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BOMAG

Operating instructions
Maintenance instructions

This manual is in accordance with product liability laws and safety regulations

BW 24 R

S/N 201 530 60 1456 ›



CE

Rubber tire roller

Catalogue number
008 156 07

08/2008

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If the machine is equipped with a battery :

CALIFORNIA
Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.
Wash hands after handling.

If the machine is equipped with a diesel engine :

CALIFORNIA
Proposition 65 Warning

The engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

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BOMAG machines are products from the wide range of BOMAG compaction equipment.

BOMAG's vast experience, together with the most up-to-date production and testing methods, including service life tests of all important components and highest quality demands, guarantee maximum reliability of your machine.

These instructions comprise:

- Safety regulations
- Operating instructions
- Maintenance instructions
- Trouble shooting

Using these instructions will

- help you to get to know the machine.
- avoid malfunctions caused by unexpert operation.

Compliance with the maintenance instructions will

- increase the reliability of your machine on the site,
- increase the service life of the machine,
- reduce repair costs and downtimes.

BOMAG shall not assume liability for safe functioning of the machine

- if it is handled in a way which does not comply with the usual modes of use,
- if it is used for purposes other than those mentioned in the instructions.

No warranty claims can be lodged for damage resulting from

- operating errors,
- insufficient maintenance and
- wrong fuels and lubricants.

Please note!

This manual has been written for the operator and the service personnel at the site.

Keep this manual always close at hand , e.g. in the tool compartment of the machine or in the container provided.

You should only operate the machine if you are fully familiar with the contents of these instructions.

You must also observe all applicable safety regulations.

Please observe also the guidelines of the Civil Engineering Liability Association "Safety Regulations for the Operation of Road Rollers and Soil Compactors" and the applicable accident prevention instructions.

For your own safety you should only use BOMAG-spare parts.

We reserve the right for technical modifications without prior notification.

These operating and maintenance instructions are also available in other languages.

A spare part catalogue can be obtained from your BOMAG dealer when giving him the serial number of your machine.

Information about the correct use of our machines in earth work and for asphalt applications can be obtained from your BOMAG dealer.

The above points do not constitute an extension of the warranty and liability conditions specified in the general terms of business of BOMAG.

We wish you much success with your BOMAG machines.

BOMAG GmbH

Printed in Germany

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Foreword

Please fill in

. . . . . .

Machine type (Fig. 1)

. . . . . .

Serial-number (Fig. 1 and 2)

. . . . . .

Engine type (Fig. 3)

. . . . . .

Engine number (Fig. 3)

i Note

Supplement the above data together with the commissioning protocol.

During commissioning our organization will instruct you in the operation and maintenance of the machine.

Please observe strictly the safety regulations and all notes on risks and dangers!

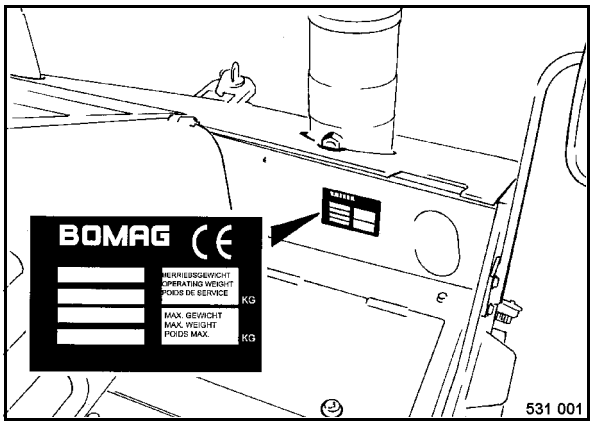


Fig. 1

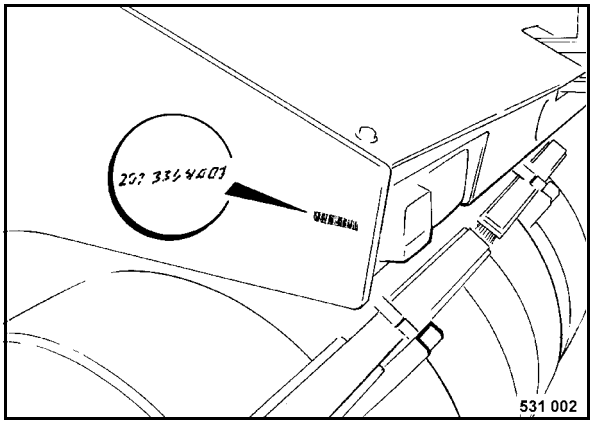


Fig. 2

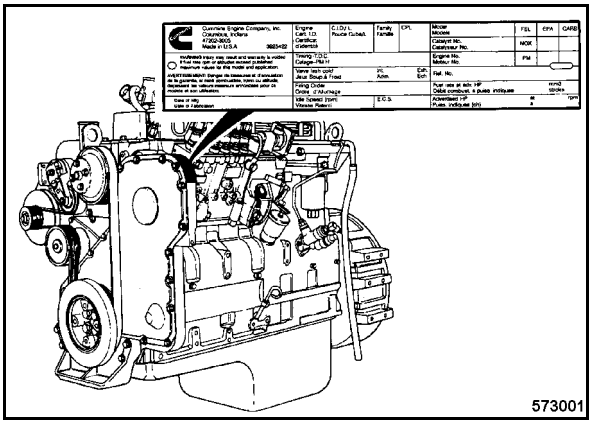


Fig. 3

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1 Technical Data

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Technical Data

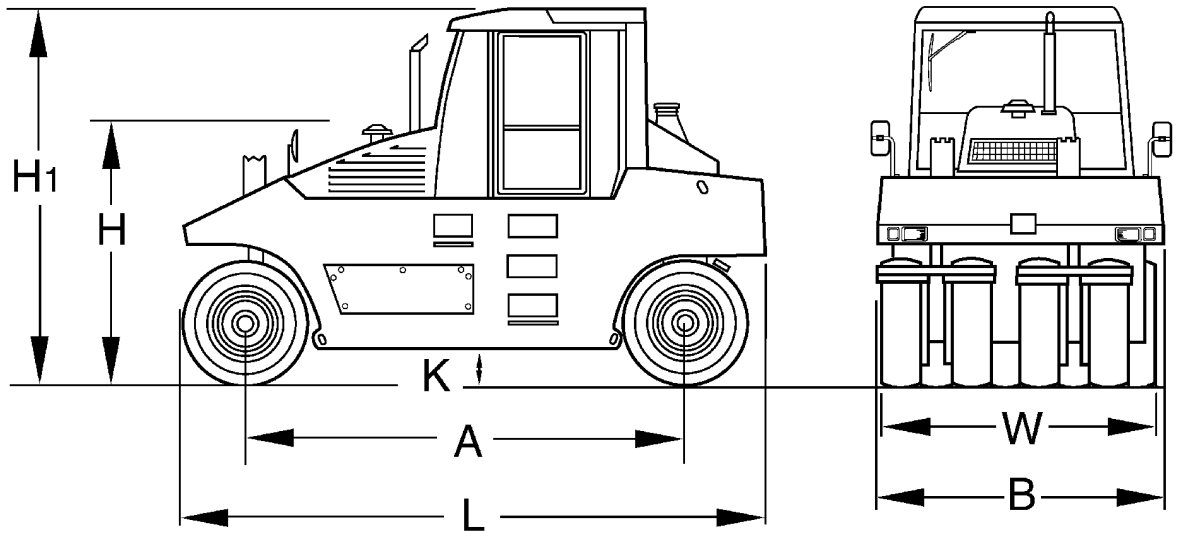


Fig. 4

Dimensions in mm	A	B	H	H1	K	L	W
BW 24 R	3800	2265	2315	3040	300	4775	1986

*

		BW 24 R
Weights		
Operating weight (CECE) with ROPS-cabin	kg	10000
Operating weight, pre-ballasted	kg	15200
Max. operating weight (CECE)	kg	24000
Max. operating weight with water	kg	18400
Max. axle load (CECE), front	kg	11400
Max. axle load (CECE), rear	kg	12600
Min. wheel load (without ballast)	kg	1300
Max. wheel load	kg	3150
Travel characteristics		
Travel speed (1)	km/h	0 ... 6
Travel speed (2)	km/h	0 ... 13
Travel speed (3)	km/h	0 ... 20
Max. gradability	%	35

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*		BW 24 R
Engine		
Engine manufacturer		Cummins
Type		4BT4.5-C852
Cooling		Water
Number of cylinders		4
Power ISO 9249/SAE J 1995	kW	71/74
Rated speed	rpm	2200
Fuel		Diesel
Electrical equipment	V	12
Drive system		hydrostatic
Driven axles		2
Brakes		
Service brake		pneum./hydr.
Parking brake		mech./pneum.
Steering		
Type of steering		2-point suspension
Steering operation		hydrostatic
Tires		
Tire size		11.00-20, 18 PR smooth
Air pressure min./max.	bar	2 ... 8,1
Tank contents		
Water	Litres	400
Fuel	Litres	250
Engine oil	Litres	15,5
Coolant	Litres	approx. 15

* The right for technical modifications remains reserved

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The following noise and vibration values according to the EC-directive for machines, edition (91/368/EEC) were measured at nominal engine speed.

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

Noise value

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

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

L_{pA} =80 dB(A)

sound capacity level:

L_{WA} = 105 dB(A)

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

Vibration value

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

Vibration of the entire body (driver's seat)

The weighted effective acceleration value determined according to ISO 1032 part 1, is less than < 0.5 m/sec^2.

Hand-arm vibration values

The weighted effective acceleration value determined according to ISO 5349 part 1, is less than $< 2{,}5$ m/sec^2.

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2 Safety regulations

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General

This BOMAG machine is built in accordance with the latest technical standard and the valid technical rules and regulations. There is, however, a risk of danger for persons and property if:

- the machine is used for purposes other than those it is intended for
- the machine is operated by untrained personnel
- the machine is modified or converted in an unprofessional way
- the applicable safety regulations are not observed.

Each person involved in operation, maintenance and repair of the machine must therefore read and apply these safety regulations. This should be confirmed by obtaining the signatures of the customer, if necessary.

Furthermore the following regulations and instructions are obviously also valid:

- applicable accident prevention instructions
- generally acknowledged safety and road traffic regulations
- country specific safety regulations. It is the duty of the operator to know and observe these regulations. This applies also for local regulations and the regulations for various types of manual work. If the recommendations in this manual differ from the regulations valid in your country, you must strictly observe the regulations in your country.

Intended use

This machine must only be used for:

- Compaction of bituminous material, e.g. road surface layers,
- light compaction work in earth construction (road sub-bases).

Unintended use

However, dangers may arise from this machine if it is operated by untrained personnel or if it is subjected of unintended use.

Starting and operation of the machine in explosive environments is prohibited.

Who is allowed to work with the machine?

The machine must only be operated by trained and authorized persons which are at least 18 years of age. The responsibilities for the operation of the machine must be clearly specified and complied with.

Persons under the influence of alcohol, medication or drugs must not operate, service or repair the machine.

Maintenance and repair tasks require specific knowledge and must therefore only be carried out by trained and qualified personnel.

Conversions and alterations to the machine

Unauthorized conversions to the machine are prohibited for safety reasons.

Original parts and accessories have been specially designed for this machine. We wish to make expressly clear that we have not tested or authorized any original parts or special equipment not supplied by us. The installation and/or use of such products can impair the active and/or passive driving safety. The manufacturer expressly excludes any liability for damage resulting from the use of non-original parts or accessories.

Safety notes in the operating and maintenance instructions:

⚠ Danger

Sections marked like this point out possible dangers for persons.

⚠ Caution

Sections marked like this point out possible dangers for the machine or for parts of the machine.

i Note

Sections marked like this provide technical information concerning the optimal economical use of the machine.

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Environment

Sections marked like this highlight activities for the safe and environmental disposal of fuels and lubricants as well as replaced parts.

Observe all environment protection regulations.

Information and safety stickers/decals on the machine

Keep stickers/decals complete (see spare parts catalogue) and fully legible and observe their meaning.

Replace damaged or illegible stickers/decals immediately.

Loading the machine

Use only strong and stable loading ramps. The ramp inclination must be lower than the gradability of the machine.

Secure the machine against turning over or slipping off.

Secure the machine on the transport vehicle against rolling off, slipping and turning over.

Persons are highly endangered if

- they step or stand under loads being lifted
- they remain in the drive range of the machine during a demonstration or during loading.

The machine must not swing about when lifted off the ground.

Use only safe lifting gear of sufficient load bearing capacity.

Attach the lifting gear only to the specified lifting points.

Towing the machine

You should generally use a tow bar.

Max. towing speed 1 km/h, max. towing distance 500 m.

Before detaching the propshaft secure the machine against unintended rolling.

Checking the Roll Over Protection Structure (ROPS)

i Note

On machines with cabin the ROPS is an integral part of the cabin.

The machine frame must not be distorted, bent or cracked in the area of the ROPS fastening points.

The ROPS must not show any signs of corrosion, damage, hairline cracks or open fractures.

The ROPS must not rattle about during driving. This would mean that it is not properly fastened. All bolted connections must be in accordance with the prescribed specifications and correctly tightened (observe the tightening torque values). Screws and nuts must not be damaged, bent or deformed.

With the cabin installed check also the condition of the cabin mounts (rubber elements and screws).

Neither must any additional parts be welded or bolted on, nor must any holes be drilled without the permission of the manufacturer, since this may impair the strength of the structure.

Starting the machine

Before starting

Operation of the machine is only permitted when sitting in the operator's seat.

Use only machines which have been properly serviced at regular intervals.

Become acquainted with the equipment, the control elements, the working mode of the machine and the area you will be working in.

Use your personal protective outfit (hard hat, safety boots etc.).

Check before mounting the machine if:

- there are persons or obstructions beside or under the machine
- the machine is free of any oily and combustible material
- all handrails, steps and platforms are free of grease, oils, fuels, dirt, snow and ice
- the engine compartment hood is closed and locked

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To climb onto the machine use steps and handrails.

Check before starting, whether:

- the machine shows any obvious defects
- all protective devices are properly secured in their place
- steering, brakes, control elements, lighting and warning horn are in order
- the seat is correctly adjusted
- the mirrors (if available) are clean and correctly adjusted.

Do not start the machine if any gauges, control lights or controls are defective.

Do not take any loose objects with you or fasten them to the machine.

On machines with ROPS you should always wear your seat belt!

Starting

Start and operate the machine only from the operator's seat

For starting set all control levers to "neutral position".

Do not use any starting aids such as Start Pilot or ether.

After starting check all gauges.

Starting with jump leads

Connect plus with plus and minus with minus (ground cable) - always connect the ground cable last and disconnect it first! Wrong connections may cause severe damage in the electric system.

Never start the engine by bridging the electrical connections on the starter, because the machine would probably start to move immediately.

Starting in closed rooms

Exhaust gases are toxic! Always ensure an adequate supply of fresh air when starting in closed rooms!

Driving the machine

Persons in the danger area

Before taking up work, also after breaks, you should always convince yourself that the danger zone is free of persons or obstructions, especially when driving in reverse.

Give warning signals, if necessary. Stop work immediately if persons remain in the danger zone, despite the warning.

Do not step or stand in the articulation area of the machine when the engine is running. Danger of squashing!

Driving

Only attempt to drive when the air pressure in the brake reservoir exceeds 5,5 bar (80 psi) and the warning buzzer goes out.

The transmission oil temperature must not exceed 121 °C (250 °F).

If the transmission clutch pressure drops below 12,7 bar (184 psi) shut the engine down immediately. Transmission failure.

If the engine oil pressure warning light lights up shut the engine down immediately and check the engine oil level.

In events of emergency and in case of danger actuate the emergency stop switch immediately. Do not use the emergency stop switch as service brake.

Restart the machine only after the danger that caused the actuation of the emergency stop switch has been eliminated.

If the machine has contacted high-voltage power lines:

- do not leave the operator’s stand
- warn others from coming close to or touching the machine
- if possible drive the machine out of the danger zone
- have the power switched off

Operate the machine only from the operator’s stand.

Keep the cabin doors closed.

Do not adjust the driver’s seat while driving.

Do not climb onto or off the machine while the machine is driving.

Change the travel direction only at standstill.

Do not use the machine to transport persons.

In case of unusual noises and development of smoke perform trouble shooting and have the fault corrected.

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Always keep a sufficient distance to excavation walls and embankments and do not use working methods that could impair the stability of the machine.

Always keep a sufficient distance when passing through subways, under bridges, tunnels, electric power lines etc.

Driving on inclinations and slopes

Do not drive on gradients exceeding the maximum gradability of the machine.

On slopes drive extremely careful and always directly up or down the slope. Change to a lower gear before starting to drive.

Wet and loose soils considerably reduce the ground adhesion of the machine on inclinations and slopes. Higher risk of accident!

Behaviour in traffic

Match the speed to the working conditions.

Always give way to loaded transport vehicles.

Switch the lights on if the visibility is poor.

Keep away from edges and embankments.

Parking the machine

Park the machine on horizontal, level, firm ground.

Before leaving the machine:

- Straighten the articulated joint to provide easier access to the machine.
- return the control lever to neutral position
- apply the parking brake
- shut the engine down, pull the ignition key off
- close the cabin
- secure the machine against unintended use.

Do not jump off the machine, but use hand grips and access steps.

Mark machines, which could be in the way, with a clearly visible sign.

Parking on slopes and inclinations

Apply suitable measures to block the machine against rolling away.

Filling the fuel tank

Do not inhale fuel fumes.

Refuel only after shutting the engine and the auxiliary heater down.

Do not refuel in closed rooms.

No open fire, do not smoke.

Do not spill any fuel. Catch running out fuel, do not let it seep into the ground.

Wipe off spilled fuel. Keep fuel free of dirt and water.

Leaking fuel tanks can cause explosions. Ensure tight fit of the fuel tank filling cover, replace it if necessary.

Fire protection measures

Make yourself acquainted with the location and the operation of fire extinguishers. Observe fire warning and fire fighting installations.

Maintenance work

Comply with the maintenance work described in the operating and maintenance instructions, including the information concerning the replacement of parts.

Support the engine hood for all maintenance and repair work in the engine compartment.

Maintenance work must only be performed by qualified and authorized persons.

For overhead maintenance and assembly work use the access steps and working platforms provided or other secure means. Do not use machine parts as access steps.

Keep unauthorized persons away from the machine.

Do not perform maintenance work while the machine is driving or the engine is running.

Park the machine on horizontal, level, firm ground.

Pull the key out of the ignition switch.

Work on hydraulic lines

Relieve hydraulic pressures before working on hydraulic lines. Hydraulic oil escaping under pressure can penetrate the skin and cause severe injury. When being injured by hydraulic oil consult a medical doctor immediately, as otherwise this may cause severe infections.

Do not change the setting of pressure relief valves.

Drain the hydraulic oil at operating temperature – danger of scalding!

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Catch running out hydraulic oil and dispose of environmentally.

Do not start the engine after draining the hydraulic oil.

Once all work is completed (with the system still depressurized!) check all connections and fittings for leaks.

Changing hydraulic hoses

Hydraulic hoses must be visually inspected at regular intervals.

Hydraulic hoses must be immediately replaced if:

- the outer layer is damaged down to the inlay (e.g. chafing, cuts, cracks)
- the outer layer is brittle (formation of cracks in the hose material)
- the hose shows deformations in pressurized and depressurized condition, which do not comply with the genuine shape of the hydraulic hose
- the hose shows deformations in bends, e.g. squeezing, buckling, layer separation, formation of blisters
- parts of the hose are leaking.
- hoses are not correctly installed.
- the hydraulic hose has separated from the fitting
- the fitting shows corrosion that impairs both function and strength.
- hoses are mixed up by mistake.
- fittings are damaged or deformed, whereby the function and strength of the hose/hose connection is impaired.

Only genuine BOMAG replacement hydraulic hoses ensure that the correct hose type (pressure range) is used at the right location.

Working on the engine

Shut the engine down before opening the engine hood.

Drain the engine oil at operating temperature – danger of scalding!

Wipe off spilled oil, catch running out oil and dispose of environmentally.

Store used filters and other oil contaminated materials in a separate, specially marked container and dispose of environmentally.

Do not leave any tools or other objects, that could cause damage, in the engine compartment.

Working on electric parts of the machine

Before starting to work on electric parts of the machine disconnect the battery and cover it with insulating material.

Do not use fuses with higher ampere ratings and do not repair fuses with a piece of wire. Fire hazard!

Disconnect the battery before starting welding work on the machine.

Working on the battery

When working on the battery do not smoke, do not use open fire!

Do not let acid come in contact with hands or clothes! When injured by acid flush off with clear water and seek medical advice.

Metal objects (e.g. tools, rings, watch straps) must not come in contact with the battery poles – danger of short circuit and burning!

When recharging serviceable batteries remove all plugs, to avoid the accumulation of explosive gases.

Observe the applicable instructions when starting with an auxiliary battery.

Dispose of old batteries according to regulations.

Switch off the charging current before removing the charging clamps.

Ensure sufficient ventilation, especially if the battery is to be charged in a closed room.

Working on the fuel system

Do not inhale any fuel fumes.

Avoid open fire, do not smoke, do not spill any fuel.

Catch running out fuel, do not let it seep into the ground and dispose off environmentally.

Working on the brake system

Have the brake fluid changed every two years.

Have maintenance and repair work on the brake system only performed by qualified specialists.

Do not reuse drained off brake fluid, but dispose of environmentally.

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Use only original brake fluid, do not fill in mineral oil.

Store brake fluid only in original cans. Mortal danger when swallowing.

Working on the transmission

Drain transmission oil at operating temperature – danger of scalding!

Wipe off spilled oil, catch running out oil and dispose of environmentally.

Store used filters and other oil contaminated materials in a separate, specially marked container and dispose of environmentally.

Working on wheels and tires

Explosion-like bursting of tires or parts of tires and rims can cause most severe or even deadly injuries.

Assembly of tires must only be performed with appropriate experience and tools. If necessary have tires assembled in a qualified workshop.

Always ensure the correct tire pressure and do not exceed the specified maximum pressure.

Check tires and wheels every day for specified pressure, cuts, bulges, damaged rims, missing wheel studs or nuts. Do not drive with damaged tires or wheels.

Ant-sticking emulsions for tires must only consist of water and anti-sticking agent, in a concentration in accordance with the specifications of the manufacturer of the anti-sticking agent. Observe applicable environmental regulations.

Cleaning work

Do not perform cleaning work while the motor is running.

Do not use gasoline or other easily inflammable substances for cleaning.

When cleaning with steam cleaning equipment do not subject electrical parts and insulation material to the direct jet of water, or cover it beforehand.

- Do not guide the water jet into the exhaust and into the air filter.

After maintenance work

After all maintenance work is completed reinstall all guards and safety installations.

Repair

Attach a warning tag to the steering wheel if the machine is defective.

Repairs must only be performed by qualified persons who have been instructed for this purpose. Use our repair instructions.

Exhaust gases are highly dangerous! Always ensure an adequate supply of fresh air when starting in closed rooms!

Test

Depending on the type of application and the operating conditions vibratory equipment has to be examined by a specialist whenever required, but at least once every year.

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3 Indicators and Controls

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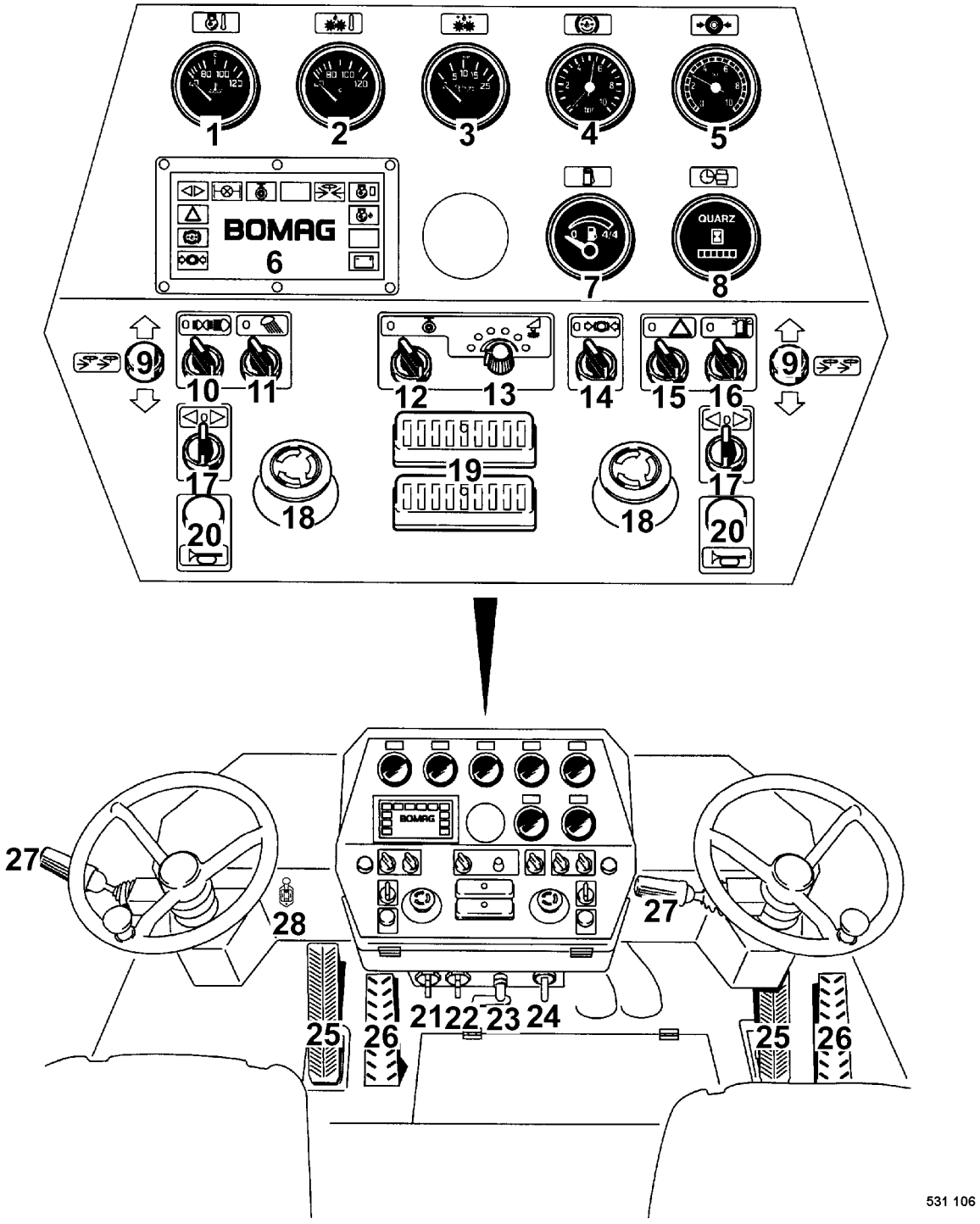


Fig. 5

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1 Engine temperature gauge
2 Transmission oil temperature gauge
3 Clutch pressure gauge, transmission
4 Gauge for brake and air tank pressure
5 Tire pressure gauge
6 Monitoring board
7 Fuel level gauge
8 Operating hour meter
9 Control light for active operator's stand
10 Rotary switch for light system (StVZO)
11 Rotary switch for working lights
12 Rotary switch for pressure sprinkler system
13 Interval switch for pressure sprinkler system
14 Rotary switch for parking brake*
15 Rotary switch for hazard light system
16 Rotary switch for flashing beacon
17 Rotary switch for direction indicators left / right
18 Emergency stop push button
19 Fuse box
20 Push button for warning horn
21 Rotary switch for tire inflation
22 Rotary switch to relieve tire pressure
23 Main battery switch
24 Ignition switch
25 Brake pedal
26 Throttle pedal
27 Travel lever
28 Hand brake valve**

* not with option BR2

** Optional equipment BR2

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3.1 General notes

Please read this section thoroughly before operating this machine if you are not yet conversant with the indicators and control elements. All functions are described in detail hereunder.

Paragraph 4 Operation contains only concise descriptions of the individual operating steps.

3.2 Description of indicators and control elements

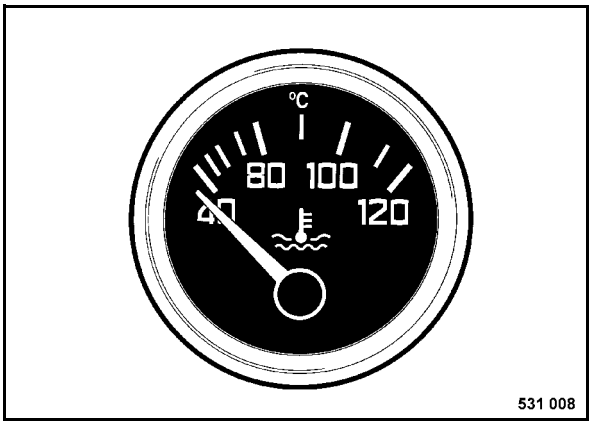


Fig. 6

No. 1 = Engine temperature gauge

Shows the coolant temperature.

Operating temperature approx. 80 ... 100 °C (176 -135,56 °C)

Max. permissible operating temperature 104 °C

⚠ Caution

If the engine oil temperature exceeds the max. permissible value, let the engine cool down and perform trouble shooting.

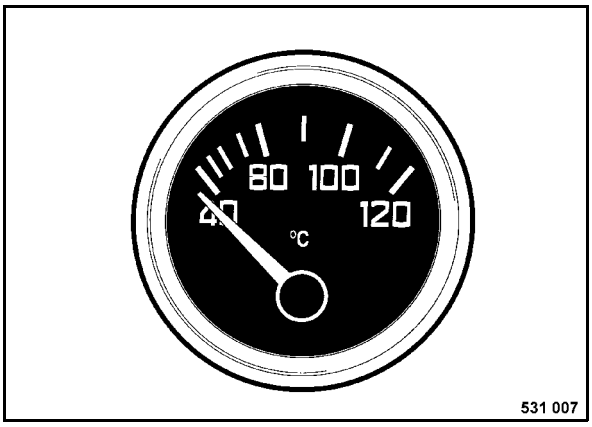


Fig. 7

No. 2 = Transmission oil temperature gauge

Operating temperature approx. 80 ... 120 °C (176 - 248 °F)

Max. permissible operating temperature 121 °C

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⚠ Caution

If the transmission oil temperature exceeds the max. permissible value shut the engine down and perform trouble shooting.

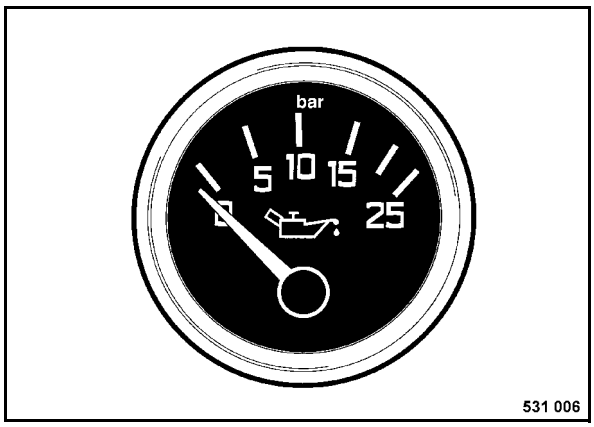


Fig. 8

No. 3 = Clutch pressure gauge, transmission

Operating pressure approx. 12,5 ... 15,5 bar (181 -225 psi)

Clutch pressure min. 12,5 bar (180 psi) at operating temperature

⚠ Caution

If the clutch pressure drops below the minimum value shut the engine down and perform trouble shooting.

This may damage the transmission.

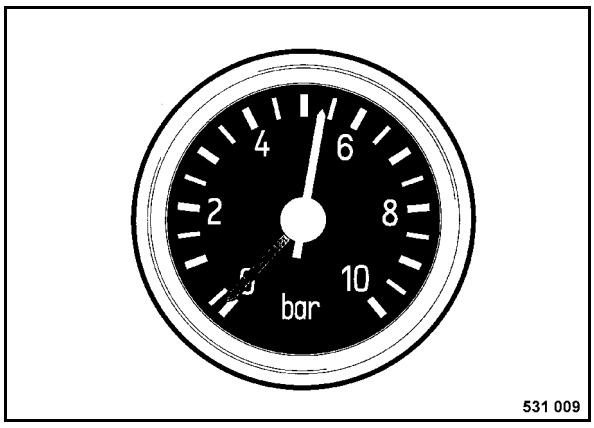


Fig. 9

No. 4 = Gauge for brake and air tank pressure

Operating pressure approx. 5,5 ... 8,1 bar (80 - 116 psi)

white pointer = air tank pressure

red pointer = brake pressure

⚠ Danger

Mortal danger!

Do not attempt to drive before the air tank pressure has reached 5.5 bar and the warning buzzer has stopped.

Should the brake pressure drop below the minimum value, the warning buzzer will sound. Stop the machine and perform trouble shooting.

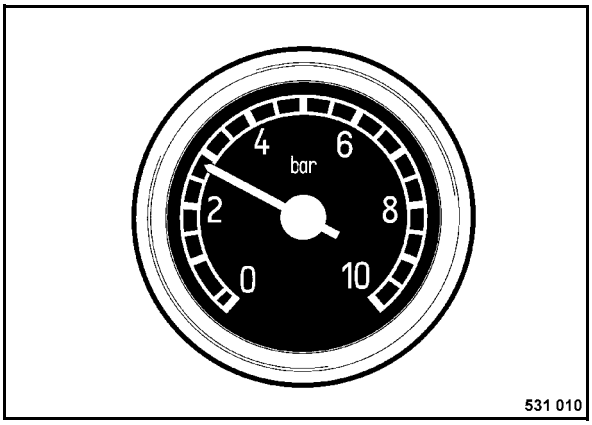


Fig. 10

No. 5 = Tire pressure gauge

Shows the current tire pressure.

Operating pressure approx. 2 ... 8,1 bar (29 - 116 psi)

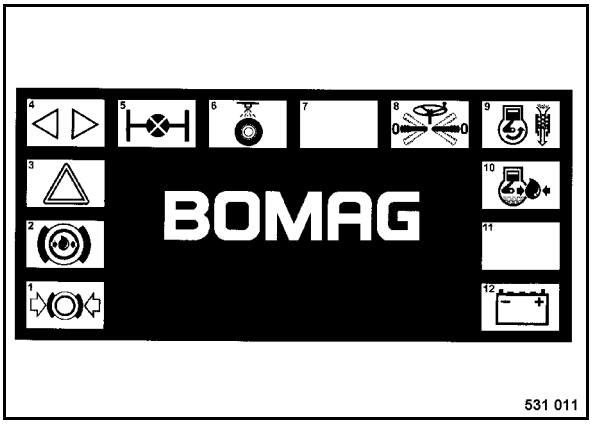


Fig. 11

No. 6 = Fault monitoring board

The control and warning lights light up:

(1) = Parking brake closed

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(2) = accumulator pressre for brake too low; lights if the accumulator pressure drops below 5,5 bar (80 psi), the warning buzzer sounds as well

(3) = Hazard light switched on

(4) = Direction indicator switched on

(5) = not used

(6) = Tire sprinkler system switched on

(7) = not used

(8) = Travel lever in "neutral", the engine can only be started in “neutral”

(9) = Air filter cartridge soiled. Clean, change the cartridge

i Note

Once the air filter service indicator lights up, work may be continued until the end of the day.

(10) = Engine oil pressure too low, check engine oil level, if necessary have the engine repaired

(11) = not used

(12) = The battery is not being charged, check the V-belt, if necessary repair the generator

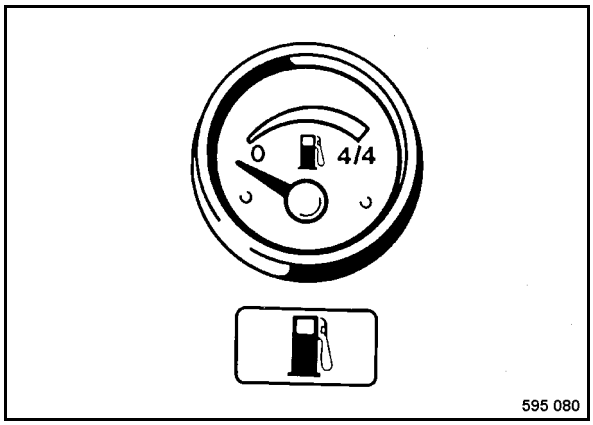


Fig. 12

No. 7 = Fuel gauge

shows the fuel level in the fuel tank.

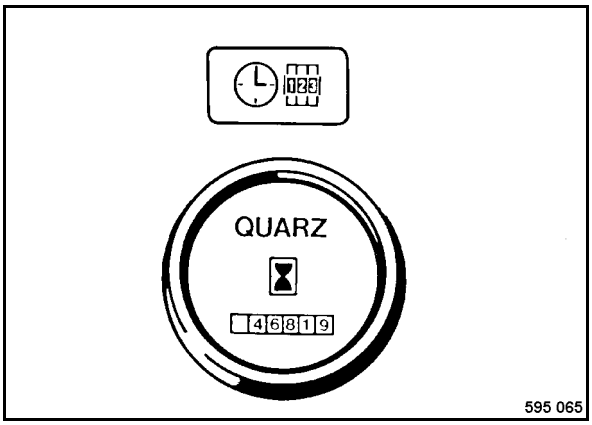


Fig. 13

No. 8 = Operating hour meter

counts the operating hours while the engine is running

All service work must be carried out according to the reading of the operating hour meter.

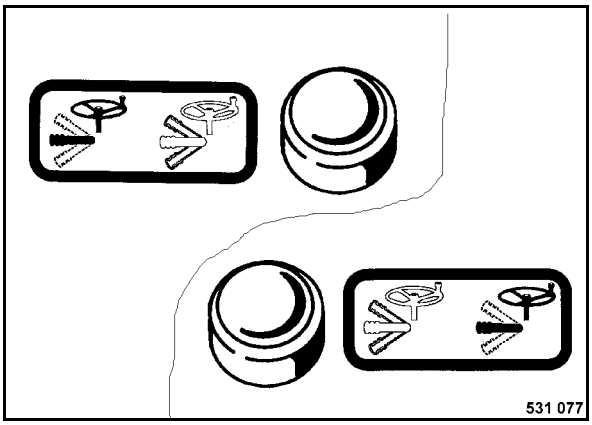


Fig. 14

No. 9 = Control light for active operator’s stand

Shows which side travel lever can be used to operate travel speed ranges and travel direction.

Both lights off with ignition switched on = both travel levers in “Neutral”, engine can be started

Both lights flashing with ignition switched on = one or both travel levers out of “Neutral”, engine cannot be started

One light on with engine running = when shifting the travel lever to “F” forward or “R” reverse, the

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control light on the corresponding side will light up, at the same time the control light on the side with the travel lever in “N” will go out

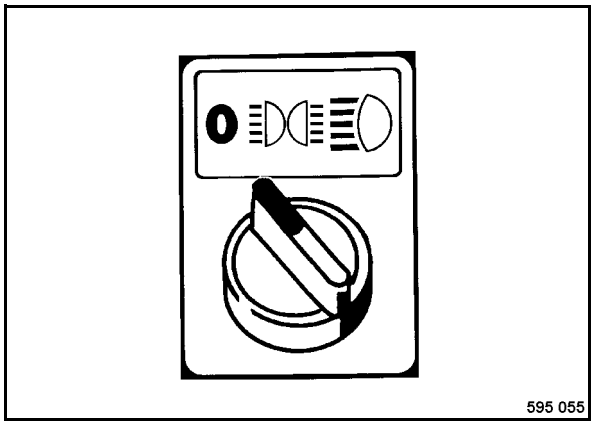


Fig. 15

No. 10 = Rotary switch for light system (StVZO)

Position "left" = Light off

Position "middle" = Sidelights on, with ignition switch in position "I" or "P"

Position "right" = Travel light on, with ignition switch in position "I".

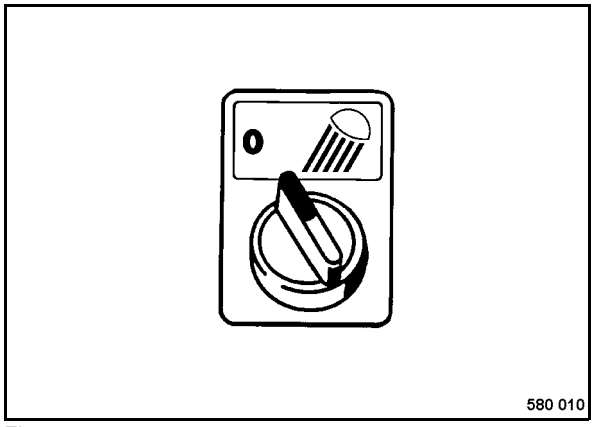


Fig. 16

No. 11 = Rotary switch for working lights

Position "left" = Light off

Position "right" = Working lights on, with ignition switch in position "I".

