring). Fig. 7 shows:

1 - Straight male nipple
2 - Stircomatic or O-ring
3 - Component to be sealed

If leakages occur, the nipple (1) should first be tightened up. If no improvement is reached, the seal ring must be changed.

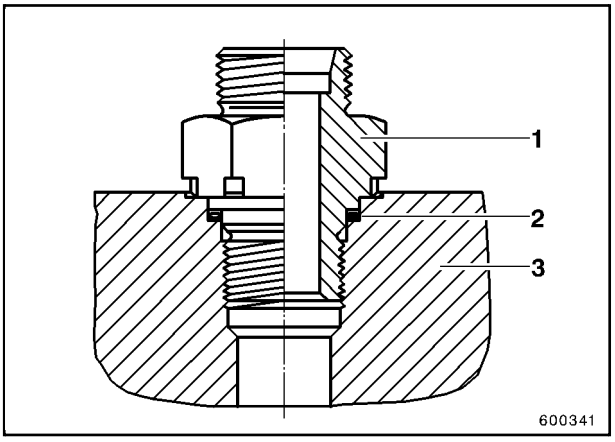


Fig. 7

Stircomatic seal rings

Stircomatic seal rings have been developed for control units, port plates, valves, threaded flanges and other connecting elements. They can be used with hydraulic oil, water and emulsions.

Fig. 1 shows the shape and construction of a Stircomatic seal ring:

1 - Cutting edge
2 - Textile inlay
3 - Rubber

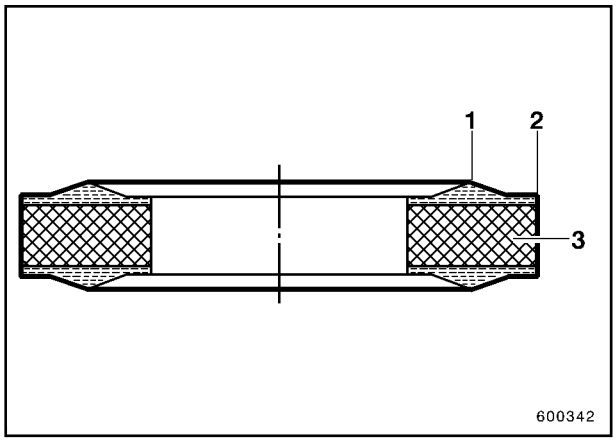


Fig. 1

Stircomatic seal rings have long-term pressure stability and high resistance to deformation.

O-rings previously used at such points can be replaced by Stircomatic rings.

Swivel couplings

Swivel couplings

Application: in hydraulics for pipes with 25, 30 and 38 mm outside diameter

Swivel coupling with straight male thread acc. to DIN (Fig. 1)

Components:

1 - Coupling body
2 - Union nut
3 - Cutting and wedging ring
4 - Union nut
5 - O-ring
6 - Straight male thread acc. to DIN
7 - Component to be sealed
8 - Retaining ring body/nut

Leakages can be remedied as follows:
In area A; sealed with cutting and wedging ring
as described under "Sealing pipe couplings".

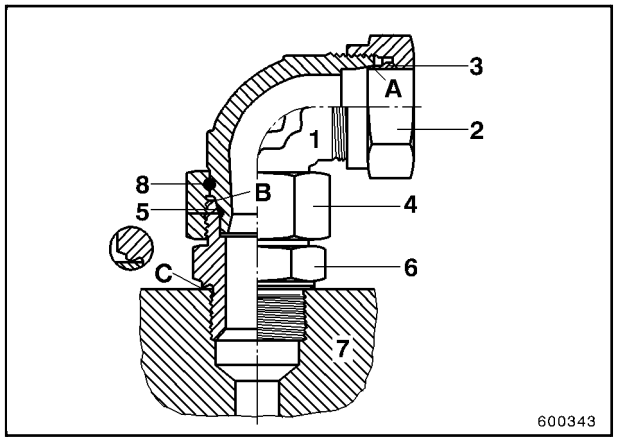


Fig. 1

In area B; sealed with O-ring
tighten up by hand - otherwise change O-ring.

in area C; sealed with sealing edge
tighten male nipple. Should this not help, check sealing surface of main component for pitting, grooving or scoring - rework with a spot facer if necessary. Male nipple to be changed if sealing edge is damaged.

Swivel coupling with long male adaptor (Fig. 2)

The swivel coupling positioned on the adaptor (6, Fig. 2) is made up of the same components as stated under "Swivel coupling with straight male thread acc. to DIN".

Any leakages are to be remedied in the same manner as given under "Swivel coupling with straight male thread acc. to DIN". The coupling is sealed in area "C" with a steel sealing ring (9).

If sealing ring or male adaptor are damaged, they are to be replaced.

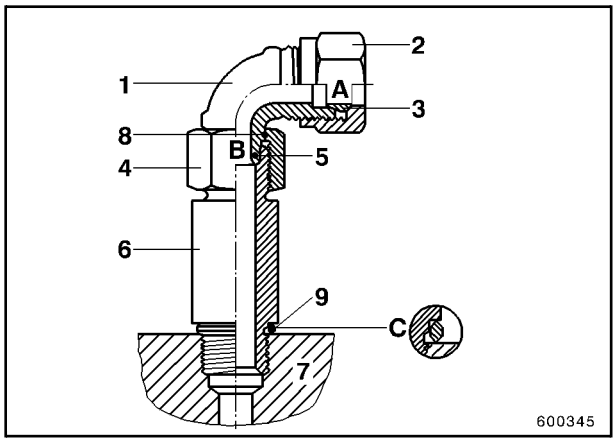


Fig. 2

Fixed angle couplings (Fig. 1)

Application: in hydraulics for pipes with outside diameters from 6 to 22 mm

Components:
1 - Coupling body
2 - Union nut
3 - Cutting and wedging ring
4 - Straight male nipple
5 - Component to be sealed

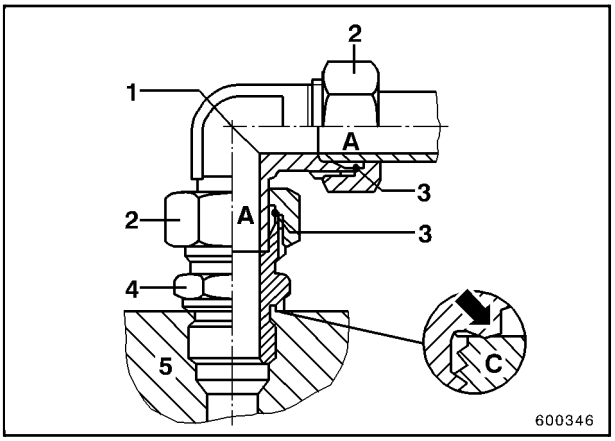


Fig. 1

Leakages can be remedied as follows:

In area A; sealed with cutting and wedging ring
as described under "sealing pipe couplings".

In area C; sealed with sealing edge
tighten male nipple. Should this not help, check sealing surface of main component for pitting, grooving or scoring - rework with a spot facer if necessary. Male nipple to be changed if sealing edge is damaged.

Banjo couplings

Application : in hydraulics for pipes with outside diameters of 16 - 38 mm

Banjo coupling (Fig. 2)

The banjo coupling comprises:
1 - Body
2 - Hollow screw
3 - Sealing ring
4 - Union nut
5 - Cutting and wedging ring
6 - Sealing ring
7 - Connecting surface

The banjo coupling is sealed by the cutting edges of the sealing rings (3 and 6, Fig. 2). Leakages can be remedied by tightening up the hollow screw (2, Fig. 2) on its hex. head, or by following the steps stated under "Swivel couplings".

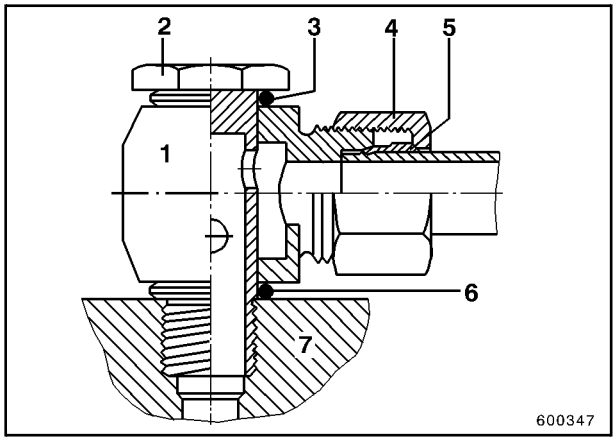


Fig. 2

When tightening the hollow screw, make sure that body (1) is at right angles to connecting surface (7) or nipple (8, Fig. 3), as the sealing rings (3) and (6) cannot otherwise fulfil their function. The connecting surface must be clean, even and at right angles to the threaded port for the hollow screw. Before tightening the hollow screw (2), it is advisable to loosen the union nut (4) slightly so that no stress forces are transferred through body (1) into the connected pipe.

On the pipe side, the coupling is sealed with the cutting and wedging ring (5). Measures to remedy leakages have already been described.

Banjo coupling with long male adaptor
(Fig. 3)

The banjo coupling screwed into the adaptor (8, Fig. 3) comprises the same components as described under "Banjo coupling".

Leakages in area A can be remedied by tightening the adaptor (8) or by undertaking measures as described under "Swivel coupling". Loosen hollow screw (2) and union nut (4) slightly before tightening up the adaptor.

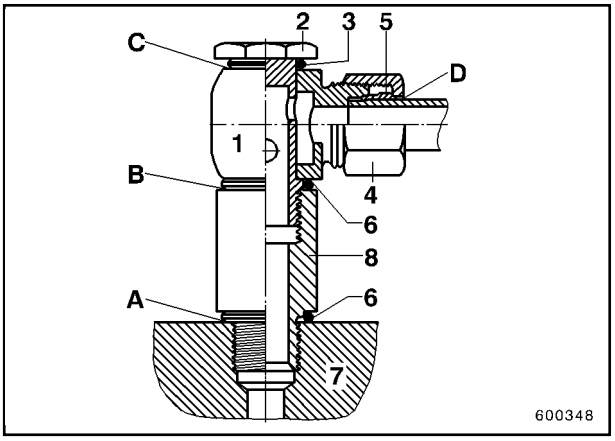


Fig. 3

FLANGE COUPLINGS WITH SAE BOLT PATTERN

Flanged pipe couplings - Flanit system (F-system)

These couplings are for pipes between Ø 25 x 3 and Ø 50 x 2.

Fig. 1 shows the components of the F-system; Fig. 2 a finished coupling. The components are:

1 - Connection surface
2 - Seal ring
3 - F-ring (wedge ring)
4 - Flange
5 - Double-hex bolt
6 - Pipe

In the F-system, the wedge ring (F-ring) is pushed onto the pipe.

The secure connection of wedge ring and pipe is achieved by tightening the double-hex bolts. A pre-assembly device is not needed.

Gap dimension "L" is used to check whether the connection has been correctly established.

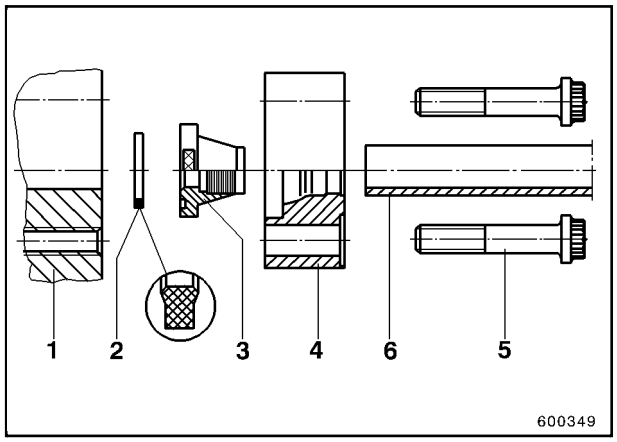


Fig. 1

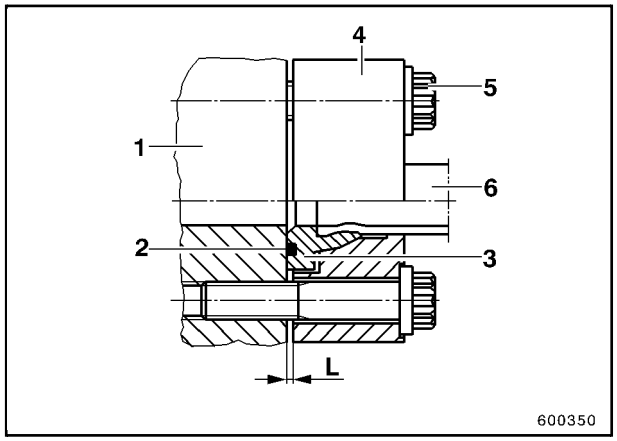


Fig. 2

Flanged pipe couplings - Zako system (Z-system)

These couplings are used for pipes Ø 50 x 6 (1", 6000 psi).