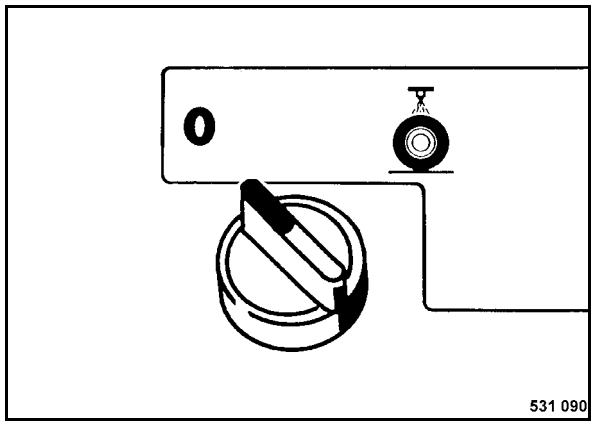


Fig. 17

No. 12 = Rotary switch for pressure sprinkler system

Position "0" = Sprinkler system switched off

Position "right" = Sprinkler system switched on

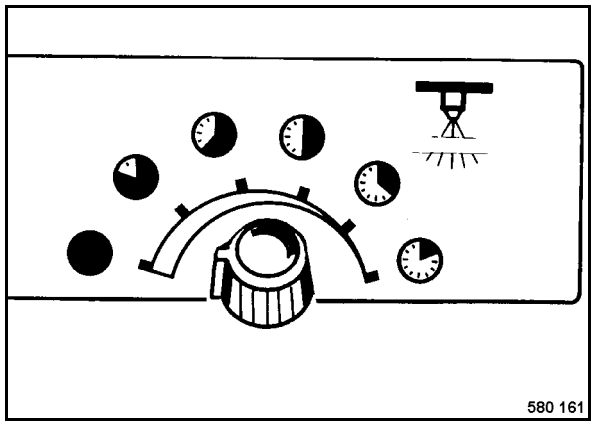


Fig. 18

No. 13 = Interval switch for pressure sprinkler system

Position "left" = permanent sprinkling when pressure sprinkling is enabled

five further positions in "clockwise" direction = various sprinkling intervals

1 = Permanet operation

2 = 2 sec. on 4 sec. off

3 = 4 sec. on 4 sec. off

4 = 4 sec. on 8 sec. off

5 = 4 sec. on 16 sec. off

6 = 4 sec. on 24 sec. off

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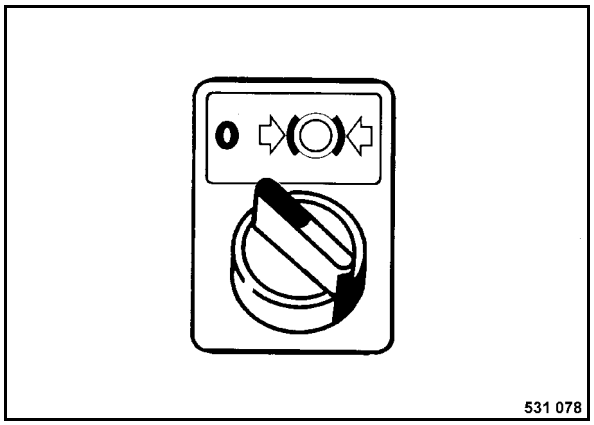


Fig. 19

No. 14 = Rotary switch for parking brake*

Position "left" = Parking brake released

Position "right" = Parking brake applied, control light in monitoring board lights up

i Note

The parking brake is a mechanical spring force operated disc brake on the drive shaft.

For releasing the brake pressure air from the air vessel is applied to a piston.

The parking brake is also automatically applied when the ignition is switched off or if no brake pressure (pneumatic) is available.

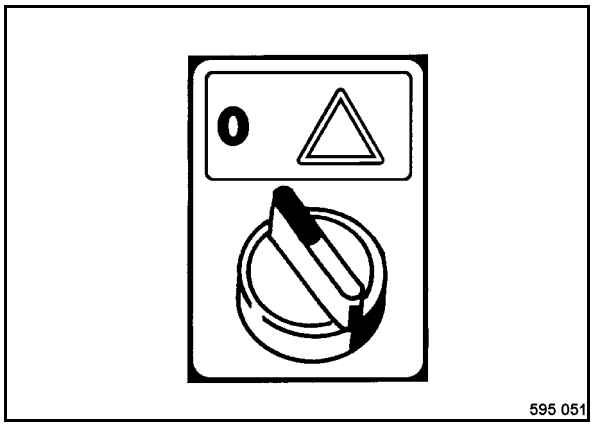


Fig. 20

No. 15 = Rotary switch for hazard light system**

Position "left" = hazard light system switched off

Position "right" = hazard light system switched on, the control light in the fault monitoring board 3 flashes.

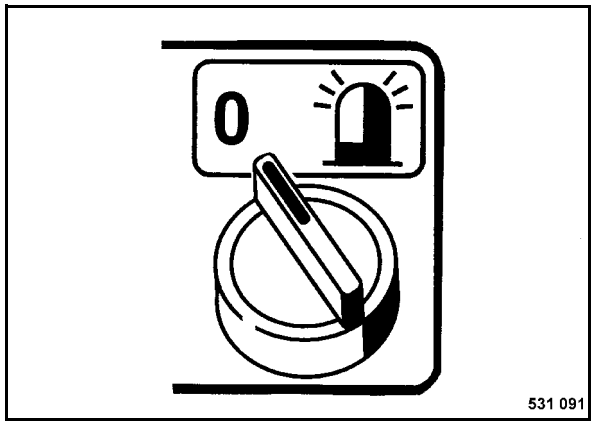


Fig. 21

No. 16 = Rotary switch for flashing beacon

Position "left" = Flashing beacon switched off

Position "right" = Flashing beacon switched on

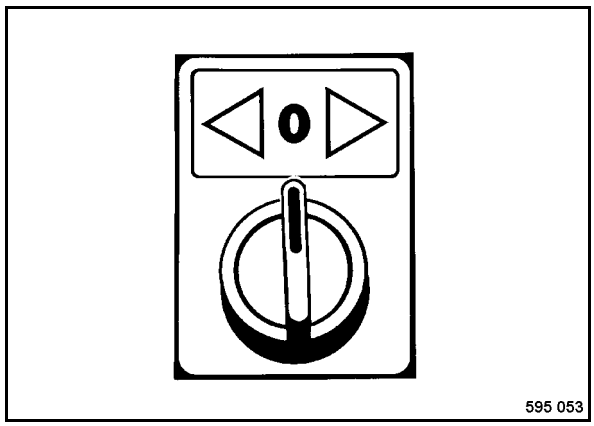


Fig. 22

No. 17 = Rotary switch for direction indicators left / right

Position "middle" = Direction indicators disabled

Position "left or right" = The front and rear direction indicators for the corresponding side of the machine light up, the control light in the fault monitoring board flashes

* Not with option BR2

** Option

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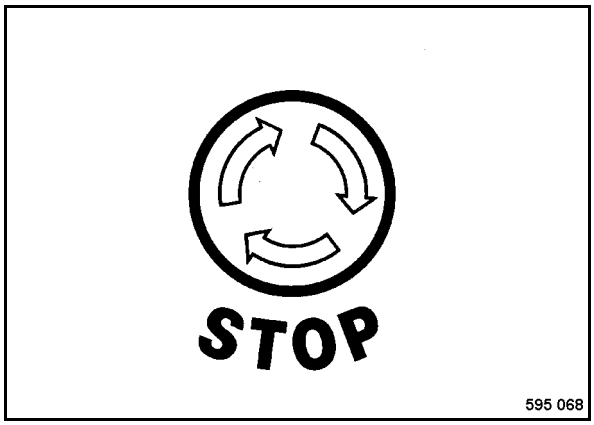


Fig. 23

No. 18 = Emergency stop switch

Shuts the engine down and closes the brake.

⚠ Danger

Danger of accident!

Actuate only in events of emergency during operation, do not use as service brake.

Restart the machine only after the danger that caused the actaution of the emergency stop switch has been eliminated.

actuate = press the button completely down, it automatically locks in fully pressed position.

unlock = turn the button clockwise and let it go.

to drive = return the travel lever first to “neutral”, then start the engine and actuate the travel lever again.

For safety reasons the machine can only start to drive after returning the travel lever to neutral position.

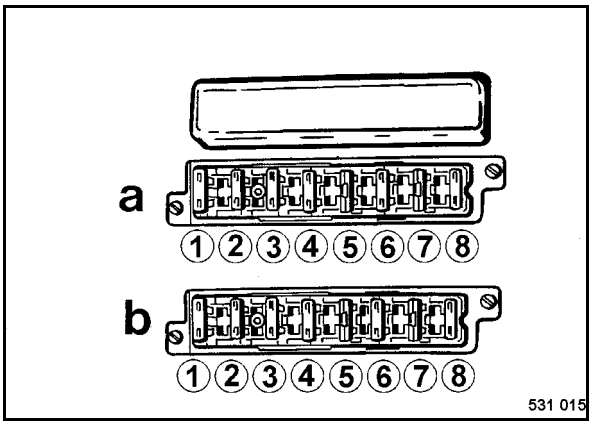


Fig. 24

No. 19 = Fuse box

Fuse box "a"

(1), 35 A = (F 01) Main fuse

(2), 10 A = (F 05) Socket

(3), 15 A = (F 07) Hazard light

(4), 5 A = (F 09) Parking and tail light, left hand side

(5), 5 A = (F 10) Parking and tail light, right hand side

(6), 10 A = (F 06) Sprinkler system

(7), 20 A = (F 41) Flashing beacon

(8), = not used

Fuse box "b"

(1), 10 A = (F 27) Wiper and washer

(2), 20 A = (F 31) Cabin ventilator

(3), 10 A = (F 33) Air conditioning

(4), 5 A = (F 11) Headlight, left hand side

(5), 5 A = (F 12) Headlight, right hand side

(6), 10 A = (F 04) Gauges and controls

(7), 15 A = (F 08) Direction indicators and working lights

(8), 10 A = (F 77) Driving

⚠ Danger

Fire hazard!

Do not use fuses with higher ampere ratings and do not bridge fuses.

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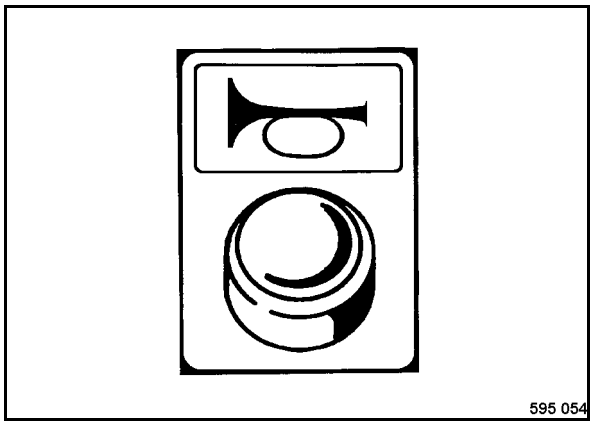


Fig. 25

No. 20 = Push button for warning horn

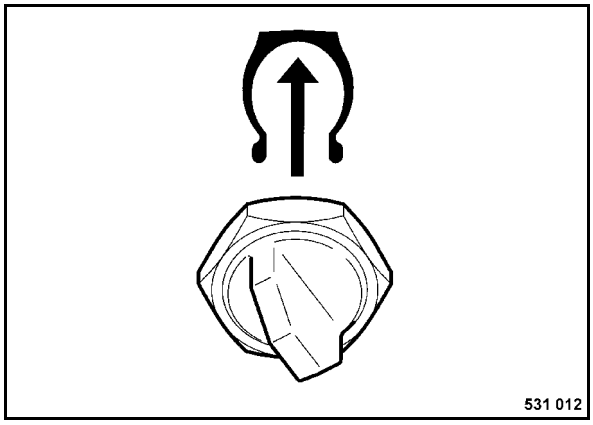


Fig. 26

No. 21 = Rotory switch for tire inflation

Position "left" = Valve closed

Position "right" = Valve open, tire is being filled

i Note

The tire will be filled up to max. 8,1 bar (116 psi).

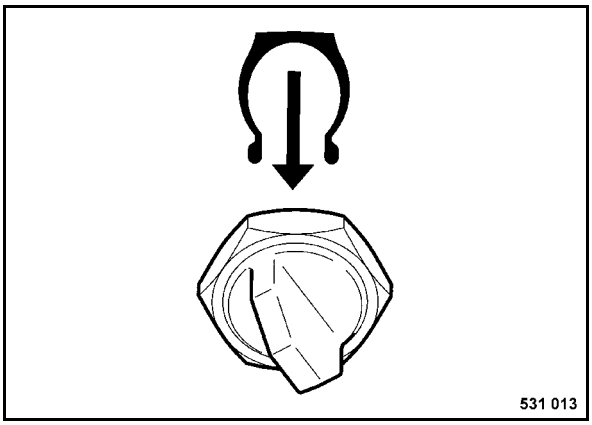


Fig. 27

No. 22 = Rotary switch to release the tire pressure

Position "left" = Valve closed

Position "right" = Valve open, the tire pressure is being released

i Note

The tire pressure can be released down to max. 2.0 bar (29 psi).

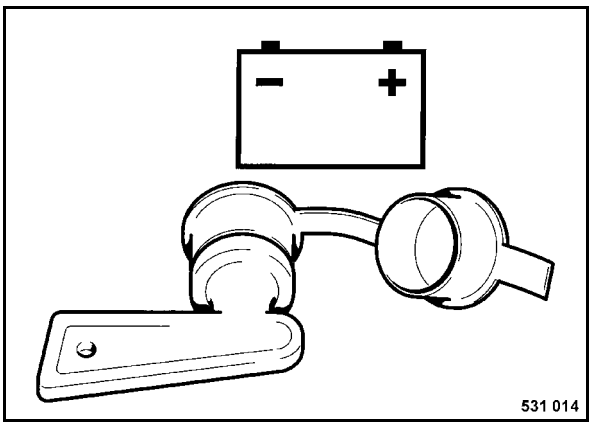


Fig. 28

No. 23 = Main battery switch

Turn "anti-clockwise" = Battery disconnected

= protection against unauthorized use

= in case of burning of cables

= during welding work on the machine

Turn "clockwise" = operating position, battery connected

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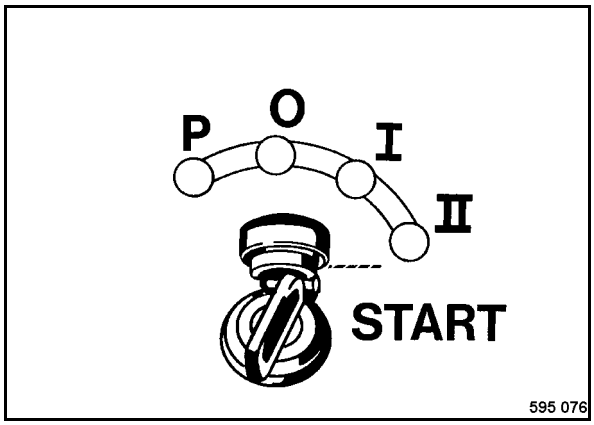


Fig. 29

No. 24 = Ignition switch

Position "P"/"0" = Ignition off, key can be pulled out, engine off, parking brake applied.

Position "I" = Ignition on, parking brake released (if not activated)

i Note

If both travel levers are in “neutral”, the engine can now be started.

The ignition switch is designed with a lock to prevent repetitive starting. For a new starting attempt the ignition key must first be turned back to position "0".

Position "II" = turn further against spring pressure, he engine starts, turn the ignition key back to position once the engine has started

i Note

During the starting process all warning and control lights in the fault monitoring board light up. This is a self test of the control lights.

⚠ Caution

Run the engine warm for a short while before starting work. Do not allow the engine to run longer than 5 minutes with idle speed.

Do not shut the engine down all of the sudden from full speed, but let it idle for a while for temperature equalization.

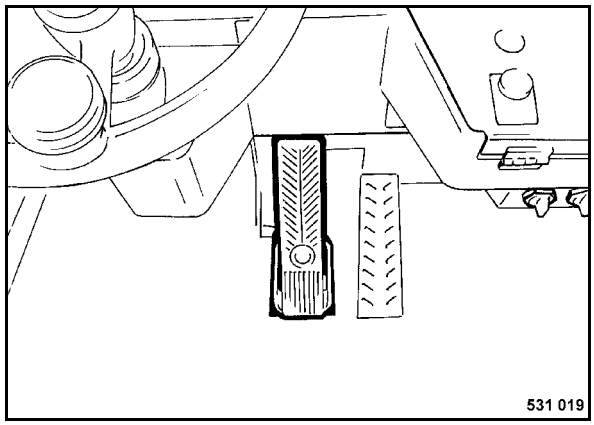


Fig. 30

No. 25 = Brake pedal

To operate the service brake on the rear axle

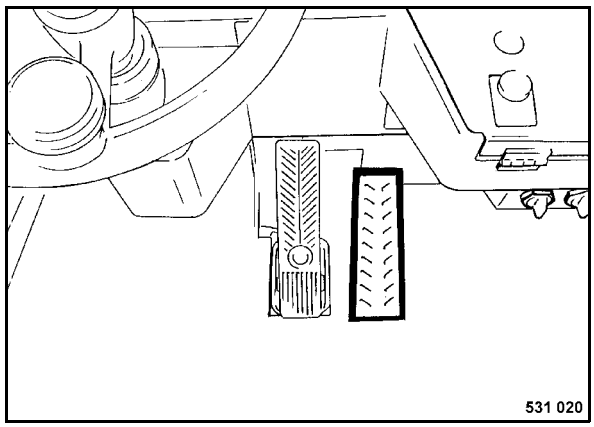


Fig. 31

No. 26 = Throttle pedal

Is used to change the engine speed / travel speed

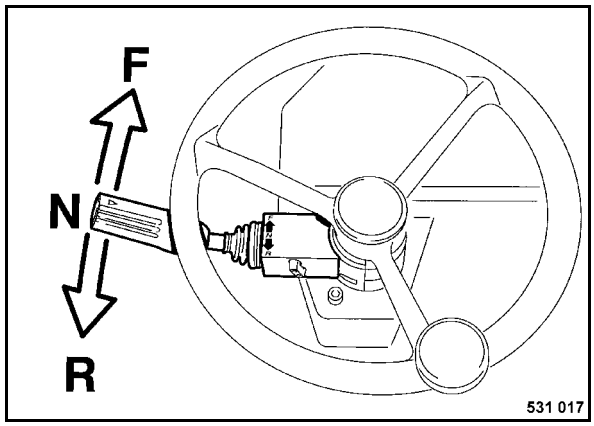


Fig. 32

No. 27 = Travel lever

The travel lever is used to pre-select the travel direction.

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Position “N” = Neutral position

Position “F” = Forward

Position ”R” = Backwards

i Note

With both travel levers in “neutral position” the control light (8) in the fault monitoring board lights up and both control lights ”active operator’s stand” are flashing. The engine can be started.

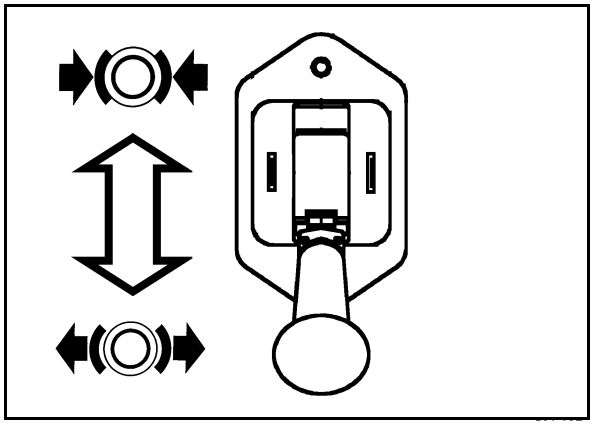


Fig. 33

No. 28 = Hand brake valve*

Position "down" = Travel position, brake released

Position "up" = Parking brake position, pull the knob to unlock the lever

i Note

The braking effect can be dosed by the lever travel, but when engaging the lever in top position the parking brake is fully applied.

* Optional equipment BR2

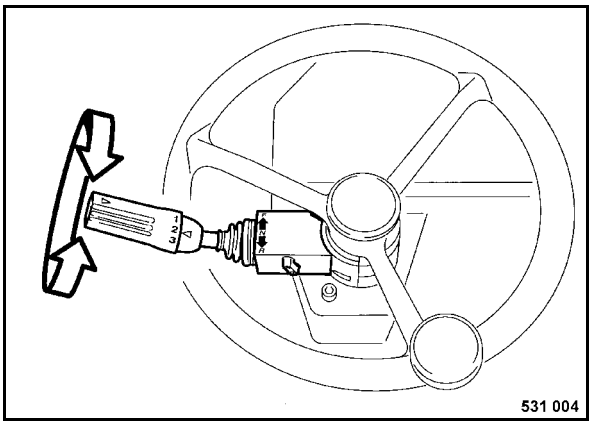


Fig. 34

No. 29 = Rotary switch, gear selection

The powershift transmission is designed with three gear ranges, which can be selected with the rotary switch.

Position "1" = 0 ... 5 km/h (0 -3,1 MPH)

Position "2" = 0 ... 11 km/h (0 -6,8 MPH)

Position "3" = 0 ... 20 km/h (0 - 12,5 MPH)

⚠ Caution

Do not drive with low travel speed in high gear.

On inclinations and slopes change to a lower gear in due time.

Before shifting to a lower gear (3 -1) you must first reduce the travel speed.

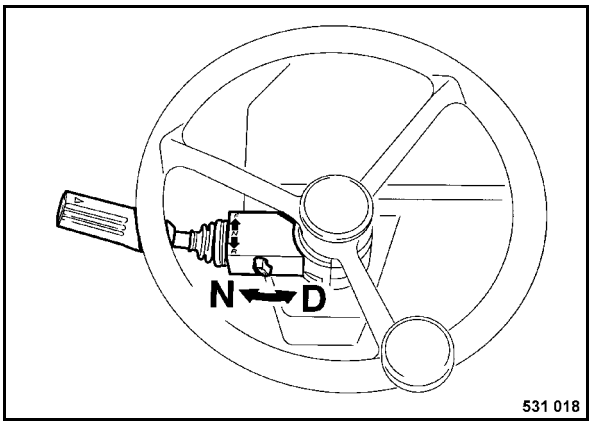


Fig. 35

No. 30 = Travel lever lock

The travel lever is used to pre-select the travel direction.

Position “N” = the travel lever is locked in “neutral position”

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Position “D” = Selection of travel direction and gear is possible

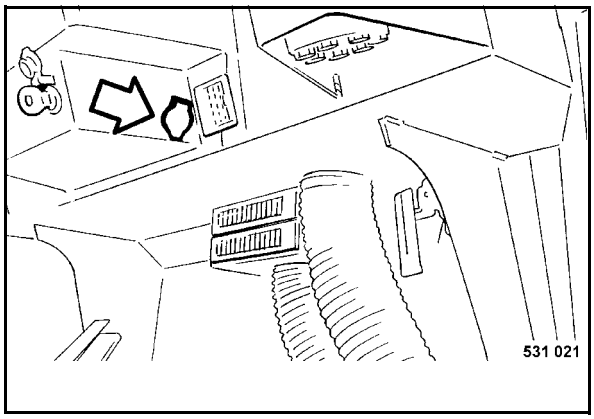


Fig. 36

No. 31 = Socket

Voltage = 12 Volt

max. load = 10 A/120 W

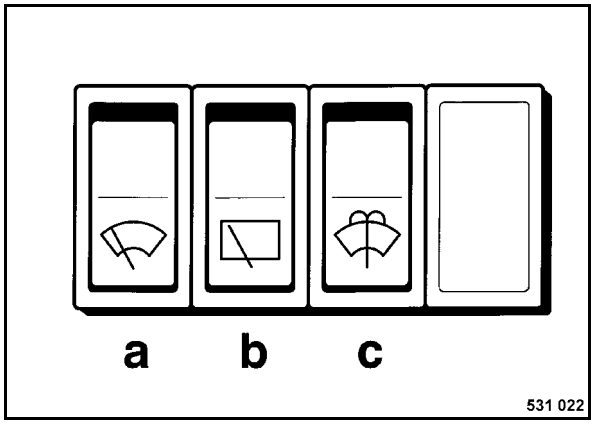


Fig. 37

No. 32 = Windscreen wiper/washer

(a) Wiper/washer for front windscreen

up = windscreen wiper moves to end position and stops

down = Front windscreen wiper on

Push button = Front windscreen is sprayed during wiping

(b) Wiper/washer for rear windscreen

up = windscreen wiper moves to end position and stops

down = Wiping of rear windscreen

Push button = Rear windscreen is sprayed during wiping

(c) Washer for front windscreen

Push button = Spraying of front windscreen

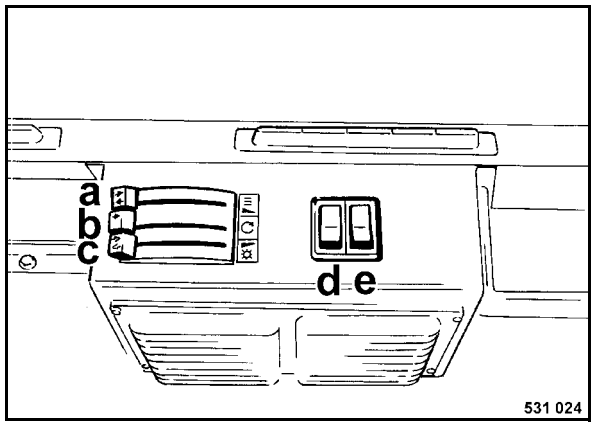


Fig. 38

No. 33 = Heating/ventilation/air conditioning*

(a) Slide for heating

left = heating off

right = heating max.

(b) Slide for fresh air/circulation air

left = fresh air

right = circulation air

(c) Slide for air conditioning*

left = air conditioning min.

right = air conditioning max.

(d) Toggle switch for ventilator

top = ventilator off

1. step = low speed

2. step = high speed

(e) Toggle switch for air conditioning*

to switch the air conditioning on

* Optional equipment

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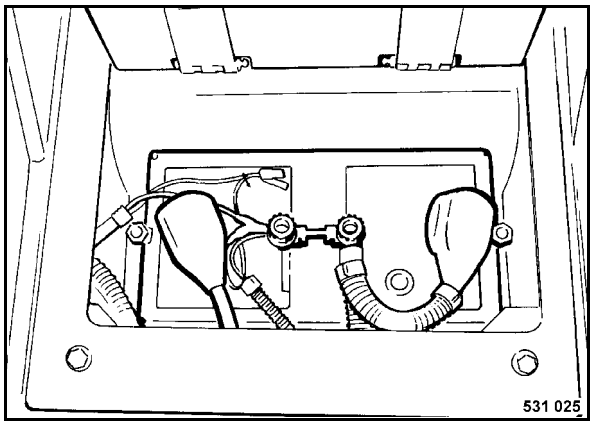


Fig. 39

No. 34 = Main fuse for battery

80A = (F00)

i Note

The main fuse is located in the battery compartment at the front right-hand side

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4 Operation

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4.1 General notes

Please read section 3 Indicators and Control Elements thoroughly before operating the machine if you are not yet fully familiar with the indicators and control elements of the machine.

All indicators and control elements are described in detail in this chapter.

4.2 Tests before taking into operation

The following inspections must be carried out before each working day or before a longer working period.

⚠ Danger

Danger of accident!

Please observe strictly the safety regulations in chapter 2 of this instruction manual!

- Park the machine on ground as level as possible.

Check:

- engine, transmission, radiator, fuel system, steering and brake hydraulics for leaks
- function of steering
- service and parking brakes
- machine for condition, cleanliness, damage
- presence of the appropriate operating and maintenance instructions
- check whether the machine has been properly serviced

i Note

For a description of the following tasks refer to the chapter "maintenance every 10 operating hours".

- Engine oil level
- Hydraulic oil level in the steering oil reservoir
- Coolant level
- Transmission oil level
- Brake fluid level

⚠ Danger

Fire hazard!

Do not refuel in closed rooms

- Fuel level
- Water level and function of the tire sprinkler system
- Water separator in fuel system, drain if necessary

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- Drain the compressed air vessel
- Air pressure in tires

4.3 Starting the engine

⚠ Danger

Danger of accident!

Always wear your seat belt.

Before starting make sure that no persons are within the danger zone.

Start the engine only from the operator's seat.

Before starting activate the parking brake and shift the travel lever to "neutral"-position.

Do not start the engine by towing the machine.

If the engine needs to be started with jump wires, connect terminals (+) with (+) and (-) with (-).

When starting with jump wires always connect the ground cable (negative) first and disconnect it last.

Never disconnect a battery cable while the engine is running.

Do not allow the engine to run longer than 5 minutes with idle speed (1500 rpm).

Do not load the engine to its limits before the operating temperature of 60 °C (140 °F) is reached.

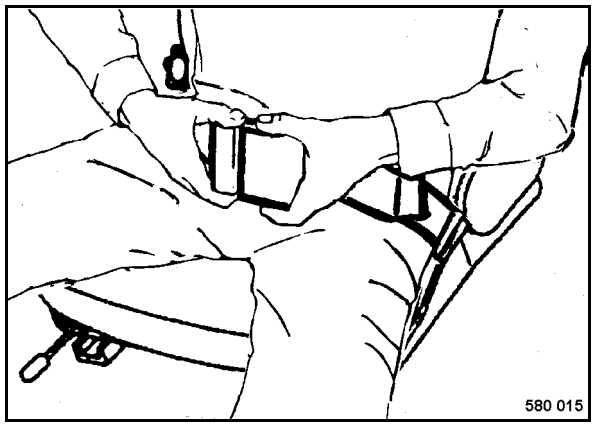


Fig. 40

- Fasten your seat belt (Fig. 40).

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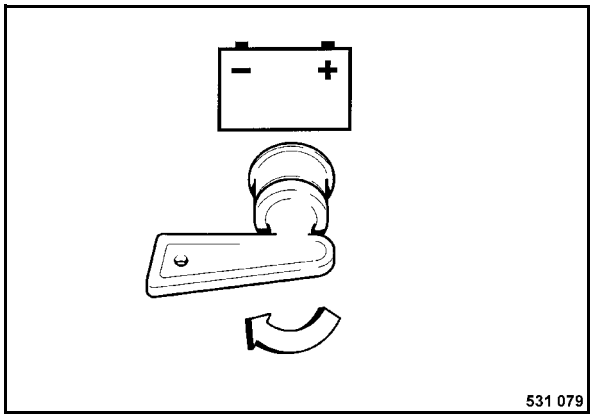


Fig. 41

- Switch the main battery switch (Fig. 41) to position “On”.

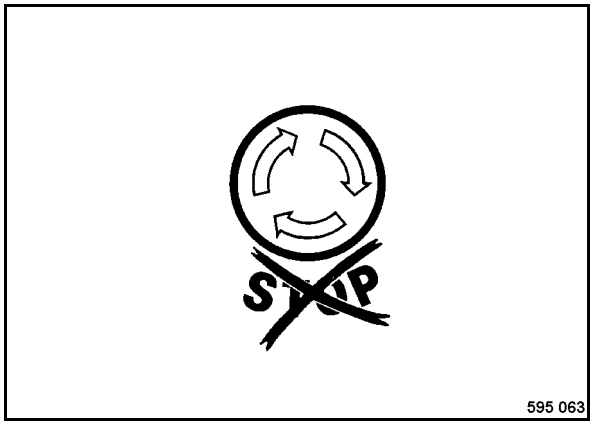


Fig. 42

- Check, whether the emergency stop switch (Fig. 42) is unlocked, unlock if necessary.

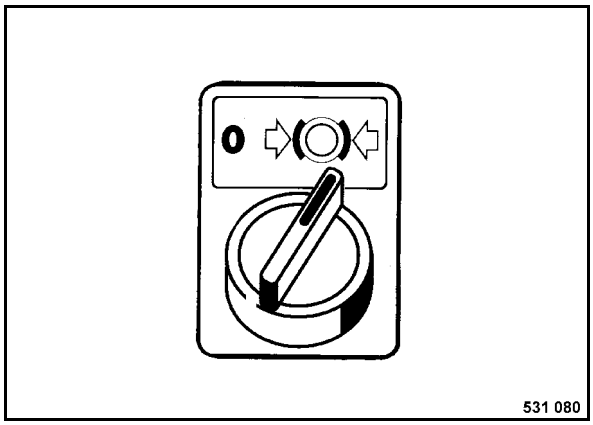


Fig. 43

- Check whether the parking brake is activated, if necessary activate the parking brake (Fig. 43)*.

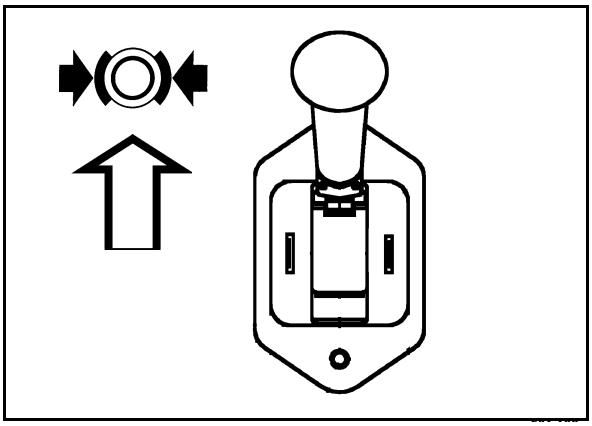


Fig. 44

- Check whether the parking brake is activated, if necessary activate the parking brake (Fig. 44)**.

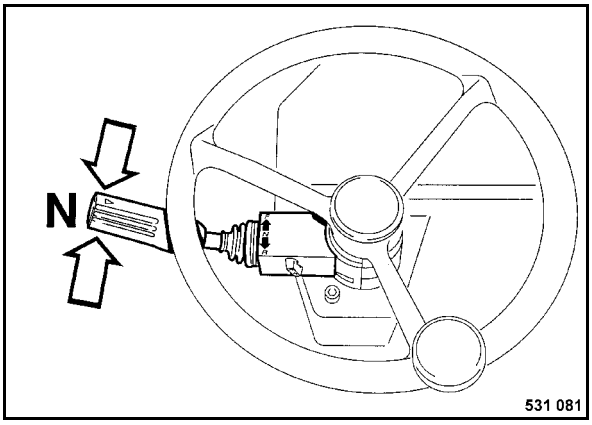


Fig. 45

- Check whether both travel levers (Fig. 45) are in “neutral”, if necessary set the levers accordingly.
- Check whether the gear selector switch is in position “1”, if necessary adjust accordingly.

* Not with option BR2
** Optional equipment BR2

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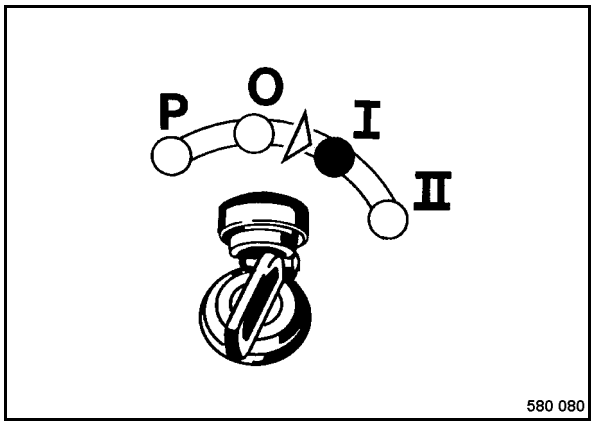


Fig. 46

- Turn the ignition key (Fig. 46) to position "I".

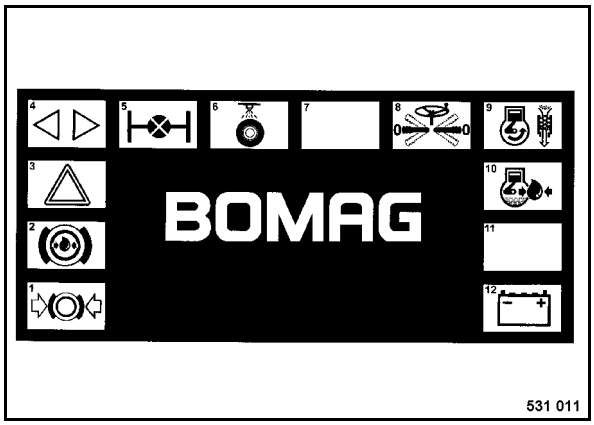


Fig. 47

Charge control light 12 (Fig. 47), neutral position light (8), engine oil pressure (10) and brake warning light (2) must light.

⚠ Caution

Perform the starting process for maximum 30 seconds without interruption and pause for a minute between starting attempts.

If the engine has not started after three attempts perform trouble shooting.

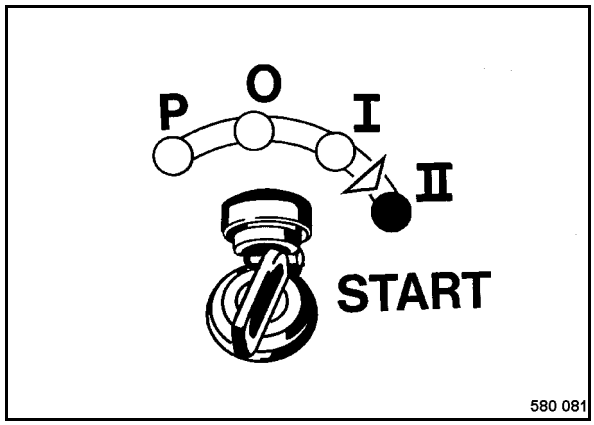


Fig. 48

- Turn the ignition key (Fig. 48) to position "II", the starter will crank the engine.
- During the starting process kick the throttle pedal slightly down.
- As soon as the engine ignites return the ignition key to position "I".

i Note

During the starting process all control and warning lights in the fault monitoring board light up and can therefore be checked.

If the engine does not start after a longer period of rest it may be necessary to bleed the fuel system.

⚠ Danger

If the pressure in the compressed air accumulator for the brake system drops below 5.5 bar (80 psi), the parking brake is activated and the warning buzzer will sound. Do not start to drive before the pressure in the compressed air accumulator is higher than 5.5 bar and the warning buzzer has stopped.

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4.4 Starting with jump wires

⚠ Caution

A wrong connection will cause severe damage in the electric system.

The voltage of the vehicle electrics (12 Volt) must comply with the voltage of the external starting aid.

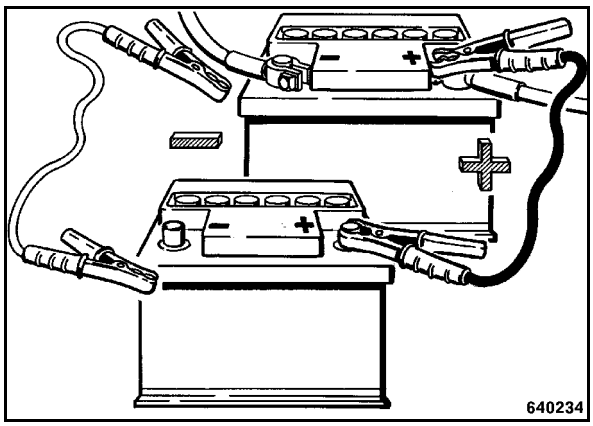


Fig. 49

- When starting with jump wires connect both positive poles (Fig. 49) first and both negative poles (ground cable) after.
- Perform all work steps as described in the previous section.
- After starting disconnect the two negative poles (ground cable) first and the two positive poles after.

4.5 Driving the machine

i Note

The machine can be operated from either of the two operator's stands.

To change the active operator's stand refer to the following section.

⚠ Danger

Danger of accident!

Wet and loose soils considerably reduce the ground adhesion of the machine on inclinations and slopes.

Soil conditions and weather influences impair the gradability of the machine.

Do not drive up and down inclinations exceeding the maximum gradability of the machine (see technical data).

Do not drive without wearing your seat belt.

Always give way to loaded transport vehicles!

Before starting to drive make sure that the drive range is absolutely safe.

Switch the lights on if the visibility is poor.

After starting the engine quickly operate the warning horn and wait for a moment, so that people can leave the danger zone.

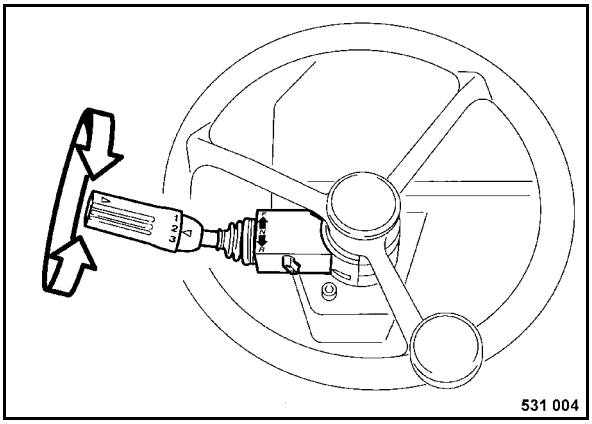


Fig. 50

- Select the desired gear (Fig. 50).

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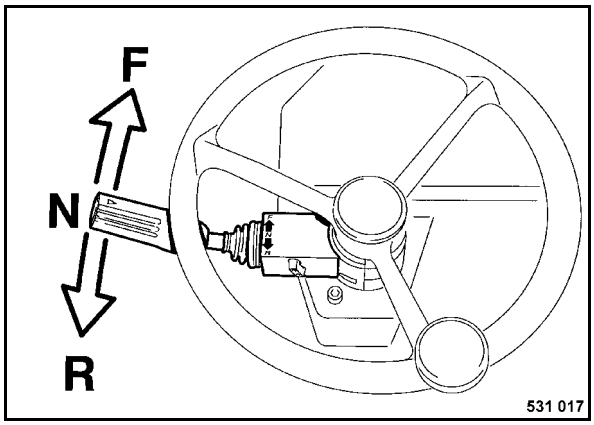


Fig. 51

- Pre-select the desired travel direction (Fig. 51).

The control light “active operator’s stand” for the corresponding side lights up.

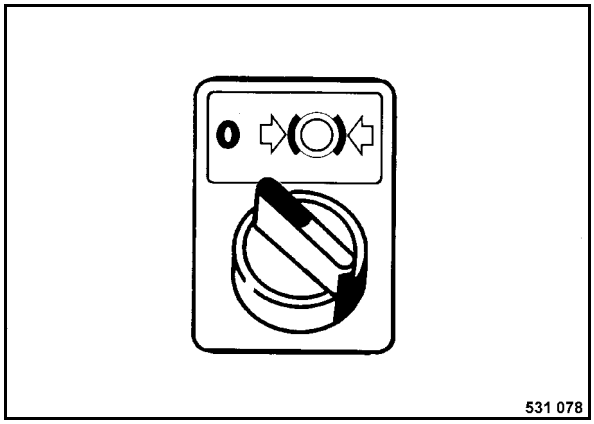


Fig. 52

- Release the parking brake (Fig. 52).

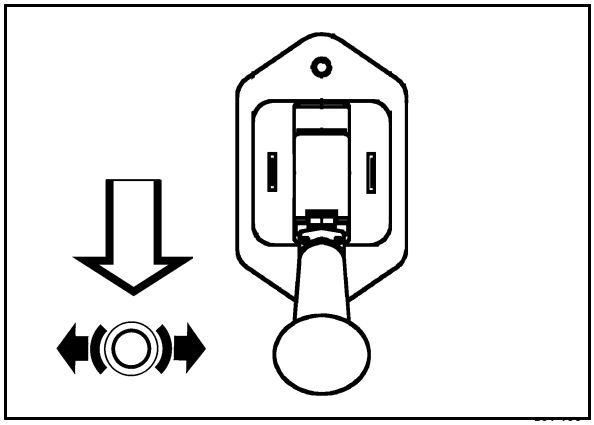


Fig. 53

- Release the parking brake (Fig. 53)*.