Fig. 1 shows the components of the Z-system; Fig. 2 a finished coupling. The components are:

1 - Connection surface
2 - Seal ring
3 - Z-ring (wedge ring)
4 - Flange
5 - Double-hex bolt
6 - Pipe

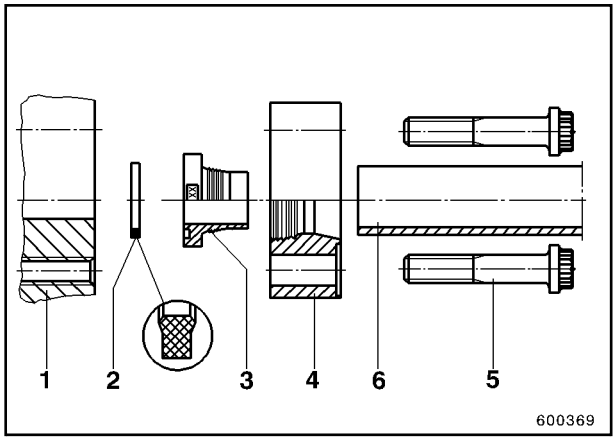


Fig. 1

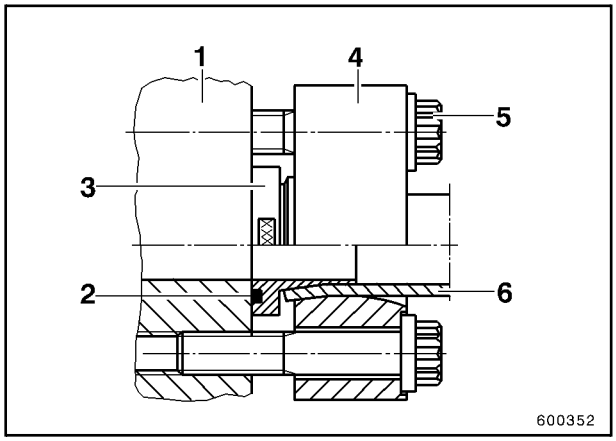


Fig. 2

In the Z-system, the wedge ring (Z-ring) is pressed into the pipe with a hydraulic tool. This causes the pipe to be stretched. The high surface pressure in the stretched area guarantees optimum sealing of the joint. Further advantages are:

- high resistance to pressure peaks and vibration
- maximum safety against pipe tearing out - the pipe being firmly held between ring and flange
- simple final assembly
- Z-rings can be re-used

Flanged hose couplings

Hydraulic hoses are supplied with ready-assembled SAE coupling fittings. These always have a seal ring groove.

The fitting is connected to the counter-component using two flange halves.

Fig. 3 shows:

1 - Connection surface
2 - Seal ring
5 - Double-hex bolt
9 - Flange halves (2 in all)
10 - Hyd. hose with SAE flange fitting

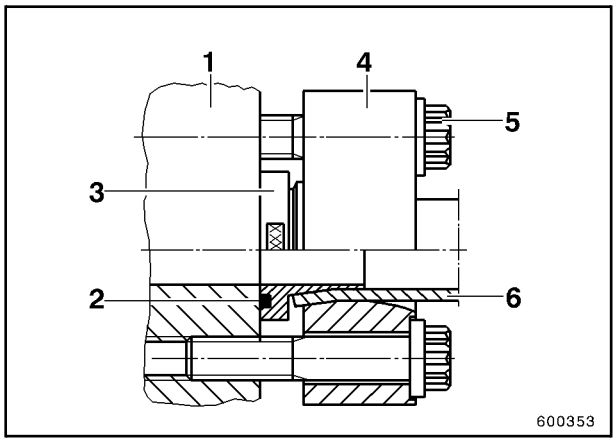


Fig. 3

Sealing and connecting components

Flanges

In the case of flanged pipe couplings, one-part flanges are used. Flanges of the same size, but different systems (Flanit/Zako) differ mainly in the contour of the middle bore.

Flanged hose couplings are assembled with two-part flanges. These are referred to as flange halves.

The flanges can be used several times.

Wedge rings

Wedge rings for flanged pipe couplings are available in two designs.

Fig. 1 (F-system, for example)
3 - Wedge ring with seal ring groove
7 - Wedge ring without seal ring groove

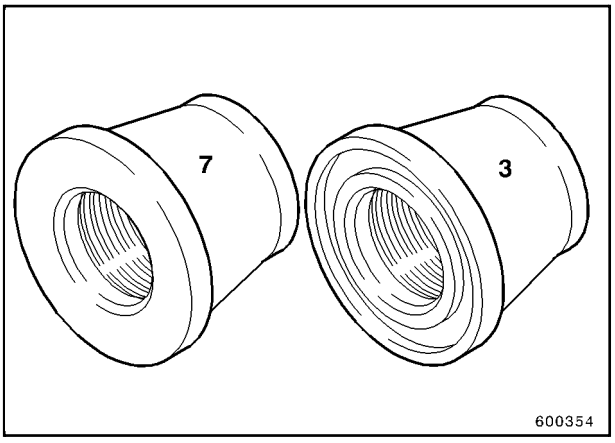


Fig. 1

When making pipe/pipe connections with either the new F-system or the Z-system, a wedge ring with seal ring groove must always be mated opposite a wedge ring without a seal ring groove .

In the original F-system, nearly all connections were made up of two wedge rings with grooves. In such installations, a centre disk (see Section "Centre disks") is necessary. Such a centre disk is also to be used with other systems in exceptional cases in which two wedge rings with grooves need to be mated together.

Direct assembly of two wedge ONLY rings with seal ring grooves is permitted in cases of emergency as a permanent seal cannot be achieved.

Used Z-rings can be removed from their pipe seating and fitted to another pipe section. During this repeated assembly, attention must be given that the cutting edges of the Z-ring are free of metal chippings.

F-rings cannot be re-used.

Seal rings

The seal rings are one-part plastic rings (Fig. 2). They can be used several times and can be installed in all connections previously sealed with the old type of 2-part seal ring.

Table 1 (Appendix) lists all of the available sizes, together with their appropriate Part Nos.

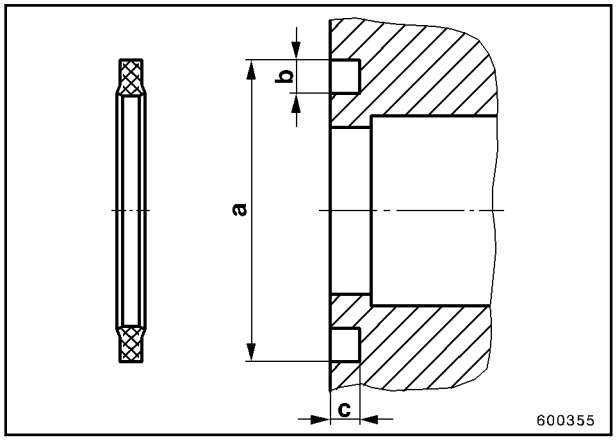


Fig. 2

Double-hex bolts (Fig. 3)

When limited space is available, and therefore whenever SAE flange couplings are being used, double-hexagon bolts are used. They have metric threads (DIN 13), material quality 10.9 (DIN 267) and surface protection A3B (DIN 267).

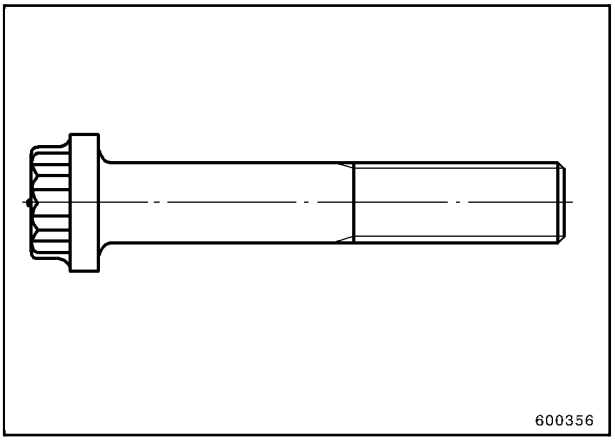


Fig. 3

Double-hex bolts bring the following advantages:

- high rust resistance - bolts are galvanized
- small wrench sizes, e.g. M 10 requires only wrench size 11 (the same size of hex. bolt requires size 17)
- tidy, positive tightening using standard ring spanners and socket spanners
- no danger of head becoming clogged, as with hexagon sockets
- easier positioning of wrench, due to twelve-sided head

Sizes of bolts available can be found in Table 2 (Appendix).

Assembly aids for wedge rings

Pre-assembly device for F-rings

In series assembly, the F-ring should be fitted to the pipe with a pre-assembly device. The relevant operating instructions are therefore to be observed.

Final assembly is direct on the respective machine component, as with manual assembly.

Fig. 1 shows a pre-assembly device, whereby:

1 - Counter ring
2 - Assembly cone
3 - F-ring (wedge ring)
4 - Flange
6 - Pipe

Detailed description - see Appendix.

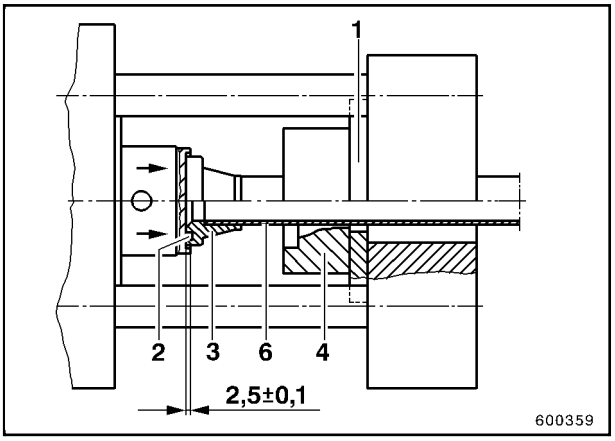


Fig. 1

Inserter for Z-rings

Following tools are required (Fig. 2)

8 - Electro-hydraulic control unit (450 bar) with hoses
9 - Assembly cylinder
10 - Jaws for pipe 50 x 6

A manual pump can also be used instead of the electro-hydraulic unit (8).

Detailed description - see Appendix.

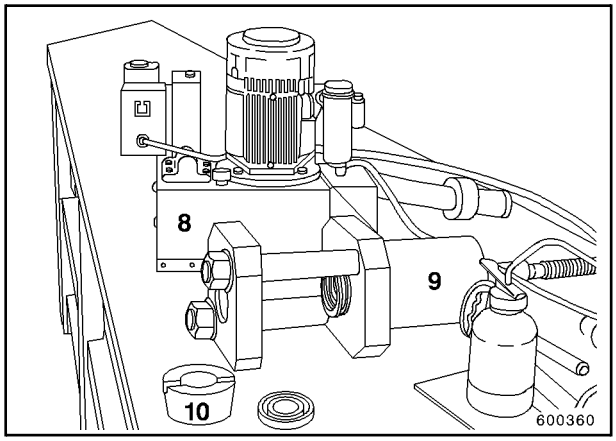


Fig. 2

Inserting the Z-ring

Working procedures are illustrated in Figs. 3 - 6:

1. Pipe prepared for installation (see "Steel pipes").

   The straight pipe end must be at least 135 mm long before any bend occurs (Fig. 3).