The control light goes out.

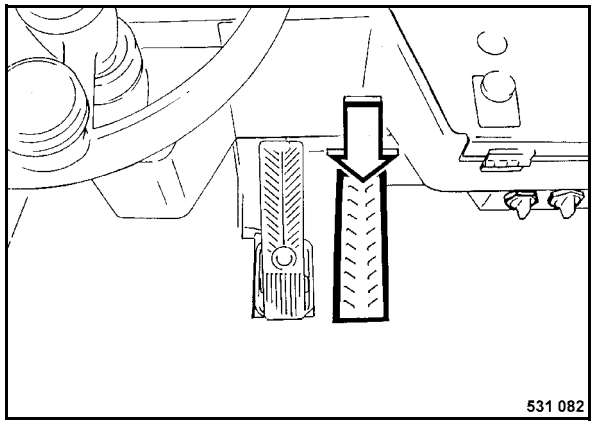


Fig. 54

- Kick the throttle pedal (Fig. 54) slowly down, according to the desired travel speed.

Important notes on travel operation

i Note

Gears (1 to 3) can be changed while driving under load.

⚠ Caution

To change the travel direction the machine must not be completely braked. With travel speeds below 3 km/h (1,9 MPH) the travel direction can be reversed. Never reverse in 3rd gear.

When driving with high speed reduce the travel speed before before changing to a lower gear.

Do not drive with low travel speed in high gear.

For low travel speeds change to a lower gear.

* Optional equipment BR2

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4.6 Changing the active operator's stand

- Stop the machine.

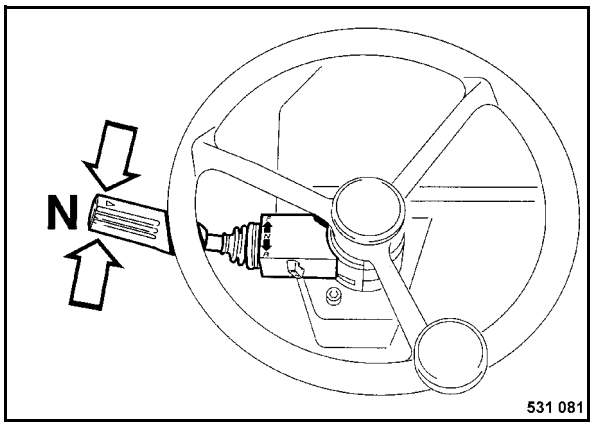


Fig. 55

- Shift the travel lever (Fig. 55) to "neutral".

The control light in the fault monitoring board lights up.

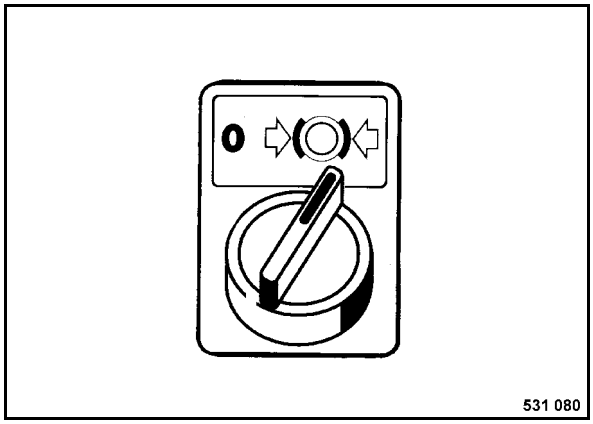


Fig. 56

- Actuate the parking brake (Fig. 56).

The control light in the fault monitoring board lights up.

- Change the driver's position.

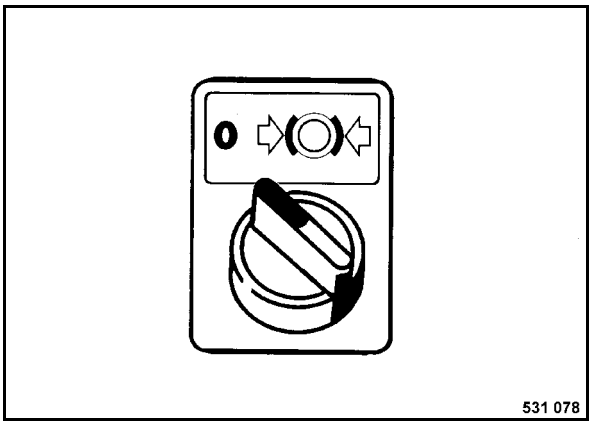


Fig. 57

- Release the parking brake (Fig. 57).

The control light in the fault monitoring board goes out.

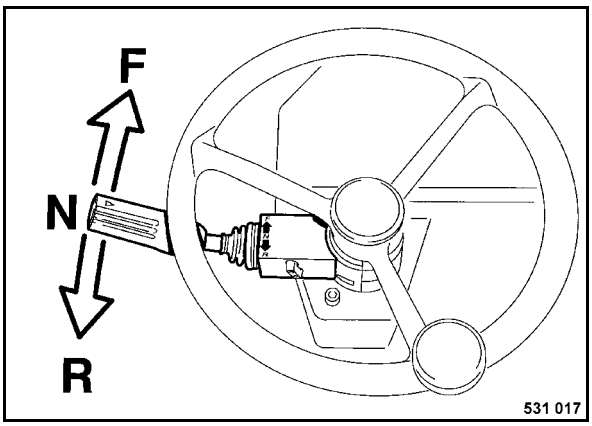


Fig. 58

- Shift the travel lever (Fig. 58) to the desired travel direction.

The control light in the fault monitoring board goes out and the control light "active operator's stand" lights up.

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4.7 Operating the parking brake

⚠ Caution

Even when leaving the machine just for a short while you should generally apply the parking brake and shut the engine down.

- Stop the machine.

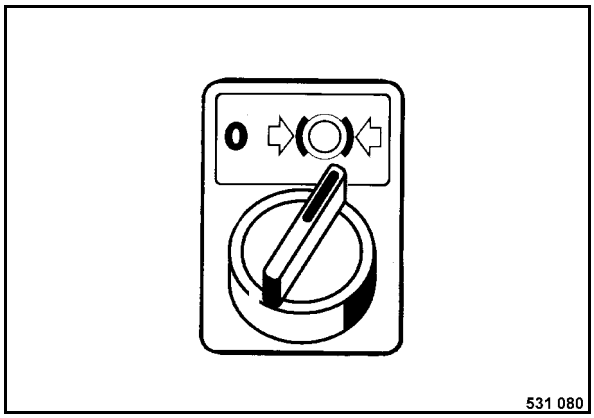


Fig. 59

- To operate the parking brake turn the rotary switch (Fig. 59) clockwise.

The control light in the fault monitoring board lights up.

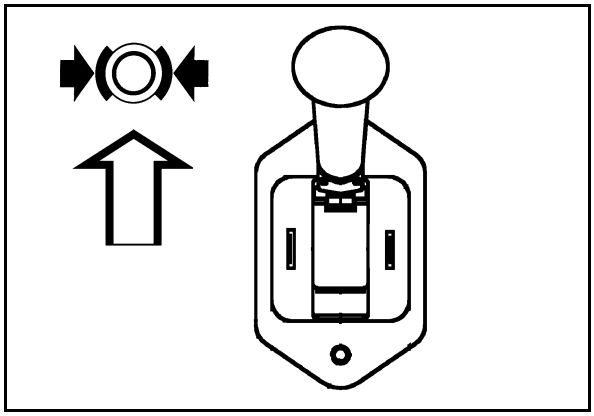


Fig. 60

- To operate the parking brake shift the* lever (Fig. 60) up and lock it in place.

* Optional equipment BR2

4.8 Shutting the engine down, parking the machine

⚠ Danger

Danger of accident!

Park the machine only in places where this is possible without any danger.

Secure the machine against unauthorized use. Always remove the ignition key and close the cabin door.

Even when leaving the machine just for a short while you should generally apply the parking brake and shut the engine down.

Block the wheels with suitable chocks.

- Stop the machine.

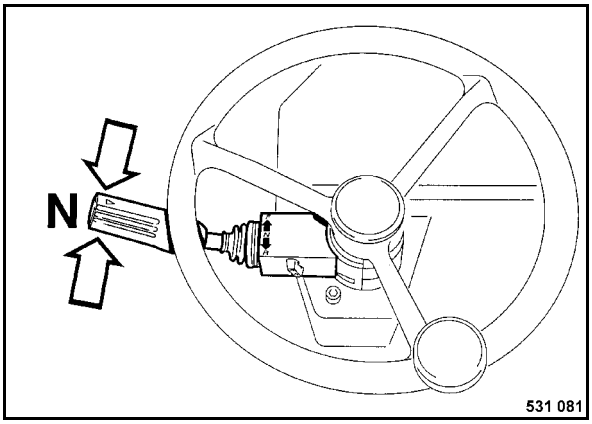


Fig. 61

- Shift the travel lever (Fig. 61) to "Neutral".

The control light in the fault monitoring board lights up

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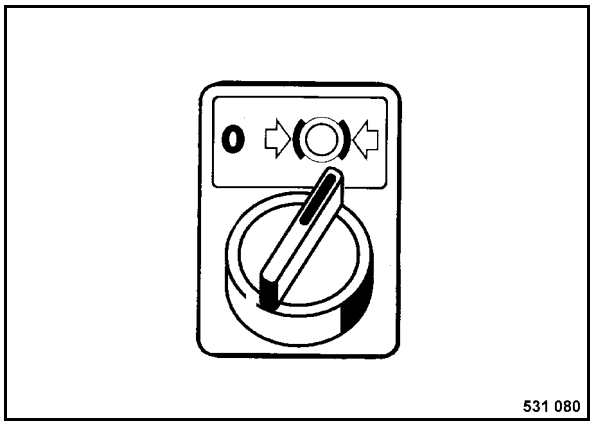


Fig. 62

- Apply the parking brake (Fig. 62).

The control light in the fault monitoring board lights up.

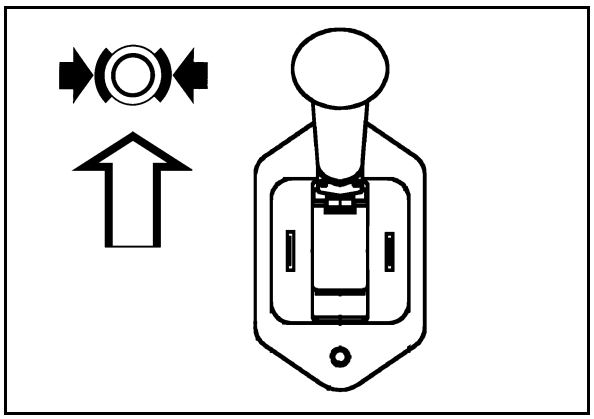


Fig. 63

- To operate the parking brake shift the* lever (Fig. 63) up and lock it in place.
- Switch off all appliances like windscreen wipers, ventilator etc.
- Check the tire pressure, if necessary inflate up to 6 bar (87 PSI).

⚠ Caution

Do not shut the engine down all of the sudden from full speed, but let it idle for approx. 3 minutes for temperature equalization.

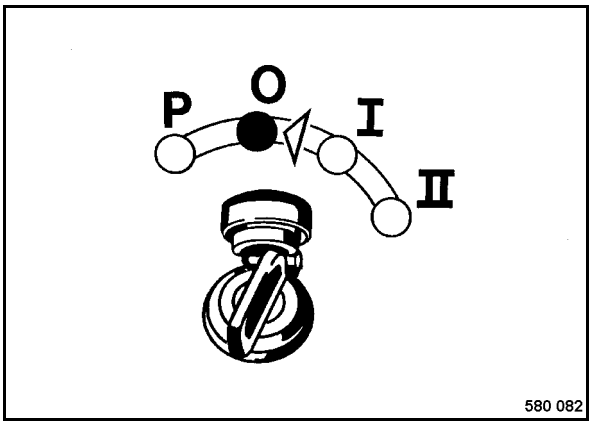


Fig. 64

- Turn the ignition switch to position “0” or “P” (Fig. 64).

The engine will stop.

- Remove the ignition key and close the switch with the protective cap.

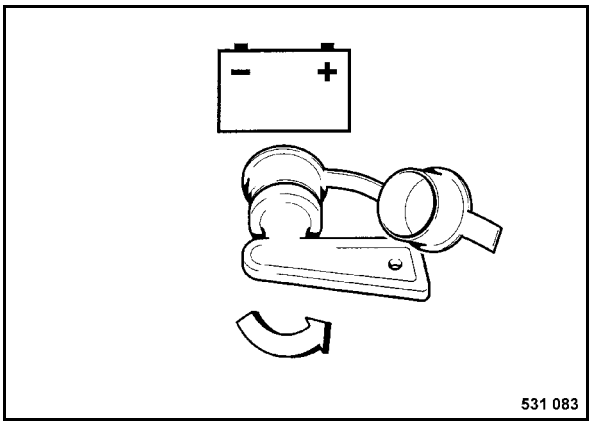


Fig. 65

- Pull off the hand lever of the main battery switch (Fig. 65) and close the switch with the protective cover.
- Close the cabin door.
- Check the condition of the machine, clean and repair it as necessary.

* Optional equipment BR2

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4.9 In events of emergency

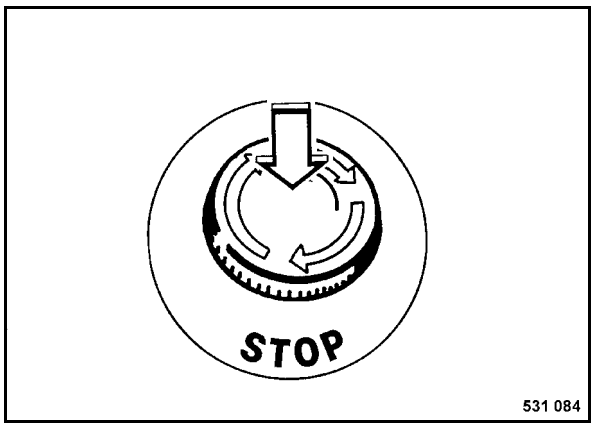


Fig. 66

- Press the emergency stop switch (Fig. 66).

Shuts the engine down immediately and closes the brake.

- For restarting turn the emergency stop switch in direction of arrow to unlock.
- Close the parking brake.
- Set the travel lever to “neutral”-position and select 1st gear.

i Note

After operating the emergency stop switch the engine cannot be started.

To start the engine both travel levers must be in “neutral”-position.

4.10 Operating the pressure sprinkler system

⚠ Caution

Before driving with drum or wheels on fresh bituminous layers to be compacted, drum and wheels must be completely wetted.

Spray the rubber tires with a suitable anti-sticking agent.

For normal travel and compaction work in earth construction lift the scraper brushes off and locke them.

- Check the water level, fill up if necessary.

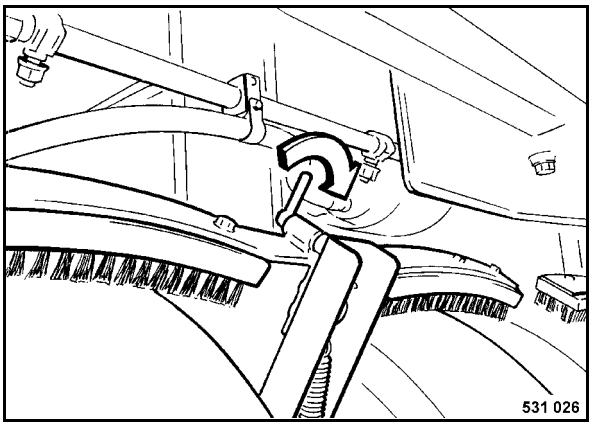


Fig. 67

- Fold the scraper brushes (Fig. 67) down on the tires.

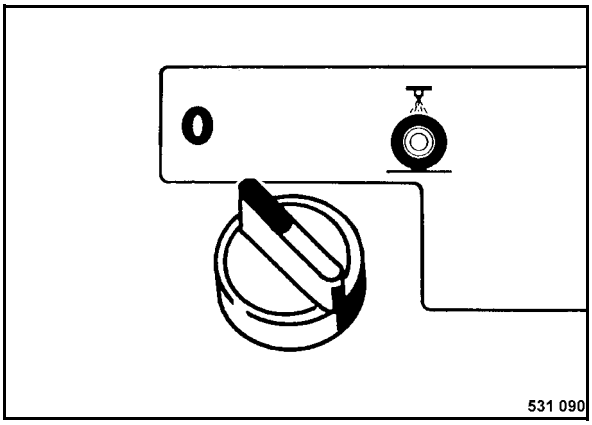


Fig. 68

- Turn the rotary switch (Fig. 68) to activate the sprinkler system.

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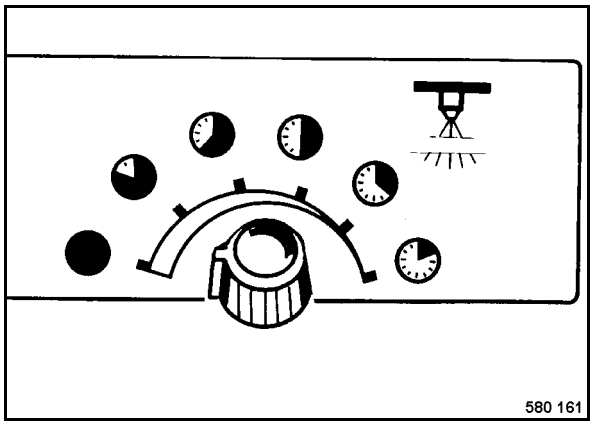


Fig. 69

- Adjust the interval switch to the desired sprinkling interval (Fig. 69).

4.11 Operating the tire inflation system

i Note

Changing of the tire pressure is possible during operation. For correct tire pressure refer to the table at the ed of this manual.

⚠ Caution

Do not activate both switches (filling / emptying) at the same time

Filling the tires

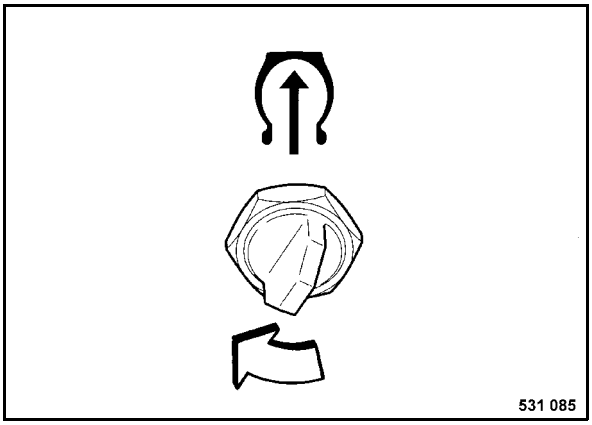


Fig. 70

- Turn the rotary switch (Fig. 70) clockwise.

The tires will be inflated, the pressure can be read on the pressure gauge in the dashboard.

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Relieving the tire pressure

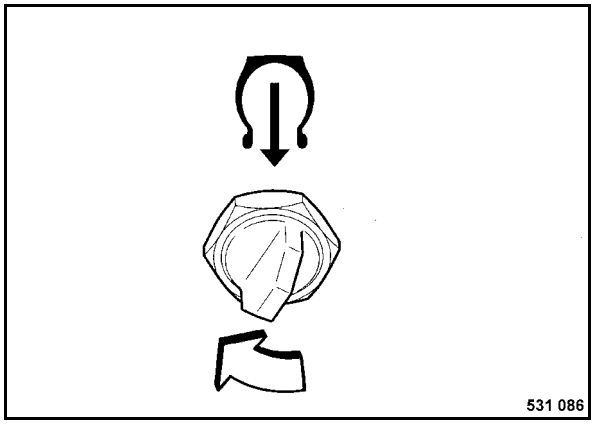


Fig. 71

- Turn the rotary switch (Fig. 71) clockwise.

The pressure in the tires will be relieved, the pressure can be read on the pressure gauge in the dashboard.

i Note

A safety device makes sure that the tire pressure does not fall below 2 bar (29 PSI).

4.12 Adjusting the seat

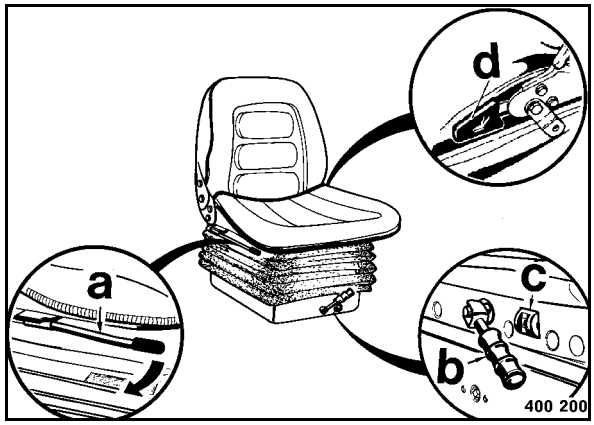


Fig. 72

- To adjust the seat in longitudinal direction push the lever a (Fig. 72) outwards.
- To adjust the weight turn the lever (b) and read the weight in the window (c).
- Actuate the lever (d) to adjust the inclination of the backrest.

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4.13 Opening / closing the hood

Opening the hood

⚠ Danger

Danger of falling down!

Use grips and access steps to climb on the machine

Be extremely careful if it is wet.

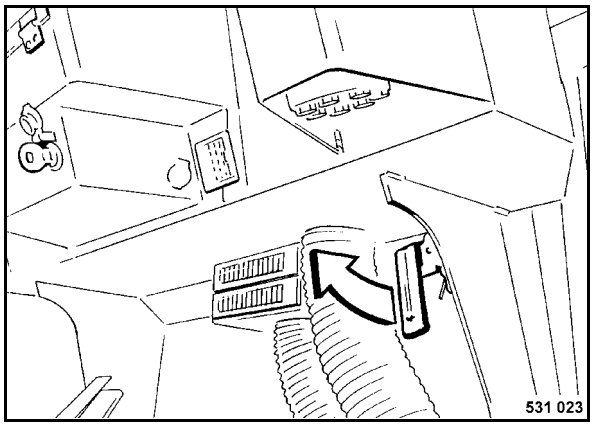


Fig. 73

- Unlock the hood with the lever (Fig. 73).

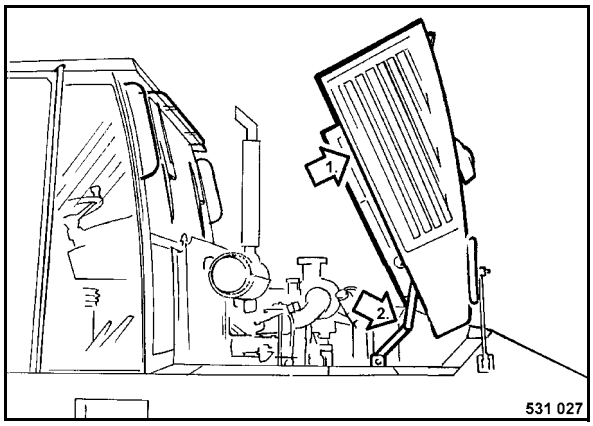


Fig. 74

- Lift the hood up (Fig. 74) and rest it on the support

Closing the hood

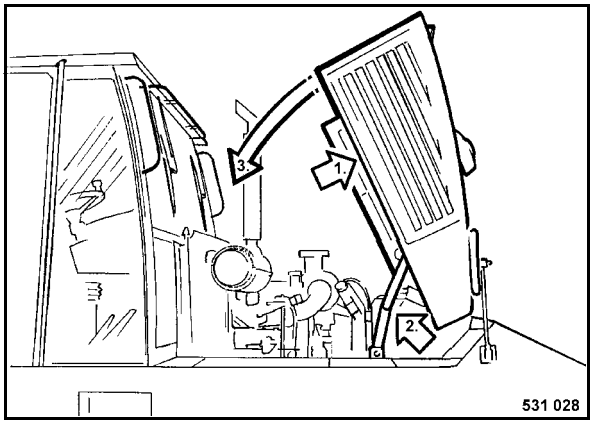


Fig. 75

- Lift the hood slightly up and buckle the support to the front (Fig. 75).
- Lower the hood and let the lock click into place.

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4.14 Ballasting of machine*

⚠ Caution

Drain all water off if there is a risk of frost.

i Note

If needed, the machine can be filled with approx. 3200 litres of water (3,2 t).

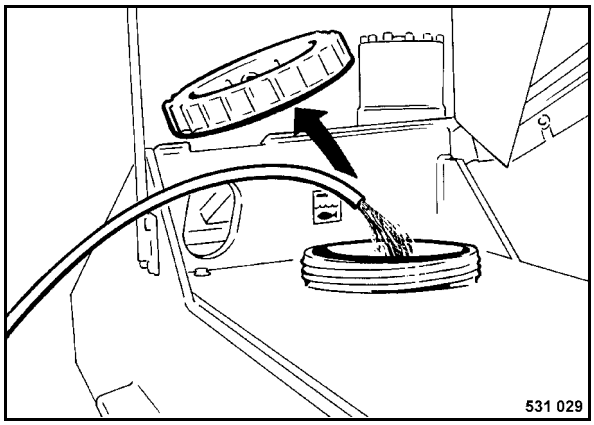


Fig. 76

- Unscrew the filler cap (Fig. 76) and fill in clean water.

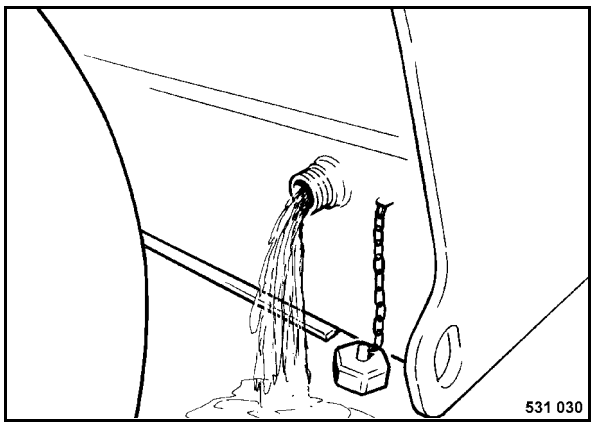


Fig. 77

- In order to reduce weight or in case of frost unscrew the cap (Fig. 77) and let all water run out.

* Option

4.15 Towing in case of an engine failure

Before towing the machine, the power transfer to the transmission must be interrupted.

If the brake air accumulator is empty (engine does not start) the parking brake must also be released mechanically.

⚠ Danger

Secure the machine with wheel chocks against unintentional rolling.

Do not tow the machine faster than 1 km/h and do not exceed a towing distance of 500 m when recovering the machine from a dangerous area.

Towing should only be performed by instructed and experienced personnel.

- Remove the floor plate between the seats.

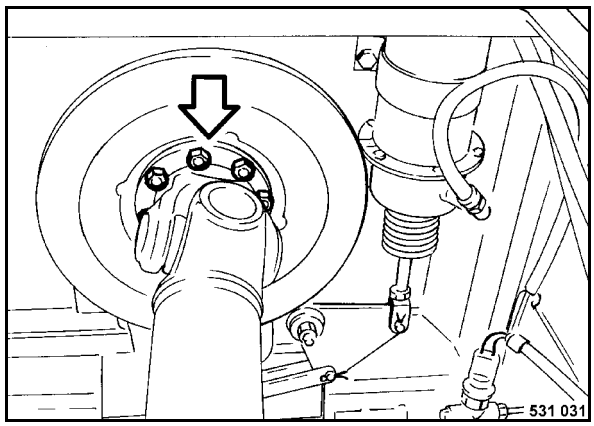


Fig. 78

- Unscrew the fastening nuts (Fig. 78) and separate the propshaft from the brake disc.

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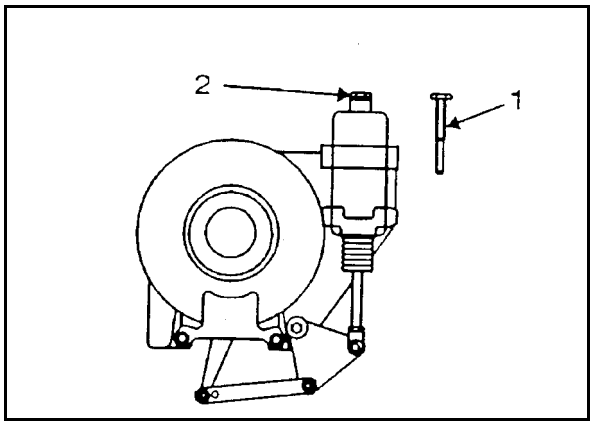


Fig. 79

- To release he parking brake unscrew plug 2 (Fig. 79) and turn in the accessory screw (1) instead.
- Attach the tow bar to the front towing eye.

4.16 Transport

⚠ Danger

Danger of accident!

Observe the safety regulations and the accident prevention instructions.

Observe national laws, as well as traffic and transport regulations.

Use only stable loading ramps of sufficient load bearing capacity.

Make sure that persons are not endangered by the machine tipping or sliding off.

Lash the machine down, so that it is secured against rolling, sliding and turning over.

Do not stand or step under loads being lifted.

Always use shackles on the lashing points for loading, lashing or lifting the machine.

Observe the loading weight (see technical data).

Observe the loading height, if necessary remove cabin or ROPS.

- Attach the articulation lock.

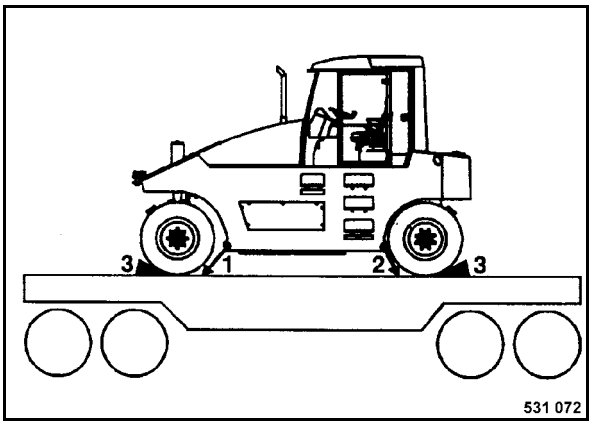


Fig. 80

- Lash the machine to the transport vehicle (Fig. 80) at front (1) and rear (2).
- Block the wheels with suitable chocks (3).

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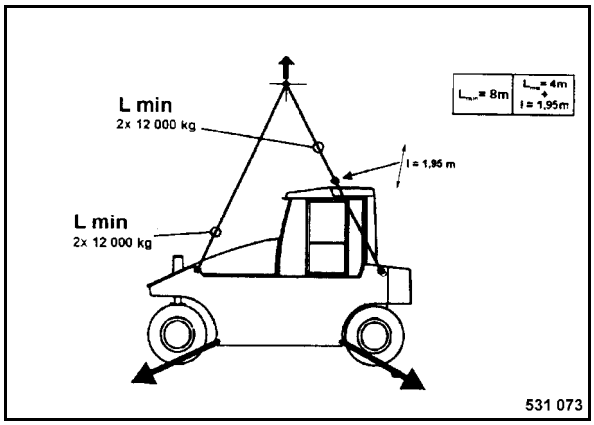


Fig. 81

- Fasten the lifting gear (Fig. 81) with shackles at the front and rear lifting points.

⚠ Caution

Keep the ropes sufficiently appart above the cabin (1,95 m), to avoid damage to the cabin.

Weights: see technical data.

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5 Maintenance

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5.1 General notes on maintenance

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

Thorough maintenance of the machine ensures maximum reliability and prolongs the service life of importants components. The work involved is small when compared with the problems which may arise if these instructions are not observed.

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

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

Environment

During maintenance catch all running oil, coolant and fuel and do not let it seep into the ground or into the sewage system. Catch oils, coolant and fuel and dispose of environmentally.

Notes on the fuel system

The lifetime of the diesel engine depends decisively on the cleanliness of the fuel.

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

Notes on the engine performance

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

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

Notes on the hydraulic system

Cleanliness is of utmost importance when servicing the hydraulic system. Make sure that no dirt or other contaminating substances fall into the system. Small particles can flute valves, cause pumps to seize and block restrictors and pilot bores, thereby causing costly repairs.

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

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Notes on the cooling system

On high performance diesel engines the preparation and control of the coolant is of special importance, since the non-observance may cause engine damage as a result of corrosion, cavitation or freezing.

The coolant is prepared by mixing the cooling water with a cooling system protection agent (ethylene glycol / propylene glycol).

Mixing of cooling system protection additives to the cooling water is necessary in all climatic zones. It prevents corrosion, lowers the freezing point and raises the boiling point of the coolant.

5.2 Fuels and lubricants

Engine oil

The use of high-quality HD brand oils in connection with the specified filter and oil change intervals results in a longer lifetime and a higher performance of the engine.

Do not use running-in oil for new or overhauled engines.

Oil viscosity

CUMMINS preferably recommends oils of viscosity class SAE 15W-40.

In order to assure perfect cold starting it is import to chose the viscosity (SAE-class) of the engine oil according to the ambient temperature.

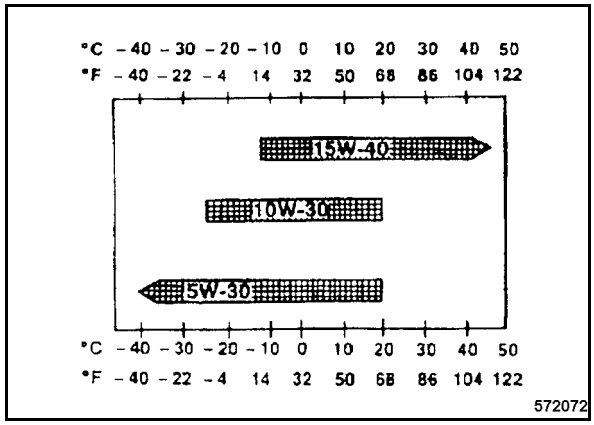


Fig. 82

Lubrication oil with a too high viscosity index causes starting difficulties. The temperature when starting the engine is therefore of highest importance when choosing the viscosity of engine oil for winter operation.

Occasional falling short of the temperature limit (e.g. use of SAE 15W/40 down to -15 °C) may effect the cold starting ability of the engine, but will not cause any engine damage.

Temperature related lubrication oil changes can be avoided by using multi-purpose oils. The following oil change intervals apply also when using multi-purpose oils.

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Oil quality

Lubrication oils are classified according to their performance and quality class. Specifications according to API (American Petroleum Institute) and CCMC (Committee of Common Market Automobile Constructors) are commonly used.

Permitted API-oils

API = CE/SG

Permitted CCMC-oils

CCMC = D5

If no oil of quality class CE/SG is available, you may also use oils of quality class CC/CD or CD/SF, when shortening the oil change intervals to half.

Lubrication oil change intervals

The longest permissible time a lubrication oil should remain in an engine is 6 months. If the following oil change intervals are not reached over a period of 6 months, the oil change should be performed at least every 6 months, irrespective of the operating hours reached.

API: CE = 250 operating hours

CCMC/D5 = 250 operating hours

API: CC/CD = 125 operating hours

Fuels

Quality

Use only commercially available brand diesel fuels with a low sulphur content.

Ensure strict cleanliness when filling in fuel.

Use only winter-grade diesel fuel under low ambient temperatures.

The fuel level should always be topped up in due time so that the fuel tank is never run dry, as otherwise filter and injection lines need to be bled.

The following fuel specifications are permitted:

CEN EN 590, DIN/EN 590;

DIN 51 601;

Nato Codes: F-54, F-75;

BS 2869: A1 and A2;

ASTM D 975-78: 1-D and 2-D.

VV-F-800C: DF-A, DF-1, DF-2.

Winter fuel

⚠ Danger

Danger of explosion!

Do not mix diesel fuel with gasoline or alcohol.

Use only winter-grade diesel fuel for winter operation, in order to avoid clogging by paraffin separation. At very low temperatures disturbing paraffin separation can also be expected when using winter diesel fuel.

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

Hydraulic oil

The hydraulic system (steering) is operated with hydraulic oil of quality ISO 6743/4 HM or HV (DIN 51524 part 2 or 3; CETOP RP 91 H) with a kinematic viscosity of 46 mm^2/s at 40 °C (ISO VG 46).

In countries with permanently high temperatures (tropical zones), where the hydraulic oil temperature can reach 80 °C (104 °F), a hydraulic oil with a kinematic viscosity of 68 mm^2/s at 40 °C (ISO VG 68) may be used.

In countries with temperatures permanently below –10 °C (14 °F), where the hydraulic oil temperature only reaches 30 °C (86 °F), a hydraulic oil with a kinematic viscosity of 32 mm^2/s at 40 °C (ISO VG 32) may be used.

For topping up or for oil changes use only high quality hydraulic oil corresponding with the permitted specifications.

Oil for powershift transmissions

The powershift transmission must be filled with the following oil:

DEXRON II D series at temperatures from -34 °C (-30 °F) to 60 °C (140 °F)

Always use the same type of oil for topping up.

⚠ Caution

Do not use any multi-purpose engine oils such as e.g. 15W/40.

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Oil for differential, gear housings

Use only transmission oil of API-class GL5 with a viscosity class SAE 80W/90.

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

Lubrication grease

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

Brake fluid

⚠ Danger

Danger of poisoning! Danger to life when consuming brake fluid.

Store brake fluid only in original cans.

Never fill brake fluid into beverage containers.

Change the brake fluid at least every two years.

Do not fill in mineral oil.

Use only brake fluid of specification ISO 4925, SAE J 1703f, DOT 3.

The brake fluid has been chosen for ambient temperatures from -50 °C (-58 °F) to 60 °C (140°F) and working temperatures from -50 °C (-58 °F) to 205 °C (400 °F). You may also use brake fluids of specification DOT 4 (Syntol HD 260).

Coolant

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

⚠ Caution

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

If no cooling system protection agent is available in tropical zones, you may also use a corrosion protection agent (CUMMINS Liquid DCA).

Do not mix in more than 50% cooling system protection agent, except when a lower frost protection is required. However, the proportion of cooling system protection agent should never exceed 68%. A higher concentrations the frost protection effect drops again.

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

Coolant must be changed every two years.

Environment

Cooling system protection agents must be disposed of environmentally.

Water quality:

100 (mg/dm^3) of sulphate

100 (mg/dm^3) chloride.

water hardness (°dGH) = 3 to 12

pH-value = 6,5 to 8,5.

Specification for cooling system protection agent

ASTM 4985 (GM6038M)

Anti-freeze concentration

Ethylene Glycol

40 % = -23 °C (-23,33 °C)

50 % = -37 °C (-36,67 °C)

60 % = -54 °C (-53,89 °C)

68 % = -71 °C (-67,78 °C)

Propylene Glycol

40 % = -21 °C (-21,11 °C)

50 % = -33 °C (-32,78 °C)

60 % = -49 °C (-48,89 °C)

68 % = -63 °C (-82 °F)

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5.3 Table of fuels and lubricants

Assembly	Fuel or lubricant		Quantity approx. Attention Observe the level marks
	Summer	Winter	
Engine	Engine oil CCMC-D4 or API: CE/SG SAE 15W/40 (-15 °C to +40 °C)		without oil filter change approx. 15,5 litres
	Fuel		
	Diesel	Winter diesel fuel	approx. 250 litres
Hydraulic system (steering)	Hydraulic oil (ISO), HV46, kinem. viscosity 46 mm^2/s at 40 °C		approx. 6,5 litres
Level compensation, front axle	Hydraulic oil (ISO), HV46, kinem. viscosity 46 mm^2/s at 40 °C		approx. 6 litres
Powershift transmission	ATF Dexron II D (-34 °C to +60 °C)		approx. 22 litres
Differential	Gear oil SAE 80W/90, API GL5		approx. 13,5 litres
Gear housings	Gear oil SAE 80W/90, API GL5		approx. 5,2 litre per side
Cooling system	Coolant		approx. 15 litres
Sprinkler system	Water		approx. 400 litres
Brake system	DOT 3, SAE J 1703F, ISO 4925		approx. 0,75 litres
Lubrication points	lithium saponified multi-purpose grease, penetration 2		as required

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5.4 Running-in instructions

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

⚠ Caution

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

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

After 50 operating hours

- Retighten bolted connections on intake and exhaust tubes, oil sump and engine mounts.
- Retighten bolted connections on axle and steering.
- Retighten all wheel fastening screws with the specified tightening torque.
- Change the oil in the differential.
- Change the oil in the gear housings.
- Change oil and filter in the powershift transmission

After 1000 operating hours

- Check the valve clearance, adjust if necessary
- Hydraulic oil filter for steering system.

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5.5 Maintenance chart

With all maintenance intervals perform also the work for shorter preceding service intervals.

No.	Designation	Note
Every 10 operating hours		
5.6	Check the engine oil level	Dipstick mark
5.7	Checking, cleaning the water separator	
5.8	Checking the fuel filter water separator	
5.9	Checking the brake fluid level	
5.10	Checking the V-belt	
5.11	Checking the coolant level	
5.12	Checking the water level in the sprinkler system	
5.13	Checking the fuel level	
5.14	Draining the air pressure vessel	
5.15	Checking the oil level in the steering oil tank	
5.16	Checking the oil level in the powershift transmission	Inspection glass
5.17	Checking, cleaning the scraper brushes	
Every 250 operating hours		
5.18	Changing engine oil and oil filter cartridge*	min. 1x per year
5.19	Checking, cleaning the cooling systemKühlanlage prüfen, reinigen	
5.20	Checking the parking brake, lubricating the linkage	
5.21	Lubricating the propshaft	
5.22	Checking the oil level in the differential	
5.23	Checking the oil level in the gear housings	
5.24	Checking, lubricating the front wheel bearings	
5.25	Lubricating the pendulum joints of the front wheels	
5.26	Lubricating the steering linkage	
Every 500 operating hours		
5.27	Servicing the battery	distilled water, pole grease
5.28	Changing the oil filter for the powershift transmission	
5.29	Checking the cleanliness of the pressure air for the brake system	
5.30	Changing the fuel filter cartridge	
5.31	Draining the sludge from the fuel tank	
5.32	Checking the brake linings	

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No.	Designation	Note
Every 1000 operating hours		
5.33	Checking V-belt tension, idler pulley and fan hub	
5.34	Changing the oil in the powershift transmission	min. 1x per year
5.35	Changing the oil in the differential	min. 1x per year
5.36	Changing the air drier for the brake system	min. 1x per year
5.37	Checking the braking and steering system	min. 1x per year
5.38	Checking the fastenings on the diesel engine	
Every 2000 operating hours		
5.39	Checking, adjusting the valve clearance	Intake = 0,25 mm (0,010 IN), exhaust = 0,50 mm (0.020 IN, with cold engine)
5.40	Changing oil and filter in the steering oil tank	
5.41	Changing the brake fluid	at least every 2 years
5.42	Changing the oil in the gear housings	at least every 2 years
5.43	Changing the coolant	at least every 2 years
5.44	Checking the supply lines for the compressor	
As required		
5.45	Checking, cleaning, changing the combustion air filter,	min. 1x every year, safety cartridge at least every 2 years
5.46	Cleaning the water sprinkler system	
5.47	Maintenance in case of frost	
5.48	Bleeding the fuel system	
5.49	Filling the windscreen washer system	
5.50	Changing the fresh air filter in the cabin	
5.51	Adjusting the brake	
5.52	Changing the tires	
5.53	Checking bolted connections for tight fit	
5.54	Temporary taking out of service	

* When using engine oil of class API CC/CD or CD/SF the oil change intervals must be reduced to half.