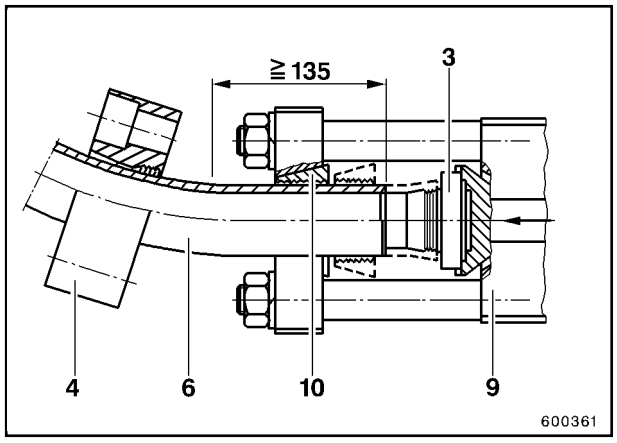


Fig. 3

2. Oil Z-ring (3) and inner contour of flange (4)
3. Push flange (4) onto pipe (5)
4. Insert Z-ring (3, Fig. 4) and push, together with pipe (6, Fig. 5), against pressure plate of cylinder (9)

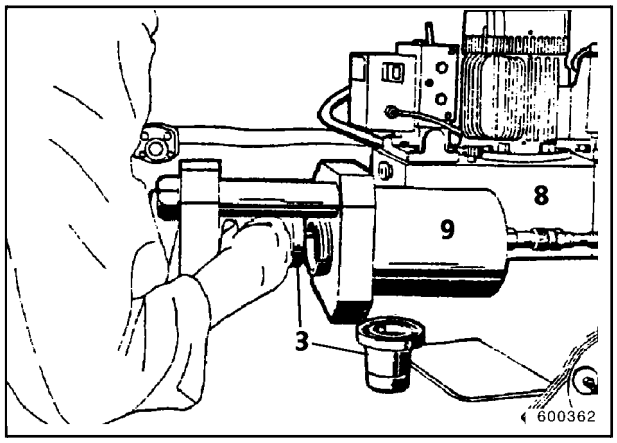


Fig. 4

5. Lay jaws (10) around pipe (6) and push into yoke cone of cylinder (9).

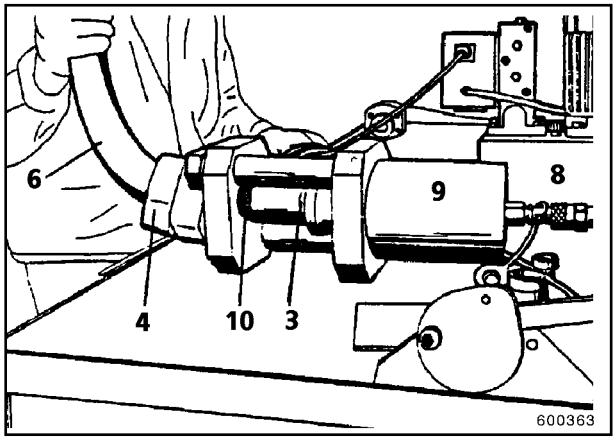


Fig. 5

6. Push Z-ring hydraulically into pipe until shoulder of ring lies up against end of pipe (Fig. 6). Inserting the ring stretches the pipe, whereby the circular cutting edges of the Z-ring cut into the pipe wall.

   A gap of 1 mm is permissible between ring shoulder and the end of the pipe (max. gap).

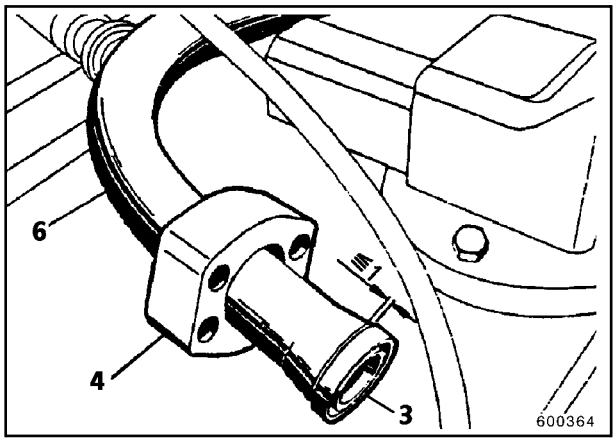


Fig. 6

Assembling flange couplings

The descriptions cover the following flange couplings:

1 - Pipe / connection surface
2 - Hose / connection surface
3 - Pipe / hose
4 - Hose / hose
5 - Pipe / pipe

Flange coupling - pipe / connection surface, F-system

Figs. 1 & 2 show:

1 - Connection surface
2 - Seal ring
3 - F-ring (wedge ring)
4 - Flange
5 - Double-hex bolt
6 - Pipe

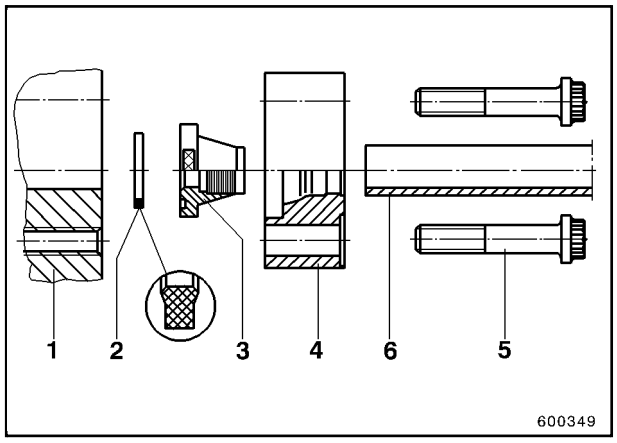


Fig. 1

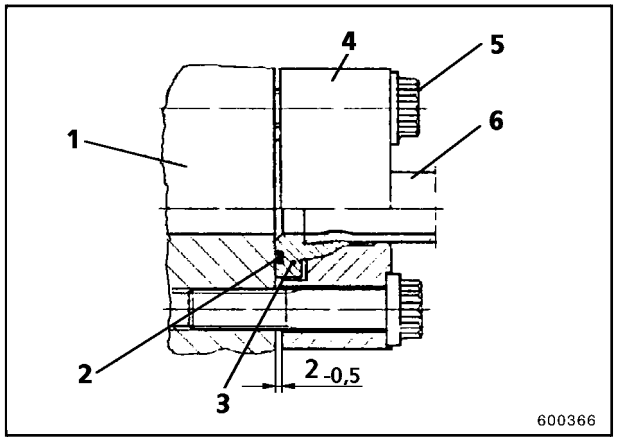


Fig. 2

Assembly:

1. Pipe preparation

   Saw the pipe off at right-angles (do not use pipe cutters). De-burr pipe inside and out.

2. Oil threads of double-hex bolts (5) and inside contour of flange (4) to reduce assembly forces

3. Push flange (4) and wedge ring (3) onto pipe (6). If wedge ring has a seal groove, fit seal first.

⚠ WARNING

Do NOT grease ring or groove.

Push pipe (6) against shoulder of wedge ring (3) and then push flange (4), with wedge ring, against connection surface (1). Insert double-hex bolts (5) and tighten as far as possible by hand.

Pipe (6) must be free of tension and at right-angles to surface (1).

4. Tighten double-hex bolts (5) diagonally in stages of max. 1/2 turn each time.

   The coupling is correctly assembled when the gap between parallel faces of connection surface and flange edge is $\mathbf{2}_{-0.5}$ **mm** (Fig. 3) (gap for first installation/assembly).

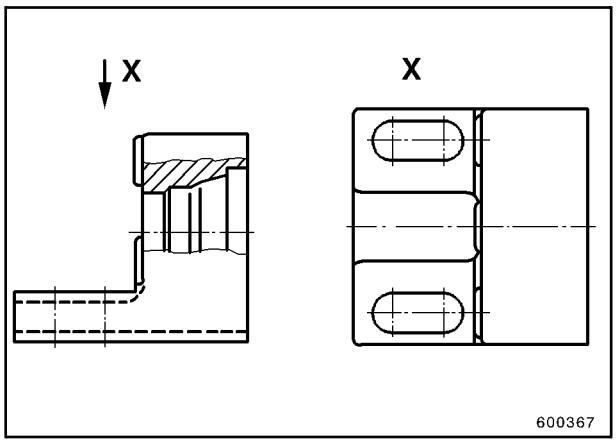


Fig. 3

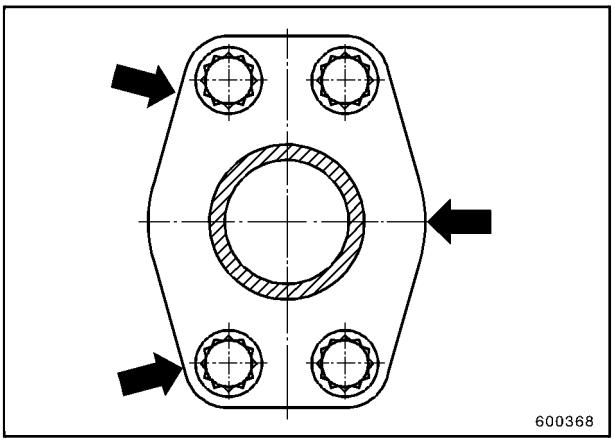


Fig. 4

Check the gap at at least 3 separate points (see arrows). Difference must not be greater than 0.3 mm.

Repeated assembly:

When a coupling is assembled a second (or further) time, the gap must be at least 0.2 mm smaller than the previous one.

Gaps must therefore be measured before couplings are loosened.

A subsequent assembly or installation is not permitted when the gap is smaller than 0.3 mm

In case of leakage:

- Leakage on seal ring (oil leaks between connection surface and flange)
  - Check that gap is parallel and smaller than 2 mm. Re-tighten otherwise.
  - If above measure does not help, check seal ring and connection surface. If necessary, change seal ring. Re-assemble coupling.
  - If coupling still leaks, change pipe, wedge ring and seal ring (gap as for first assembly: $2_{-0.5}$ mm). If gap is smaller than 0.3 mm, replace flange too.
- Leakage between wedge ring and pipe (oil leaks between flange and pipe)
  - Check that gap is parallel and smaller than 2 mm. Re-tighten otherwise.
  - If above measure does not help, tighten bolts by one stage, i.e. reduce existing gap by 0.2 mm. If leakage is only reduced, tighten up a further stage.
  - If coupling still leaks, change pipe, wedge ring and seal ring (gap as for first assembly: $2_{-0.5}$ mm). If gap is smaller than 0.3 mm, replace flange too.

Zako-system

Figs. 5 & 6 show:

1 - Connection surface
2 - Sealring
3 - Z-ring (wedge ring)
4 - Flange
5 - Double-hex bolt
6 - Pipe

Assembly:

1. Pipe prepared for assembly (see "Inserting the Z-ring")
2. Place seal ring (2) into Z-ring
3. Press pipe (6), with Z-ring (3), against the connection surface.

WARNING

Pipe (6) must be free of tension and at right-angles to surface (1).

4. Push flange (4), with bolts (5), against surface. Tighten up bolts as far as possible by hand.

WARNING

Flange (4) must be at right-angles to pipe axis and parallel to the connection surface. Permissible deviation from parallel: max. 0.3 mm

Check visually.

5. Tighten bolts (5) diagonally and evenly.
   Tightening torque: 250 Nm (185 lbft) (final torque).

   It is not necessary to check gap dimension.

In case of leakage:

Tighten up bolts (5) evenly. Torque = 250 Nm (185 lbft). Otherwise change seal ring (2).