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5.6 Checking the engine oil level

i Note

The machine must stand on level ground. Shut the engine down and wait for approx. 15 minutes until all oil has run back into the oil sump.

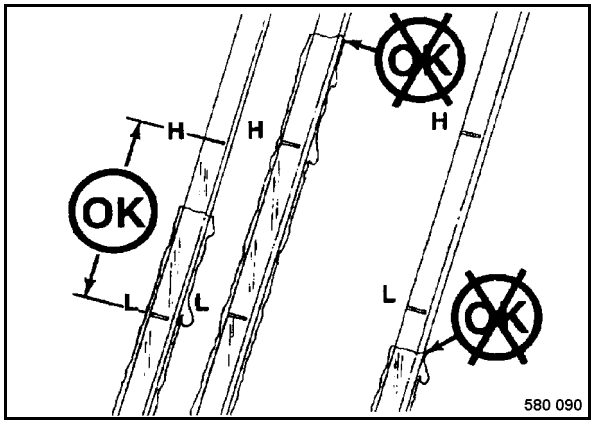


Fig. 83

- Pull the oil dipstick (Fig. 83) out, wipe it clean with a lint-free cloth and reinsert it until it bottoms.
- Pull the oil dipstick out again.
- The oil level must be between the "L" and "H"-marks.
- Top up oil immediately if the oil level is too low.
- If the oil level is too high detect the cause and drain the oil off.

⚠ Caution

Before a longer work period fill the oil up to the "MAX"-mark.

Filling quantity between "L" and "H" mark 4-cylinder engine:

approx. 1 Liter

For quality and quantity of oil refer to the table of fuels and lubricants.

5.7 Checking, cleaning the water separator

i Note

The service intervals for the water separator depend on the water content in the fuel and can therefore not be determined precisely. After taking the engine into operation you should therefore check the water separator every day for signs of water.

After cleaning refill the filter bowl with fuel.

Environment

Catch running out fuel and dispose of environmentally.

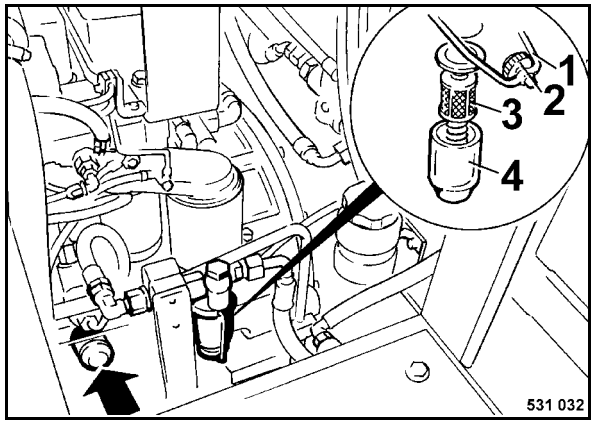


Fig. 84

- Slacken the clamping nut 2 (Fig. 84) and flip the bow (1) t the side.
- Take the filter bowl (4) with filter screen (3) off and clean it.
- Fill the filter bowl using the hand pump (arrow).
- After reassembling check the filter bowl for tight fit.

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5.8 Checking, cleaning the fuel filter water separator

⚠ Danger

Danger of injury!

Support the engine hood for all maintenance and repair work.

i Note

The service intervals for the water separator depend on the water content in the fuel and can therefore not be determined precisely. After taking the engine into operation you should therefore check the water separator every day for signs of water.

If a to high quantity is drained off, the filter must be refilled with fuel. See chapter "maintenance as required", bleeding the fuel system.

Environment

Catch running out fuel and dispose of environmentally.

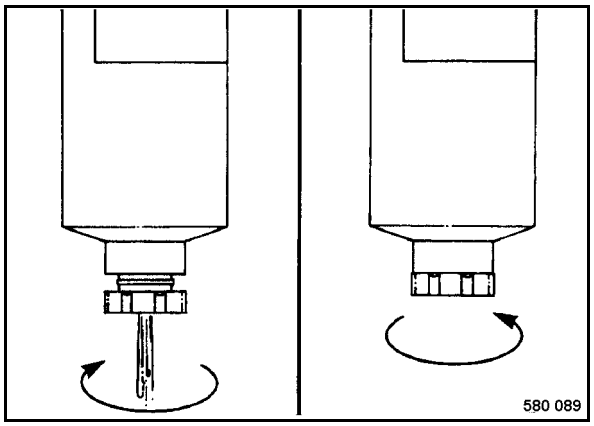


Fig. 85

- Slacken the drain plug (Fig. 85) for a few turns and catch running out fuel / water.
- Tighten the drain plug again and check for leaks, if necessary replace the seal ring.

5.9 Checking the brake fluid level

⚠ Danger

Danger of poisoning! Danger to life when consuming brake fluid.

Avoid direct contact with the skin, wear safety gloves.

Store brake fluid only in original cans.

Never fill brake fluid into beverage containers.

Do not fill in mineral oil.

When loosing brake fluid perform trouble shooting, check the brake hydraulics for leaks

⚠ Caution

Brake fluid may attack paint coatings.

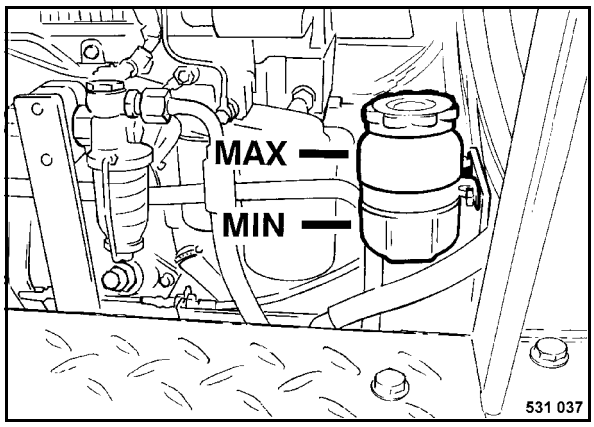


Fig. 86

- Check the brake fluid level (Fig. 86).
- Before topping up clean the area around the filler cap, unscrew the cap and fill in brake fluid up to the MAX-mark.

For quality of brake fluid refer to the section on fuels and lubricants.

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5.10 Checking the V-belt

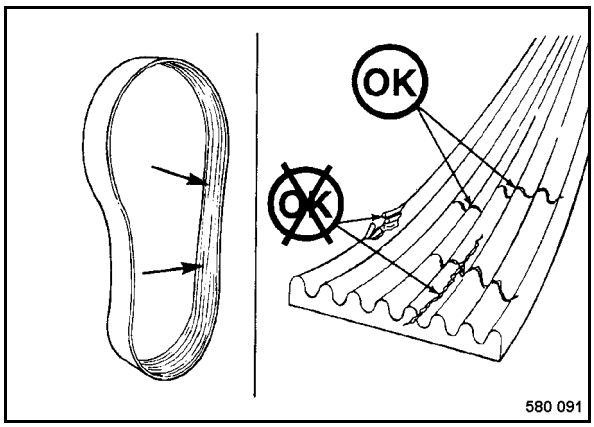


Fig. 87

- Check the condition of the V-belt (Fig. 87).

Small cracks in transverse direction are permitted.

Crack in longitudinal direction are not permitted.

- Replace the V-belt in case of broken out material, intersecting cracks in longitudinal and transverse direction or fraying.

5.11 Checking the coolant level

⚠ Danger

Danger of scalding!

Do not remove the cap from the compensation tank when the engine is still hot.

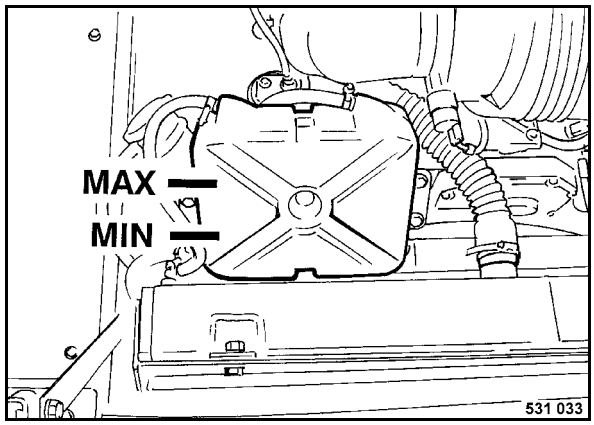


Fig. 88

- Check the coolant level (Fig. 88).

⚠ Caution

If, during the daily inspection the coolant level is found to have dropped, check all lines, hoses and engine for leaks.

Do not use radiator sealant to seal leaks.

Do not fill cold coolants into a hot engine.

- To top up unscrew the filler cap and fill in coolant up to the MAX-mark.

For quality of coolant refer to the chapter 5.2, fuels and lubricants.

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5.12 Checking the water level in the sprinkler system

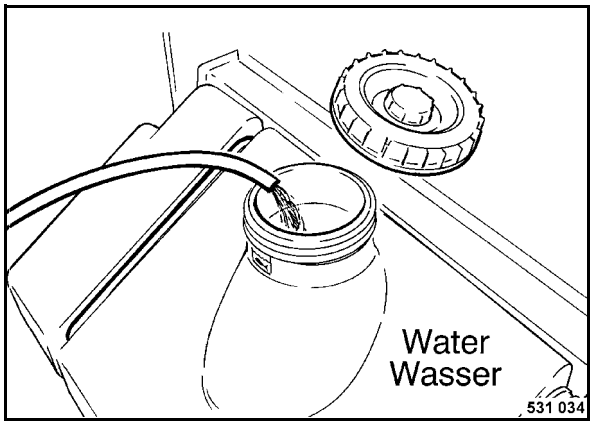


Fig. 89

- Unscrew the filler cap (Fig. 89) from the water tank and fill in clean water through the screen filter.
- Close the tank again.

⚠ Caution

In the event of frost observe the notes on "maintenance in case of frost".

Make sure that the ventilation bore in the tank cover is free.

5.13 Checking the fuel level, topping up fuel

⚠ Danger

Fire hazard!

When working on the fuel system do not use open fire, do not smoke, do not refuel in closed rooms, do not inhale any fuel fumes.

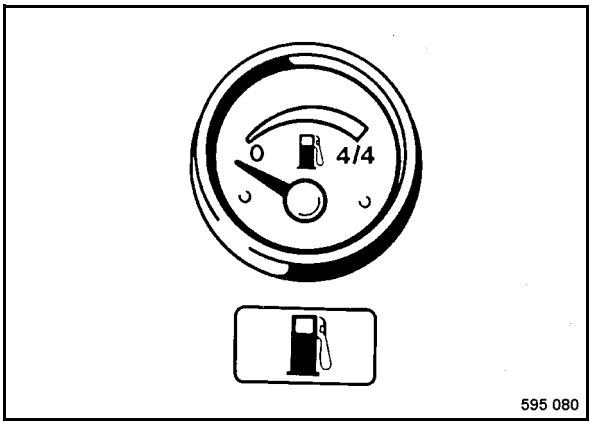


Fig. 90

- Check the fuel level on the fuel gauge (Fig. 90).

i Note

Do not drive the fuel tank dry, as otherwise the fuel system needs to be bled.

- Clean the area around the filler opening.

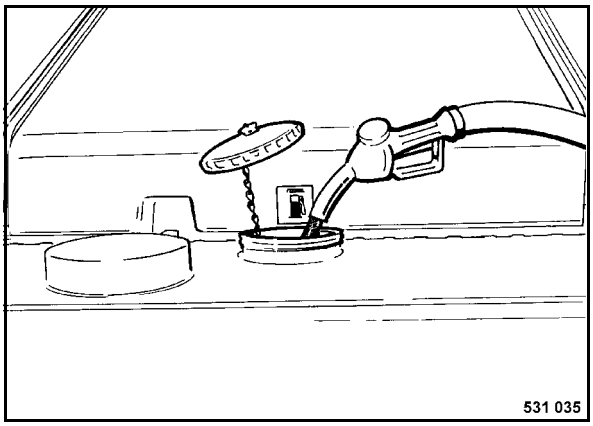


Fig. 91

- Open the fuel tank cover (Fig. 91).

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⚠ Caution

Contaminated fuel can cause malfunction or even damage of the engine.

If necessary, fill in fuel through a funnel with screen.

- If necessary top up with fuel (diesel or winter diesel).

For quality of fuel refer to the table of fuels and lubricants.

5.14 Draining the air pressure vessel

i Note

This work can be performed at the end of the working day when the pressure air vessel is completely full.

- Shut the engine down and operate the parking brake.

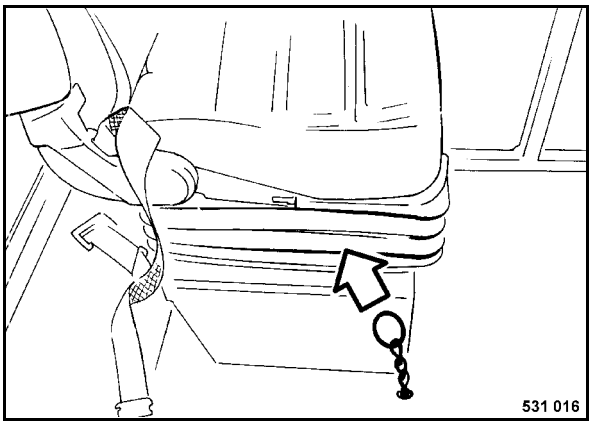


Fig. 92

- Pull the actuator chain (Fig. 92) for the drain valve for a short moment.

i Note

During the draining process listen to the sound of the escaping air.

If the sound changes while draining:

Remove the cover between the seats and check whether water or dirt comes out of the bleeding valve.

In this case the air drier must be replaced.

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5.15 Checking the oil level in the steering oil tank, topping up

- Open the service flap for the steering oil tank.

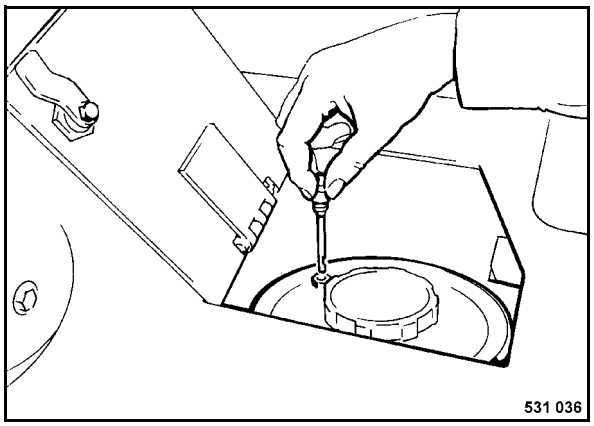


Fig. 93

- Turn the dipstick (Fig. 93) out and wipe it off with a clean cloth.
- Turn the dipstick back in and check the oil level again.

Nominal value:

top mark.

⚠ Caution

If, during the daily inspection of the oil level the hydraulic oil level is found to have dropped, check all lines, hoses and components for leaks.

- If necessary fill in oil and check for the cause of the oil loss.

For quality of oil refer to the table of fuels and lubricants.

5.16 Checking the oil level in the powershift transmission

i Note

This work can be performed at the end of the working day when the transmission oil has reached operating temperature.

⚠ Danger

Danger of injury!

Do not touch rotating parts of the engine.

Danger of scalding when oil is hot.

⚠ Caution

Check the oil level at a transmission oil temperature of approx. 82 ... 93 °C (180 to 200 °F).

- Remove the cover from between the pedals.
- Start the engine and run it at idle speed.

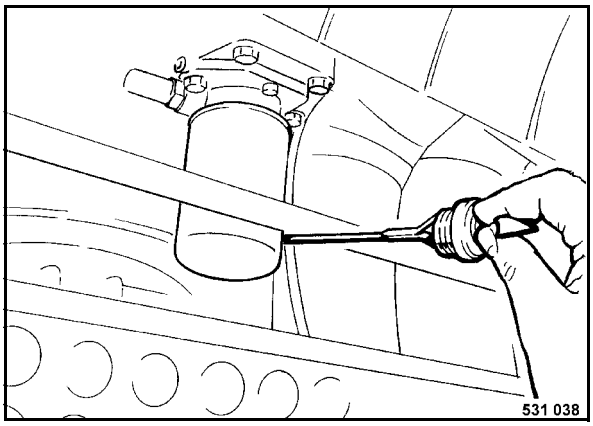


Fig. 94

- Turn the dipstick (Fig. 94) out and wipe it off with a clean cloth.
- Turn the dipstick back in and check the oil level again.

Nominal value:

top mark.

- If necessary fill in oil and check for the cause of the oil loss.

For quality of oil refer to the table of fuels and lubricants.

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5.17 Checking, cleaning the scraper brushes

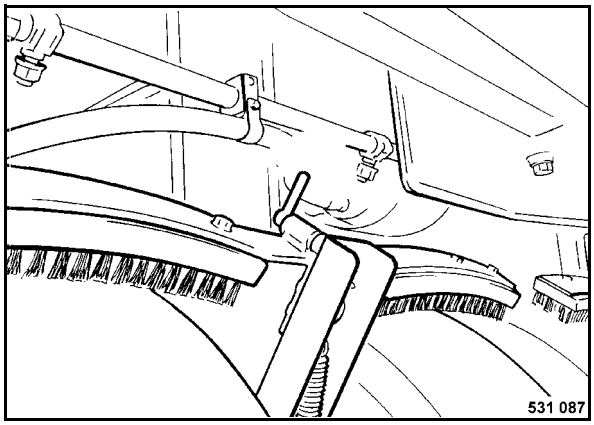


Fig. 95

- Check the condition of the scraper brushes (Fig. 95), replace if necessary.

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Every 10 operating hours

https://truckmanualshub.com/

5.18 Changing engine oil and oil filter cartridge

⚠ Caution

The oil change at 250 operating hours refers to the use of oils of oil quality class API CE/SG or CCM D5 respectively.

When using oils of quality classes API CC/CD or CD/SF the oil change intervals must be halved (see chapter 5.2, fuels and lubricants).

Drain the engine oil only when the engine is warm.

⚠ Danger

Danger of scalding!

When draining off hot oil.

By hot oil when unscrewing the engine oil filter.

Environment

Catch running out oil and dispose of environmentally together with the engine oil filter cartridge.

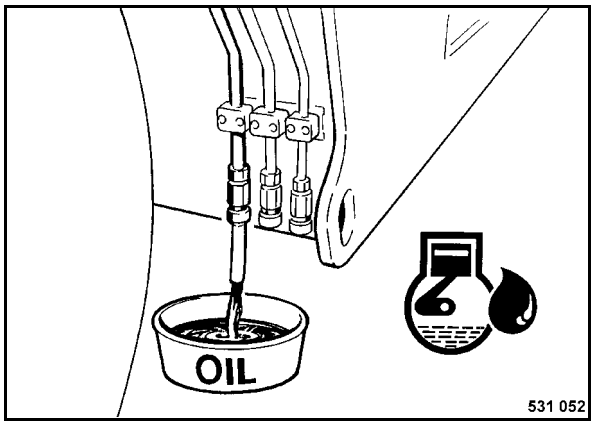


Fig. 96

- Take the drain hose from the accessories and connect it to the drain valve (Fig. 96).
- Catch running out oil with a suitable container.
- Remove the drain hose and close the drain valve with the protective cap.

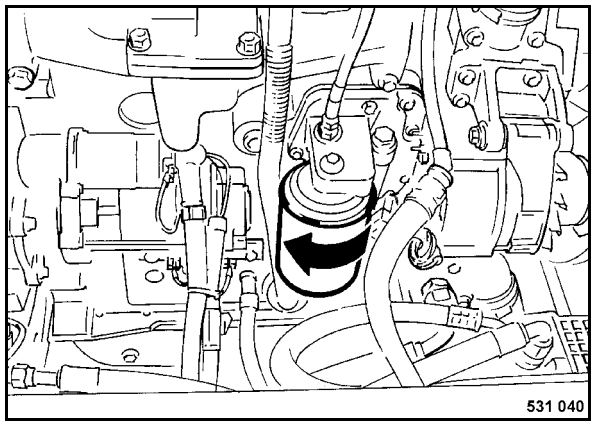


Fig. 97

- Unscrew the filter cartridge (Fig. 97) using an appropriate filter wrench.
- Clean the sealing face on the filter carrier from any dirt.

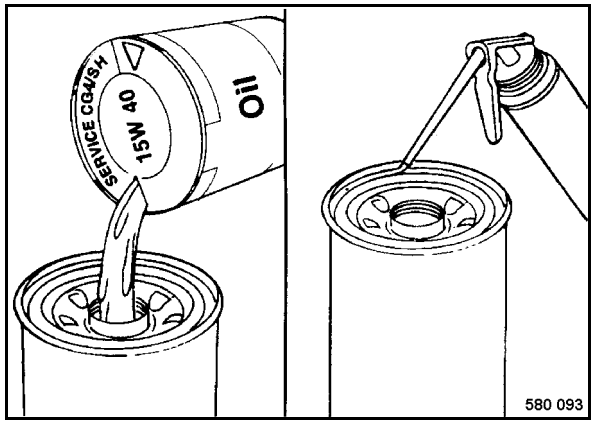


Fig. 98

- Fill the filter cartridge (Fig. 98) with fresh engine oil.
- Slightly oil the rubber seal on the new filter cartridge.

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Every 250 operating hours

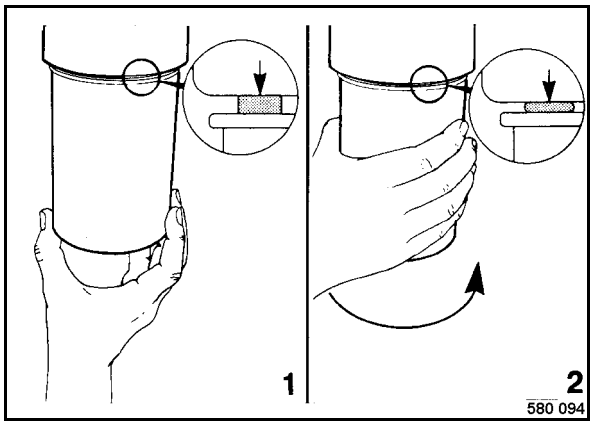


Fig. 99

- Turn the new filter cartridge (Fig. 99) on by hand, until the seal contacts.
- Tighten the filter element for another half turn.

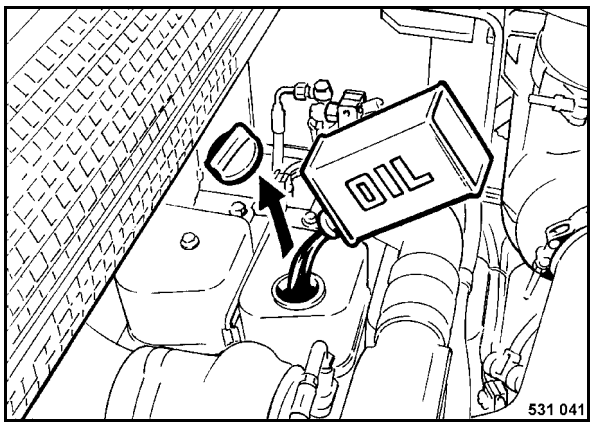


Fig. 100

- Fill in new engine oil (Fig. 100).

For quality and quantity of oil refer to the table of fuels and lubricants.

- Tighten the oil filler cap properly.
- After a short test run check the oil level on the dipstick, if necessary top up to the top dipstick mark.
- Check filter cartridge and drain plug for leaks after a short test run.
- Shut the engine down and wait for about 15 minutes, so that all oil can flow back into the oil sump.

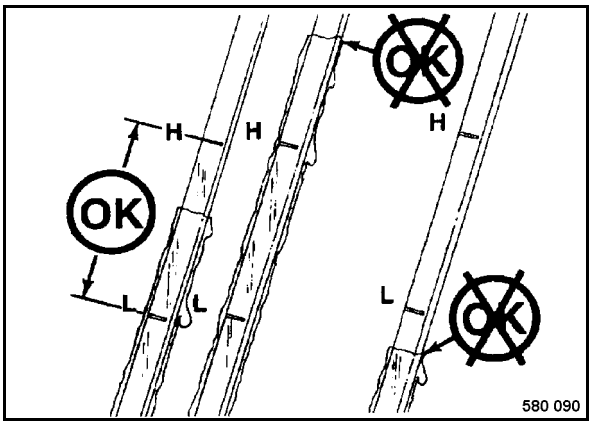


Fig. 101

- Check the oil level again (Fig. 101), if necessary fill up to the top dipstick mark.

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5.19 Checking, cleaning the cooling systemKühlanlage prüfen, reinigen

⚠ Danger

Danger of injury!

Perform cleaning work only after the engine has cooled down and with the engine stopped.

⚠ Caution

Do not damage any cooling fins on the cooler core when cleaning.

i Note

Dirt on fan blades and oil cooler reduce the cooling effect. Dirt deposits in these areas are substantially supported by oil and fuel on these surfaces. For this reason you should always seal and oil or fuel leaks in the vicinity of the cooling fan or the oil cooler and clean the cooling surfaces after.

- Check the condition and tightness of all radiator hoses.

Cleaning with compressed air

i Note

Start to blow out from the exhaust side.

If necessary remove the radiator cover.

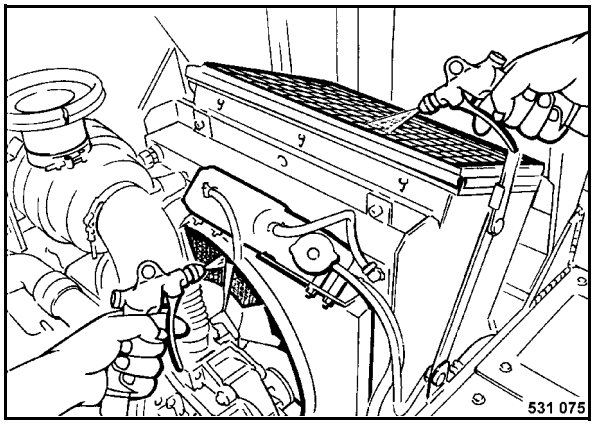


Fig. 102

- Blow the radiator (Fig. 102) out with compressed air.

Cleaning with cold cleansing agent

⚠ Caution

Protect electrical equipment such as generator, regulator and starter against the direct water jet.

Environment

Perform cleaning only in permitted areas with oil separator.

- Spray the radiator with a suitable cleansing agent, e.g. cold cleanser, let it soak in for a while and spray it off with a strong water jet.
- Run the engine warm for a while to avoid corrosion.

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5.20 Checking the parking brake, lubricating the linkage

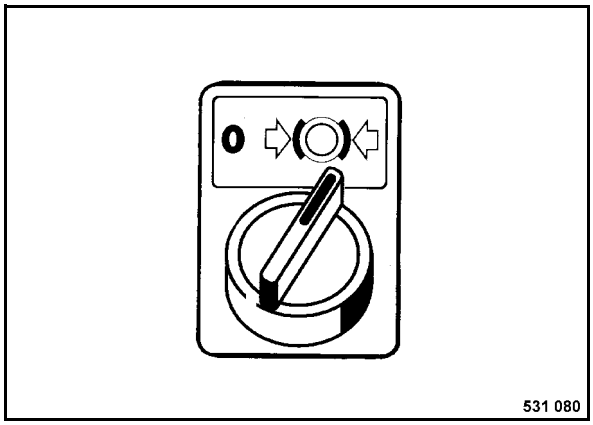


Fig. 103

- Apply the parking brake (Fig. 103) and perform a drive test.

The machine should not move.

- Remove the floor plate between the seats.

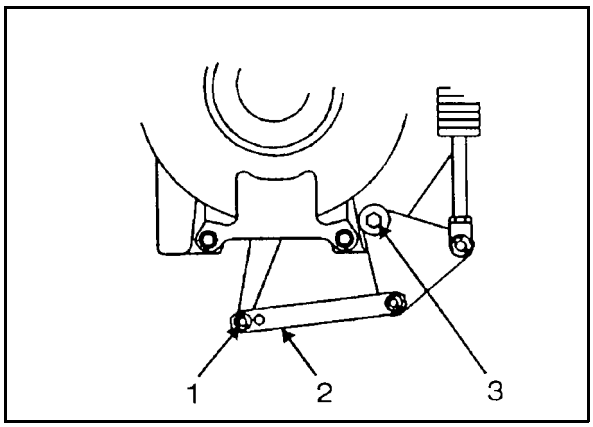


Fig. 104

- Operate the parking brake and check the position of the brake lever (Fig. 104).
- If the movement of the brake lever in moving direction exceeds the vertical position, change the connection between brake lever and pulling rod (1) to the second hole in the pulling rod (2).

⚠ Caution

Do not soil the brake disc with grease.

- Clean the grease nipple (3) and lubricate it with max. 2 strokes from the grease gun.

For quality of grease refer to the chapter 5.2, fuels and lubricants.

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5.21 Lubricating the propshaft

- Remove the floor plate between the seats.

⚠ Caution

Do not soil the brake disc with grease.

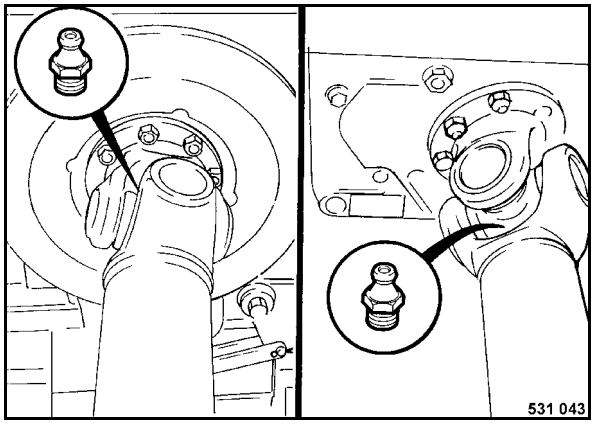


Fig. 105

- Clean the grease nipples and lubricate the propshaft with the grease gun (Fig. 105) until fresh grease emerges from the bearings.

For quality of grease refer to the chapter 5.2, fuels and lubricants.

5.22 Checking the oil level in the differential, topping up

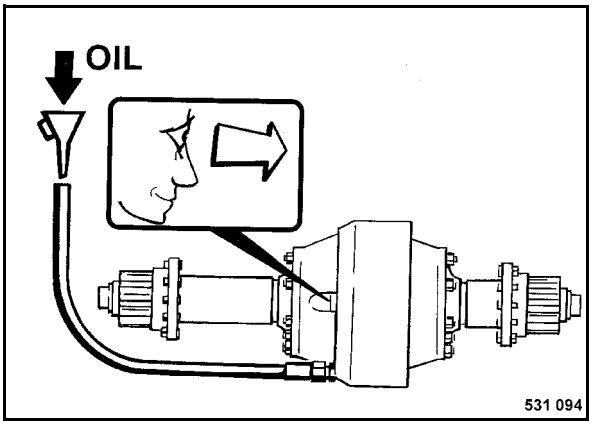


Fig. 106

- Unscrew the oil level inspection plug (Fig. 106) and check the oil level.

The oil level must reach the bottom edge of the level bore.

- If necessary investigate the reason for the oil loss.
- If topping up is required fasten the oil drain hose to the drain valve and fil in oil, until it starts to run out through the level inspection bore.
- Remove the drain hose and close the drain valve with the protective cap.
- Turn the level inspection plug tightly back in.

For quality of oil refer to the table of fuels and lubricants.

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5.23 Checking the oil level in the gear housings

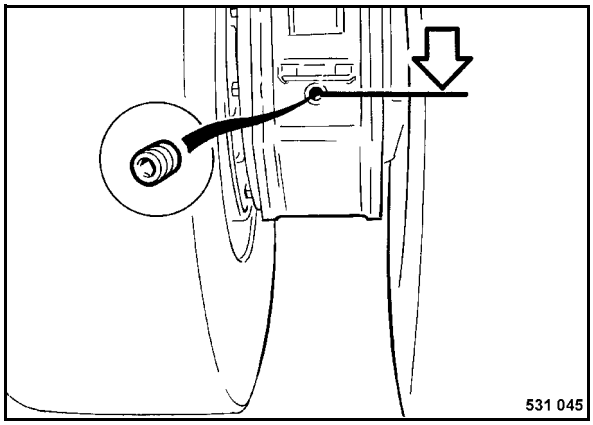


Fig. 107

- Clean the area around the filler plug (Fig. 107).
- Unscrew the oil filler plug.
- Check the oil level.

Nominal value:

The oil level must reach the bottom edge of the level bore.

- If necessary fill in oil and check for the cause of the oil loss.
- Repeat this inspection on the other side.

For quality of oil refer to the table of fuels and lubricants.

5.24 Checking, lubricating the front wheel bearings

⚠ Danger

Danger of squashing!

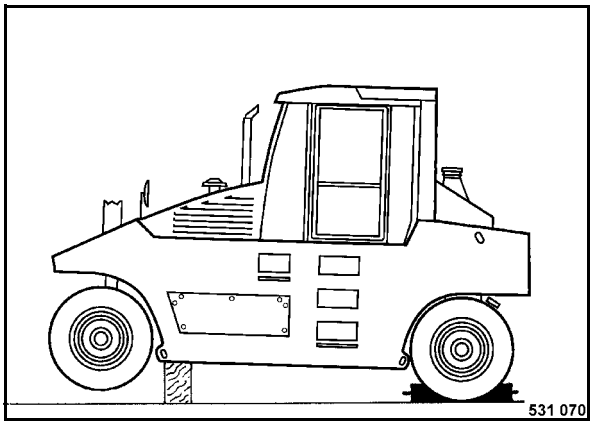


Fig. 108

- Secure the rear wheels with chocks (Fig. 108).
- Lift the front of the machine, so that the wheels can turn freely.
- Support the machine safely.

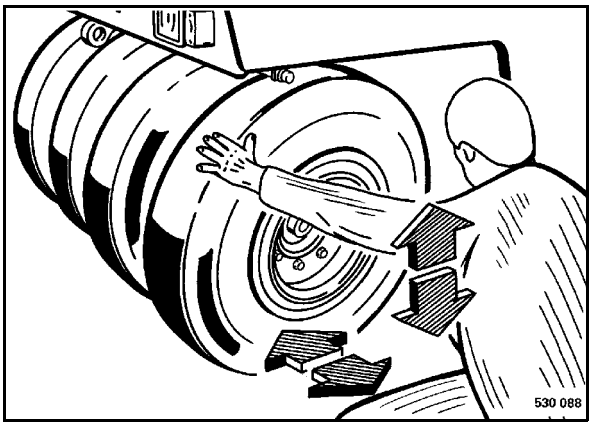


Fig. 109

- Move the wheels sideways (Fig. 109) to find out whether there is a noticeable play, if necessary adjust the wheel bearings.

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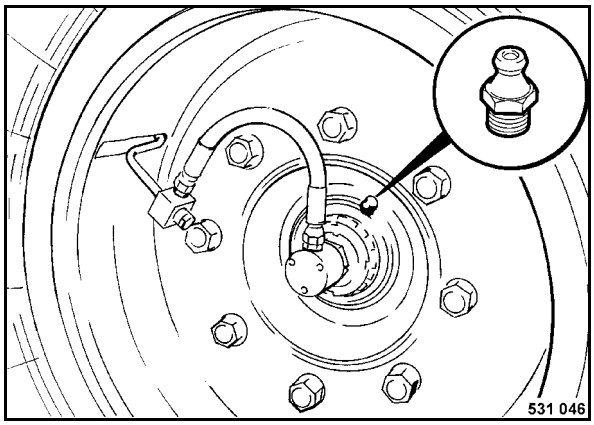


Fig. 110

- Pull off the safety cap (Fig. 110) and clean the grease nipple.
- Lubricate the wheel bearing with approx. 5 shots from the grease gun.
- Repeat this procedure on all other wheels.

For quality of grease refer to the chapter 5.2, fuels and lubricants.

5.25 Lubricating the pendulum joints of the front wheels

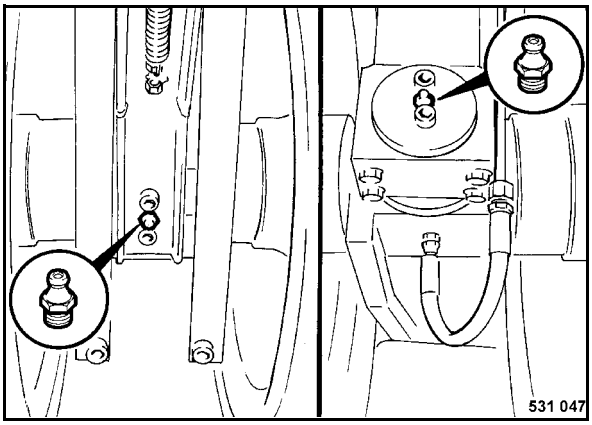


Fig. 111

- Pull off the safety cap (Fig. 111) and clean the grease nipple.
- Lubricate the bearing with approx. 5 shots from the grease gun.
- Repeat this measure on the opposite side.

For quality of grease refer to the chapter 5.2, fuels and lubricants.

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5.26 Lubricating the steering linkage

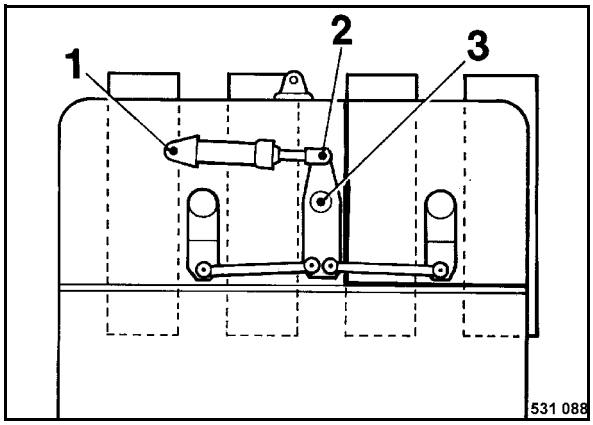


Fig. 112

- Pull off all safety caps (Fig. 112) and clean the grease nipples.
- Lubricate the bearing with approx. 5 shots from the grease gun.

For quality of grease refer to the chapter 5.2, fuels and lubricants.

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5.27 Servicing the battery

⚠ Danger

Danger of causticization !

When working on the battery do not use open fire, do not smoke!

Do not let acid come in contact with skin or clothes!

Wear protective clothing!

Do not lay any tools on the battery!

For recharging remove the plugs from the battery to avoid the accumulation of highly explosive gases.

Environment

Dispose of the old battery environmentally.

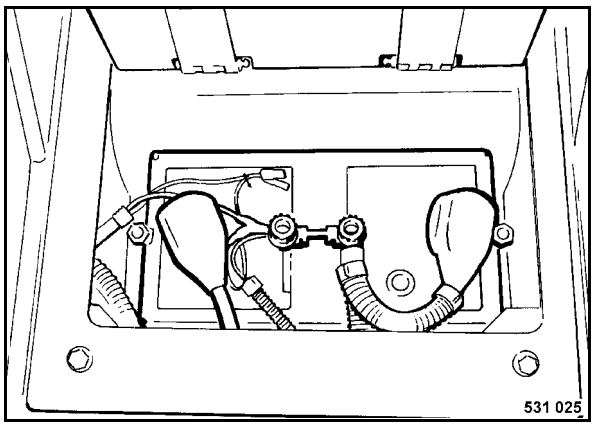


Fig. 113

- Remove the battery (Fig. 113) and clean the battery compartment.
- Clean the outside of the battery.
- Clean battery poles and pole clamps and grease them with pole grease (Vaseline).
- Check the fastening of the battery.
- On serviceable batteries check the acid level, if necessary top up to the filling mark with distilled water.

5.28 Changing the oil filter for the powershift transmission

⚠ Danger

Danger of scalding!

Let the transmission oil cool down below 50 °C (122 °F).

Environment

Catch running out oil and dispose of environmentally together with the transmission oil filter cartridge.

- Remove the cover from between the pedals.

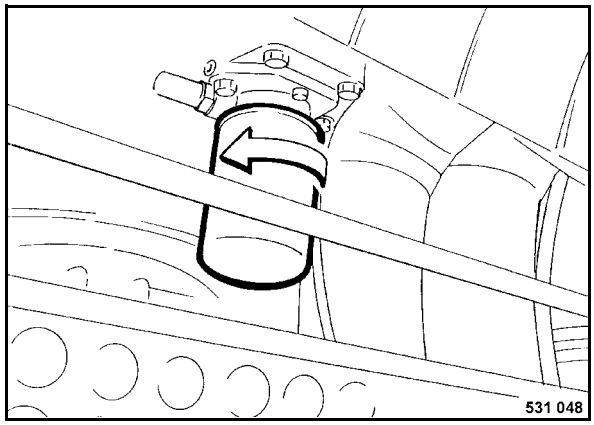


Fig. 114

- Unscrew the filter cartridge (Fig. 114) using an appropriate filter wrench.
- Clean the sealing face on the filter carrier from any dirt.
- Slightly oil the rubber seal on the new filter cartridge.

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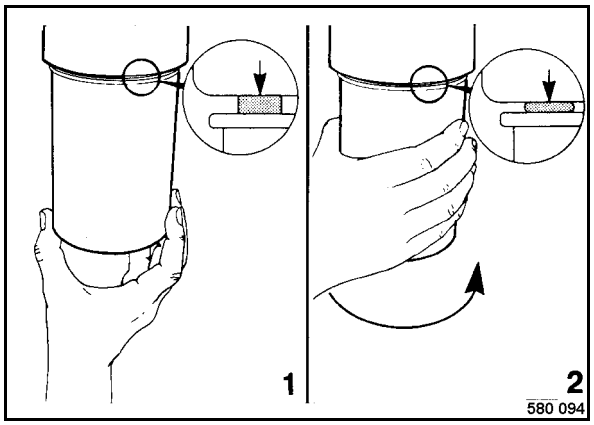


Fig. 115

- Turn the new filter cartridge (Fig. 115) on by hand, until the seal contacts.
- Tighten the filter element for another half turn.
- Perform a short test run and check for leaks, if necessary top up oil.

5.29 Checking the cleanliness of the pressure air for the brake system

- Run the engine, until the air pressure vessel for the brake is filled with a pressure of 6,5 bar (95 psi).
- Shut the engine down and operate the parking brake.
- Remove the floor plate between the seats.

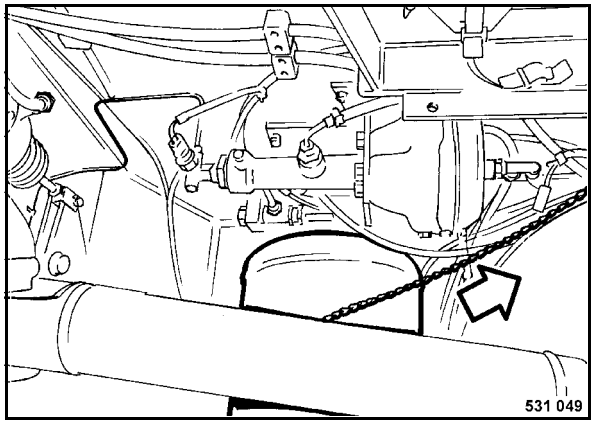


Fig. 116

- Operate the actuating chain (Fig. 116) of the drain valve and check the cleanliness of the air escaping under the pressure air vessel.

⚠ Caution

If the escaping air is dirty or contains water, replace the air drier cartridge immediately.

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5.30 Changing the fuel filter cartridges

⚠ Danger

Fire hazard!

When working on the fuel system do not use open fire, do not smoke, do not spill any fuel.

Catch running out fuel, do not let it seep into the ground.

Do not inhale any fuel fumes.

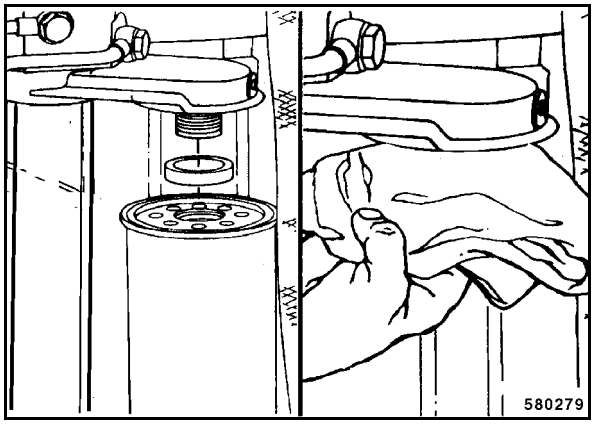


Fig. 117

- Unscrew the filter cartridge (Fig. 117) with a suitable filter wrench.
- Clean the sealing faces on the filter carrier from all dirt.

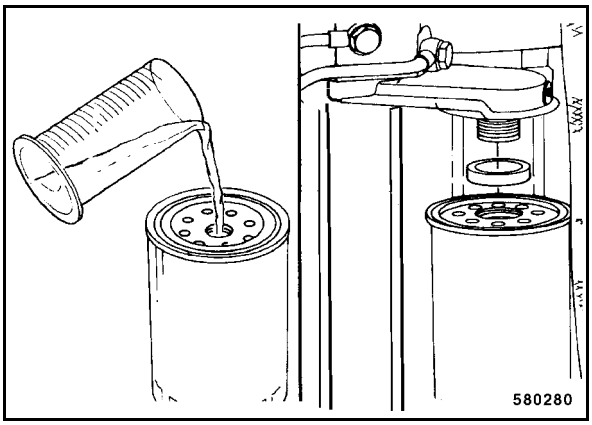


Fig. 118

- Fill the new filter cartridge (Fig. 118) with clean fuel according to the table of fuels and lubricants.
- Cover the seal rings lightly with oil.

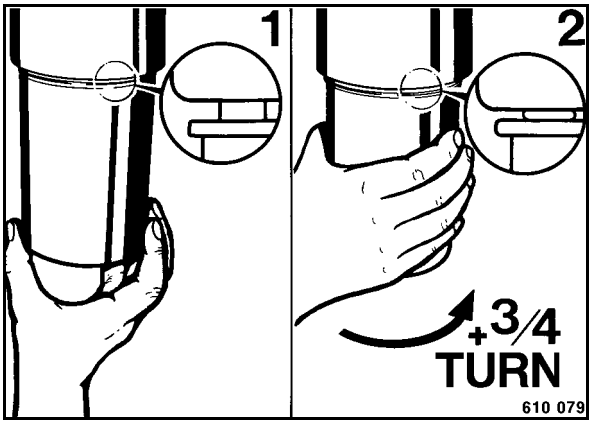


Fig. 119

- Screw the filter cartridge on by hand until the seal touches the filter head 1 (Fig. 119).
- Tighten for a 3/4 turn (2).

i Note

Small amounts of air, which enter the fuel system when changing the filter, are automatically discharged through the return line.

Manual bleeding

- if the filter has not been filled with fuel before removal,
- if the injection pump has been changed,
- if injection lines were changed
- if the fuel tank has been driven empty.

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Observe 'Bleeding the fuel system' in the paragraph "Maintenance as Required".

5.31 Draining the sludge from the fuel tank

⚠ Danger

Fire hazard!

When working on the fuel system do not use open fire, do not smoke!

Do not spill any fuel.

Do not inhale any fuel fumes.

Environment

Catch running out fuel, do not let it seep into the ground.

i Note

Before draining off the sludge wait until the fuel has settled.

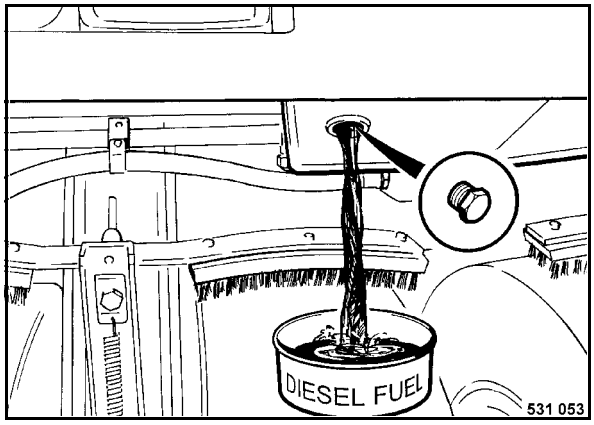


Fig. 120

- Unscrew the plug (Fig. 120) and drain off approx. 5 litres of fuel.
- Turn the plug tightly back in.

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5.32 Checking the brake linings

⚠ Danger

Danger of squashing!

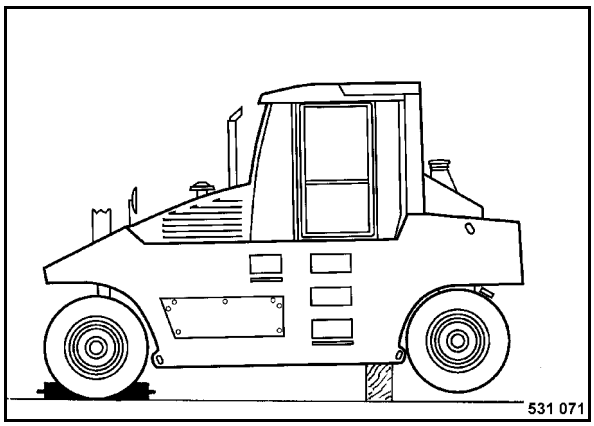


Fig. 121

- Secure the front wheels with chocks (Fig. 121).
- Lift the rear of the machine, so that the wheels can turn freely.
- Support the machine safely.

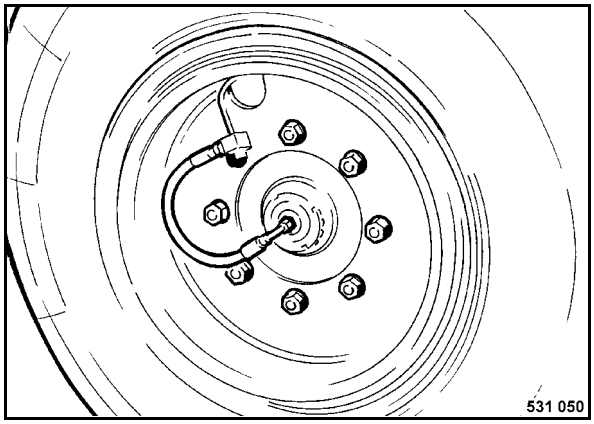


Fig. 122

- Disconnect the air hose 1 (Fig. 122) from the hub.
- Unscrew the wheel nuts and take the wheel off.
- Release the parking brake.

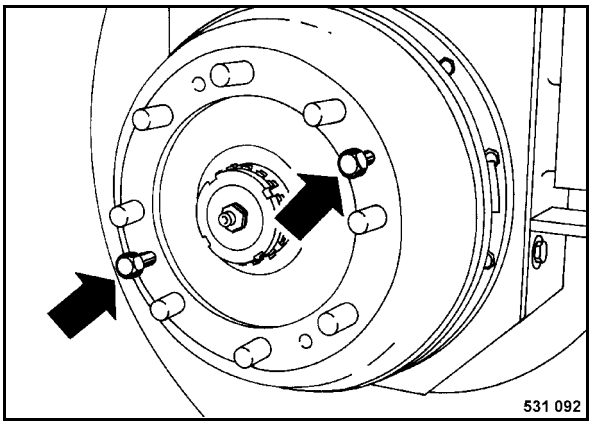


Fig. 123

- Pull the brake drum off, if necessary use forcing screws (Fig. 123).
- Check the condition of brake linings, brake drum and tightness of brake cylinders, if necessary have the brake repaired by a specialist.

Nominal value brake lining thickness:

minimum 2 mm

⚠ Caution

If the brake lining thickness is found to be 4 mm or less, the next inspection of the brake lining thickness must already be performed after 250 operating hours.

Brake linings with a thickness of less than 2 mm must be replaced immediately.

Retighten the wheel nuts with 340 Nm (250 ft lbs).

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Every 500 operating hours

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5.33 Checking V-belt tension, idler pulley and blower hub

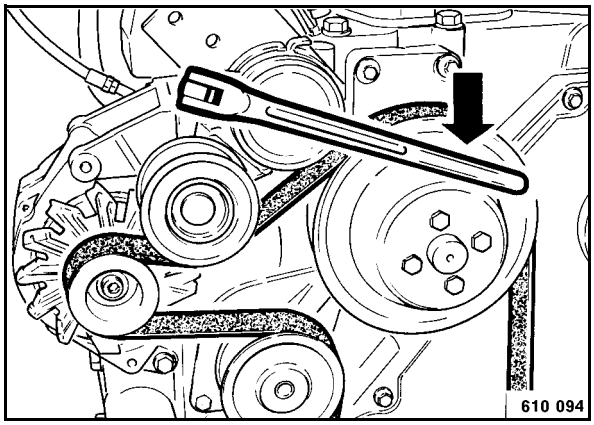


Fig. 124

- Lift the idler pulley up by means of a socket wrench (Fig. 124) and take the V-belt off.

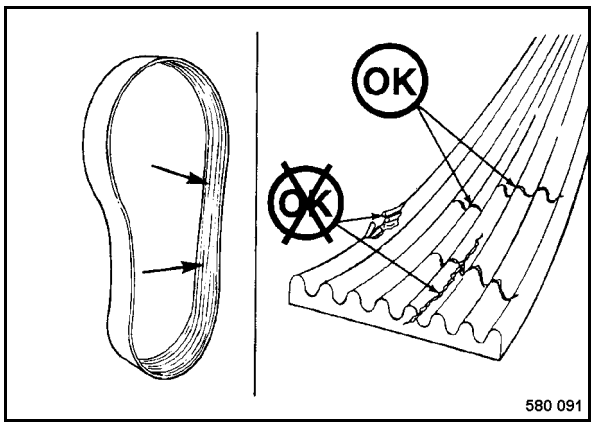


Fig. 125

- Check the condition of the V-belt (Fig. 125).

Small cracks in transverse direction are permitted.

Cracks in longitudinal direction are not permitted.

Replace the V-belt in case of broken out material, intersecting cracks in longitudinal and transverse direction or fraying.

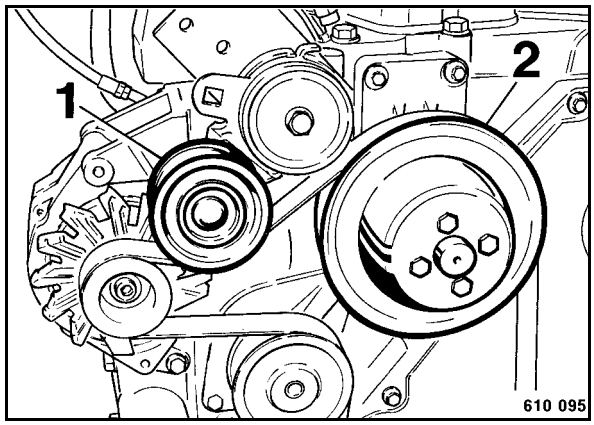


Fig. 126

- Check the bearings for idler pulley 1 (Fig. 126) and blower hub (2), replace if necessary.
- Reinstall the V-belt.

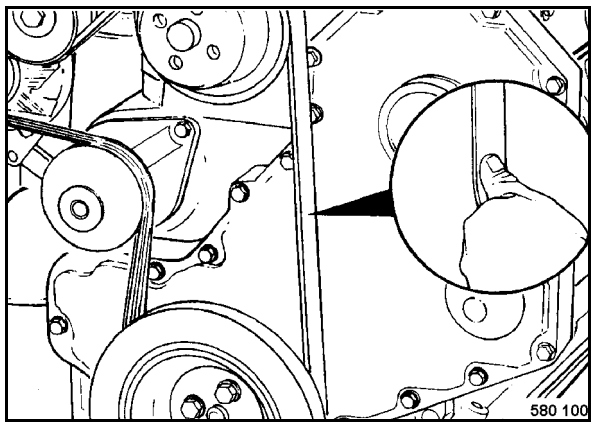


Fig. 127

- Check the V-belt tension (Fig. 127).

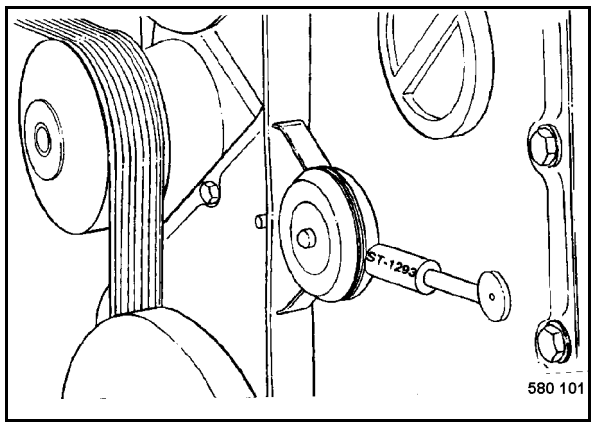


Fig. 128

We recommend to use the Cummins V-belt tension tester (Fig. 128) Part. No. ST-1293.

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Nominal value:
267 to 578 N (60 to 130 Lbf)

5.34 Changing the oil in the powershift transmission

⚠ Danger

Danger of scalding!

Let the transmission oil cool down below 50 °C (122 °F).

Environment

Catch running out oil and dispose of environmentally together with the transmission oil filter cartridge.

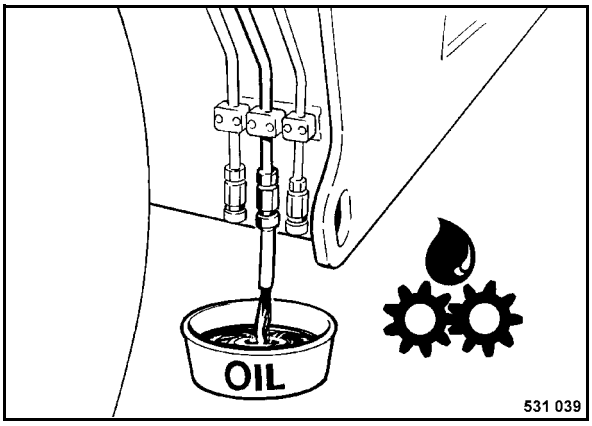


Fig. 129

- Take the drain hose from the accessories and connect it to the drain valve (Fig. 129).
- Catch running out oil with a suitable container.
- Remove the drain hose and close the drain valve with the protective cap.
- Remove the cover from between the pedals.

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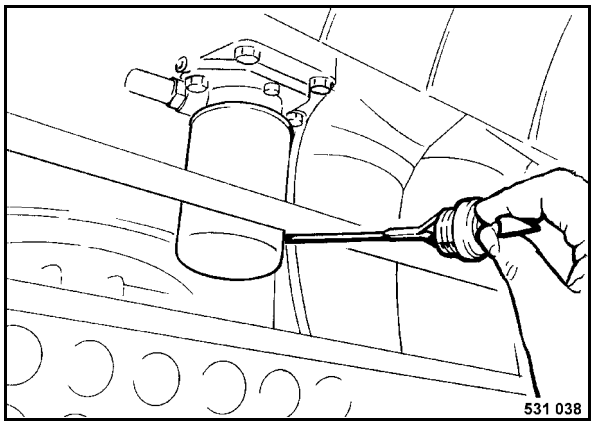


Fig. 130

- Pull the dipstick (Fig. 130) out and fill in oil.

For quality and quantity of oil refer to the table of fuels and lubricants.

- Replace the oil filter for the powershift transmission (see chapter “every 500 operating hours”).
- Start the engine and check the oil level after running 2 minutes with idle speed.
- Perform a test run and check the oil level again at a transmission oil temperature of 82 ... 93 °C (180 - 200 °F), if necessary top up to the MAX-mark.

5.35 Changing the oil in the differential

Environment

Catch the oil and dispose of environmentally.

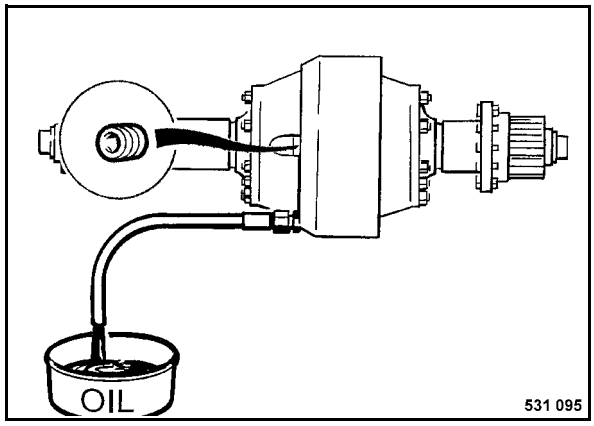


Fig. 131

- Take the drain hose from the accessories and connect it to the drain valve (Fig. 131).
- Catch running out oil with a suitable container.

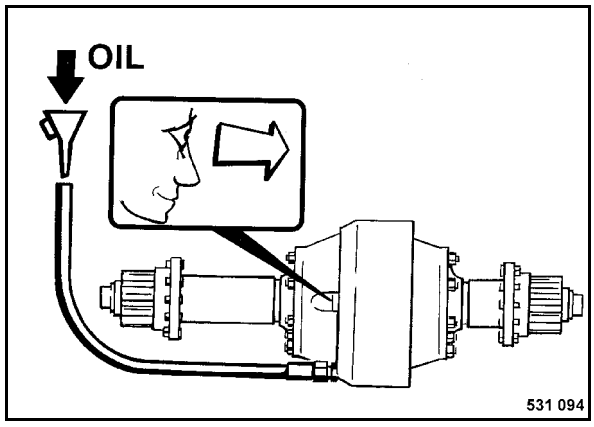


Fig. 132

- Unscrew the oil level control plug (Fig. 132).
- Fill in oil through the drain hose until the oil level reaches the bottom edge of the level inspection bore.
- Remove the drain hose and close the drain valve with the protective cap.
- Turn the level inspection plug tightly back in.

For quality and quantity of oil refer to the table of fuels and lubricants.

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5.36 Changing the air drier for the brake system

Environment

Dispose of the filter environmentally.

Note

The filter cartridge is located on the right hand side under the floor plate of the operator's platform.

- Run the engine, until the air pressure vessel for the brake is filled with a pressure of 6,5 bar (95 psi).
- Shut the engine down and operate the parking brake.
- Remove the floor plate between the seats.

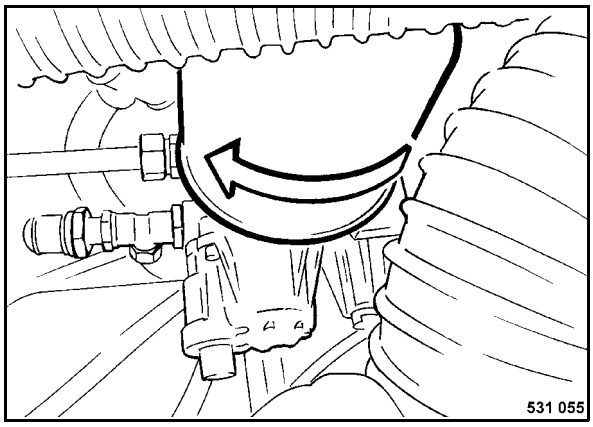


Fig. 133

- Unscrew the filter cartridge (Fig. 133) using an appropriate filter wrench.
- Clean the sealing face on the filter carrier from any dirt.
- Slightly oil the rubber seal on the new filter cartridge.
- Turn the new filter cartridge on by hand, until the seal contacts.
- Tighten the filter element for another half turn.

5.37 Checking the braking and steering system

Caution

The following tests must be carried out by a specialist at least once every year

- Condition and tightness of the entire pressure air operated brake system
- Condition and function of the parking brake system (emergency brake).
- Condition and tightness of the service brake (hydraulic)
- Condition and tightness of the steering hydraulics.
- Condition and tight fit of the mechanical components in the steering system.

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5.38 Checking the fastening elements on the engine

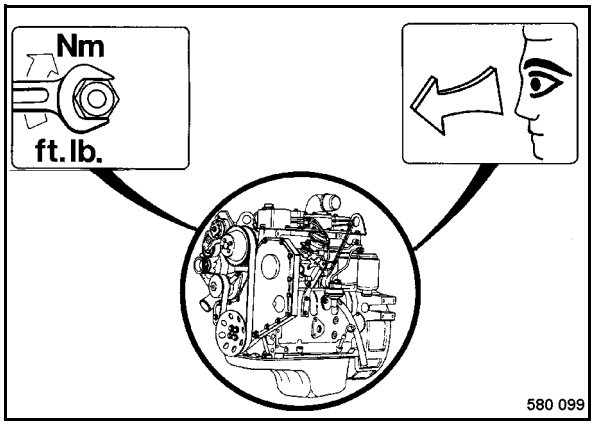


Fig. 134

- Check the fastening of air intake and exhaust tube (Fig. 134) on the cylinder heads for tight fit.
- Check the bellows and clamps between air filter, turbo charger and charge air line as well as the lubrication oil line for tight fit.
- Check the fastening screws for the oil sump and the engine mounts for tight fit.

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Every 1000 operating hours

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5.39 Check, adjust the valve clearance

⚠ Caution

Before checking the valve clearance let the engine cool down for at least 30 minutes. The engine oil temperature must be less than 60 °C.

After a short test run check the engine for leaks.

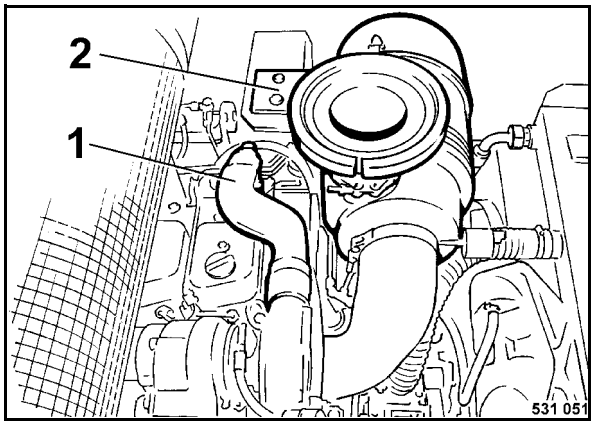


Fig. 135

- Disconnect air filter 1 (Fig. 135) and pressure line (2) from the turbo charger.

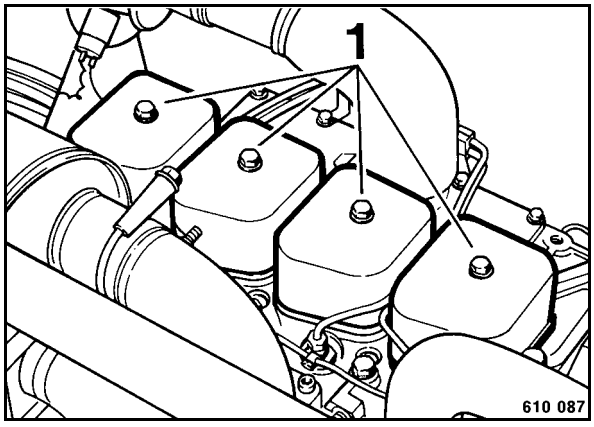


Fig. 136

- Remove all valve covers 1 (Fig. 136).

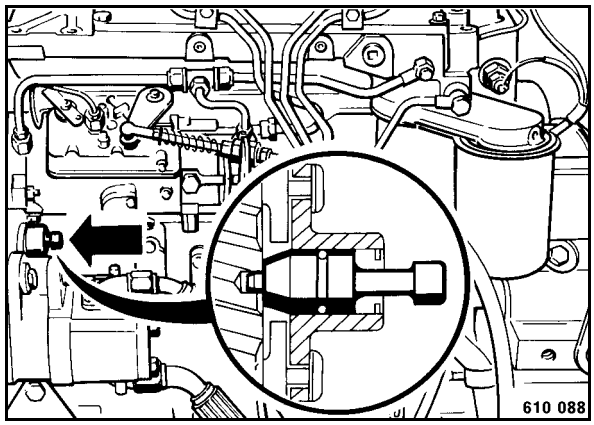


Fig. 137

- Press the adjustment mandrel (Fig. 137) in.

⚠ Caution

Release the mandrel again after the adjustment.

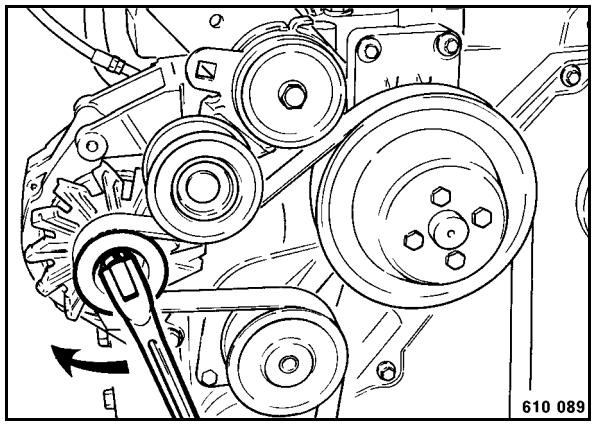


Fig. 138

- Turn the engine slowly (Fig. 138) until the adjustment mandrel engages.

The engagement position of the adjustment mandrel complies exactly with the top dead centre of the first cylinder during the compression stroke.

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Every 2000 operating hours

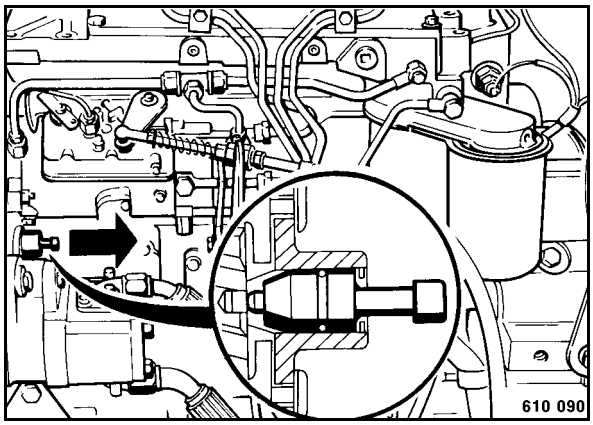


Fig. 139

⚠ Caution

Release the mandrel (Fig. 139) again after the adjustment.

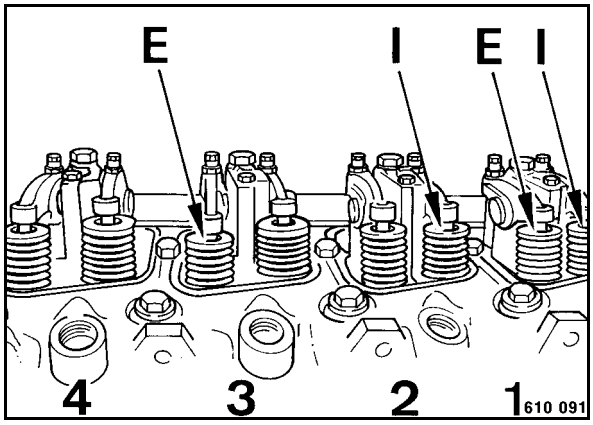


Fig. 140

- Check the clearance between rocker arm and valve (Fig. 140) with a feeler gauge, adjust if necessary.

Setpoint :

Intake valve (I) 0,25 mm (0.010 IN)

Exhaust valve (E) 0,50 mm (0.020 IN)

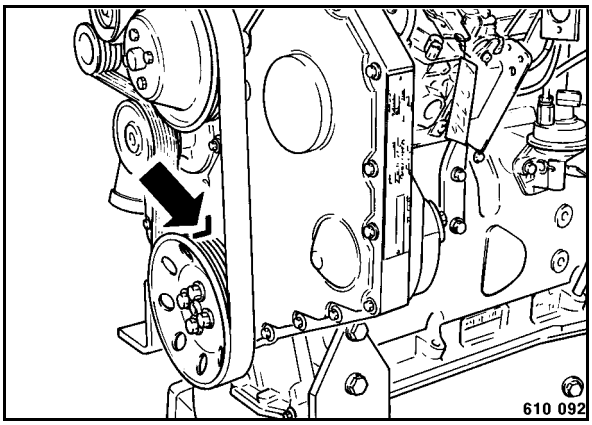


Fig. 141

- Mark the V-belt pulley (Fig. 141) and turn the engine one revolution (360°) further.

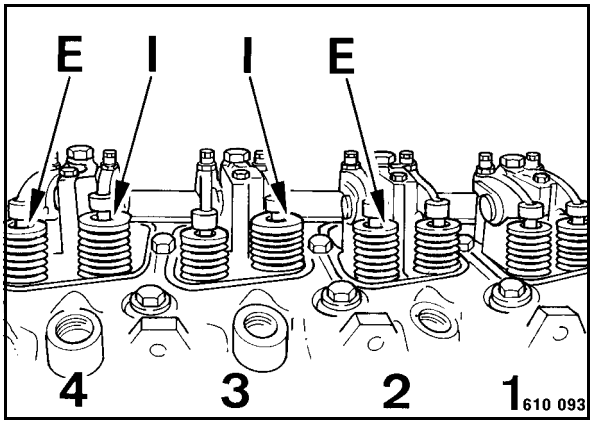


Fig. 142

- Check the valve clearance on all other valves (Fig. 142) and adjust if necessary.
- Check the gasket of the valve cover, replace it if necessary.
- Reassemble the cylinder head cover.
- Swivel the ventilation valve back to correct position and fasten it.
- Fasten the air filter again and ensure correct fit of combustion air hoses and clamps.

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5.40 Changing oil and filter in the steering oil tank

Environment

Catch running out oil and dispose of environmentally together with the oil filter cartridge.

- Open the service flap for the steering oil tank.

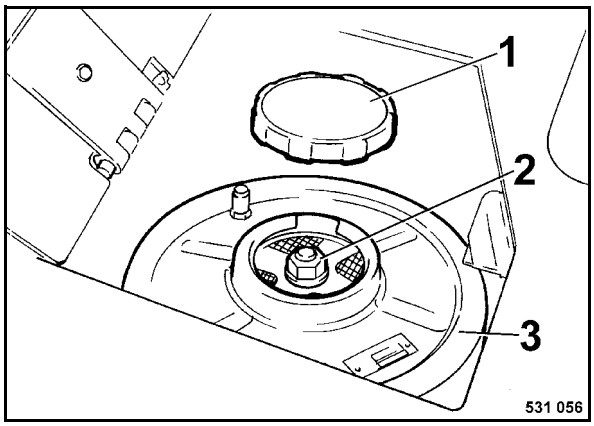


Fig. 143

- Unscrew the tank cover 1 (Fig. 143) from the steering oil tank.
- Unscrew the fastening nut (2).
- Remove the cover from the steering oil tank (3).

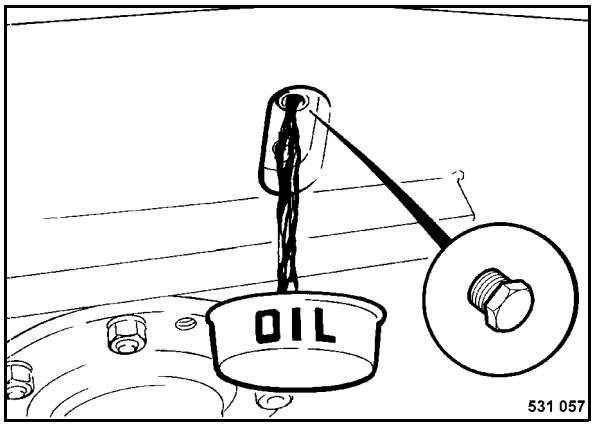


Fig. 144

- Unscrew the drain plug (Fig. 144) and catch running out oil.
- Turn the drain plug tightly back in.
- Replace the filter element in the tank.
- Reassemble the tank cover and fill in oil

For quality and quantity of oil refer to the table of fuels and lubricants.

- Start the engine and operate the steering several to the right and to the left agsint the end stops.
- Shut the engine down.
- Check the oil level again.

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5.41 Changing the brake fluid

⚠ Danger

Danger of poisoning! Danger to life when consuming brake fluid.

Avoid direct contact with the skin, wear safety gloves.

Store brake fluid only in original cans.

Never fill brake fluid into beverage containers.

Do not fill in mineral oil.

When loosing brake fluid perform trouble shooting, check the brake hydraulics for leaks

Danger of squashing when jacking the machine up.

Environment

Catch all brake fluid and dispose of environmentally.

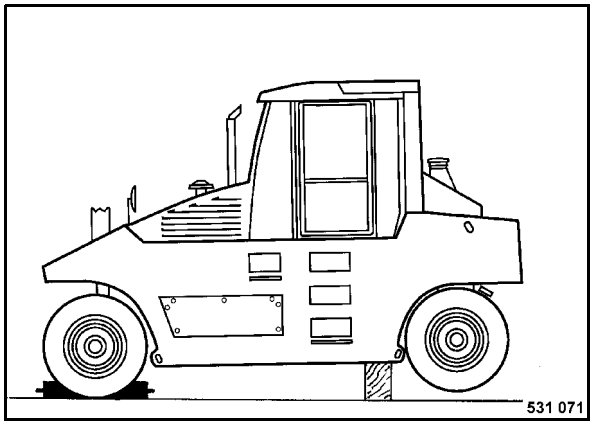


Fig. 145

- Secure the front wheels with chocks (Fig. 145).
- Lift the rear of the machine, so that the wheels can turn freely.
- Support the machine safely.
- Run the engine, until the air pressure vessel for the brake is filled with a pressure of 6,5 bar (95 psi).
- Shut the engine down.

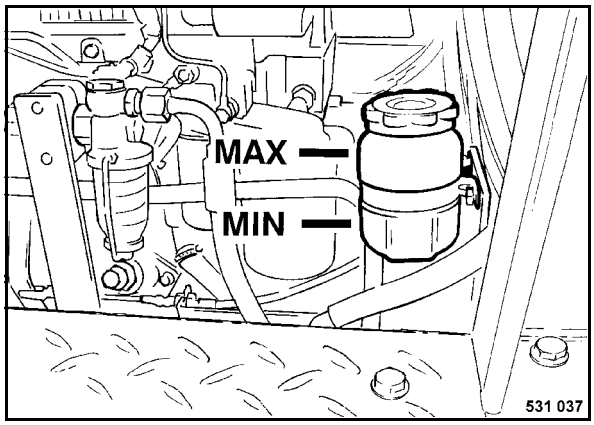


Fig. 146

- Draw all brake fluid out of the container (Fig. 146).
- Fill in new brake fluid up to the MAX-mark.

For quality of brake fluid refer to the section on fuels and lubricants.

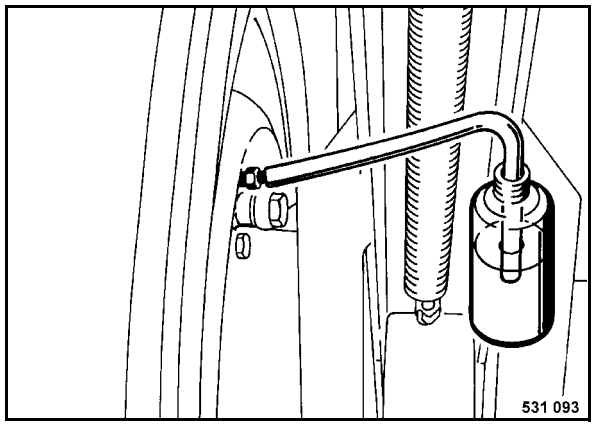


Fig. 147

- Connect the hose with the bleeding container (Fig. 147) to the bleeding valve on the right hand wheel and open for two turns.
- Switch the ignition on and actuate the brake pedal, until the brake fluid container is almost pumped empty or new brake fluid runs out without air bubbles.
- Close the bleeding valve while operating the brake pedal.
- Top up with fresh brake fluid.
- Repeat this bleeding procedure on bleeding valves of all other brake cylinders.

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⚠ Caution

Always top up brake fluid in due time, so that no air is drawn in.

Do not reuse old brake fluid.

If necessary fill the pressure air vessel while the engine is running.

- Close the bleeding valves with the safety caps.
- Finally fill the brake fluid container up to the MAX-mark and perform a braking test.

5.42 Changing the oil in the gear housings

⚠ Caution

Perform the oil change when the gear oil is warm.

Environment

Catch the oil and dispose of environmentally.

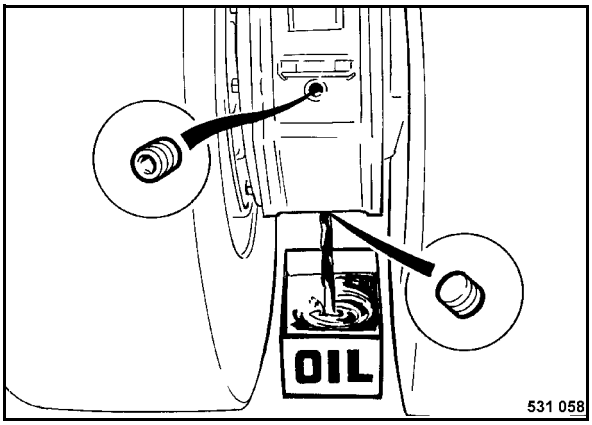


Fig. 148

- Unscrew the level inspection and drain plugs (Fig. 148).
- Catch running out oil with a suitable container.
- Turn the drain plug tightly back in.

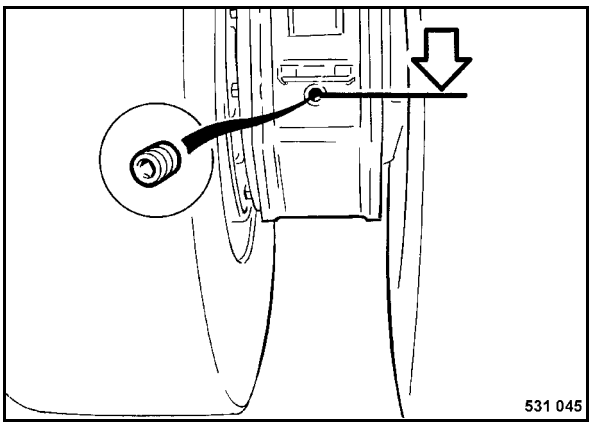


Fig. 149

Nominal value:

Top up oil to the bottom edge of the bore (Fig. 149).

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i Note

The oil can also be filled into the gear housings after removing the top covers. This requires the removal of the water tank.

For quality and quantity of oil refer to the table of fuels and lubricants.

- Turn the level inspection plug tightly back in.
- Repeat this measure on the opposite side.

5.43 Changing the coolant

⚠ Danger

Danger of scalding!

Do not change the coolant when the engine is hot.

Environment

Catch running out coolant and dispose of environmentally.

- Set the cabin heater to "hot".

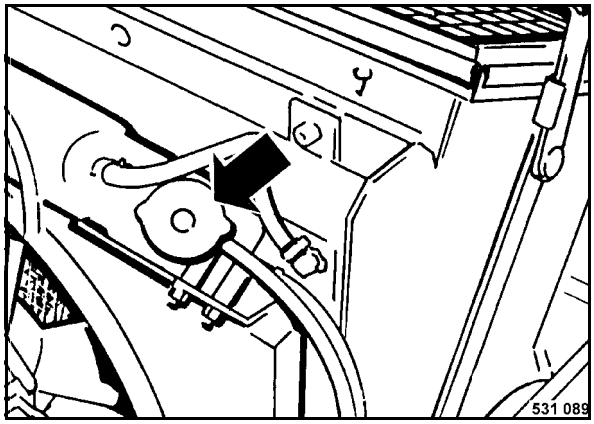


Fig. 150

- Remove the cap (Fig. 150) from the compenation tank.