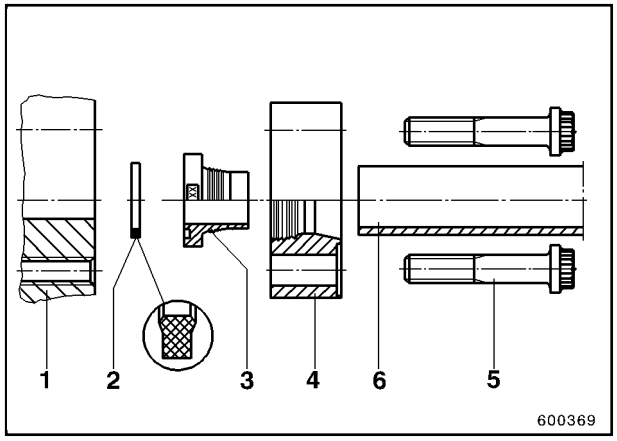


Fig. 5

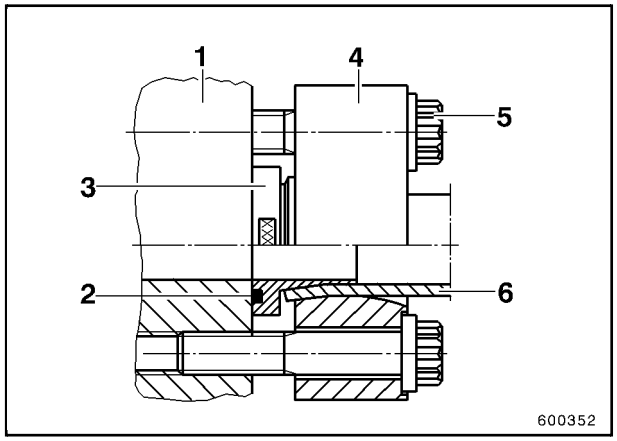


Fig. 6

Flange coupling hose / connection surface

Fig. 1 shows:

1 - Connection surface
2 - Seal ring
5 - Double-hex bolt
9 - Flange half
10 - Hyd. hose with SAE flange fitting

Assembly:

1. Fit seal ring (2) into seal ring groove (see "Seal rings")
2. Push hose (10) up against connection surface. Face of fitting must make contact over whole circumference.
3. Fit the two flange halves (9) one after the other. Screw in bolts (5) as far as possible by hand.
4. Tighten up bolts (5) diagonally to the torques specified. The required torques (final torques) can be found in Table 2.

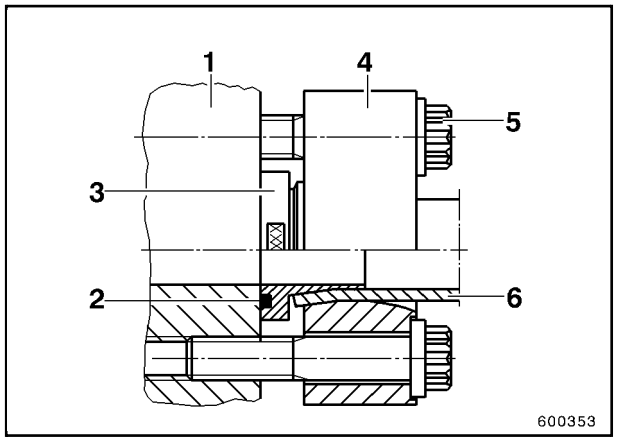


Fig. 1

Table 2: Tightening torques for double-hex bolts

Thread	Wrench size	Tightening torque Nm (lbft)
M 10	11	60 (44)
M 12	13	100 (74)
M 14	15	160 (118)
M 16	19	250 (185)

It is not necessary to check the gap dimension.

In case of leakage:

Tighten up bolts (5) to prescribed torque. Otherwise change seal ring (2).

Flange coupling - pipe / hose

F-system

Fig. 1 shows:

2 - Seal ring
4 - Flange (one-part)
5 - Double-hex bolt
6 - Pipe
7 - F-ring (wedge ring) without seal ring groove[1)]
9 - Flange half
10 - Hydraulic hose with SAE flange fitting
11 - Hex. nut

[1)] If F-ring has a seal ring groove (3, Fig. 3), a centre disk (8) and a second seal ring (2) must be used.

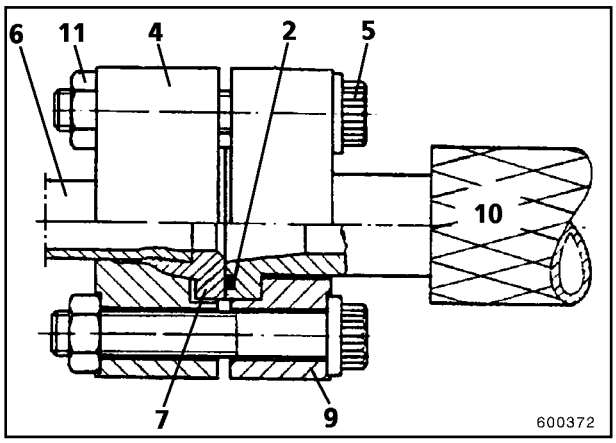


Fig. 2

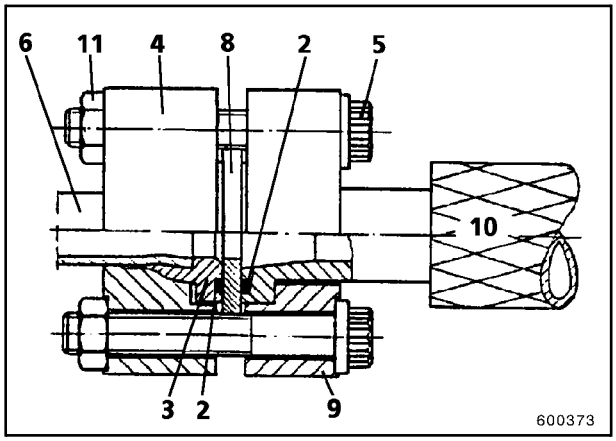


Fig. 3

Assembly:

1. Prepare pipe for assembly.
2. Oil bolts (5, Fig. 2) and inner contour of flange (4).
3. Push F-ring (7) and flange (4) onto pipe.
4. Place seal ring (2) into groove. If necessary, fit a second seal ring (2) and centre disk (8).
5. Push hydraulic hose (10) up against pipe (6) with F-ring (7) and fit the two flange halves (9) into position.
6. Insert bolts (5), fit nuts (11) and tighten up bolts as far as possible by hand.

⚠ WARNING

Flanges (4, 9) must be at right angles to pipe or hose axes, and must be parallel to one another.
Permissible deviation from parallel = 0.3 mm.

Check visually.

7. Tighten bolts (5) diagonally and evenly to prescribed torque. The tightening torques required can be found in Table 2 (final torques). It is not necessary to check the gap dimension.

In case of leakage:

Tighten up bolts (5) to prescribed torque. Otherwise change seal ring (2).

Z-system

Fig. 4 shows:

2 - Seal ring
4 - Flange (one-part)
5 - Double-hex bolt
6 - Pipe
7 - Z-ring (wedge ring) without seal groove
9 - Flange half
10 - Hydraulic hose with SAE flange fitting
11 - Hex. nut

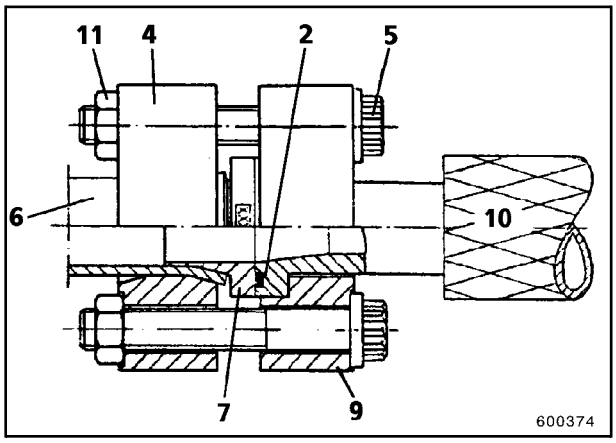


Fig. 4

Assembly:

1. Prepare pipe for assembly (see " Inserting the Z-ring")
2. Oil bolts (5) and inner contour of flange (4)
3. Fit seal ring (2) into seal groove
4. Press hydraulic hose (10) up against pipe (6) with Z-ring (7) and fit both flange halves (9).
5. Fit bolts (5), add nuts (11) and tighten bolts as far as possible by hand.

⚠ WARNING

Flanges (4 + 9) must be at right angles to the pipe or hose axes.
Permissible deviation from parallel = 0.3 mm.

Check visually.

6. Tighten bolts (5) evenly and diagonally. Tightening torque = 250 Nm (185 lbft) (final torque)
   It is not necessary to check the gap dimension.

In case of leakage:

Tighten up bolts (5) to prescribed torque. Otherwise renew seal ring (2).

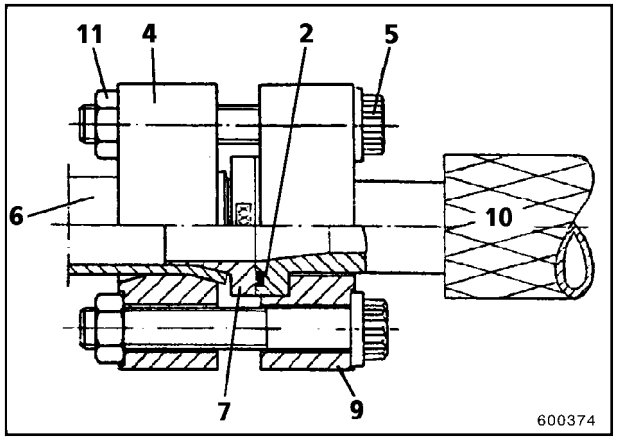


Fig. 5

Flange coupling - hose / hose

Fig. 1 shows:

1 - Seal ring
2 - Double-hex bolt
3 - Centre disk
9 - Flange half
10 - Hydraulic hose with SAE flange fitting
11 - Hex. nut

Assembly:

1. Fit seal rings (2)
2. Oil bolts (5)
3. Press the hose ends, with fittings, against one another, fit the flange halves (9), position the bolts (5), add nuts (11) and tighten bolts as far as possible by hand.

WARNING

Flanges (9) must be at right angles to the axis. Their faces must be parallel.

Check visually.

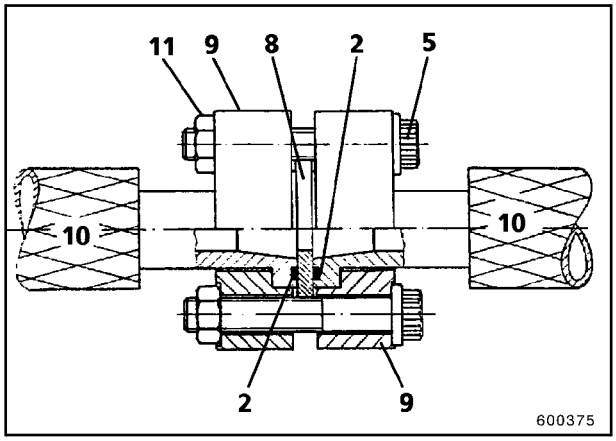


Fig. 6

4. Tighten bolts (5) diagonally and evenly to relevant torque. The required torques (final torques) can be found in Table 3 below.

Table 3: Tightening torques for double-hex bolts

Thread	Wrench size	Tightening torque Nm (lbft)
M 10	11	60 (44)
M 12	13	100 (74)
M 14	15	160 (118)
M 16	17	250 (185)

It is not necessary to check the gap dimension.

In case of leakage:

Tighten bolts (5) to the prescribed torque. Otherwise renew seal ring (2).

Flange coupling - pipe / pipe

F-system

Figs. 1 and 2 show:

2 - Seal ring
3 - F-ring (wedge ring) with seal ring groove
4 - Flange(one-part)
5 - Double-hex bolt
6 - Pipe
7 - F-ring (wedge ring) without seal ring groove[1)]
11 - Hex. nut

[1)] If the second F-ring also has a seal ring groove (3, Fig. 3), a centre disk (8) and a second seal ring (2) must be used.