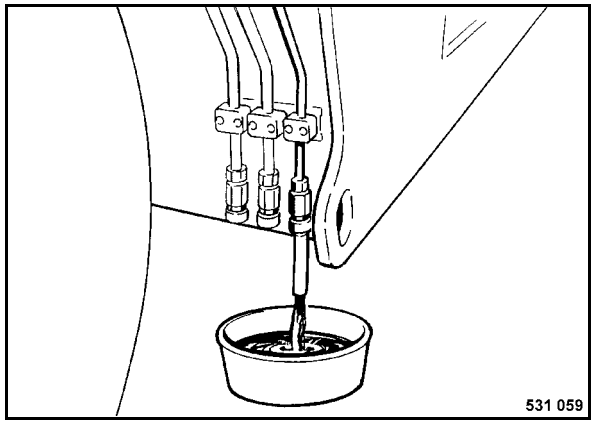


Fig. 151

- Take the drain hose from the accessories and connect it to the drain valve (Fig. 151).

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- Catch running out coolant with a suitable container.
- Remove the drain hose and close the drain valve with the protective cap.

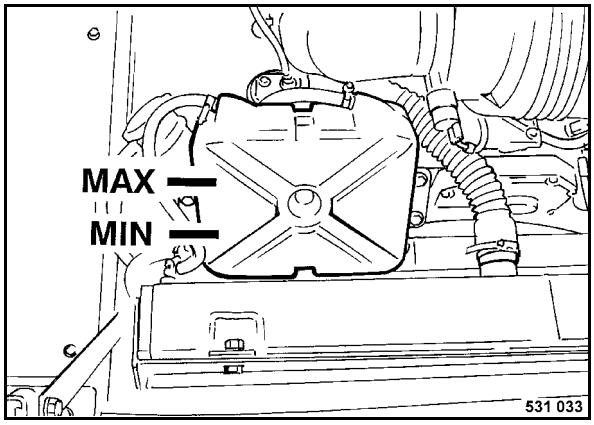


Fig. 152

- Fill in coolant up to the MAX-mark (Fig. 152) and screw the filler cap back on.

For quality of coolant refer to the chapter 5.2, fuels and lubricants.

- Start the diesel engine and run it warm to operating temperature.
- Let the engine cool down and check the coolant level again, top up if necessary.

5.44 Checking the supply lines for the compressor

- Shut the engine down and operate the parking brake.

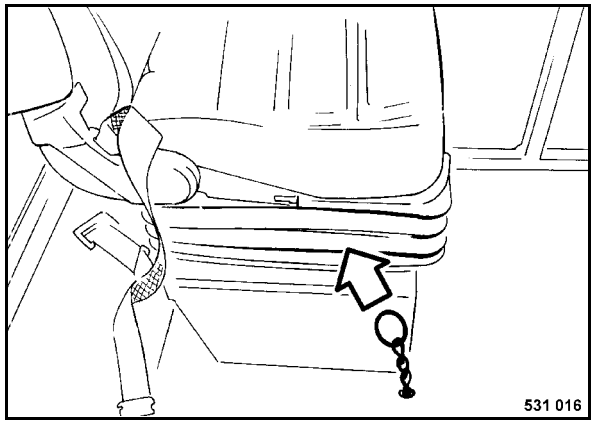


Fig. 153

- Operate the actuating chain (Fig. 153) of the drain valve, until the pressure air vessel is empty.

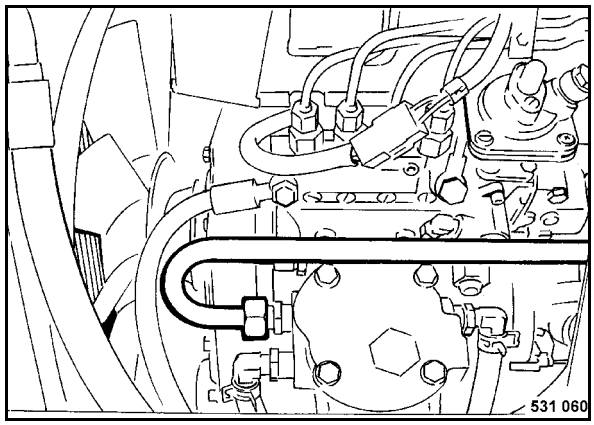


Fig. 154

- Remove the supply lines (Fig. 154) for the compressor.

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Every 2000 operating hours

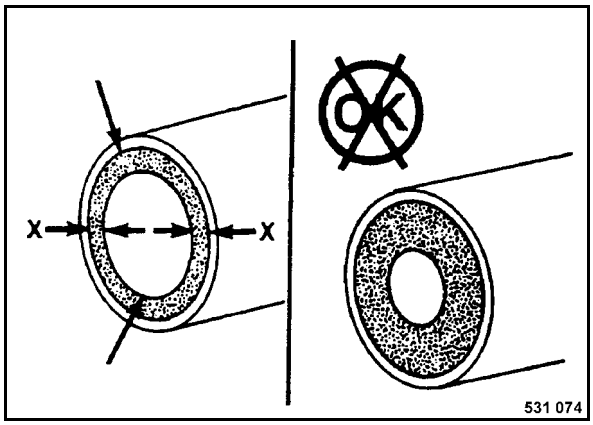


Fig. 155

- Check for deposits inside the pipes (Fig. 155).

⚠ Caution

If the value x+x=2 mm is exceeded clean or replace the pipe.

Have the compressor repaired.

- Reconnect the pipes.
- Start the engine and fill the pressure air vessel.
- Check the pressure air system for leaks.

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5.45 Checking, cleaning, changing the combustion air filter

⚠ Caution

Perform cleaning, maintenance and repair work only with the engine shut down. Do not start the engine after removing the filter element.

Do not use gasoline or hot fluids to clean the filter element.

After cleaning the filter element must be inspected for damage using a torch.

Air filter elements with damaged paper bellows or seal lips must be replaced in any case.

The main filter element must be replaced after 3 times cleaning, but at the latest after one year, irrespective of the operating hours.

Each cleaning interval must be marked with a cross on the cover of the filter element.

Cleaning does not make sense if the air filter element is covered with a sooty deposit. Use a new filter element.

Incorrectly handled filter elements may become ineffective because of damage (e.g.: cracks) and cause engine damage.

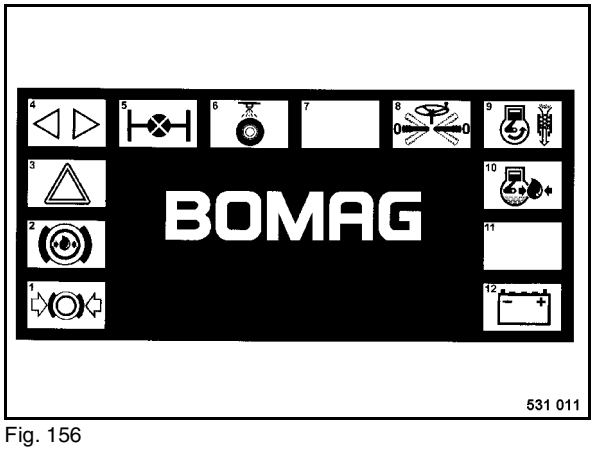


Fig. 156

Maintenance of the dry air filter is due when control light 9 (Fig. 156) in the fault monitoring board lights permanently when the engine is running, but at the latest after one year.

i Note

Once the air filter service indicator lights up, work may be continued until the end of the day.

- Open the engine hood.

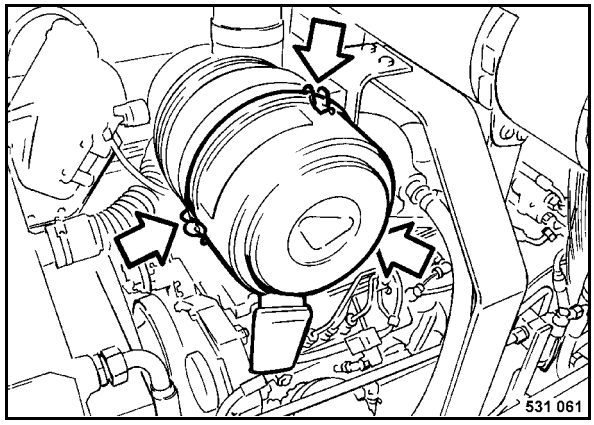


Fig. 157

- Release the locking hook (Fig. 157) and take the filter hood off.
- Clean filter hood and dust discharge valve.

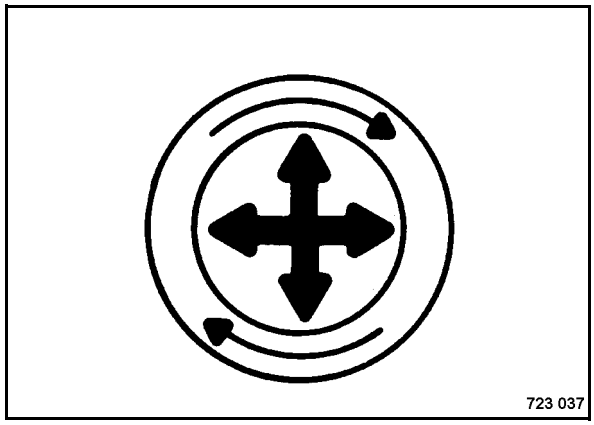


Fig. 158

- Carefully loosen the main filter element (Fig. 158).

The main filter element is located directly on the air intake tube, thereby providing a seal on the inside of the filter cover. Carefully remove the main filter element, in order to reduce the released amount of dust. To release the seal pull the main filter element carefully up, down and sideways or turn it (Fig. 158) .

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⚠ Caution

Avoid contact between main filter element and housing.

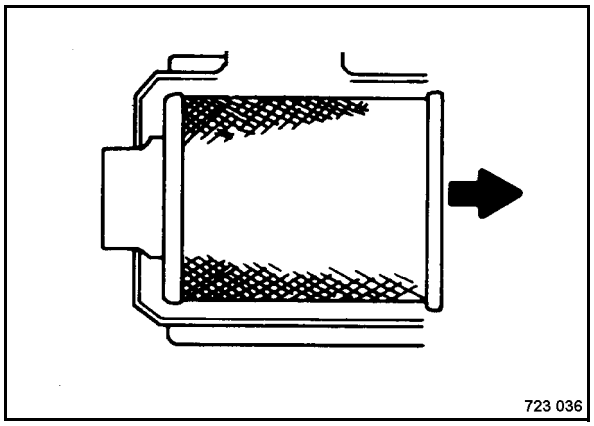


Fig. 159

- Pull the main filter element (Fig. 159) carefully out of the housing.

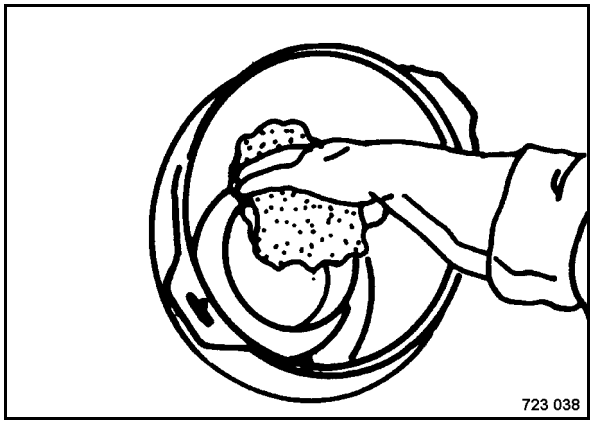


Fig. 160

- Clean the sealing face on the outlet tube (Fig. 160).

Dust on the outer diameter of the outlet tube can impair effective sealing.

- Check the old main filter element.

The old main filter element can be of help to discover foreign particles on the sealing face, which could lead to leaks. A line of dust on the clean air side of the filter may be a sign for such a leak. Eliminate this problem before installing a new main filter element.

- If the main filter element is damaged, the safety element must be replaced as well.
- Clean or replace the main filter element.

i Note

We generally recommend to change the filter. A new filter element is far less expensive than a possible engine damage.

- Examine the main filter element thoroughly for damage.

Before installing the new main filter element check it for possible damage from transport, cleaning or incorrect handling. Especially on the inside of the open end (sealing area). Do not install damaged filter elements.

- If necessary use safety elements.

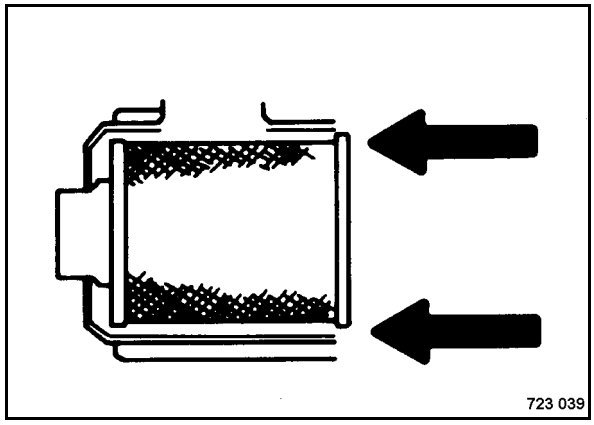


Fig. 161

- Insert the main filter element (Fig. 161).

The radial sealing area is located at the inside of the open filter edge. This critical sealing area must be under slight tension after the filter has been installed. In order to achieve a tight seal apply pressure to the outer edge of the filter and not to the moveable centre.

- Reinstall the filter hood with the dust discharge valve.

⚠ Caution

The dust discharge valve must point vertically downwards.

Dry cleaning of the main filter element

⚠ Danger

Eye injury!

Wear protective clothing (goggles, gloves).

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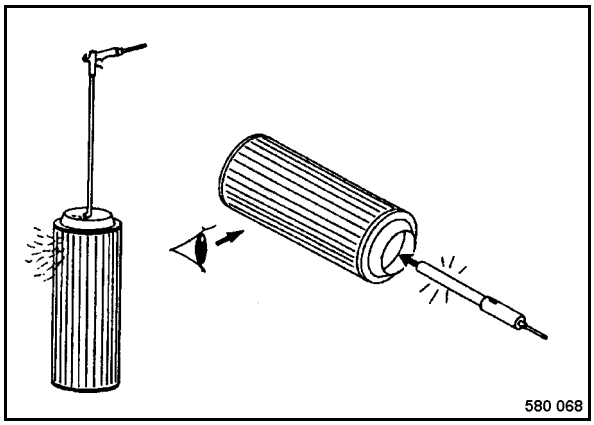


Fig. 162

i Note

For cleaning purposes fit a tube to the compressed air gun (Fig. 162), the end of which should be bent for approx. 90°.

The length should reach down to the bottom of the element.

- Blow the main filter element out with compressed air (max. 5 bar) from inside to outside by moving the tube up and down inside the element, until it if free of dust.
- Examine the main filter element with a torch for cracks and holes in the paper bellows.

⚠ Caution

Do not continue to use a damaged main filter element. If in doubt use a new main filter element.

Changing the safety filter element

⚠ Caution

The safety filter element must not be cleaned and should not be used again after it has been removed.

The safety filter element must be replaced:

if the main filter element is defective,

after three times cleaning of the main filter element,

if the warning light comes on again immediately after servicing the main filter cartridge,

at the latest after 2 years.

- Remove the housing cover and pull the main filter element off.

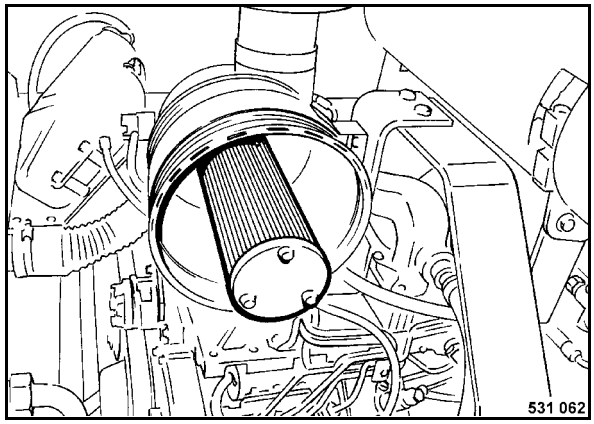


Fig. 163

- Pull the safety element (Fig. 163) out by turning it lightly.
- Push in a new safety filter element.
- Reassemble main filter element and cover.

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5.46 Cleaning the water sprinkler system

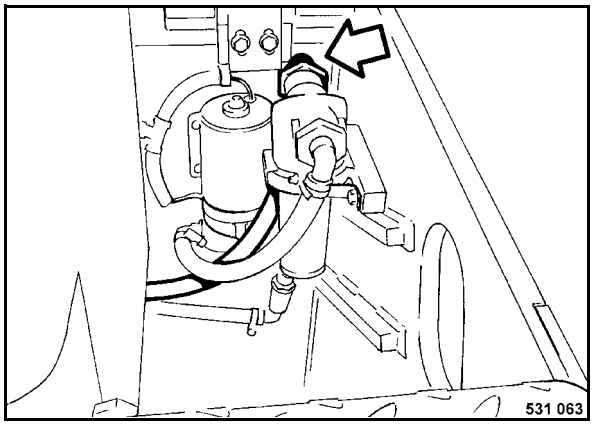


Fig. 164

- Remove the suction hose (Fig. 164) from in front of the water filter and let the water run out.
- Flush the water tank out with a strong water jet.
- Let all water with dirt run out.

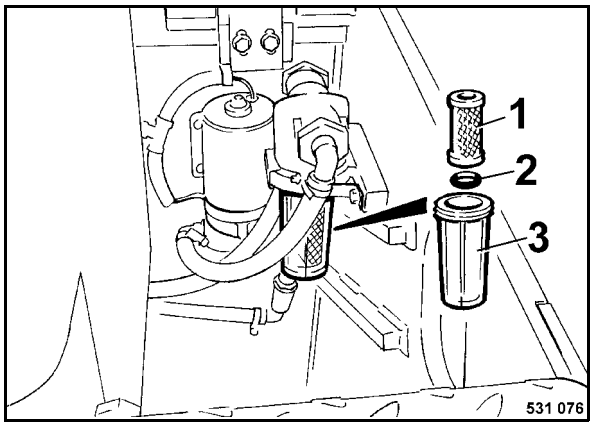


Fig. 165

- Unscrew the filter bowl 3 (Fig. 165).
- Take the screen insert (1) out.
- Clean filter bowl and screen insert.
- Check the seal ring (2), replace if necessary.
- Reassemble the filter bowl with the screen insert.

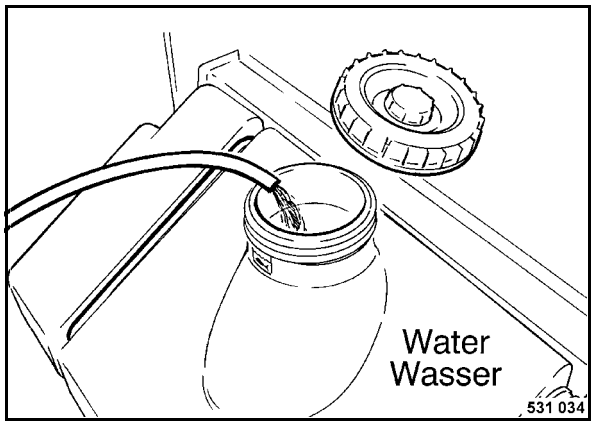


Fig. 166

- Fill the water tank with clean water (Fig. 166).

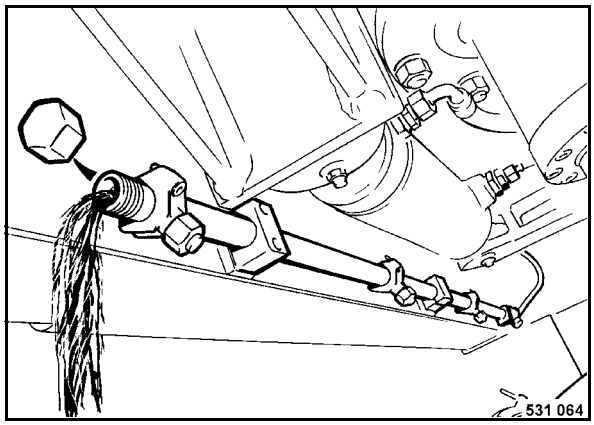


Fig. 167

- Unscrew the plugs (Fig. 167) from the sprinkler tubes.
- Activate the sprinkler system for a short while so that all lines are flushed out.
- Seal the threads with Teflon tape and screw the plugs back in.
- Check the spray nozzles, replace if necessary.

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5.47 Maintenance in case of frost

Water sprinkler system

⚠ Caution

If there is a risk of frost the water sprinkler system must be emptied or filled with an anti-freeze mixture.

In this case frost protection measures are of greatest importance in order to avoid freezing of sensitive components like pump, solenoid valve and water filter.

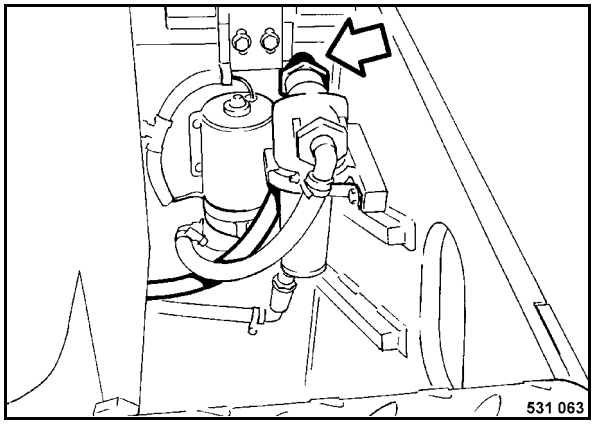


Fig. 168

- Remove the suction hose (Fig. 168) from in front of the water filter and let the water run out.
- Reconnect the suction hose.
- Fill the water tank with approx. 25 l of an anti-freeze mixture (water and anti-freeze agent, e.g. glysantin).
- Switch the sprinkler system on, until anti-freeze mixture comes running out of the sprinkler tubes.

Environment

After the frost period drain off the anti-freeze mixture and dispose of environmentally.

Ballast tank

⚠ Caution

If there is a risk of frost the ballast tank must be emptied in order to avoid severe deformation of the vehicle body.

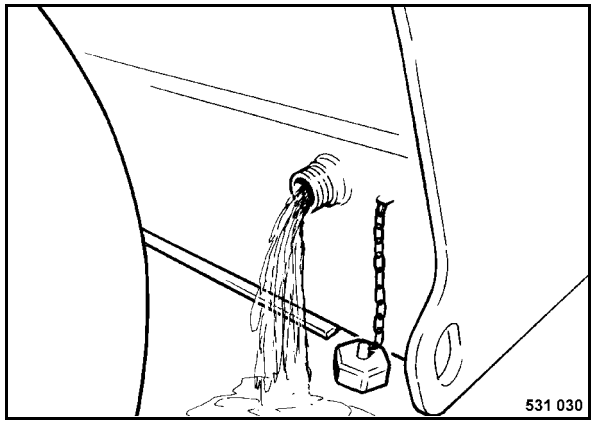


Fig. 169

- Unscrew the cover (Fig. 169) and let all water run out.

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5.48 Bleeding the fuel system

Bleeding low pressure fuel lines and fuel filter

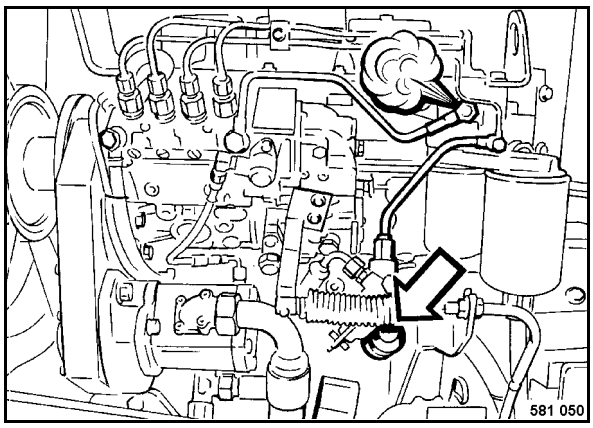


Fig. 170

- Slacken the bleeding screw (Fig. 170).
- Operate the fuel pump, until fuel runs out without air bubbles.
- Retighten the bleeding screw.

Bleeding the injection pump

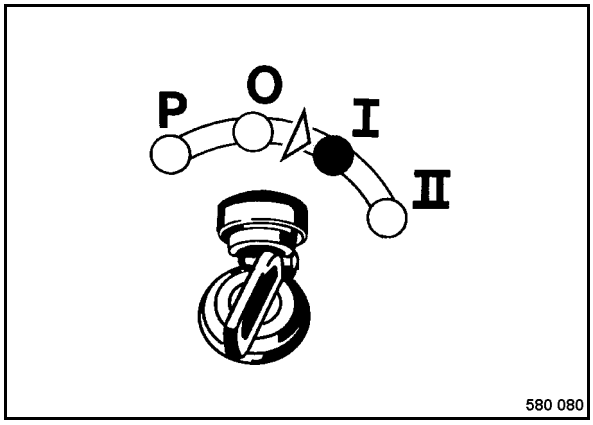


Fig. 171

- Turn the ignition to 'I' (Fig. 171).

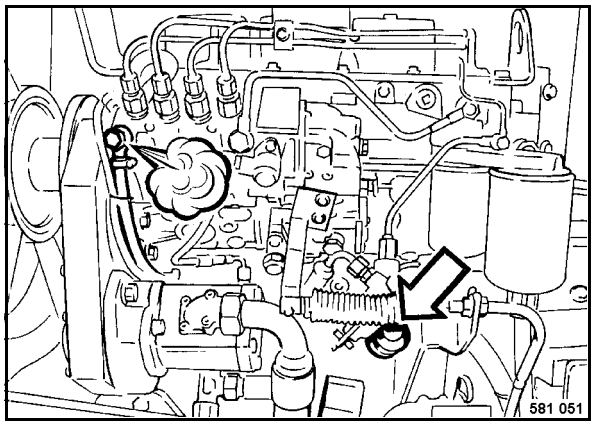


Fig. 172

- Slacken the bleeding screw (Fig. 172).
- Operate the fuel pump, until fuel runs out without air bubbles.
- Retighten the bleeding screw.

Bleeding the high pressure fuel lines

⚠ Danger

High pressure can damage your skin. Do not bleed while the engine is hot – fire hazard.

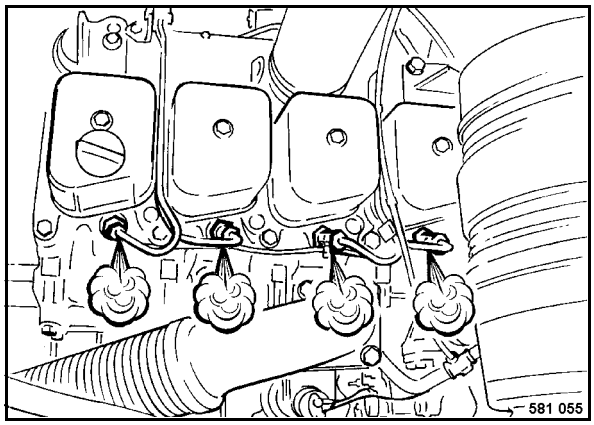


Fig. 173

- Slacken the fuel line on the injection nozzle (Fig. 173).
- Crank the engine with the starter so that the air can escape.
- Start the engine and run it at idle speed.
- Bleed all lines, one after the other, until the engine runs regularly.

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5.49 Filling the windscreen washer system

⚠ Caution

In the event of frost the windscreen washer system must be filled with an anti-freeze mixture.

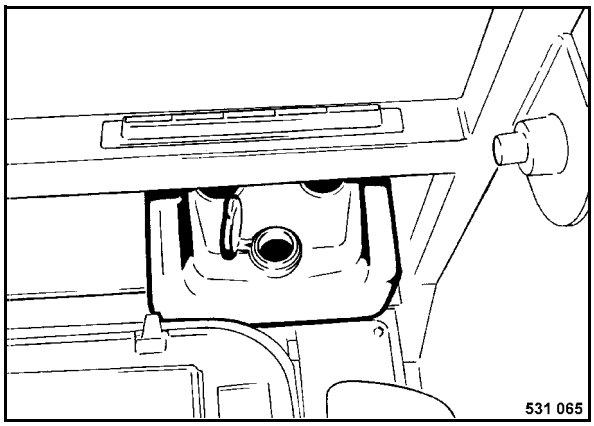


Fig. 174

- Open the cap (Fig. 174) and fill in water with a windscreen washing agent.
- In case of frost fill in the appropriate quantity of anti-freeze agent for windscreen washer systems.

⚠ Caution

Observe the information of the manufacturer.

5.50 Changing the fresh air filter in the cabin

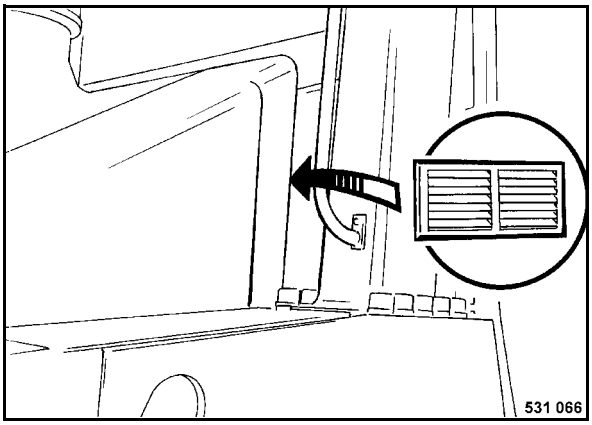


Fig. 175

- Unscrew the fastening screws for the filter brackets (Fig. 175) and take the filter out.
- Insert a new filter and reassemble the filter brackets.

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5.51 Adjusting the brake

i Note

This work must be performed when the brake pedal can be kicked down too far.

⚠ Danger

Danger of squashing!

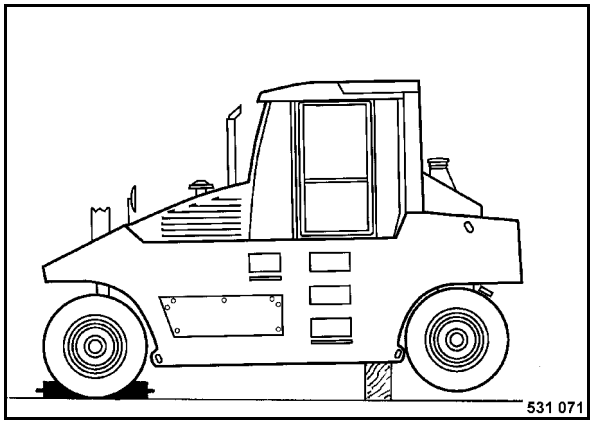


Fig. 176

- Secure the front wheels with chocks (Fig. 176).
- Lift the rear of the machine, so that the wheels can turn freely.
- Support the machine safely.

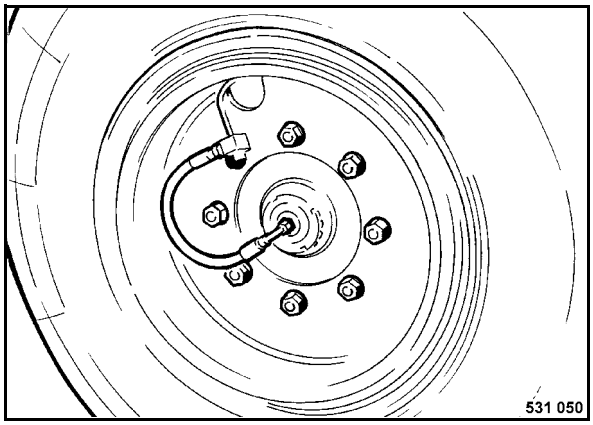


Fig. 177

- Disconnect the air hose 1 (Fig. 177) from the hub.
- Unscrew the wheel nuts and take the wheel off.
- Release the parking brake.

⚠ Caution

Adjust the brake only when it is cold.

- Turn the adjustment wheel, until the brake shoes are tightly pressed against the brake drum and the brake drum can no longer be turned.
- Turn the adjustment wheel back, until the brake drum can rotate freely.

⚠ Caution

Retighten the wheel nuts with 340 Nm (250 ft lbs).

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5.52 Changing the tires

⚠ Danger

Danger of squashing!

Observe all safety regulations for the lifting of loads.

- Secure the machine with wheel chocks against rolling.
- Lift the rear or the front of the machine, so that the wheels can turn freely.
- Support the machine safely.

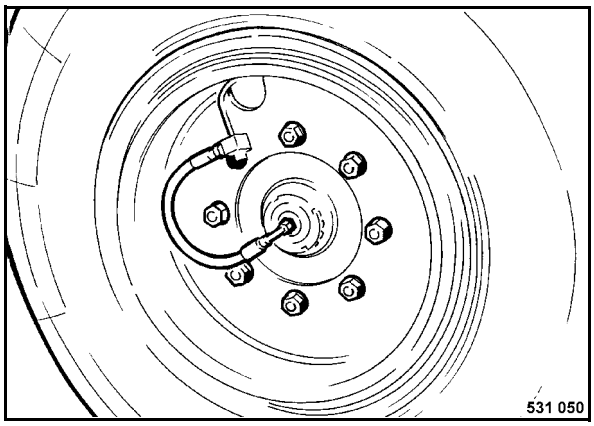


Fig. 178

- Disconnect the air hose (Fig. 178) from the hub.
- Unscrew the wheel nuts and take the wheel off.
- Unscrew the wheel nuts and take the wheel off.
- Attach a new wheel and tighten the wheel nuts crosswise with 340 Nm (250 ft. lb.).
- Reconnect the air hose.

5.53 Checking bolted connections for tight fit

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

Fig. 179

* Strength classes for screws with untreated, non-lubricated surface. Screw quality designations are stamped on the screw heads.

8.8 = 8G

10.9 = 10K

12,9 = 12K

The values result in a 90% utilization of the screw yield point at a coefficient of friction μ total = 0,14. When using lubricant MOS_2 the specified tightening torques do not apply.

i Note

Self-locking nuts must always be replaced once they have been unscrewed.

Check the following points at regular intervals:

- Engine and transmission mounts for condition and tight fit.
- The tight fit of connecting bolts between engine and transmission
- The fastening of the rear axle on the frame.
- The fastening of the front axle on the frame.
- The fastening of the steering levers on the frame.
- The tight fit of all wheel nuts.

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5.54 Temporary taking out of service

If the machine is to be shut down for a longer period of time (e.g. over winter), we recommend the following measures:

- Clean the machine thoroughly.
- If possible park the machine in a well ventilated hall or weather protected under a roof.
- Inflate the tires to max. pressure.
- Clean the engine, including the cooling system. For this purpose use cold cleansing agent or, even better, a steam cleaner.
- Run the engine warm and shut it down.
- Drain the still warm engine oil and fill in anti-corrosion engine oil.
- Drain off all coolant and fill in fresh system protection agent.
- Drain the fuel from the fuel tank, mix it well with 10% anti-corrosion oil and fill it back in.
- Then run the engine for 10 minutes, so that lines, filter, pump and nozzles are filled with the conserving mixture and the new engine oil is distributed to all parts.
- Crank the engine several times by hand (without ignition) in order to spray all combustion chambers.
- Take the V-belt off and spray the grooves of the V-belt pulley with anti-corrosion oil. Remove the anti-corrosion oil before taking the machine back into service.
- Close air intake on air filter and exhaust opening tightly.

i Note

Depending on weather conditions these conservation measures will protect the machine for approx. 6 to 12 months.

Before taking the machine back into service you must drain off the conservation oil and replace it with engine oil, see table of fuels and lubricants, according to API-(MIL-) classification.

A machine with conserved engine must be clearly marked by attaching a clear warning tag.

Anti-corrosion oils are all oils complying with the specification MIL-L-21260 B or TL 9150-037/2 or Nato Code C640/642.

- Jack the front and rear of the machine up in order to protect the rubber tires.
- Grease all hinges on doors and flaps.
- Grease the machine.

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6 Trouble shooting

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6.1 General notes

The following work must only be carried out by qualified and trained personnel or by the sales service.

Please observe strictly the safety regulations in chapter 2 of these operating and maintenance instructions.

Faults occur frequently due to the fact, that the machine has not been properly operated or serviced. Therefore, whenever a fault occurs, read through these instructions on correct operation and maintenance. If you cannot locate the cause of the fault or eliminate it yourself by following the trouble shooting charts, you should contact our customer service departments at our branch office or dealers.

⚠ Danger

Danger of injury!

Keep away from rotating parts of the engine.