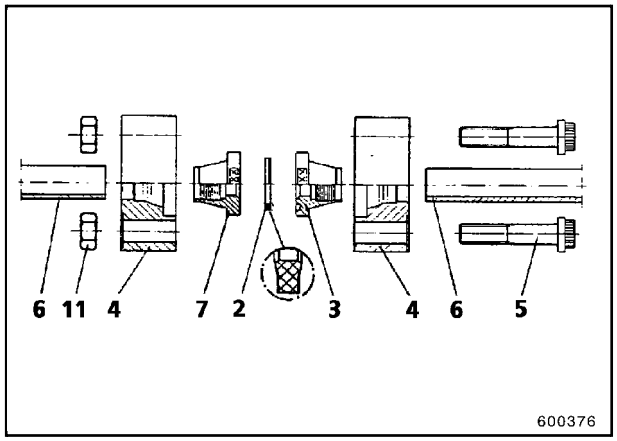


Fig. 1

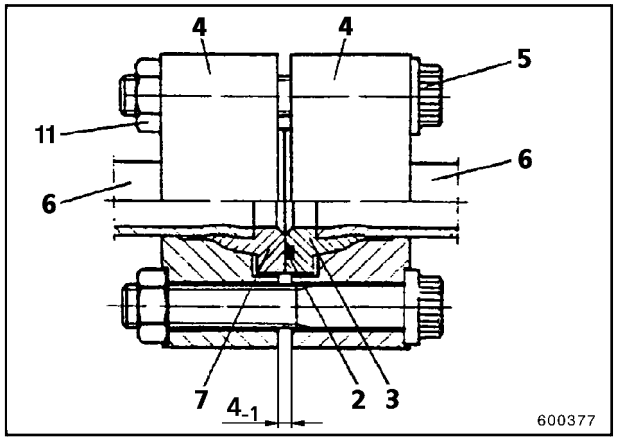


Fig. 2

Assembly:

1. Prepare pipe for assembly.
2. Oil bolts (5) and inner contours of flanges (4).
3. Push flanges (4) and F-rings (3 & 7) onto pipes. Place seal ring (2) into groove. If necessary, fit a second seal ring (2) and centre disk (8).
4. Push pipes (6) against shoulders of F-rings (3 & 7). F-rings must lie firmly against one another and must be seated securely in the flanges (4).
5. Insert bolts (5) and tighten as far as possible by hand.

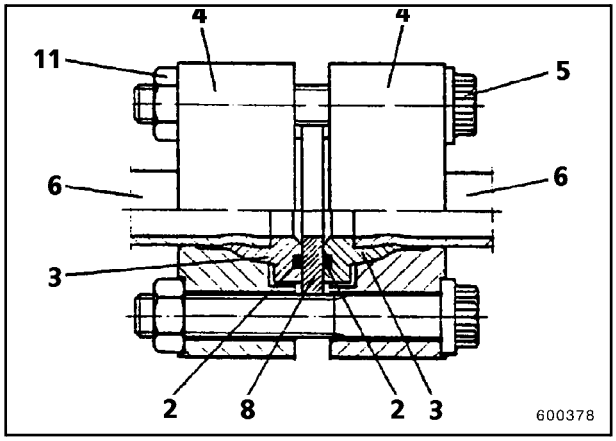


Fig. 3

⚠ WARNING

Flanges (4) must be at right angles to the pipe axes and parallel to one another.

Tighten double-hex bolts (5) diagonally in stages of max. 1/2 a turn each.

The coupling has been assembled correctly when the gap between the parallel faces of the flanges is 4_{-1} mm (gap for first assembly).

Exception: If a centre disk (8) is being used, the gap dimension increases by the thickness of the relevant disk.

Check gap at least three separate points (see arrows, Fig. 4). The difference must not be greater than 0.3 mm.

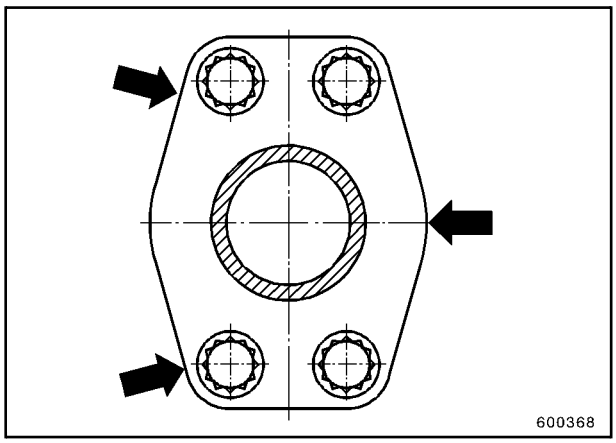


Fig. 4

Z-system

Figs. 5 and 6 show:

2 - Seal ring
3 - Z-ring (wedge ring) with seal groove
4 - Flange (one-part)
5 - Double-hex bolt
6 - Pipe
7 - Z-ring (wedge ring) without seal groove
11 - Hex. nut

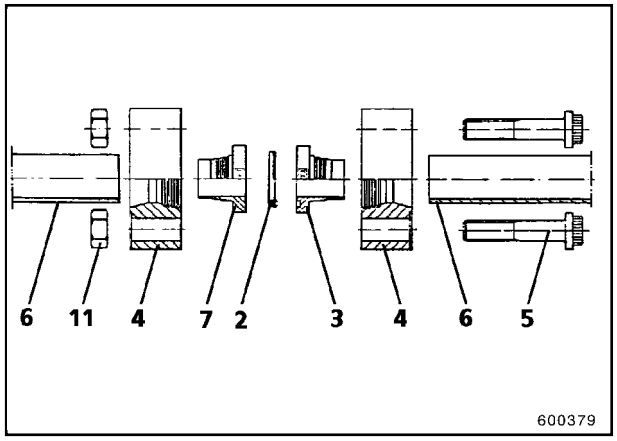


Fig. 5

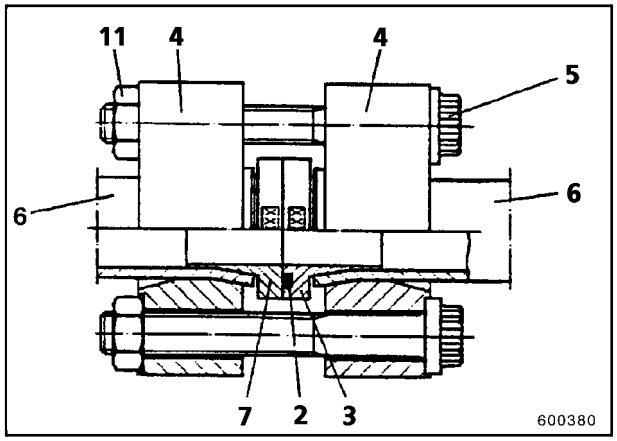


Fig. 6

Assembly:

1. Prepare pipe for assembly (see "Inserting the Z-ring")
2. Oil bolts (5) and inner contour of flanges (4)
3. Fit seal ring (2) into seal ring groove. Press both pipes (6), with flanges (4), against each other. Fit bolts (5), position nuts (11) and tighten up bolts as far as possible by hand.

WARNING

Flanges (4) must be at right angles to the pipe axes.

Permissible deviation from parallel = 0.3 mm

Check visually.

4. Tighten bolts (5) diagonally and evenly. Tightening torque = 250 Nm (185 lbft) (final torque). It is not necessary to check the gap dimension.

In case of leakage:

Tighten up bolts (5) evenly to prescribed torque. Otherwise change seal ring (2).

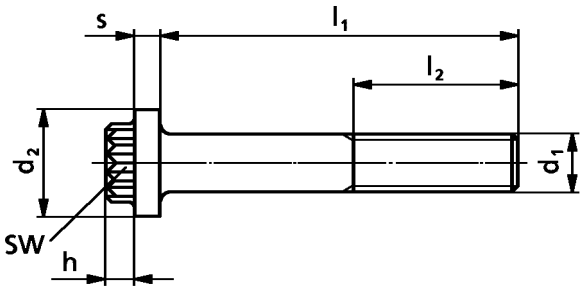
Appendix

Table 1: Seal rings for flange couplings

Size	DN	a	$b^{+0.4}$	$c^{+0.1}$	Parts No.
$^1/_2$"	13	$25.4^{+0.1}$	4	2.8	73170952
$^3/_4$"	20	$31.75^{+0.1}$	4	2.8	73170341
1"	25	$39.6^{+0.1}$	4	2.8	73170327
1 $^1/_4$"	32	$44.45^{+0.1}$	4	2.8	73170346
1 $^1/_2$"	40	$53.7^{+0.2}$	4	2.8	73170350
2"	50	$63.3^{+0.2}$	4	2.8	73170468

(DN = nominal diameter; dimensions a, b, c - see Fig. 2, Page 27)

Table 2: Double - Hex. Bolts



d_1 x l_1 (mm)	Part No.	SW (mm)	l_1 (mm)	l_2 (mm)	d_2 (mm)	h (mm)	s (mm)	Tightening torque Nm (lbft)
M 10 x 30	73170470	11	30	20	17	7	4	60 (44)
M 10 x 45	73171494	11	45	26	17	7	4	
M 10 x 55	73171495	11	55	26	17	7	4	
M 10 x 80	73171496	11	80	26	17	7	4	
M 10 x 100	73171497	11	100	26	17	7	4	
M 12 x 30	73170469	13	30	22	19	8	5	100 (74)
M 12 x 50	73171498	13	50	30	19	8	5	
M 12 x 65	73171499	13	65	30	19	8	5	
M 12 x 90	73171500	13	90	30	19	8	5	
M 12 x 120	73171501	13	120	30	19	8	5	
M 14 x 60	73171502	15	60	34	21	9	6	160 (118)
M 14 x 105	73171503	15	105	34	21	9	6	
M 14 x 150	73170356	15	150	40	21	9	6	
M 16 x 40	73171504	19	40	35	24	19	6	250 (185)
M 16 x 70	73171505	19	70	38	24	10	6	
M 16 x 90	73171506	19	90	38	26	10	4	
M 16 x 100	73171507	19	100	38	24	10	6	
M 16 x 120	73170351	19	120	44	24	10	6	
M 20 x 120	73171508	22	120	52	30	12	6	490 (362)

Strength class: 10.9, Surface protection : A3B

Accessories

Pre-assembly aids for pipe flange couplings

1. Flanit system

Following pre-assembly units can be used:

Parts No. 73175994

- electro-hydraulic unit, comprising
  - control unit with foot switch
  - assembly cylinder
  - connecting hose

Parts No. 73175995

- manual hydraulic unit, comprising
  - hand pump
  - assembly cylinder
  - connecting hose

In addition, the following pre-assembly jaw blocks and counter-rings are also necessary.

Pre-assembly jaw blocks		Counter-ring	
Size	**Parts No.**	**Pipe dimensions**	**Parts No.**
3/4"	73175999	25 x 3 28 x 2	73176146 73176147
1"	73176000	30 x 3,5	73176148
1 1/4"	73176001	35 x 2 38 x 4	73176149 73176150
1 1/2"	73176002	42 x 2	73176151
2"	73176003	50 x 2	73176152

2. Zako system

Following pre-assembly units can be used:

Parts No. 73175996

- electro-hydraulic unit, comprising
  - control unit with foot switch
  - assembly cylinder
  - connecting hose

Parts No. 73175997

- manual hydraulic unit, comprising
  - hand pump
  - assembly cylinder
  - connecting hose

In addition, a set of jaws for pipe 50 x 6, Parts No. 73175998, is also required.

Flanges-90°

90° flanges (Fig. 1) are used in cases in which there is little or no room for a pipe or hose bend (e.g. on hydraulic cylinders).

They are each provided with 4 through and 4 threaded holes, as well as with a seal ring groove (seal ring - see Section "Flange coupling - pipe / hose").

Parts Nos. for the various flange sizes, as well as for the appropriate fixing bolts, can be taken from Table 3 below.

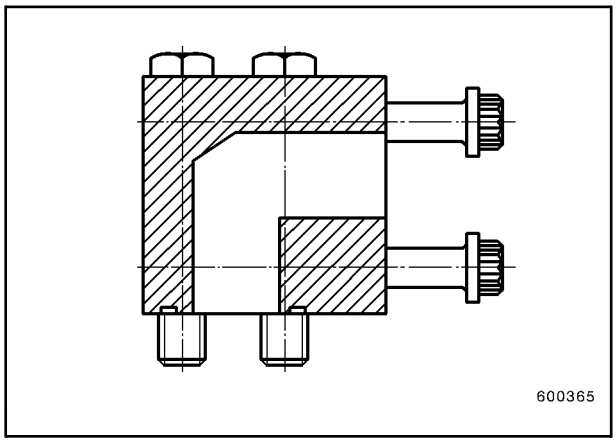


Fig. 1

Table 3: Parts Nos. for 90° flanges

Size	DN (mm)	Pressure range (bar)	(psi)	Parts No. 90°-flange	Parts No. Double-hex bolt	Parts No. Hex. bolt
3/4"	20	---	---	---	---	---
		420	6000	73175988	73171494	73175327
1"	25	210	3000	73175989	73171495	73175214
		420	6000	73170357	73171498	73170360
1 1/4"	32	210	3000	73175990	73171495	73175987
		420	6000	73171366	73171502	73171367
1 1/2"	40	210	3000	73175991	73171439	73171187
		420	6000	73175993	73171505	73175986
2"	50	210	3000	73175992	73171499	73171346
		---	---	---	---	---

Gauge connections

As it is often necessary, when checking over hydraulic systems, to undertake pressure measurements in large-diameter lines, special gauge connections (Fig. 1) have been developed.