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6.2 Engine

Faults	Possible cause	Remedy
The engine does not start	Starter defective or pinion not engaging	Have examined by a specialist
	Fuel tank empty	Fill and bleed the tank
	Temperature below starting limit	Use winter fuel and engine oil acc. to the ambient temperature.
	Fuel filter clogged, in winter due to paraffin separation.	Change the filter. use winter fuel
	Fuel lines leaking	Check all line connections for leakages and tighten the fittings.
	Battery discharged or not connected	Tighten the pole clamps, check the cable connections
	Injection valves or injection pump defective	Have examined by a specialist
The engine starts poorly and works irregularly with poor power	Battery power too low, battery clamps loose or oxidized, causing the starter to turn too slowly	Have the battery checked, clean the terminal clamps, tighten them and cover them with acid free grease
	Especially during winter: the use of too viscous engine oil	Use engine oil suitable for the ambient temperature
	Fuel supply restricted, in winter fuel system clogged due to paraffin separation	Change the fuel filter. Check the line connections for leaks and tighten the fittings. Use winter fuel in the cold season.
	Incorrect valve clearance	Adjust the valve clearance
	Injection valve defective	Have examined by a specialist
	Injection lines leaking	Check the lines for leakages
	Turbo charger defective	Have examined by a specialist
	Dry air filter dirty	clean, replace if necessary
	Excessive play in the throttle cable	Adjust the throttle cable, change it if necessary

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Trouble shooting

Faults	Possible cause	Remedy
Excessive exhaust smoke	Engine oil level too high	Drain the oil to the upper dipstick mark
	Dry air filter dirty	clean, replace if necessary
	Exhaust gas turbo-charger defective	Have examined by a specialist
	Poor compression due to burned or broken compression rings or incorrect valve clearance	Have compression rings and pistons examined by a specialist, adjust the valve clearance
	Incorrect valve clearance	Adjust the valve clearance
Engine overheats, shut down immediately!	Cooling fins on radiator extremely soiled (the warning light "engine oil temperature" lights)	Clean the cooling fins
	Injection valve defective	Have examined by a specialist
	Engine oil level too low	Top up engine oil to the upper dipstick mark
	Filling capacity of the injection pump not correctly adjusted	Have adjusted by a specialist
	Cooling air flow restricted	Clean the cooling air duct
	V-belt loos or broken	Tension or replace the V-belt
Poor engine power	Engine oil level too high	Drain the engine oil down to the upper dipstick mark
	Dry air filter dirty	clean, change if necessary
	Exhaust gas turbo-charger defective	Have examined by a specialist
	Charge air hose leaking	Check fastening and connections
	Incorrect valve clearance	Adjust the valve clearance
	Injection valve defective	Have examined by a specialist
Engine oil pressure too low	Engine oil level too low (control light "engine oil pressure" lights, the warning buzzer sounds)	Top up oil
	Leakages in the lubrication system	Shut the engine down immediately, check fittings on oil lines, lubrication oil filter and oil cooler for leaks, if necessary tighten the fittings.
The charge control light lights during operation, the warning buzzer sounds	Generator speed too low	Check the V-belt tension, replace the V-belt if necessary
	The generator does not charge the battery, because generator or regulator is defective	Have examined by a specialis

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Trouble shooting

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7 Tire compaction values

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7.1 Tables of tire compaction values

Contact width (mm)

11.00-20 18 PR Compactor	Wheel load (kN)					
	Wheel load	12,75	14,71	19,61	24,52	29,42
Tire pressure (kPa	300	279,0	280,0	281,0	282,0	283,0
	600	278,2	279,0	280,0	282,3	283,0
	700	277,0	279,0	281,0	282,0	283,0
	800	274,5	279,0	280,5	282,0	283,0
	900	270,0	276,0	280,5	282,0	283,5
	1000	265,5	275,0	280,0	281,0	283,0

Table of contact widths (mm)

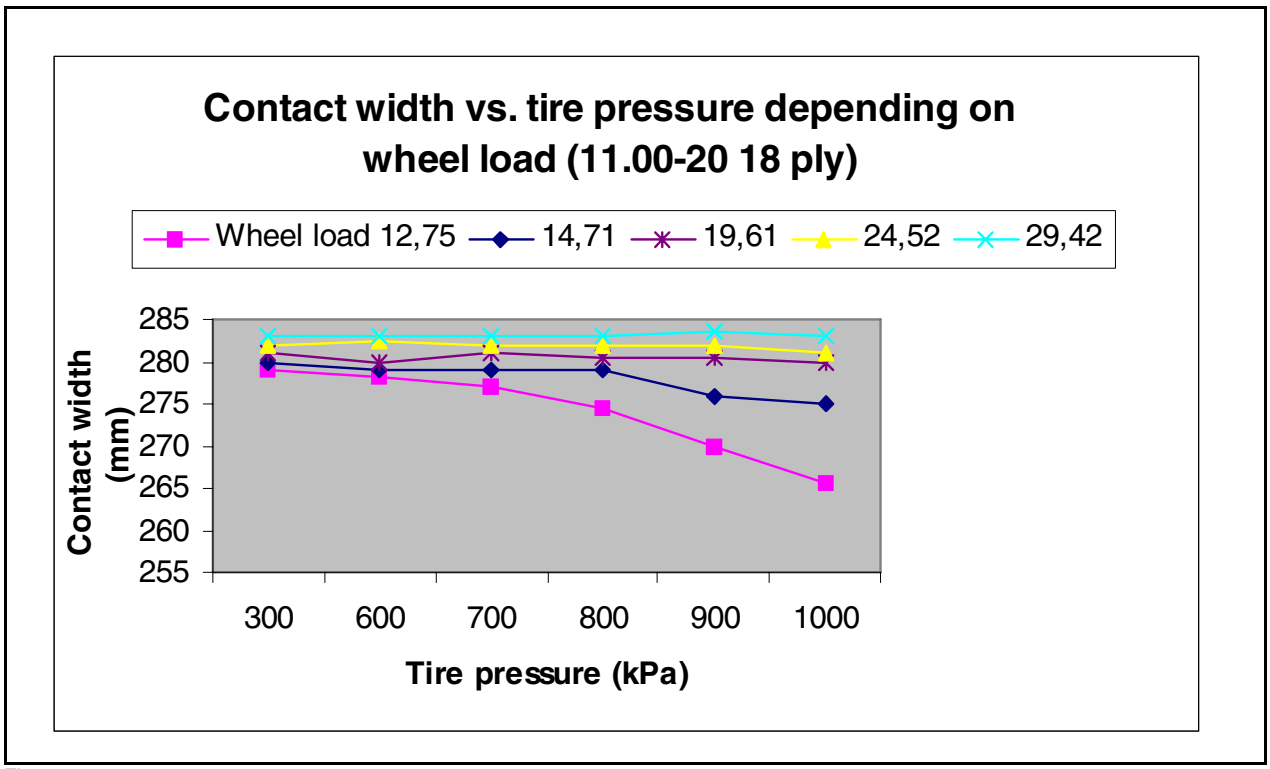


Fig. 180

Diagram of contact width (mm)

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Contact area (cm^2)

11.00-20 18 PR Compactor	Wheel load (kN)					
	Wheel load	12,75	14,71	19,61	24,52	29,42
Tire pressure (kPa	300	408,7	442,1	530	604,5	688,2
	600	334,3	364,4	433,5	506,5	560,0
	700	310,5	344,5	424,5	495,5	540,5
	800	292,3	328,4	398,6	462,7	511,5
	900	269,1	301,9	376,1	436,2	495,2
	1000	250,1	286,6	369,5	418,1	471,8

Table of contact area (cm^2)

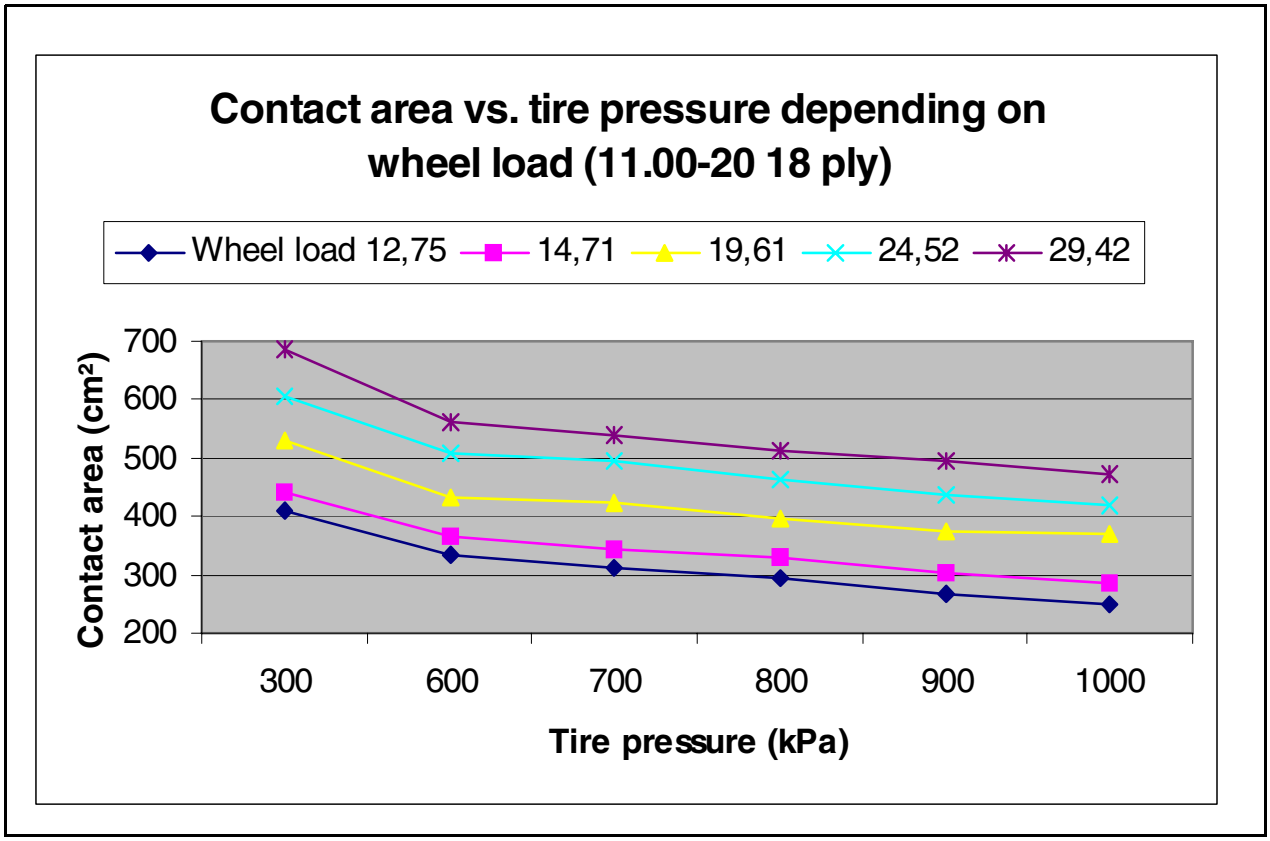


Fig. 181

Diagram of contact area (cm^2)

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Tire compaction values

Mean contact pressure (kPa)

11.00-20 18 PR Compactor	Wheel load (kN)					
	Wheel load	12,75	14,71	19,61	24,52	29,42
Tire pressure (kPa	300	312,0	332,7	369,6	405,6	427,5
	600	381,4	403,7	452,4	484,1	525,4
	700	410,6	427,0	462,0	494,9	544,3
	800	436,2	447,9	492,0	529,9	575,2
	900	473,8	487,2	521,4	562,1	594,1
	1000	509,8	513,3	530,7	586,5	623,6

Table of mean contact pressure (kPa)

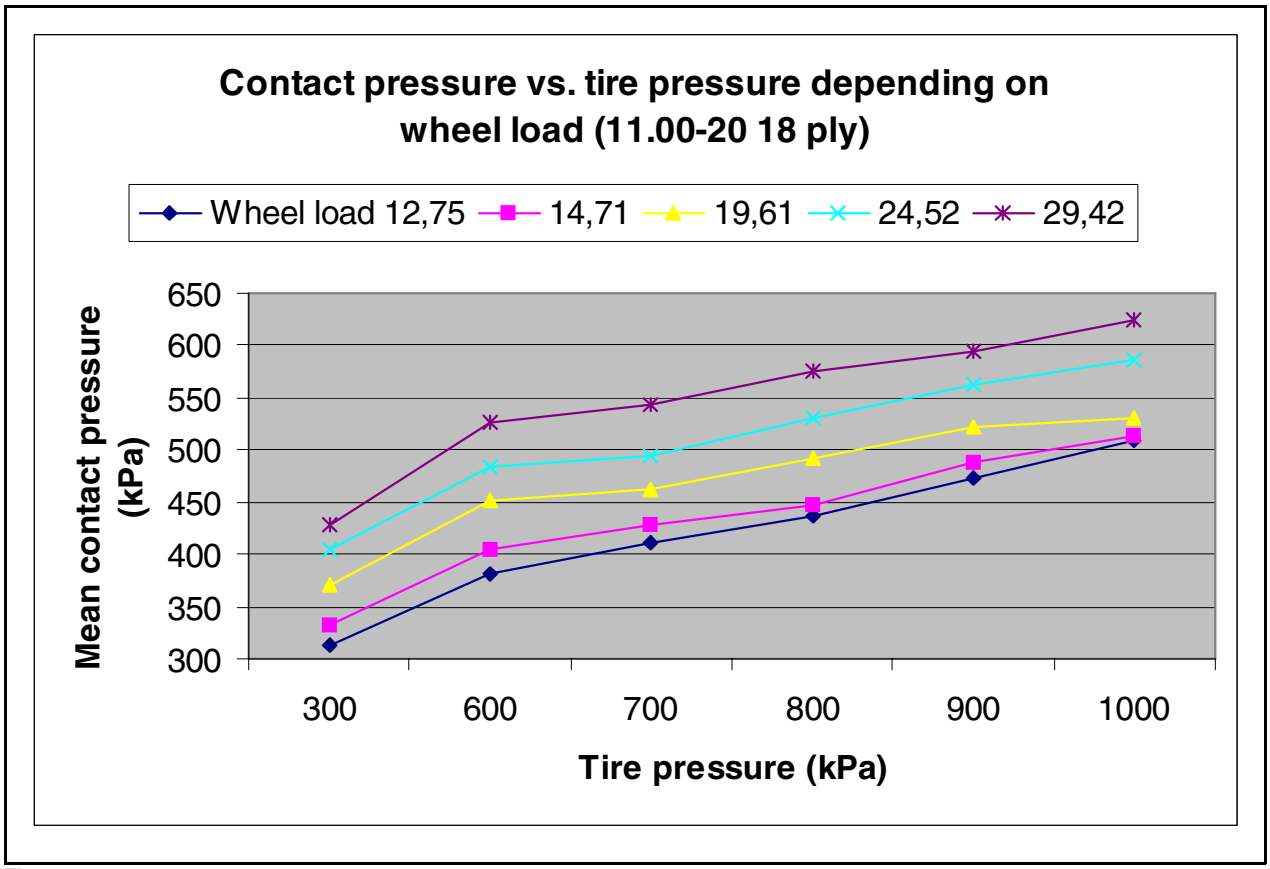


Fig. 182

Diagram of mean contact pressure (kPa)

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- in situ:

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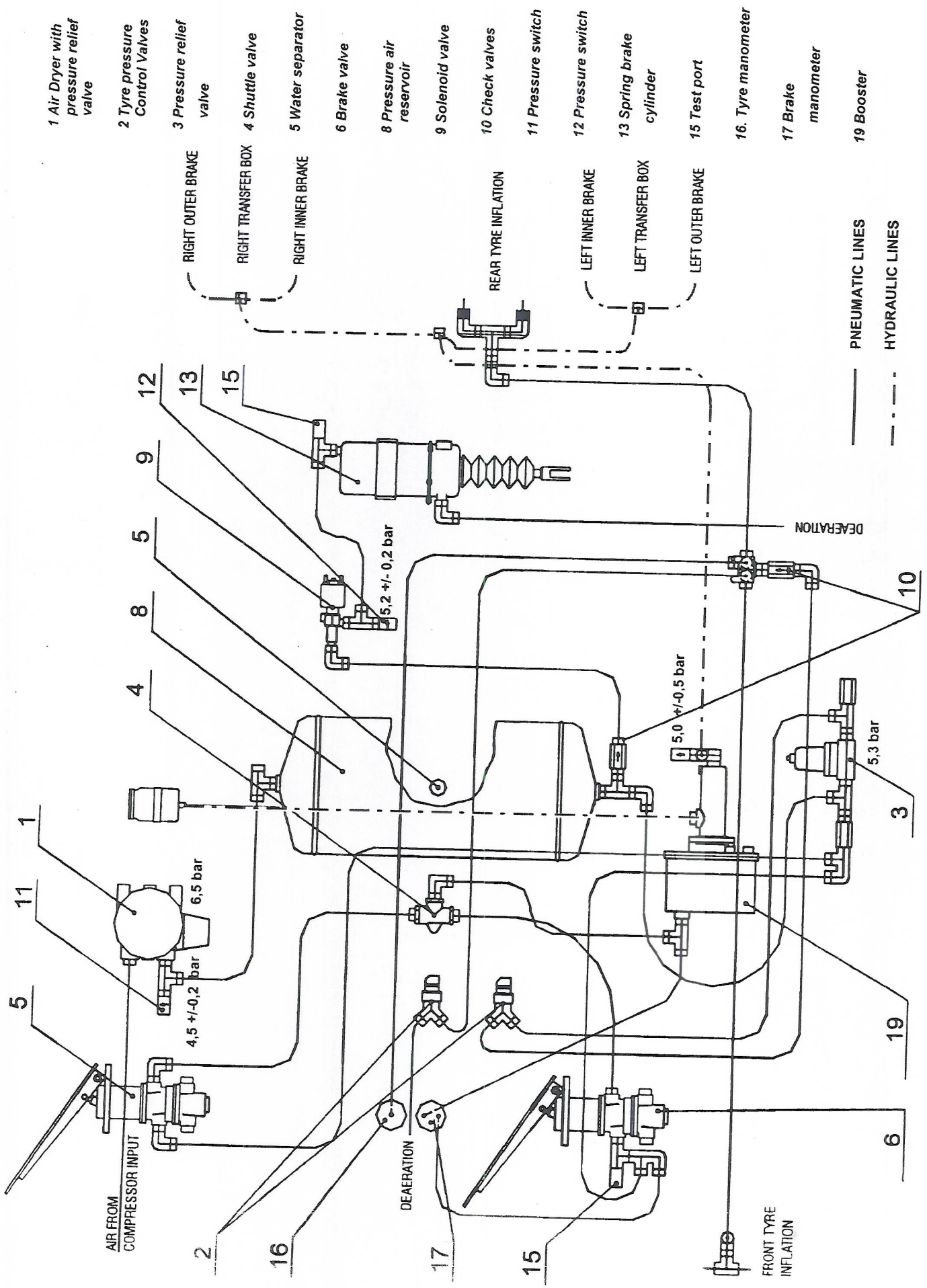
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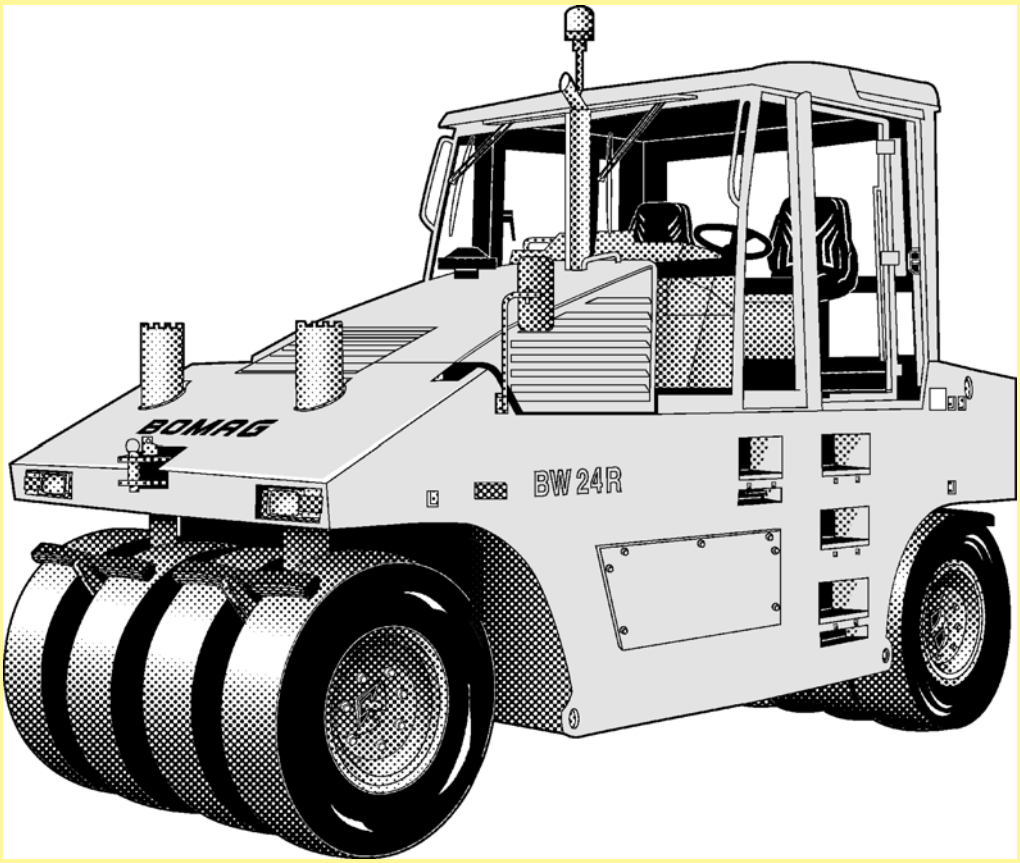
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BOMAG

Service - Manual

BW 24 R

S/N 201 530 60 1456 ›



Rubber tire roller

Catalogue number.
008 910 64

06/2006

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1 General

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1.1 Introduction

This manual contain all necessary information for training and repair work.

The repair instructions describe the removal or dismantling and assembly of components and assembly groups.

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

⚠ Danger

Danger of injury

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

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

Reliable construction equipment is of benefit for all parties involved:

- they enable the customer/user to exactly calculate the running times and the completion of projects within the specified time.
- in the rental business machines can be reliably used and planned, so that the number of stock machines can be kept at a low level.
- for the manufacturer satisfied customers provide a good image and give a feeling of confidence.

It is BOMAG's philosophy to design and produce the machines with highest possible reliability. This aspect of simple and easy maintenance was one of the key issues when developing and designing the machine:

- the location of components in the machine eases maintenance work,
- the high quality standard of BOMAG is the basis for the considerable extension of the service and maintenance intervals.
- the After Sales Service of BOMAG, including excellent operating and maintenance instruction manuals, high quality training courses and on-site machine demonstrations helps the customer to maintain their machines in good condition over a long period of time.

Permanent training of BOMAG’s own service personnel as well as the service personnel of BOMAG Profit Centres and dealers is therefore a general prerequisite for BOMAG’s excellent world-wide service.

This program of permanent training is only possible with appropriate and up-to-date training material for trainers as well as persons attending the training courses.

This training manual has not only been written as a support for the professional work of the trainer, but also for the trainees attending these training courses.

The different levels of product training demand, that the training performed by BOMAG, its Profit Centres or its dealers reflects the high quality of the training conducted at the Training Centre at BOMAG in Boppard. For this reason we invested a lot of time in the preparation of these materials.

Documentation

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

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

You should only use genuine BOMAG spare parts.

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

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

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

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

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Important notes

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

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

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

⚠ Danger

Paragraphs marked like this highlight possible dangers for persons.

⚠ Caution

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

i Note

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

Environment

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

Observe the regulations for the protection of the environment.

General

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

Special safety regulations

- Use only genuine BOMAG spare parts for repair purposes. Original parts and accessories have been specially designed for this machine.
- We wish to make explicitly clear that we have not tested or approved any parts or accessories not supplied by us. The installation and/or use of such products may therefore have an adverse effect on the specific characteristics of the machine and thereby impair the active and/or passive driving safety. The manufacturer explicitly excludes any liability for damage caused by the use of non-original parts or accessories.
- Unauthorized changes to the machine are prohibited for safety reasons.
- If tests on the articulated joint need to be performed with the engine running, do not stand in the articulation area of the machine, danger of injury!
- Do not perform cleaning work while the engine is running.
- If tests must be performed with the engine running do not touch rotating parts of the engine, danger of injury.
- Exhaust gases are highly dangerous. Always ensure an adequate supply of fresh air when starting the engine in closed rooms.
- Refuel only with the engine shut down. Ensure strict cleanliness and do not spill any fuel.
- Keep used filters in a separate waste container and dispose of environmentally.
- Dispose of oils and fuel environmentally when performing repair or maintenance work.
- Do not refuel in closed rooms.
- Do not heat up oil higher than 160 °C because it may ignite.
- Wipe off spilled oil and fuel.

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- Do not smoke when refuelling or when checking the acid level in the battery.
- Do not check the acid level of the battery with a naked flame, danger of explosion!
- Old batteries contain lead and must be properly disposed of.
- There is a danger of scalding when draining off engine or hydraulic oil at operating temperature.
- on machines with rubber tires a tire may busr if incorrectly assembled. This can cause severe injury.
- Do not exceed the specified highest permissible tire pressure.

Hydraulics

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

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

Air conditioning system

⚠ Danger

Do not open refrigerant containers which contain refrigerant!

- When opening refrigerant containers the contents may escape in liquid or vaporous state. The higher the pressure in the container, the fiercer this process will take place. The height of the pressure depends on two conditions. 1. Which type of refrigerant is in the container. The following applies: The lower the boiling point, the higher the pressure. 2. The height of the temperature. The following applies: The higher the temperature, the higher the pressure.
- In a refrigerant container there must be a steam space above the liquid space. The liquid expands with increasing temperature. The steam filled space becomes smaller. From a certain time on the container will be filled with just liquid. After this only a minor temperature increase is enough to generate very high pressures in the container, because the liquid would like to expand, but there is no more room. The related forces are high enough to cause the container to burst. In order to avoid overfilling of a container the pressure gas directive clearly specifies how many kilograms of refrigerant may be filled into the container per litre volume.
- In case of occurring mechanical damage or corrosion on the refrigerant container, the container must be replaced, in order to prevent it from bursting and causing further damage.
- Since the fluid container is pressurized, the manufacture and testing of these pressure vessels is governed by the pressure vessel directive. (New edition from April 1989). This directive divides the pressure vessels into test groups according to their permissible operating pressure "p" in bar, the volumetric content "l" in litres and the pressure content product "p x l". . On the basis of these prerequisites the fluid containers must be classified as per testing group II. Paragraph 10 of the pressure vessel directive demands that these pressure containers must be periodically inspected and tested by a specialist, according to paragraph 32. . In this case periodically recurring inspections consist of external examinations, normally on containers in operation . The refrigerant container must be visually examined twice every year in connection with the inspection. Special attention must thereby be paid to signs of corrosion and mechanical damage. If the pressure vessel is in no good condition, it should be replaced for safety reasons, thus to make sure that sufficient precautions have been applied to protect the operator and third parties. .
- Wear safety goggles! Put on your safety goggles. This will protect your eyes against coming into contact with refrigerant, which could cause severe damage by freezing.
- Wear safety gloves and an apron! Refrigerant are excellent solvents for greases and oils. In contact with skin they will remove the protective grease film. However, degreased skin is very sensitive against cold temperatures and germs.
- Do not allow liquid refrigerants to come into contact with skin! Refrigerant takes the heat required for evaporation from the environment. Very low temperatures may be reached. The results may be local frost injuries (boiling point of R134a -26.5°C at ambient pressure).

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- Do not inhale higher concentrations of refrigerant vapours! Escaping refrigerant vapours will mix with the ambient air and displace the oxygen required for breathing.
- Smoking is strictly prohibited! Refrigerants may be decomposed by a glowing cigarette. The resulting substances are highly toxic and must not be inhaled.
- Welding and soldering on refrigeration equipment! Before starting welding or soldering work on vehicles, (in the vicinity
  of air conditioning components) all refrigerant must be drawn out and the rests removed by blowing out the system with nitrogen. The decomposition products created from the refrigerant under the influence of heat not only are highly toxic, but also have a strong corrosive effect, so that pipes and system components may be attacked. The substance is mainly fluorohydrogen.
- Pungent smell! In case of a pungent smell the afore mentioned decomposition products have already been created. Extreme care must be exercised not to inhale these substances, as otherwise the respiratory system, the lungs and other organs may be harmed.
- When blowing out components with compressed air and nitrogen the gas mixture escaping from the components must be extracted via suitable exhaust facilities (workshop exhaust systems).

Handling pressure vessels

- Secure pressure vessels against tipping over or rolling away
- Do not throw pressure vessels. Pressure vessels may thereby be deformed to such an extent, that they will crack. The sudden evaporation and escape of refrigerant releases excessive forces. This applies also when snapping off valves on bottles. Bottles must therefore only be transported with the safety caps properly installed.
- Refrigerant bottles must never be placed near heating radiators. Higher temperatures will cause higher pressures, whereby the permissible pressure of the vessel may be exceeded. The pressure vessel directive therefore specifies that a pressure vessel should not be warmed up to temperatures above 50 °C.
- Do not heat up refrigerant bottles with an open flame. Excessive temperatures can damage the material and cause the decomposition of refrigerant.
- Close empty vessels to avoid the diffusion of moisture.
- Do not overfill refrigerant bottles, since any temperature increase will cause enormous pressures.

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General

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

Hydraulic system

⚠ Caution

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

Please note

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

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

Before commissioning

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

Commissioning

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

After commissioning

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

Seals and gaskets

- Generally use new seals and gaskets when performing assembly work. The required seal kits are available as spare parts.

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Electrics

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

Diagnostics according to plan

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

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

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

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

General:

- Before changing any expensive components, such as control units, you should run a systematic trouble shooting session to eliminate any other possible fault sources. Electric signals must be checked at the locations to which they are applied, i.e. on control unit or sensor technology. So, if the system had been diagnosed without unplugging the control unit and checking the wiring, one should be alerted.
- Check for good cable and ground contacts, therefore keep all mechanical transition points between electric conductors (terminals, plugs) free of oxide and dirt, as far as this is possible.
- Perform trouble shooting in a systematic way. Do not become confused by the high number and variety of electric cables, current can only flow in a closed circuit. You should first become acquainted with the function of the corresponding electric circuit by following the correct wiring diagram. Detected faults should be rectified immediately. If the system still does not work correctly after this measure, trouble shooting must be continued. Several faults very rarely occur at the same time, but it is not impossible.
- Surge voltages in the electric system must be strictly avoided: For electric and inert gas welding all electric components, battery and generator must be electrically isolated. When performing welding work always fasten the earth clamp of the welding unit in the immediate vicinity of the welding location. Strictly disconnect the cables from the generator before starting work.
- Do not disconnect or connect battery or generator while the engine is running. Do not operate the main battery switch under load. Do not use jump leads after the battery has been removed.
- Sensors and electric actuators on control units must never be connected individually or between external power sources for the purpose of testing, but only in connection with the control unit in question, as otherwise there may be a risk of destruction (damage)!
- Even with an existing polarity reversal protection incorrect polarity must be strictly avoided. Incorrect polarity can cause damage to control units!
- Plug-in connectors on control units are only dust and water tight if the mating connector is plugged on! Control units must be protected against spray water, until the mating connector is finally plugged on!
- Disconnecting the control unit plug connectors with the control unit switched on, i.e. with the power supply (terminal 15 "On"), is not permitted. Switch the voltage supply "off" first - then pull out the plug.

Air conditioning system

CFC - halon prohibition

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

Contents:

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

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

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

The use of refrigerant must be documented.

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

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

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

Notes on repair

- In case of a repair on the refrigeration system you should first evacuate the air conditioning system for at least 45 minutes to remove any moisture from the system, before you start to refill. Moisture bonded in the compressor oil / refrigeration oil (PAG oil) can only be removed from the system by changing the oil.
- During repair work on refrigerant lines and components, these must be kept closed as far as possible, in order to prevent the invasion of air, moisture and dirt, because the operational reliability of the system can only be assured if all components in the refrigerant circuit are clean and dry from inside.
- Make sure that no dirt or foreign parts can enter into the compressor or the air conditioning system. The area around the refrigerant hoses should be cleaned with a gasoline free solvent.
- All parts to be reused should be cleaned with a gasoline free solvent and blow-dried with clean compressed air or dried with a lint-free cloth.
- Before opening all components should have warmed up to ambient temperature, to avoid that damp air is drawn into the component by the difference in temperatures.
- Damaged or leaking parts of the air conditioning must not be repaired by welding or soldering, but must generally be replaced.
- Do not fill up refrigerant, but extract existing refrigerant and refill the system.
- Different types of refrigerant must not be mixed. Only the refrigerant specified for the corresponding air conditioning system must be used.
- Refrigerant circuits with refrigerant type R134a must only be operated with the compressor oil / refrigeration oil approved for the compressor.
- Used compressor oil / refrigeration oil must be disposed of as hazardous waste.
- Due to its chemical properties compressor oil / refrigeration oil must never be disposed of together with engine or transmission oil.
- Compressor oil / refrigeration oil is highly hydroscopic. Oil cans must strictly be kept closed until use. Oil rests should not be used, if the can had been opened over a longer period of time.
- All O-rings as well as pipe and hose fittings must be oiled withcompressor oil / refrigeration oilibefore assembly.
- When replacing a heat exchanger, e.g. evaporator or condenser, any compressor oil / refrigeration oil lost by exchanging the components, must be replaced with fresh oil.
- A too high compressor oil / refrigeration oil level adversely affects the cooling performance and a too low oil level has a negative effect on the lifetime of the compressor.
- If a air conditioning unit needs to be opened, the dryer must be replaced in any case.
- Always use new O-rings when reassembling the unit.
- Always use two spanners when connecting pipes or hoses, to prevent the pipe end from being damaged.
- Tighten screw fittings with the specified torque.
- Check the connections of pipes, fittings or components thoroughly; do not use if damaged.
- Do not leave the refrigerant circuit unnecessarily open to the atmosphere. Do not attempt to repair bent or burst pipes.
- Compressor valves must only be opened after the system has been properly sealed.
- The use of leak detection colouring matter is not permitted, because its chemical composition is unknown and its effect on compressor oil and rubber elements is not predictable. The use of leak detection colouring matter makes any warranty claims null and void.
- Tools used on refrigeration circuits must be of excellent condition, thus to avoid the damage of any connections.
- The dryer is to be installed last, after all connections in the refrigerant circuit have been tightened.
- After completion of repair work screw locking caps (with seals) on all connections with valves and on the service connections. Start up of the air conditioning system. Observe the filling capacity.
- Before start up of the air conditioning system after a new filling: - Turn the compressor approx. 10 revolutions by hand using the clutch or V-belt pulley of the magnetic clutch. - Start the engine with the compressor/control valve switched off. - Once the idle speed of the engine has stabilized switch on the compressor and run it for at least 10 minutes at idle speed and maximum cooling power.
- Never operate the compressor over longer periods of time with high engine speeds without a sufficient amount of refrigerant in the system. This could probably cause overheating and internal damage.

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Tightening torques

- Tighten fastening screws and nuts according to the table of tightening torques.
- Tightening torques deviating from the ones in the table are specially mentioned in the repair instructions.

⚠ Caution

Self-locking nuts must be generally renewed.

Tightening torques for screws with metric unified thread

Screw dimension	Tightening torque Nm* (ft-lb)		
	8.8	10.9	12.9
M4	3 (2)	5 (4)	5 (4)
M5	6 (4)	9 (7)	10 (7)
M6	10 (7)	15 (11)	18 (13)
M8	25 (18)	35 (26)	45 (33)
M10	50 (37)	75 (55)	83 (61)
M12	88 (65)	123 (91)	147 (108)
M14	137 (101)	196 (145)	235 (173)
M16	211 (156)	300 (221)	358 (264)
M18	290 (213)	412 (303)	490 (361)
M20	412 (304)	578 (426)	696 (513)
M22	560 (413)	785 (559)	942 (695)
M24	711 (524)	1000 (738)	1200 (885)
M27	1050 (774)	1480 (1092)	1774 (1308)
M30	1420 (1047)	2010 (1482)	2400 (1770)

Tightening torques for screws with metric fine thread

Screw dimension	Tightening torques Nm[1] (ft-lb)		
	8.8	10.9	12.9
M8 x 1	26 (19)	37 (27)	48 (35)
M10 x 1.25	52 (38)	76 (56)	88 (65)
M12 x 1.25	98 (72)	137 (101)	126 (119)
M12 x 1.5	93 (69)	127 (94)	152 (112)
M14 x 1.5	152 (112)	216 (159)	255 (188)
M16 x 1.5	225 (166)	318 (235)	383 (282)
M18 x 1.5	324 (239)	466 (344)	554 (409)
M20 x 1.5	461 (340)	628 (463)	775 (572)
M22 x 1.5	618 (456)	863 (636)	1058 (780)
M24 x 2	780 (575)	1098 (808)	1294 (1416)
M27 x2	1147 (846)	1578 (1164)	1920 (1416)
M30 x 2	1568 (1156)	2254 (1662)	2695 (1988)

1 Strength classes for screws with untreated, non-lubricated surface.

The values result in a 90% utilization of the screw's yield point at a coefficient of friction μ total = 0,14.

Compliance with the tightening torques is checked with torque wrenches.

Tightening torques deviating from the ones mentioned in the table are specially mentioned in these descriptions.

The values specified in the table apply for screws black, oiled and with surface protection A4C.

The quality designation of the screws is stamped on the screw heads.

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2 Technical data

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BOMAG Central Service - Technical data and adjustment values

Status: 2006-04-12

Product type:	**BW 24 R**
Type No.:	530 60
Serial numbers from:	201 530 60 1456
Engine:	
Type:	4BT 4.5C / 74 KW
Combustion principle:	4-stroke-Diesel
Cooling:	Water
Number of cylinders:	4
Power acc. to ISO 9249:	74 kW
Power data at nominal speed of:	2200 1/min
Low idle speed:	850+/-150 1/min
High idle speed:	2375+/-125 1/min
Spec. fuel consumption:	233 g/kWh
Valve clearance, inlet:	0,25 mm
Valve clearance, outlet:	0,51 mm
Opening pressure, injection valves:	240-254 bar
Starter voltage:	12 V
Powershift reversing transmission:	
Type:	1203 FT 20302-10/4
Number of gears forward/reverse:	3/3
Transmission ration 1st gear forward:	0-6 km/h
Transmission ration 2nd gear forward:	0-13 km/h
Transmission ration 3rd gear forward :	0-20 km/h
Transmission ration 1st gear reverse:	0-6 km/h
Transmission ration 2nd gear reverse:	0-13 km/h
Transmission ratio 3rd gear reverse:	0-20 km/h
Steering valve:	
Type:	LAGC 200 LSD
System:	Rotary valve
Filling capacities:	
Engine coolant:	15 l (50% Water, 50% Anti-freeze agent on Ethane-diol-basis)
Engine oil:	15,5 l (SAE 15W-40, API SJ/CF)
Hydraulic oil:	6,5 l (HVLP 46 VI 150)
Torque converter, powershift transmission:	22 l (ATF Dexron II D)

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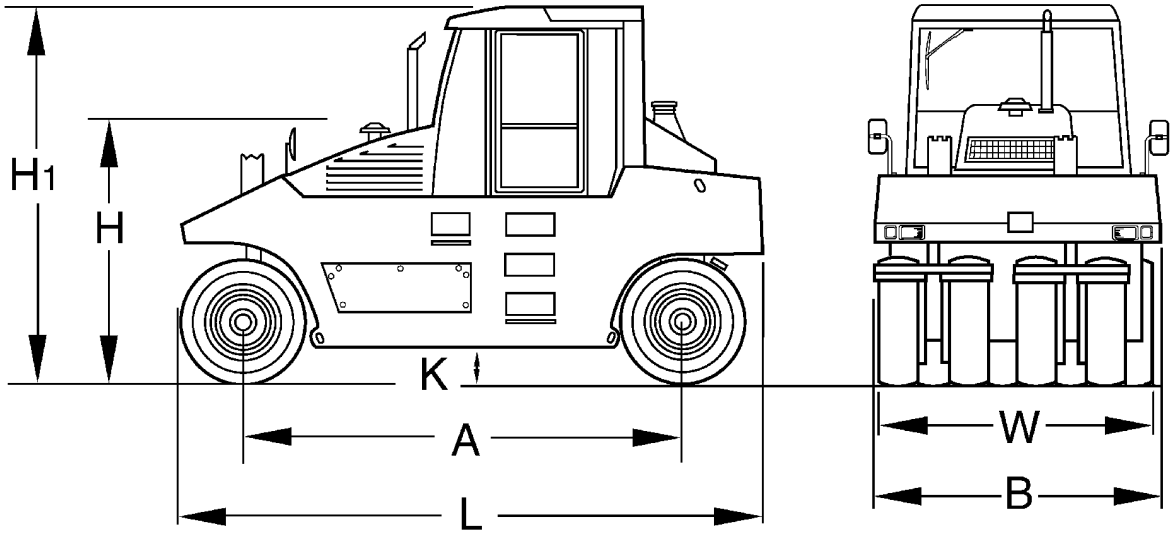


Fig. 1

Dimensions in mm	A	B	H	H1	K	L	W
BW 24 R	3800	2265	2315	3040	300	4775	1986

1

		BW 24 R
Weights		
Operating weight (CECE) with ROPS-cabin	kg	10000
Operating weight, pre-ballasted	kg	15400
Max. operating weight (CECE)	kg	24000
Max. operating weight with water	kg	18400
Max. axle load (CECE), front	kg	11400
Max. axle load (CECE), rear	kg	12600
Min. wheel load (without ballast)	kg	1300
Max. wheel load	kg	3150
Travel characteristics		
Travel speed (1)	km/h	0 ... 6
Travel speed (2)	km/h	0 ... 13
Travel speed (3)	km/h	0 ... 20
Max. gradability	%	35
Engine		
Engine manufacturer		Cummins
Type		4BT4.5-C99
Cooling		Water
Number of cylinders		4
Power ISO 9249/SAE J 1995	kW	71/74
Rated speed	rpm	2200
Fuel		Diesel
Electrical equipment	V	12
Drive system		hydrostatic
Driven axles		2

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1		BW 24 R
Brakes		
Service brake		pneum./hydr.
Parking brake		mech./pneum.
Steering		
Type of steering		2-point suspension
Steering operation		hydrostatic
Tires		
Tire size		11.00-20, 18 PR smooth
Air pressure min./max.	bar	2 ... 8,1
Tank contents		
Water	Litres	400
Fuel	Litres	250
Engine oil	Litres	15,5
Coolant	Litres	approx. 15

1 The right for technical modifications remains reserved

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2.2 Maintenance chart

With all maintenance intervals perform also the work for shorter preceding service intervals.

No.	Designation	Note
Every 10 operating hours		
5.6	Check the engine oil level	Dipstick mark
5.7	Checking, cleaning the water separator	
5.8	Checking the fuel filter water separator	
5.9	Checking the brake fluid level	
5.10	Checking the V-belt	
5.11	Checking the coolant level	
5.12	Checking the water level in the sprinkler system	
5.13	Checking the fuel level	
5.14	Draining the air pressure vessel	
5.15	Checking the oil level in the steering oil tank	
5.16	Checking the oil level in the powershift transmission	Inspection glass
5.17	Checking, cleaning the scraper brushes	
Every 250 operating hours		
5.18	Changing engine oil and oil filter cartridge[1]	min. 1x per year
5.19	Checking, cleaning the cooling systemKühlanlage prüfen, reinigen	
5.20	Checking the parking brake, lubricating the linkage	
5.21	Lubricating the propshaft	
5.22	Checking the oil level in the differential	
5.23	Checking the oil level in the gear housings	
5.24	Checking, lubricating the front wheel bearings	
5.25	Lubricating the pendulum joints of the front wheels	
5.26	Lubricating the steering linkage	
Every 500 operating hours		
5.27	Servicing the battery	distilled water, pole grease
5.28	Changing the oil filter for the powershift transmission	
5.29	Checking the cleanliness of the pressure air for the brake system	
5.30	Changing the fuel filter cartridge	
5.31	Draining the sludge from the fuel tank	
5.32	Checking the brake linings	
Every 1000 operating hours		
5.33	Checking V-belt tension, idler pulley and fan hub	
5.34	Changing the oil in the powershift transmission	min. 1x per year
5.35	Changing the oil in the differential	min. 1x per year
5.36	Changing the air drier for the brake system	min. 1x per year
5.37	Checking the braking and steering system	min. 1x per year
5.38	Checking the fastenings on the diesel engine	
Every 2000 operating hours		
5.39	Checking, adjusting the valve clearance	Intake = 0,25 mm (0,010 IN), exhaust = 0,50 mm (0.020 IN, with cold engine)

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No.	Designation	Note
5.40	Changing oil and filter in the steering oil tank	
5.41	Changing the brake fluid	at least every 2 years
5.42	Changing the oil in the gear housings	at least every 2 years
5.43	Changing the coolant	at least every 2 years
5.44	Checking the supply lines for the compressor	
As required		
5.45	Checking, cleaning, changing the combustion air filter,	min. 1x every year, safety cartridge at least every 2 years
5.46	Cleaning the water sprinkler system	
5.47	Maintenance in case of frost	
5.48	Bleeding the fuel system	
5.49	Filling the windscreen washer system	
5.50	Changing the fresh air filter in the cabin	
5.51	Adjusting the brake	
5.52	Changing the tires	
5.53	Checking bolted connections for tight fit	
5.54	Temporary taking out of service	

1 When using engine oil of class API CC/CD or CD/SF the oil change intervals must be reduced to half.

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2.3 Table of fuels and lubricants

Assembly	Fuel or lubricant		Quantity approx. Attention Observe the level marks
	Summer	Winter	
Engine	Engine oil CCMC-D4 or API: CE/SG SAE 15W/40 (-15 °C to +40 °C) Fuel		without oil filter change approx. 15,5 litres
	Diesel	Winter diesel fuel	approx. 250 litres
Hydraulic system (steering)	Hydraulic oil (ISO), HV46, kinem. viscosity 46 mm^2/s at 40 °C		approx. 6,5 litres
Level compensation, front axle	Hydraulic oil (ISO), HV46, kinem. viscosity 46 mm^2/s at 40 °C		approx. 6 litres
Powershift transmission	ATF Dexron II D (-34 °C to +60 °C)		approx. 22 litres
Differential	Gear oil SAE 80W/90, API GL5		approx. 13,5 litres
Gear housings	Gear oil SAE 80W/90, API GL5		approx. 5,2 litre per side
Cooling system	Coolant		approx. 15 litres
Sprinkler system	Water		approx. 400 litres
Brake system	DOT 3, SAE J 1703F, ISO 4925		approx. 0,75 litres
Lubrication points	lithium saponified multi-purpose grease, penetration 2		as required

2.4 Fuels and lubricants

Engine oil

The use of high-quality HD brand oils in connection with the specified filter and oil change intervals results in a longer lifetime and a higher performance of the engine.

Do not use running-in oil for new or overhauled engines.

Oil viscosity

CUMMINS preferably recommends oils of viscosity class SAE 15W-40.

In order to assure perfect cold starting it is import to chose the viscosity (SAE-class) of the engine oil according to the ambient temperature.

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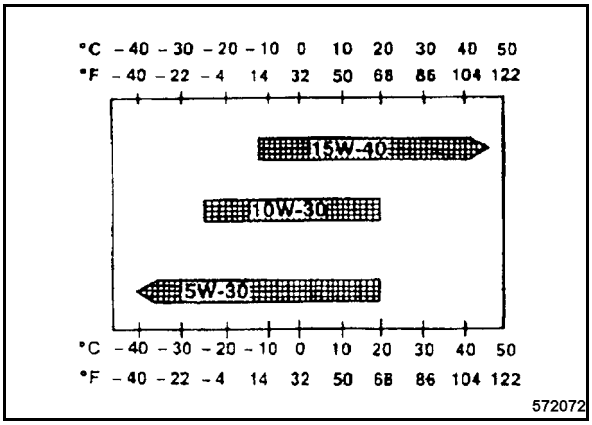


Fig. 2

Lubrication oil with a too high viscosity index causes starting difficulties. The temperature when starting the engine is therefore of highest importance when choosing the viscosity of engine oil for winter operation.