This type of connection allows manometers with mini measuring ports (M 14 x 1.5 - Parts No. 73715985) to be connected.

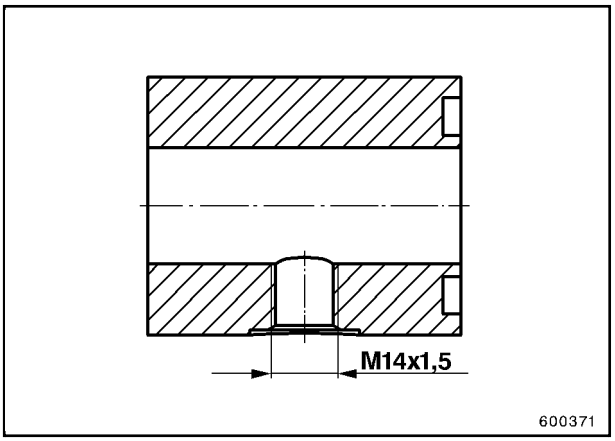


Fig. 1

The gauge connections can be installed between lines (pipes or hose) and relevant component (e.g. travel motor) - see Fig. 2. For this purpose, additional, longer double-hex bolts, as well as a seal ring (see Section "Seal rings") are necessary.

Parts Nos. for such components can be found in Table 4 below.

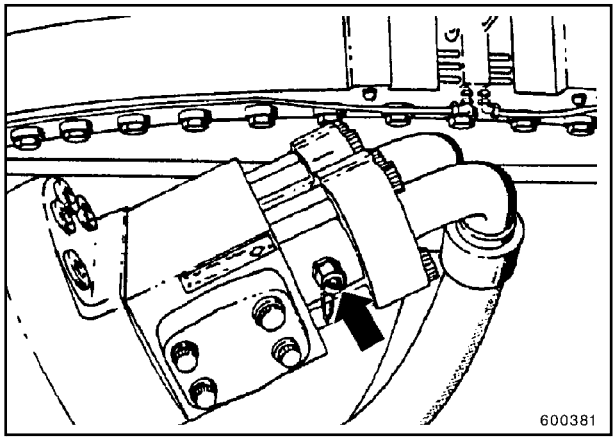


Fig. 2

Table 4: Parts Nos. for gauge connections and accessories

Size	DN (mm)	Pressure range (bar)	(psi)	Parts No. Gauge conn.	Parts No. Double-hex bolt	Parts No. Seal ring (two-part)
$^3/_4$"	20	210	3000	---	---	---
		420	6000	73175976	73171497	73170341
1"	25	210	3000	73175978	73171496	73170327
		420	6000	73175979	73171494	73170327
1 $^1/_4$"	32	210	3000	73175980	73171496	73170346
		420	6000	73175981	73171503	73170346
1 $^1/_2$"	40	210	3000	73175982	73171500	73170350
		420	6000	73175983	73170351	73170350
2"	50	210	3000	73175984	73171500	73170468
		420	6000	---	---	---

Notes

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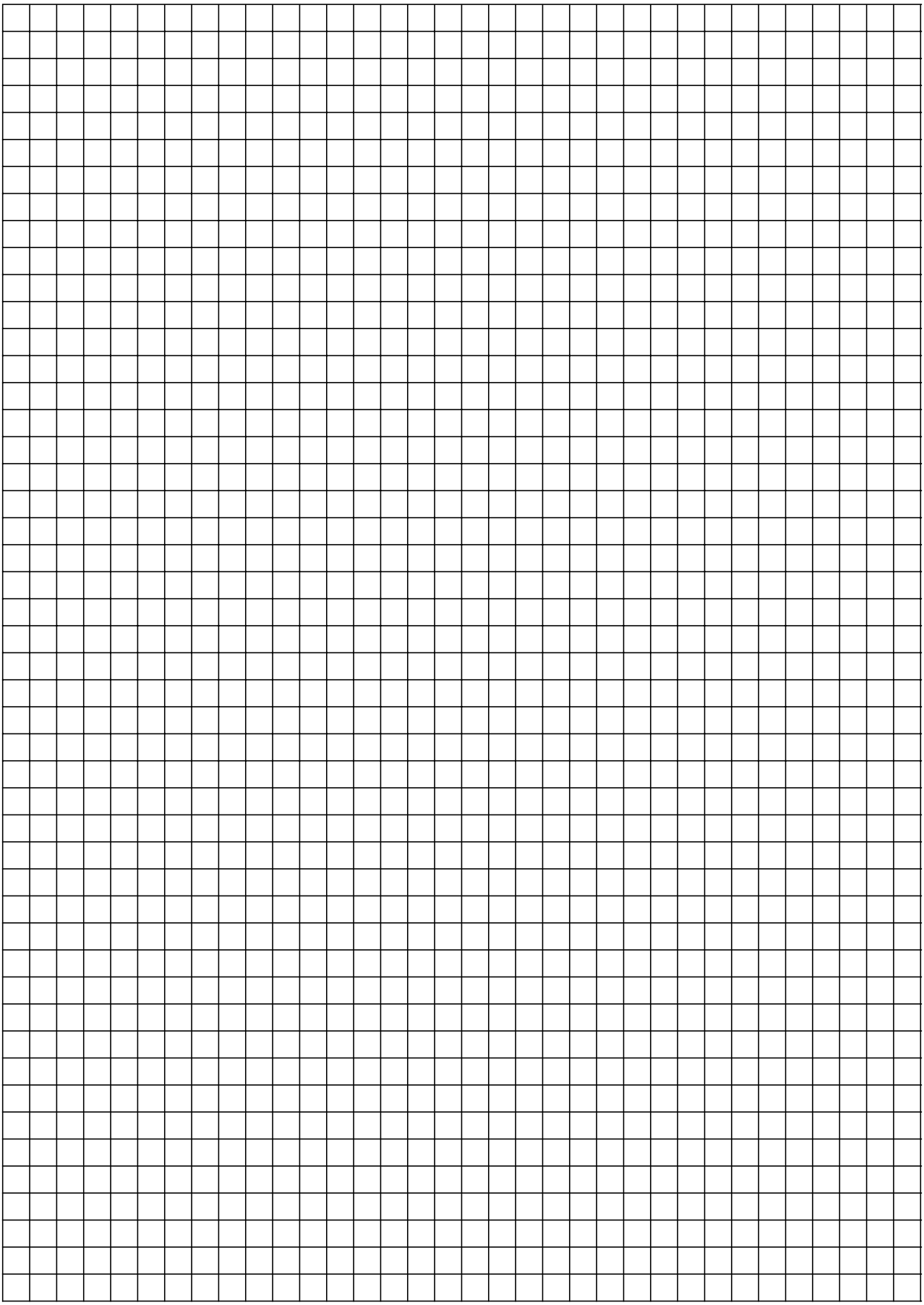

R

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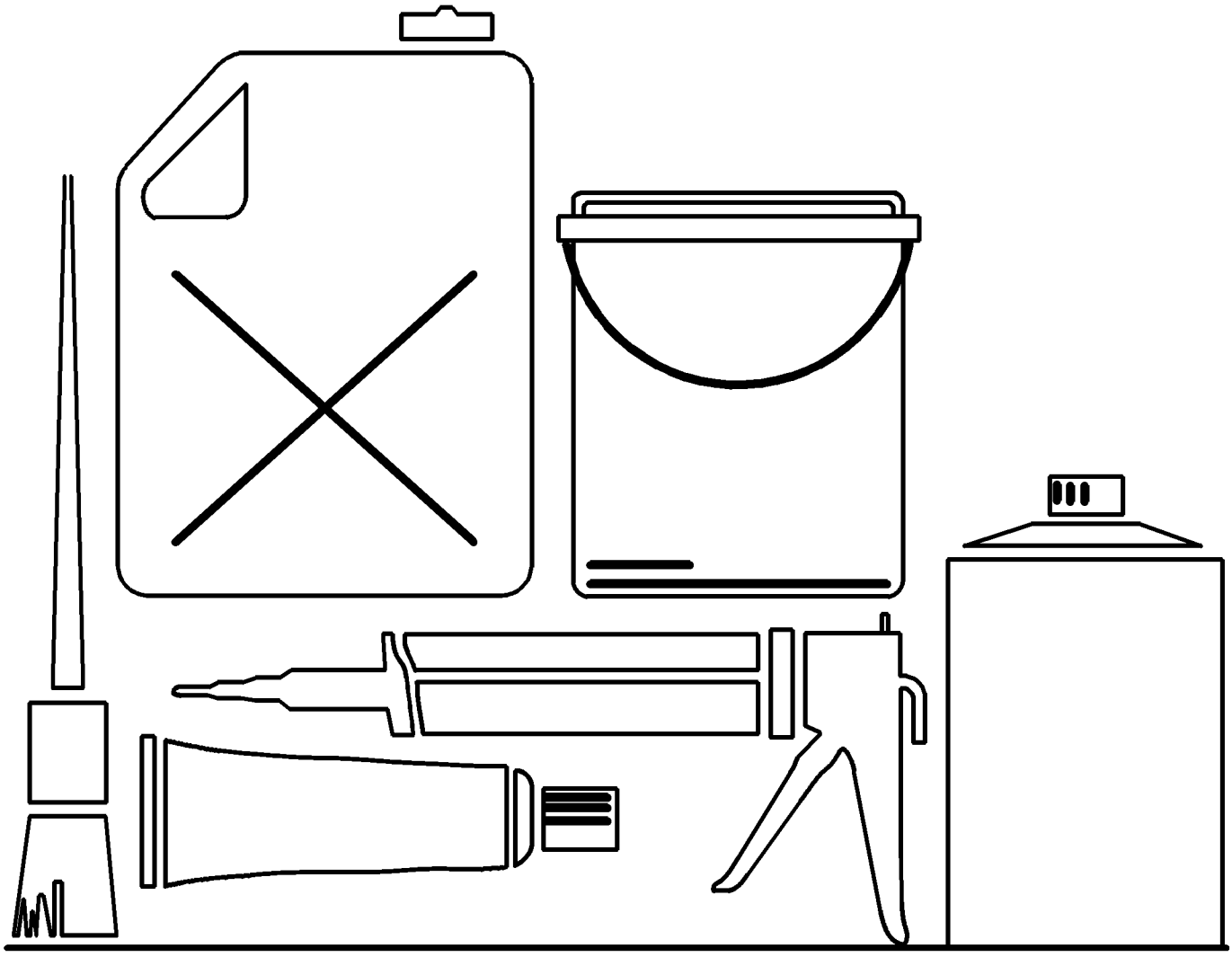
Technical Handbook

Sealing, protective, testing and cleaning agents



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INTRODUCTION

2801914

This Technical Handbook (THB) provides a compilation of the directions for using recommended sealing, protective, testing and cleaning agents.

All of these agents are necessary for various assembly procedures.

The agents can all be ordered from this Spare Parts Service.

Products from other manufacturers are only to be used when they possess the same characteristics and qualities as those of the agents stated.

If in doubt, ask the After-Sales Service.

Further descriptions and directions (over and above those given here) are to be found in the relevant manufacturer's instructions and literature. □

FUNDAMENTAL SAFETY INSTRUCTIONS

2801915

Warnings and symbols

The following signs are used in the manual to designate instructions of particular importance:

WARNING

Precautionary rules and measures designed to protect the machine operator and other persons from life-threatening danger or injuries and to prevent extensive damage.

CAUTION

Information and precautionary measures designed to prevent damage to the machine or other property.

Safety Instructions

⚠ WARNING

Personnel

The machine must not be started by unauthorized persons.

It must therefore be secured.

Observe the accident prevention regulations.

The machine may be operated, serviced or repaired only by specially trained and authorized personnel with the appropriate technical know-how.

If such know-how is lacking, meticulous instruction must be given by experienced personnel.

The personnel must have read and understood the operating instructions and in particular the chapter "Fundamental Safety Instructions".

Only such persons may start up the machine during assembly work in order to adjust the attachments.

Incorrect operation of the machine or the attachments may give rise to life-threatening situations.

During all works, always observe the start-up and shut-down procedures prescribed in the operating instructions.

Personnel

Personal protective gear and working clothing:

Wear a safety helmet, safety footwear, gloves and safety glasses.

Wear closely fitting working clothing when working on the machine.

Loose, wide garments may catch on machine parts and result in injury.

If the work to be carried out requires auxiliaries, e.g. foreman, the duties of each individual helper must be clearly defined beforehand.

The individual responsibilities must be meticulously observed to avoid misunderstanding and unsafe activity.

⚠ WARNING

Tools and auxiliaries

Tools, hoists, slings, jackstands and other devices must be in a reliable, safe condition.

Metal splinters may cause injury when attachment bolts are being driven in or out.

A brass or copper punch should therefore be used for this purpose, and safety glasses must be worn.

For climbing onto or off the machine, use only the ladders, steps, platforms and handrails provided for this purpose.

Always keep ladders, steps and platforms in a non-slip condition.

Remove any oil, grease, dirt, clay, snow, ice and other foreign material immediately.

Securing the working equipment

Before carrying out assembly work, the machine and the attachments must be secured against inadvertent and unauthorized starting, e.g. by placing chocks under the wheels or tracks and by resting the working equipment on the ground.

Rest the working equipment on the ground in such a way that no movements can be made when mechanical or hydraulic connections are detached.

Secure any equipment or component which is to be mounted or dismantled or whose position is to be changed using hoists or appropriate slinging/supporting devices to prevent them from moving, slipping or falling inadvertently.

Systems and units (e.g. pipes, accumulators, etc.) must be properly depressurized before being opened.

Protective devices on moving machine parts may be opened or removed only when the drive unit is stationary and protected against inadvertent starting.

Before recommissioning, all protective devices must be refitted.

⚠ WARNING

Sealing, protective, testing and cleaning agents

The safety instructions contained in this Technicel Handbook with respect to accident prevention and those set out on the packing of the above-mentioned agents must be observed.

Hydraulic and lubricating system

Always observe the safety regulations applicable to the product when handling oils, greases and other chemical substances.

Unused but open containers, pipelines and hose connections must be closed in a pressure- tight manner.

Refill collected hydraulic oil back into the hydraulic system only through the return-flow filters.

Dispose of waste oil without polluting the environment.

Observe the correct working sequence when fitting or replacing components or equipment.

The working sequence has been specified and tested by qualified experts.

Replace defective, mechanically prestressed units (e.g. nitrogen accumulators) only as an entirety. Never open them.

In exceptional cases, open only when the system and the operating sequence are precisely known. The Technical Manual contains no information on such work. When the machine is at operating temperature, the consumables are at least at the same temperature. Precautions must therefore be taken to prevent burning or scalding.

Be careful when handling acids, e.g. battery acid. Acid splashes may injure the eyes and the skin.

Do not smoke when handling flammable liquids.

Be careful with open flames and unprotected lighting.

Not only fuel but also other consumables often have a low flash point and catch fire easily.

⚠ WARNING

Conversions or modifications to the machine

Unauthorized conversions or modifications of the machine are forbidden for reasons of safety.

The nominal pressure of pressure relief valves must not be modified.

Do not remove the lead seals from pressure-relief valves and pressure accumulators.

⚠ CAUTION

Recommissioning

Prior to recommissioning:

- **Grease all lubricating points.**
- **Check all oil levels and make the necessary corrections.**
- **Carry out function checks of all repaired components.**
- **Check all functions of the machine including the brakes during a test run. Release the machine for recommissioning only after all functions have been found to work perfectly.**

□

PRESERVATION OF GEARBOXES

Scope

The following specifications apply to the internal protection of gearboxes and axles that are to be stored individually without oil in them, or that are installed in machines (and therefore filled with oil) that are to be decommissioned for a long period of lay-up.

Rust inhibitor

A thin, solvent-based product, soluble in mineral-oil based lube oils and as specified in Part No. 73171464 is to be used.

Such an inhibitor contains: 55% solids
45% solvent

The solids content (which increases on account of solvent evaporation) must not exceed 75% as rust inhibition is then no longer ensured.

The solids content can be determined by carrying out an evaporation test in a measuring beaker.

Such a test can be carried out by the manufacturer using approx. 0.5 litres of the rust inhibitor.

Application to gearboxes and axles without oil filling

1. Clean the gearbox or axle externally using diesel fuel or cold cleaner.
2. Drain gear oil while still warm following a trial run.
   Allow the gearbox to cool down to 68˚ - 77˚F.
3. Fill rust inhibitor up to oil-level marker.
4. Run the gearbox load free to circulate the inhibitor through all internal chambers and channels.
5. Drain off the rust inhibitor. The inhibitor can be used again.
6. Allow the gearbox to dry off for approx. 30 minutes.
7. Carefully seal up all openings on the gearbox using oil paper, plastic plugs or other suitable materials.
8. Brush or spray rust inhibitor onto all blank external surfaces of the gearbox.
9. When commissioning the gearbox, do not remove the film of rust inhibitor. Only fill the gearbox with the prescribed gear oil.

Preservation period

The preservation measures protect against rust for

2 years when stored indoors
1 year when stored in the open

Whatever the type of storage, gearboxes and axles must be protected against dampness and dirt.

Gearboxes and axles with oil filling

Upon installation of the gearboxes into machines, a trial run of the machine, and therefore of the gearbox/axle, is to be carried out. The gear oil then flushes the rust inhibitor off the internal parts. Because the gear oil remains in the gearbox/axle during the lay-up, those components and surfaces lying above the oil level do not have any protection against rust.

For this reason, the machine is to be moved every 3 - 4 weeks. This coats all of the gearbox/axle components with fresh oil and provides temporary protection for all motors and hydraulic components.

Protective finishes

The internal surfaces of gearboxes and axle housings are given a rust protection in our works. This protection is reached by:

1. sand blasting the housing sections before assembly
2. priming the housing sections before assembly
3. coating the assembled components with an oil- and acidresistant synthetic resin paint

   - yellow RAL 1009 or
   - yellow RAL 1017 Part No. 73171465

Check the paint finish during any repair/overhauling work. Before touching up the paint finish, remove any rust or oil/grease from the areas to be painted. Apply paint with a brush to give a complete cover coat.

Choose a colour that agrees with the originally applied primer coating so that it does not "show through". Carry out a trial application if necessary.

PRESERVATION OF CYLINDER PISTON RODS

Scope

The following specifications apply to all machines. Preservation should be carried out to protect exposed piston rods against fret corrosion and aggressive environmental influences both before storage and before dispatch of a machine for sea transport.

Corrosion inhibitor

For piston rods of machines in storage and before the shipment - exception sea transport - a special long-term lubricating grease acc. to part no. 73176179 is to be used.

For sea transport a product which is viscous, contains solvent and is soluble in hydraulic oils, danger class II, parts no. 73171466 is to be used as coorosion preventive.

The inhibitor can be removed with diesel fuel, petrol, petroleum and the like.

Consumption of inhibitor

The amount required depends upon the type (and therefore size) of the machine.

Example: approx. 20 g are needed to coat the exposed rod ends on the machine.

Application of inhibitor

1. Retract all cylinder piston rods as far as possible.
2. Allow the exposed rod ends to cool to ambient temperature and then clean them with a fiber-free cloth. Remove any fret corrosion.
3. Apply the rust inhibitor with a soft brush.

Preservation period

The inhibitor protects piston rods against corrosion for:

12 months when stored indoors
6 months when stored in the open

Removing the inhibitor

The inhibitor is scraped off by the cylinder wiper rings when the piston rod is retracted - special procedures are not necessary.

Any inhibitor that should get into the cylinder(s) is absolutely harmless to the hydraulic system.

Renewing the inhibitor

When machines are stored in the open air, the protective coating of inhibitor is to be renewed at the latest after 6 months. The piston rods must be cleaned beforehand.

The inhibitor coating must also be renewed if the cylinder/s has/have been actuated.

⚠ CAUTION

Do NOT put machines into stock without a coating of inhibitor on their piston rods.

Corrosion protection for pins and bearings (bushings and hubs) 2801916

⚠ CAUTION

Use Voler A.C. anti-corrosive agent only.

Other agents are not approved.

All pins and bearings (bushings and hubs) of the working equipment or in equipment components must be treated with **Voler A.C.** anti-corrosive agent before fitting.

Voler A.C.:

- permits easy fitting and dismantling
- protects against rust, oxidation and similar wear
- prevents seizing and fretting corrosion in non-moving parts of bearings.

This is achieved by aluminium and copper particles forming a protective layer on the metal. This layer removes surface irregularities and does not sweat, seize or harden.

Part nos. for Voler A.C.

P/N 73171461 - 0,5 l spray can (CFC-free)

P/N 73171462 - 0,5 kg tin

P/N 73171463 - 4,5 kg bucket

Available from the Spare-Parts Service.

Application of Voler A.C.

- Clean off grease, oil, dirt and corrosion protection agents from pins and bearings using white spirit or diesel fuel.

  Rust patches must be thoroughly removed, if any.

  All parts must present a dry, bright metal surface.

- Apply a thin layer of Voler A.C. on pins and all bearings using a brush or a spray can. Pin shafts and bearings must be completely covered by the protective layer.

  If the protective layer of a pin already treated with Voler A.C. is damaged, these areas must be touched up before fitting the part.

- Fitting and securing of pins

  If the pin is too heavy to be fitted manually, apply Voler A.C. at first only on abt. a quarter of the pin's length

  Then position pin by means of a lifting gear ready for fitting.

  Apply Voler A.C. on the remaining length of pin shaft, fit pin and secure. □

S0LUTION 1 CORROSION INHIBITOR FOR CYLINDER ROD THREADS

Part No.: **73171467**

Application:

To prevent corrosion, e.g. between bearing eye and piston rod of hydraulic cylinders

Properties:

Prevents corrosion, especially fret corrosion, where different types of materials are mated.

Application:

Apply with brush, roller or spray.
On hydraulic cylinders, for example, apply to threaded end of piston rod, thread run-out, heads and exposed ends of bearing eye clamping bolts. On "split" eyes, also into the "split" itself.

Binder:

Bitumen

Solvent:

Petroleum spirits, aromatics

Flash point:

+100˚F

Drying time:

Dust dry in 40 to 50 min. at 68˚F

Removal:

Can be washed off with a cleaner

Storage stability:

Unlimited storage when in tightly sealed containers

WARNING

Flash point of solvent is +100˚F.

Containers are therefore to be stored cool and tightly sealed.

Smoking, naked lights and fire are forbidden during application.

Residues must not be allowed to get into the ground water or into the sewerage.

RIVOLTA W.S.X, NU CORROSION INHIBITOR FOR ELECTRICAL SYSTEMS

Part No.: **73171468**

Application:

To prevent corrosion in/on electrical systems and components. Prevents failure due to corrosion and leakage currents following moisture ingression.

WARNING

Not to be used on computers and millivolt contacts.

Application:

Thoroughly clean the parts to be treated.

Apply inhibitor with a spray pistol or brush.

Flash point:

+117˚F

Storage stability:

Unlimited storage when in tightly sealed containers

WARNING

Flash point +117˚F.
Containers are therefore to be stored cool and tightly sealed.

Smoking forbidden during application.

Care is to be taken in small, enclosed rooms where evaporation fumes could displace the oxygen supply.

Splashes in the eyes are to be flushed out of the eyes, then rinsed in abundant water.

If high fume concentrations are inhaled, adequate fresh air must be obtained immediately.

SURFACE SEALING AGENTS

WKT black - H

Part No.: **73171469**

Application:

To seal gearbox housing sections.

Application:

Clean the surfaces to be sealed using a grease solvent. Allow solvent to evaporate fully and then apply an approx. 1 mm thick layer of WKT black-H to one of the surfaces.
When using a pistol, apply a cord of the sealer. The sealer then spreads itself out when the two surfaces are pressed together.

Consumption:

approx. 3 ml/150 sq.cm. of surface

Re-using:

Possible, providing the surface is free of dirt and grease. Points at which the sealer has crumbled away can be covered with fresh sealer. The sealer vulcanizes itself with the older, hardened sealing agent without any kind of treatment being necessary.

Removal:

When vulcanized (hardened), the film of sealing agent can be pulled off the surface.

Loctite 573 (proprietary brand from Loctite Ltd.,)

Part No.: **73171469**

Application:

as above WKT black - H.

Application :

Clean the surfaces to be sealed using a grease solvent. Allow solvent to evaporate fully and then apply adequate Loctite 573 to one of the surfaces. Apply with a foam or short-pile roller, with a brush or directly from the tube.
When using a roller, pour sufficient (e.g. as much as is needed in one day) into a plastic tray and then apply with the slightly moist roller.
Prevent dirt getting into the Loctite 573.
Do NOT pour unused Loctite 573 back into the container.

Consumption:

approx. 1 m1/150 sq.cm. of surfaces.

Hardening time:

Sealing effect is immediate on level surfaces.
Final hardness reached after 12 - 24 hours.

Re-using:

Hardened Loctite 573 does not need to be removed from surfaces after disassembly. Before re-assembly, clean the sealing surfaces with a grease colvent. The solvent must be allowed to evaporate completely.
Apply a small quantity of Loctite 573 evenly to one of the two sealing surfaces.

HYLOMAR SQ 32/M SEALING AGENT (THREAD SEALER)

Part No.: **73171471**

Application:

For permanently elastic sealing of threads, IC engines, gearboxes etc.,

Properties:

Elastic at temperatures between -122˚F and +572˚F. Prevents element formation between differing metal surfaces. Is not flammable, non-toxic and is a bad conductor of heat.

Resistance:

Resistant to all oils and lubricants, all fuels, air, water, gases, water/glycol and water/methanol mixtures, and to continuous vibration.

Application:

Brush or spread onto cleaned, oil-free surfaces. Wait approx. 10 minutes between application and assembly to allow the solvent content time to evaporate.

Re-using:

Possible, provided that sealing surface is free of dirt and grease.
Points at which sealing film has broken away can be re-sealed with fresh sealer.
Fresh sealer vulcanizes with older sealer without any special treatment being necessary.

Removal:

Hylomar is alcohol-soluble and can therefore be removed by, for example, using a cloth saturated in methylated spirits.

LIQUID THREAD ADHESIVES

The following products are approved for securing (medium tight) and sealing threaded connections:

1. **Loctite 242 / P/No. 73171473**
2. **Omnifit Rapid 100 M / P/No. 73171473**

Threaded connections treated with these securing adhesives are resistant against vibrations although they can still be loosened.

Application:

1. Screws and bolts can be used in the condition in which they are delivered.

2. Very dirty threads are to be cleaned with a grease solvent.
   The solvent must be allowed to evaporate completely.

3. a) For screws and bolts, apply a ring of the adhesive to the first three thread pitches.
   b) For blind-end threaded holes, coat the internal thread.
   c) For threaded through-holes, apply the adhesive to the screw/bolt thread.

4. Tighten the screw/bolt to the prescribed torque.

Hardening:

When using Loctite 242 to secure threaded components, following hardening times can be assumed:

- hand tight after 15 - 30 minutes
- final hardness after 3 hours

If shorter hardening times are required, activator "T" is to be used. First apply activator "T" to the screws/bolts and allow it to dry completely. Then apply Loctite 242 to the threads.

Hardening time is shortened to 20 minutes. Activator "TN" P/No. 73171475.

Resecuring a threaded connection:

Remove hardened thread adhesive with compressed air or a wire brush. Apply fresh adhesive as described under "Application".

METAL ADHESIVES

The following products are approved:

Omnifit Rapid 200 H / P/No. 73171476

Application:

Swing bearing and track pad mountings.

Application:

Clean all traces of paint and grease from all contact surfaces using AK-PHTH-thinner DV 2404 (P/No. 73171477).

Apply a continuous strip, approx. 1 mm thick, in a ring around each bolt hole. Keep the ring a slight distance away from the bolt hole to prevent the adhesive from being squeezed into the thread when the bolts are tightened up.

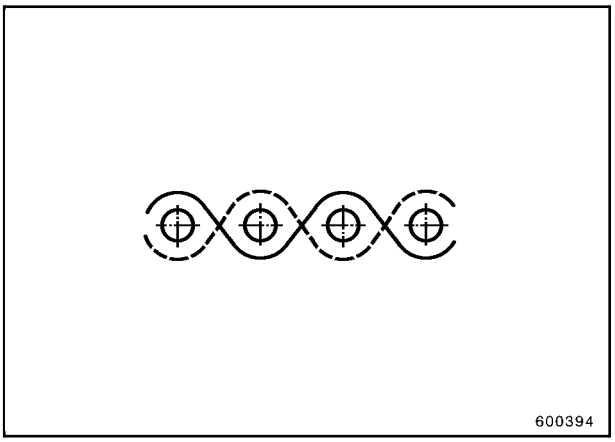

Fig. 1

Tighten the bolts within 30-45 minutes.
Hardening begins after adhesive has been applied and has contact to the air.

Re-tighten the bolts after 50-60 operating hours and in the intervals given in the machine's Servicing and Inspection Instructions.

Disassembly:

Before lifting off a swing bearing, loosen it at several points using a crowbar.
On small swing bearings, it is usually sufficient to hit the undercarriage or superstructure mounting surfaces with a hammer. Large swing bearings can be lifted off as soon as the bolts have been loosened.
Once the bolts have been removed, the small fissures in the adhesive film (due to unevenness) increase in size and cause the adhesive to crumble away.

ADHESIVES FOR PLASTICS

Acrylic cyanide (Loctite IS 414)

Part No.: **73171478**

Application:

Plastic to plastic
Plastic to rubber

The adhesive contains acrylic cyanide ester which brings about an instantaneous adhesion. Humidity should be between 50 and 60% during application.

Hardening time: 2 - 5 seconds

Temperature range:

-140˚ to +176˚F

Storage stability:

6 months at +72˚F.

Storage in a refrigerator (+41˚F) lengthens the storage life. Fresh adhesive can be freeze stored.

Solubility:

In acetone, methylene-chloride, nitro-methane

WARNING

Avoid any contact with skin and eyes. Keep working areas well ventilated.

ADHESIVE FOR O-RINGS

Part No.: **73171480**

Application:

As an adhesive to form endless rubber piping (as supplied) into O-rings.

Application:

1. Place the rubber piping into the groove and cut off slightly longer than required.

2. Cut one end at a **right angle** (do not chamfer it) by pulling a sharp, clean, grease-free blade through it.

3. Cut the other end to length with a **straight cut**. Cut the rubber material 1 - 2 mm shorter than needed so that the O-ring lies with light tension in the groove and does not fall out.

   Greater tension of the ring twisting in its groove during installation causing leakages.

4. Glue the two ends together in a butt joint. Push the two ends together (with the hands) for at last 20 seconds

WARNING

The adhesive must NOT be allowed to come into contact with the skin as it can lead to the skin flaking away.

LUBRICANTS

Solid lubricating paste

Part No.: **73171481**

Application:

High-perfomance lubricant for reducing friction and wear, among others for fitting and trouble-free removal of ball/roller bearings, bushings etc.,

Solid lubricant:

Molybdenum disulphide

Method of application:

Brush

Temperature range:

-77° to +113°F

Solid lubricant paste spray

Part No.: **73171482**

Application:

High-perfomance lubricant for reducing friction and wear where low coefficients of friction are encounted, among others for fitting and removal of bearings, bushings etc., and for badly accessible points.

Method of application:

Spray

Composition

Molybdenum disulphide and other solid lubricants.

Temperature range:

-95° to +113°F

Skin contact:

no objections

Compound spray

Part No.: **73171483**

Special lubricant, grease and bitumen free, with EP additives and an especially high viscosity.

Application:

Lubricant for swing bearings, exposed gear wheels, racks, guides etc.,

Solid constituent:

Graphite

Adhesion and plasticity:

Very tough, no fracture formation

Temperature range:

-59° to +149°F

Method of application:

Spray

WARNING

Do NOT inhale solvents. Keep work-places well ventilated. Do NOT spray into open flames.

Store spray cans at temperatures below +122°F.

Mineral-based lubricating paste

Part No.: **73171484**

Application:

Assembly paste for reduction of friction and fret corrosion on press and bearing seatings, pins, splines, V-rollers etc.,

Compatibility to seal rings:

good

Method of application:

Brush

Temperature range:

-86° to +302°F

Skin contact:

No objection, except in cases of allergy

Lithium soap grease

Part No.: **73171485**

Application:

Lithium soap grease with solid constituent (e.g. Molycote multi-purpose grease), resistant to water, consistency 2 for highly stressed plain and roller/ball bearings.

Method of application:

Brush, grease gun

Temperature range:

-86° to +266°F

SOLID LUBRICANT FOR MOLYCOTE-COATED BOLTS

Part No.: **73171486**

In series assembly, Molycote-coated bolts are use for all bolt sizes of M 36 and above. The Molycote coating lowers the coefficient of friction and therfore the necessary tightening torque.

Before re-inserting such a bolt, coat the thread and the turning seating (bolt head or nut) with Molycote, P/No. 73171486.

SILICON-CORUNDUM POWDER (REDURIT)

Part No.: **73171487**

Application:

Track pads of crawler excavators

Application:

Sand down the contact surfaces between chain link and track pad.
The contact surface of the chain link must have a smooth finish.

Brush a light film of petroleum onto the track pad and scatter a thin coating of silicon-corundum powered (grain size 150 - 250) onto it.

Fit and tighten up track pad.

Tighten up track pad bolts after 50 - 60 operating hours.

P3 COLD CLEANER

Part No.: **73171488**

Application:

P 3 cold cleaner is a concentrated cleaning liquid that is used (at room temperature) diluted with either petroleum or diesel (fuel) oil.

P 3 cold cleaner has a neutral characteristic so that all metal and alloys can be treated without being endangered by corrosion formation.

P 3 cold cleaner is suitable for cleaning grease and oil from dirty and oiled machine and engine components. Flash point approx. 140˚F.

Using P 3:

P 3 is first to be diluted with petroleum or diesel (fuel) oil. The concentration of the resulting solution depends upon the degree of dirt to be removed. It is usually sufficient to dilute with 2 to 4 parts of petroleum.
If the degree of dirt is low, a seven-to-one dilution with diesel (fuel) oil is sufficient.

The part to be cleaned is usually placed into the solution. After a suitable cleaning time, it is then taken out of the solution and washed down with a strong water jet.
The cleaning solution itself must not come into contact with water as this affects the cleaning characteristics.
Cleaning is always carried out cold. The time for cleaning depends upon the amount of dirt to be removed. 20 to 30 minutes are usually adequate. Very dirty, encrusted parts should be left in the solution over night.
To clean large or fixed components, the cold cleaner can be sprayed on. P 3 cold cleaner is to be diluted and sprayed onto the component. If a spray pistol is not available, the P 3 solution can be applied with a brush. After the cleaning period, the component is to be washed down with a water jet.

P 3 cleaner must NOT come into contact with sensitive lacquer/paint finishes.

Gloves should be worn for continuous use, resp. when spraying or brushing on the P 3 cold cleaner.

SURFACE CRACK CHECKING AGENT (METAL-CHECK)

Cracks and other faults in metal plates, forged and cast steel parts can be localized using a dye-penetration check. This is the simplestmethod of testing.

Further tests, e.g. magnaflux (magnetic-powder) or ultra-sonic testing, require specialist knowledge and special apparatus.

The dye-penetration (metal-check) test requires only the following:

red penetration fluid	- P/No. 73171489
special cleaner	- P/No. 73171491
white developer fluid	- P/No. 73171492

Checking:

1. Clean the area to be checked.

2. Spray on the red penetration fluid and allow 5 - 10 minutes for it to penetrate.

3. Remove the red penetration fluid using the special cleaner.

4. Spray on the white developer.
   Any cracks/faults show up as red "veins" against the white background. The extent of the "veining" and the time allowed for development provide indications as to the depth of the cracks/faults.
   Wipe off the developer with a cloth.