Occasional falling short of the temperature limit (e.g. use of SAE 15W/40 down to -15 °C) may effect the cold starting ability of the engine, but will not cause any engine damage.

Temperature related lubrication oil changes can be avoided by using multi-purpose oils. The following oil change intervals apply also when using multi-purpose oils.

Oil quality

Lubrication oils are classified according to their performance and quality class. Specifications according to API (American Petroleum Institute) and CCMC (Committee of Common Market Automobile Constructors) are commonly used.

Permitted API-oils

API = CE/SG

Permitted CCMC-oils

CCMC = D5

If no oil of quality class CE/SG is available, you may also use oils of quality class CC/CD or CD/SF, when shortening the oil change intervals to half.

Lubrication oil change intervals

The longest permissible time a lubrication oil should remain in an engine is 6 months. If the following oil change intervals are not reached over a period of 6 months, the oil change should be performed at least every 6 months, irrespective of the operating hours reached.

API: CE = 250 operating hours

CCMC/D5 = 250 operating hours

API: CC/CD = 125 operating hours

Fuels

Quality

Use only commercially available brand diesel fuels with a low sulphur content.

Ensure strict cleanliness when filling in fuel.

Use only winter-grade diesel fuel under low ambient temperatures.

The fuel level should always be topped up in due time so that the fuel tank is never run dry, as otherwise filter and injection lines need to be bled.

The following fuel specifications are permitted:

CEN EN 590, DIN/EN 590;

DIN 51 601;

Nato Codes: F-54, F-75;

BS 2869: A1 and A2;

ASTM D 975-78: 1-D and 2-D.

VV-F-800C: DF-A, DF-1, DF-2.

Winter fuel

⚠ Danger

Danger of explosion!

Do not mix diesel fuel with gasoline or alcohol.

Use only winter-grade diesel fuel for winter operation, in order to avoid clogging by paraffin separation. At very low temperatures disturbing paraffin separation can also be expected when using winter diesel fuel.

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

Hydraulic oil

The hydraulic system (steering) is operated with hydraulic oil of quality ISO 6743/4 HM or HV (DIN 51524 part 2 or 3; CETOP RP 91 H) with a kinematic viscosity of 46 mm^2/s at 40 °C (ISO VG 46).

In countries with permanently high temperatures (tropical zones), where the hydraulic oil temperature can reach 80 °C (104 °F), a hydraulic oil with a kinematic viscosity of 68 mm^2/s at 40 °C (ISO VG 68) may be used.

In countries with temperatures permanently below – 10 °C (14 °F), where the hydraulic oil temperature only reaches 30 °C (86 °F), a hydraulic oil with a kinematic viscosity of 32 mm^2/s at 40 °C (ISO VG 32) may be used.

For topping up or for oil changes use only high quality hydraulic oil corresponding with the permitted specifications.

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Oil for powershift transmissions

The powershift transmission must be filled with the following oil:

DEXRON II D series at temperatures from -34 °C (-30 °F) to 60 °C (140 °F)

Always use the same type of oil for topping up.

⚠ Caution

Do not use any multi-purpose engine oils such as e.g. 15W/40.

Oil for differential, gear housings

Use only transmission oil of API-class GL5 with a viscosity class SAE 80W/90.

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

Lubrication grease

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

Brake fluid

⚠ Danger

Danger of poisoning! Danger to life when consuming brake fluid.

Store brake fluid only in original cans.

Never fill brake fluid into beverage containers.

Change the brake fluid at least every two years.

Do not fill in mineral oil.

Use only brake fluid of specification ISO 4925, SAE J 1703f, DOT 3.

The brake fluid has been chosen for ambient temperatures from -50 °C (-58 °F) to 60 °C (140°F) and working temperatures from -50 °C (-58 °F) to 205 °C (400 °F). You may also use brake fluids of specification DOT 4 (Syntol HD 260).

Coolant

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

⚠ Caution

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

If no cooling system protection agent is available in tropical zones, you may also use a corrosion protection agent (CUMMINS Liquid DCA).

Do not mix in more than 50% cooling system protection agent, except when a lower frost protection is required. However, the proportion of cooling system protection agent should never exceed 68%. A higher concentrations the frost protection effect drops again.

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

Coolant must be changed every two years.

Environment

Cooling system protection agents must be disposed of environmentally.

Water quality:

100 (mg/dm^3) of sulphate

100 (mg/dm^3) chloride.

water hardness (°dGH) = 3 to 12

pH-value = 6,5 to 8,5.

Specification for cooling system protection agent

ASTM 4985 (GM6038M)

Anti-freeze concentration

Ethylene Glycol

40 % = -23 °C (-23,33 °C)

50 % = -37 °C (-36,67 °C)

60 % = -54 °C (-53,89 °C)

68 % = -71 °C (-67,78 °C)

Propylene Glycol

40 % = -21 °C (-21,11 °C)

50 % = -33 °C (-32,78 °C)

60 % = -49 °C (-48,89 °C)

68 % = -63 °C (-82 °F)

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3 Fundamental electrics

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3.1 Understanding circuit diagrams

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

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

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

Structure:

- Table of contents
- Function groups
- List of components

Table of contents

The table of contents lists all function groups.

Standardverkabelung: dicke Linien — standard wireing: thick lines

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

Inhaltsverzeichnis:
table of contents:

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

1 2 3 4 5 6 7 8 9 10

Datum: Name: | E0001 Stromlaufplan circuit diagram | Seite: page: von: 001 from: 001 | Ers.f.: Replaces: | Blatt Nr.: sheet no.: 001

Fig. 3 Table of contents

Example:

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

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Function groups

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

Arrangement of current paths

The individual current paths must be read as follows:

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

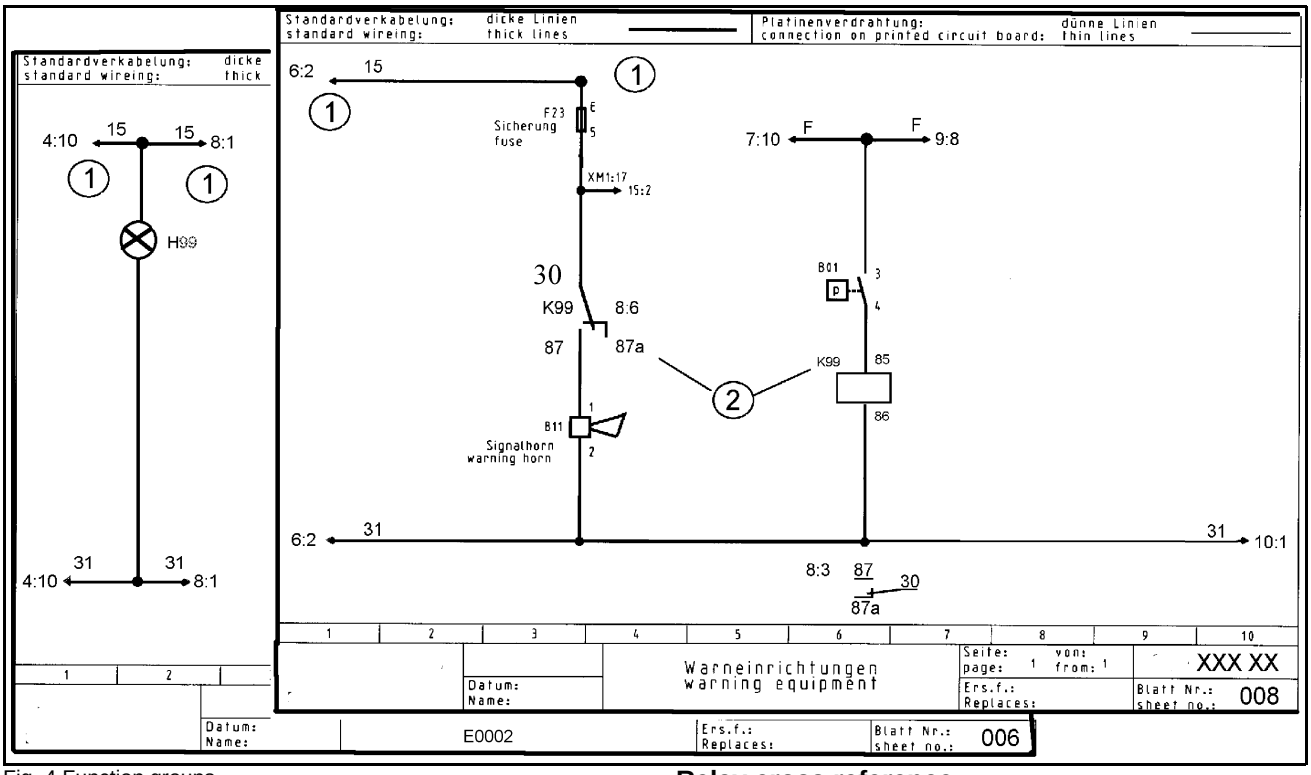


Fig. 4 Function groups

Potential cross references

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

Example:

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

Relay cross reference

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

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

Example:

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

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

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

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Current paths

The pages of a circuit diagram are sub-divided into current paths (Fig. 5) (0 ..... 20).

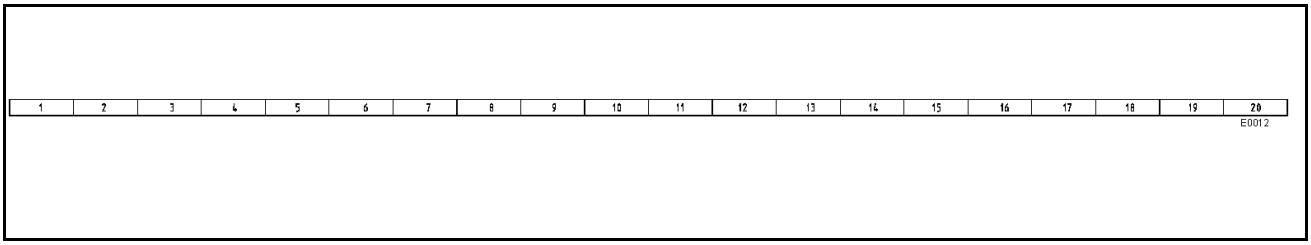
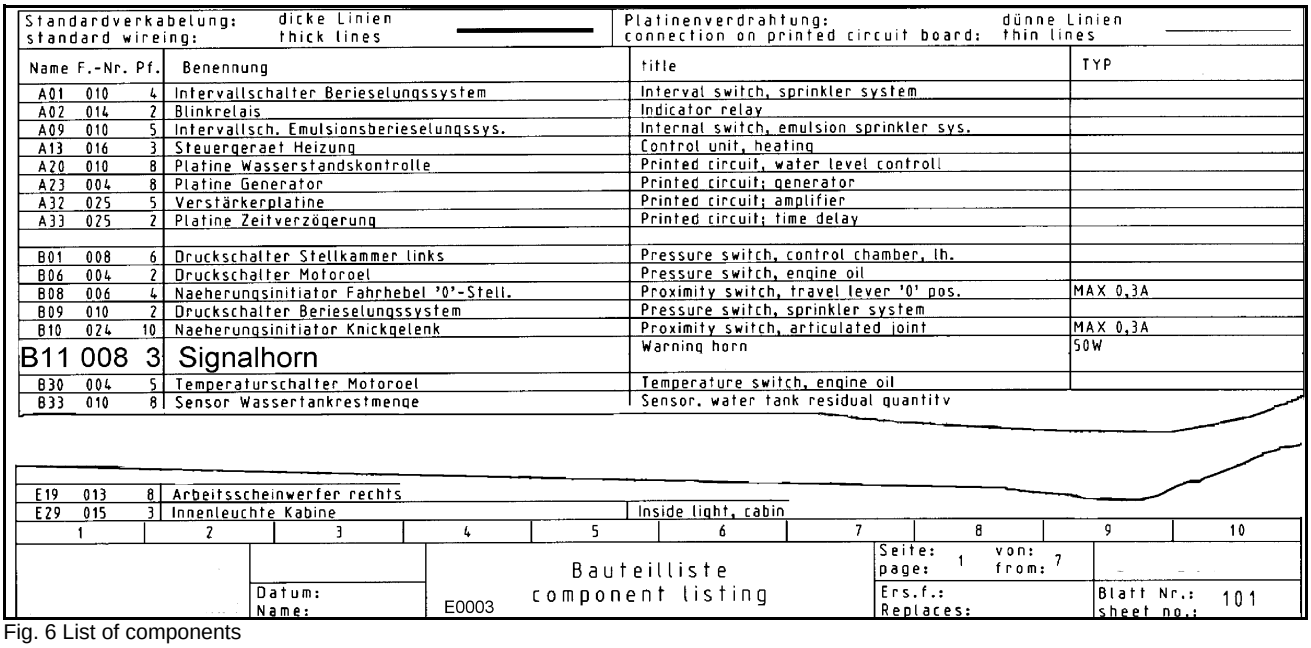


Fig. 5 Current paths

List of components

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



Standardverkabelung: dicke Linien — standard wireing: thick lines
Platinenverdrahtung: dünne Linien — connection on printed circuit board: thin lines

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

1 2 3 4 5 6 7 8 9 10

Datum: Name:
E0003
Bauteilliste
component listing
Seite: page: 1 von: from: 7
Ers.f.: Replaces:
Blatt Nr.: sheet no.: 101

Fig. 6 List of components

Component cross references

Example:

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

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Graphic symbol

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

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

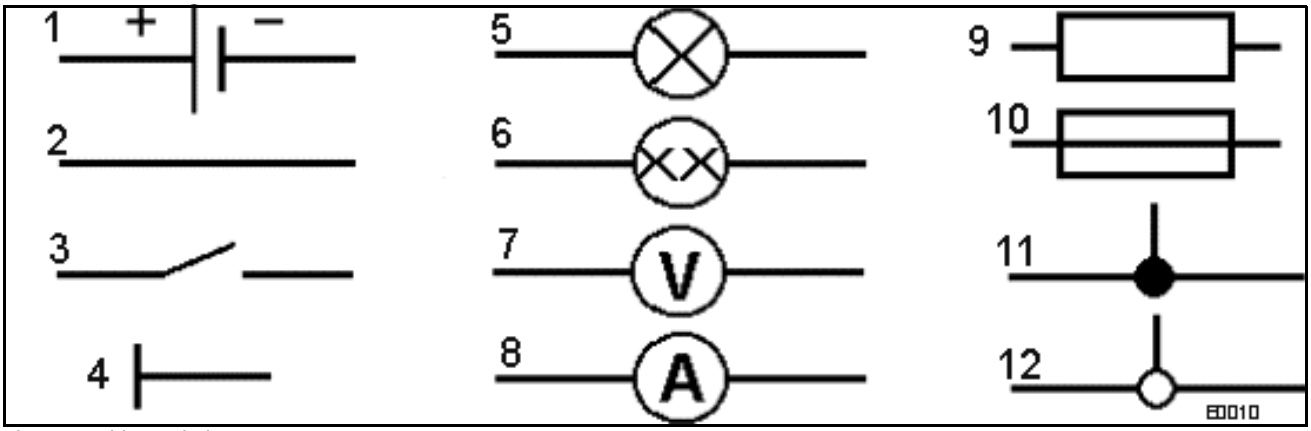


Fig. 7 Graphic symbol

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

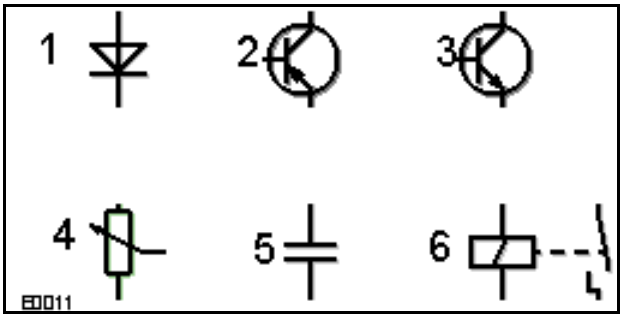


Fig. 8 Graphic symbol

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

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3.2 Terminal designations

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

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

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

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

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

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3.3 Current and voltage

General

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

One simply compares electric current with water.

Voltage

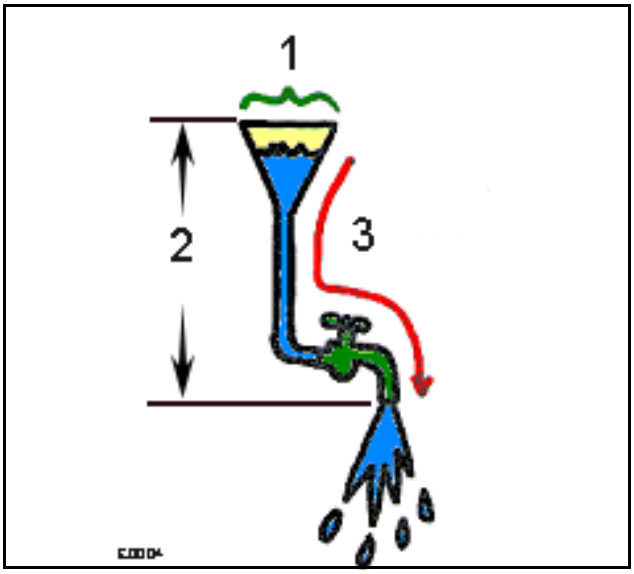


Fig. 1

1 (Fig. 1) Charge

2 Voltage

3 Current

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

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

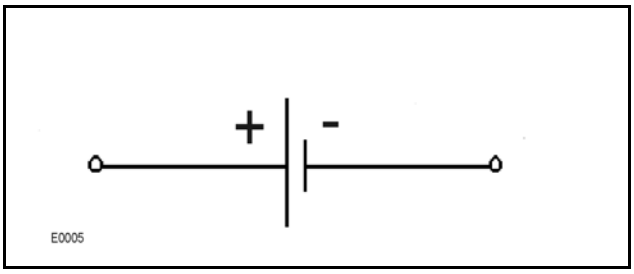


Fig. 2

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

Plus pole= lack of electrons

Minus pole = excess of electrons

The following statements concerning electric voltage can be made

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

Voltage is measured with a Voltmeter.

Unit, Volt

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

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Current

Electric current generally describes the directed movement of charge carriers.

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

Current is measured with an ammeter.

Unit, Ampere

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

The technical flow direction is specified from PLUS to MINUS.

i Note

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

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

Circuit

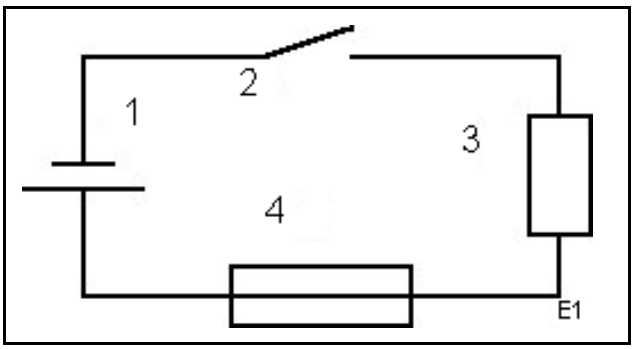


Fig. 3 Circuit

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

When the circuit is closed, current can flow.

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

The system is protected by a fuse (4).

Types of current

Direct current (D.C.)

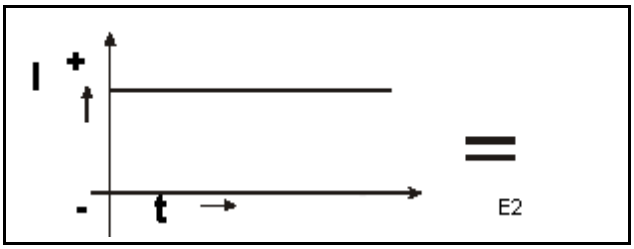


Fig. 1 Direct current (D.C.)

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

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

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

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

Alternating current (A.C.)

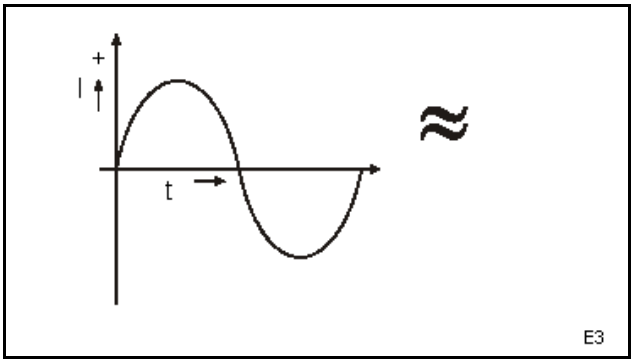


Fig. 2 Alternating current (A.C.)

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

Pulsating direct current

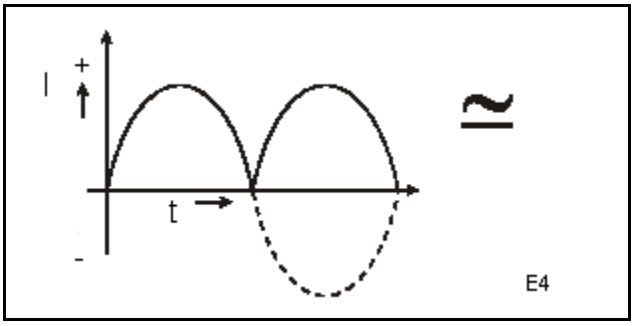


Fig. 3 Pulsating direct current

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

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Pulse width modulation (PWM)

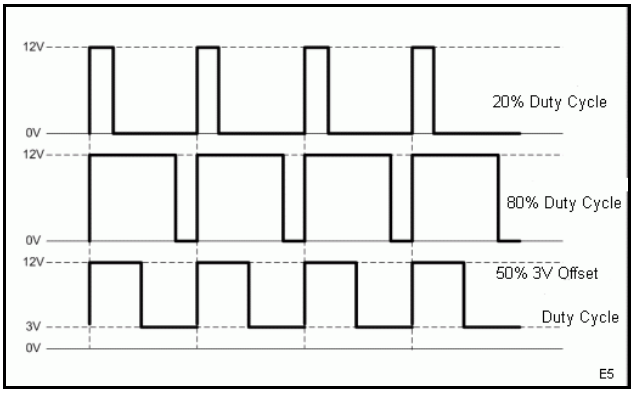


Fig. 4 PWM

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

The following applies:

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

⚠ Caution

Solenoid valves must not be interference suppressed with suppressor diodes.

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Controller Area Network (CAN)

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

Development objectives:

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

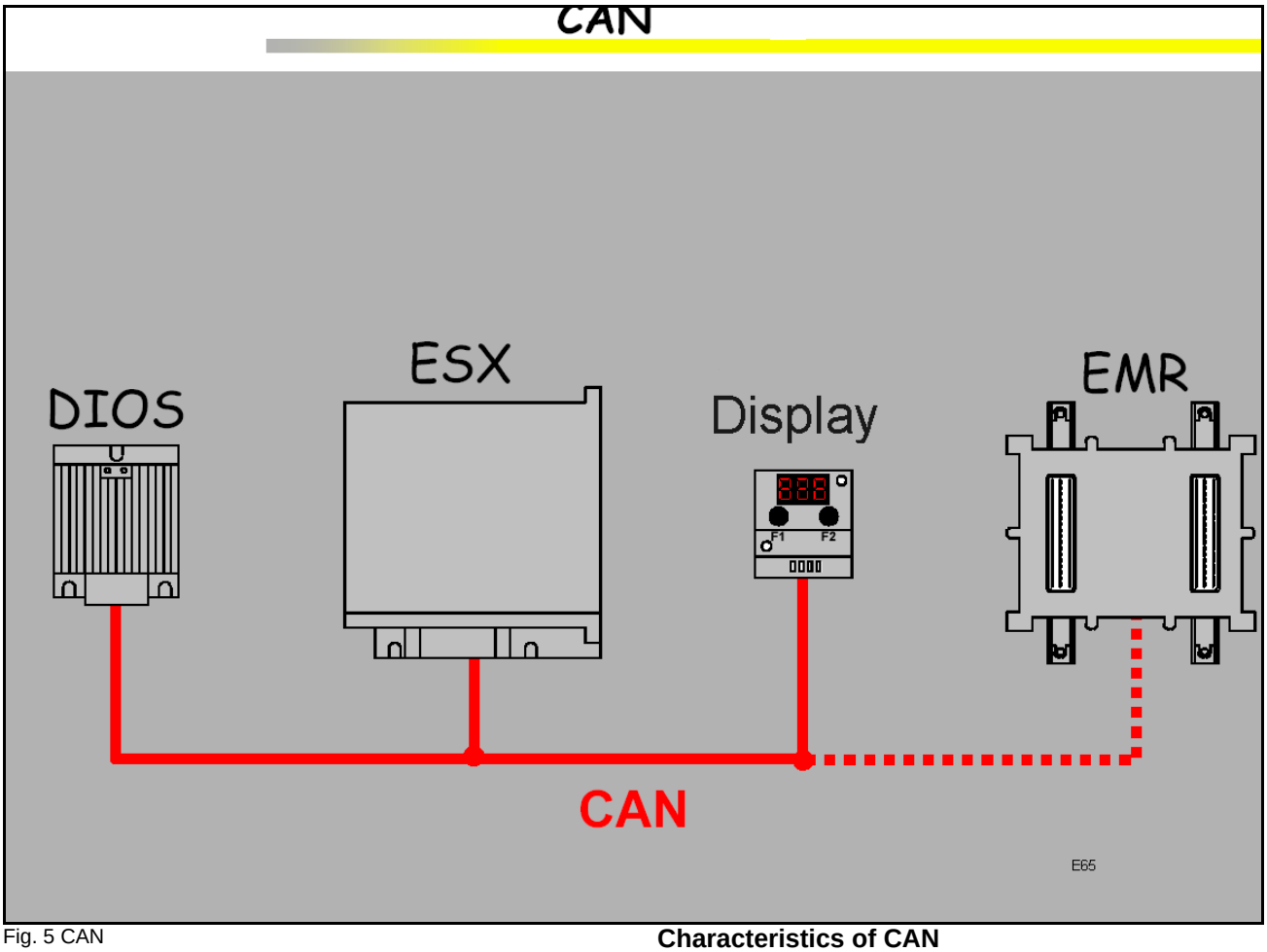


Fig. 5 CAN

Why CAN?

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

Characteristics of CAN

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

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

Wire (+) = cable colour blue

Wire (-) = cable colour yellow

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3.4 Resistance

Resistance and voltage drop

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

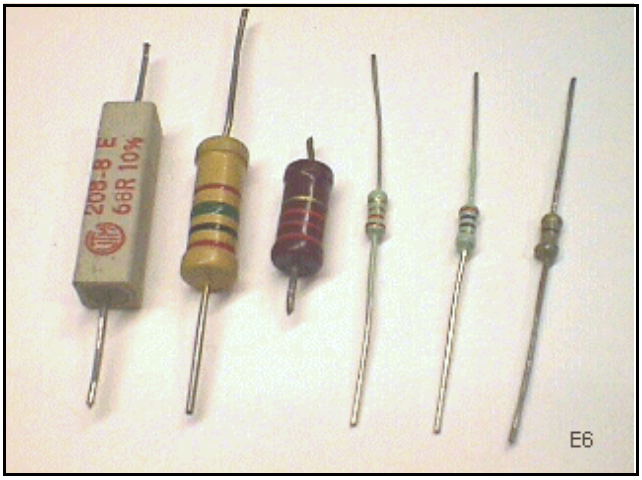


Fig. 1 Various size resistors

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

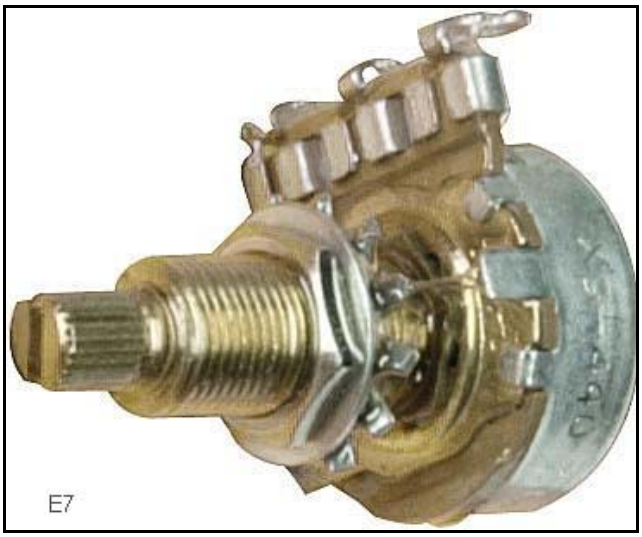


Fig. 2 Potentiometer, infinitely adjustable resistor

The resistance can only be measured with a Multimeter.

Symbol, R

Unit, Ohm

The electric resistance (R) is measured in Ohm.

Rule of thumb:

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

Unnecessary resistances

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

Bad

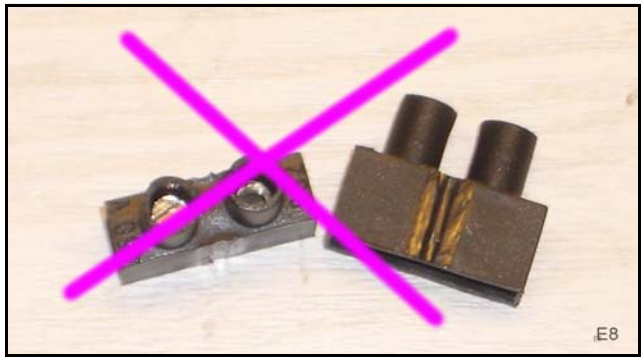


Fig. 1 Screw-type terminals

Copper wires are squashed and thus become faulty.

Better



Fig. 2 Spring clamps

Connecting clamps for flexible conductors

BOMAG No. 057 565 72

Ampacity up to 20 Amp.

Cable cross-section 0.08 to 2.5 qmm

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Fig. 3

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

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



Fig. 4 Balistol oil

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

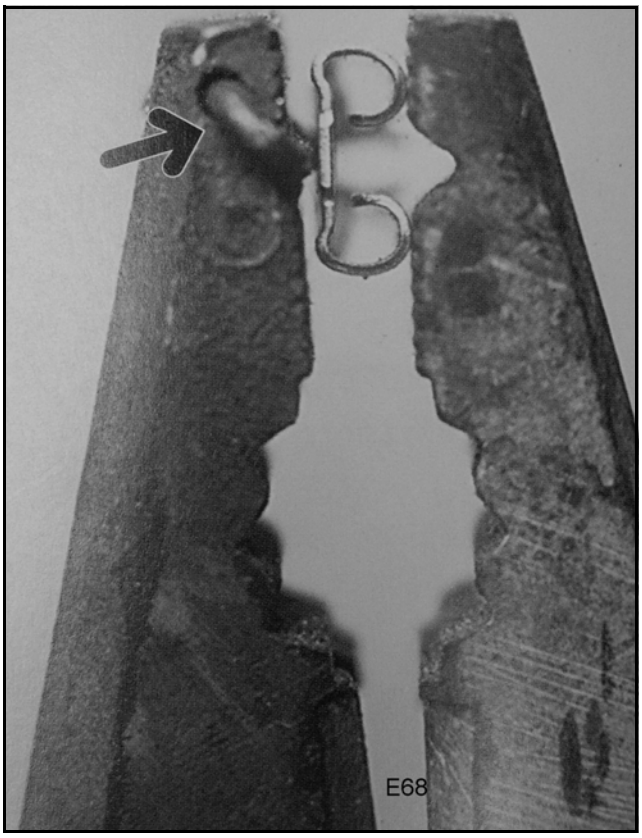


Fig. 5

Hint for practice:

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

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3.5 Series / parallel connection

Series connection

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

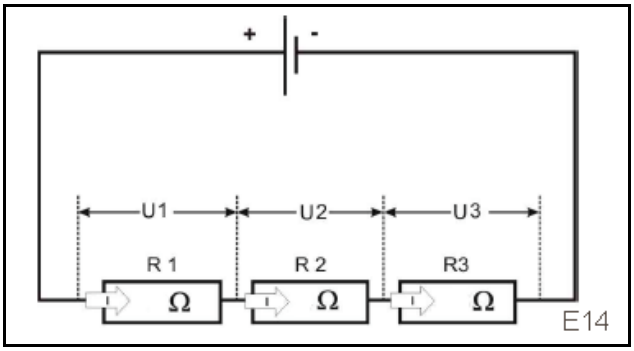


Fig. 1 Series connection

Current

In series connection the current is identical at every point.

Itotal = I1 = I2 = I3

Voltage

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

Utotal = U1 + U2 + U3

Resistance

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

Rtotal = R1 + R2 + R3

Series connection of batteries

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

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

Parallel connection

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

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

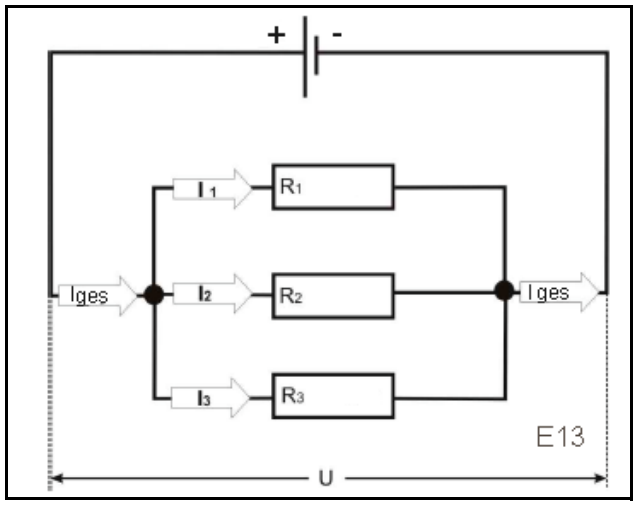


Fig. 2 Parallel connection

Current

The total current is the sum of all currents.

Itotal = I1 + I2 + I3

Voltage

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

Utotal = U1 = U2 = U3

Resistance

The total resistance is less than the lowest individual resistance.

Parallel connection of batteries

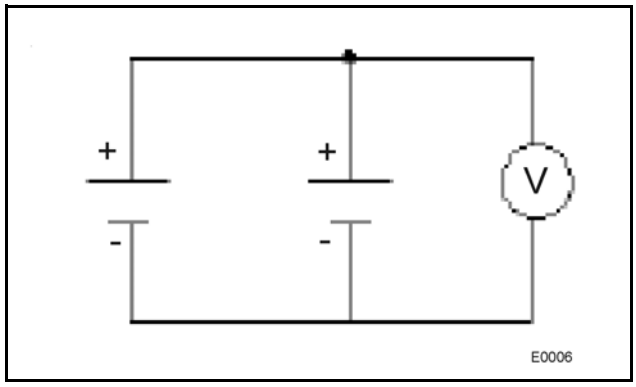


Fig. 3

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

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

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

3.6 Ohm's law

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

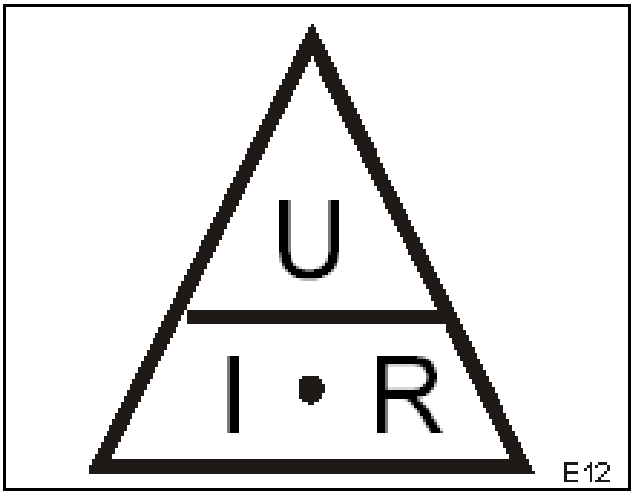


Fig. 1

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

Advice

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

Voltage U = I multiplied with R

Resistance R = U divided by I

Amperage I = U divided by R

U = Voltage in Volt

I = Current in Ampere

R = Resistance in OHM

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3.7 Electrical energy

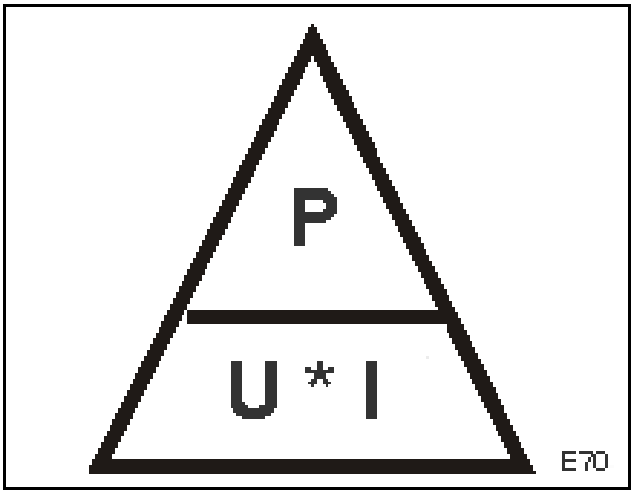


Fig. 1

In a closed electric circuit current and voltage generate energy.

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

Advice

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

Energy P = I multiplied with U

Amperage I = P divided by U

Voltage U = P divided by I

U = Voltage in Volt

I = Current in Ampere

P = Power in Watt

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3.8 Formula diagram

Description:

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

Example:

P = 150 Watt

U = 24 Volt

Sought for = Current in Ampere

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

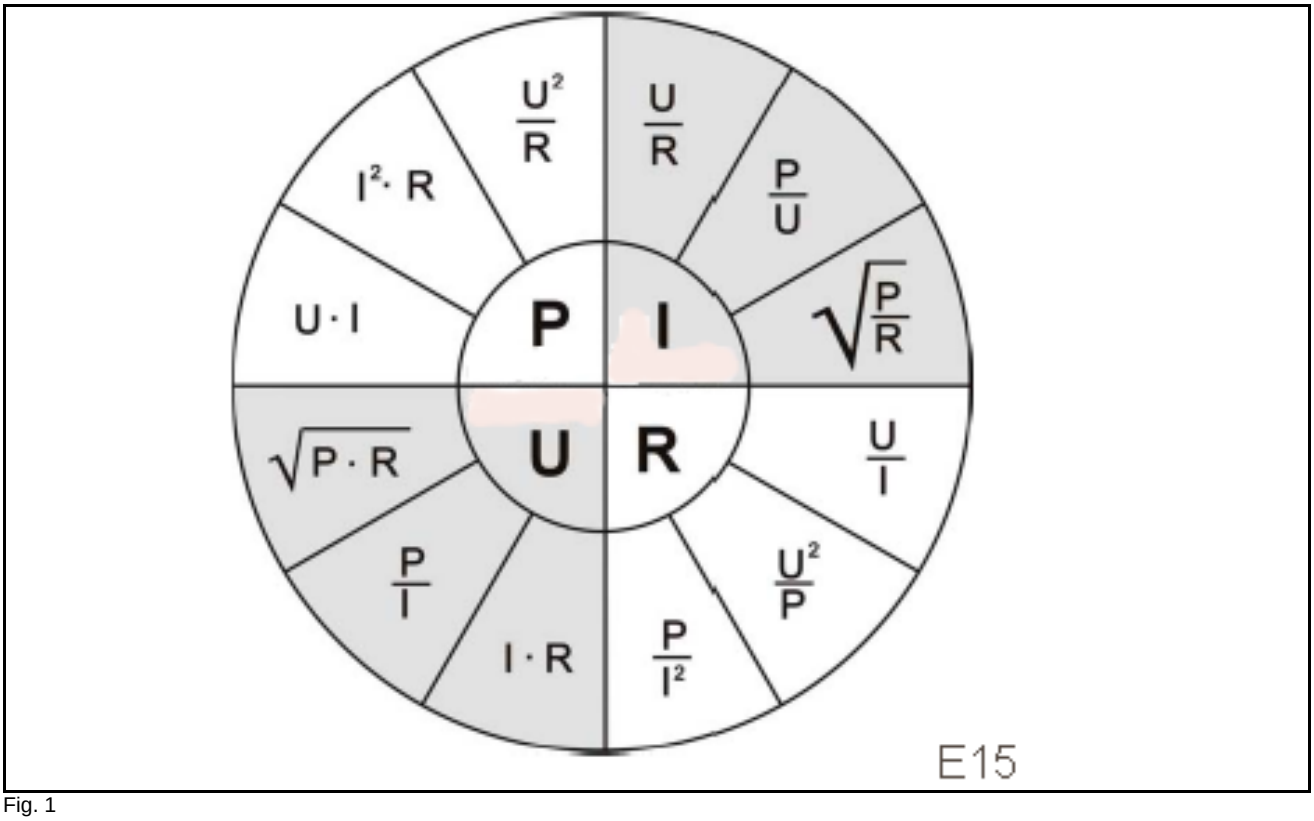


Fig. 1

Resistance, R Ohm

Voltage, U Volt

Current, I Ampere

Power, P Watt

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3.9 Metrology

Test lamps

Test lamp

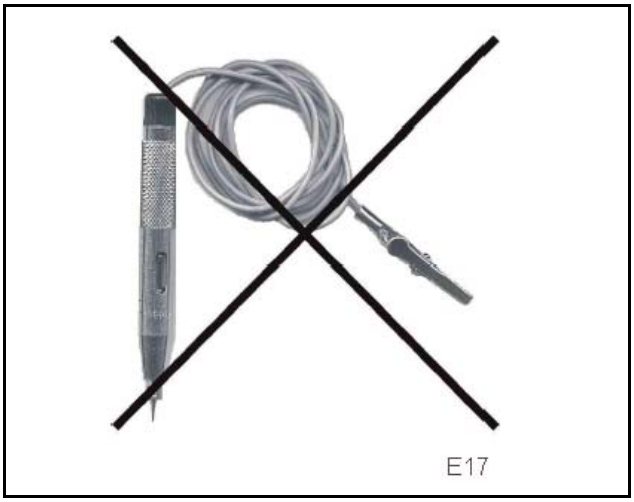


Fig. 1 Test lamp

⚠ Caution

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

Diode test lamp

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

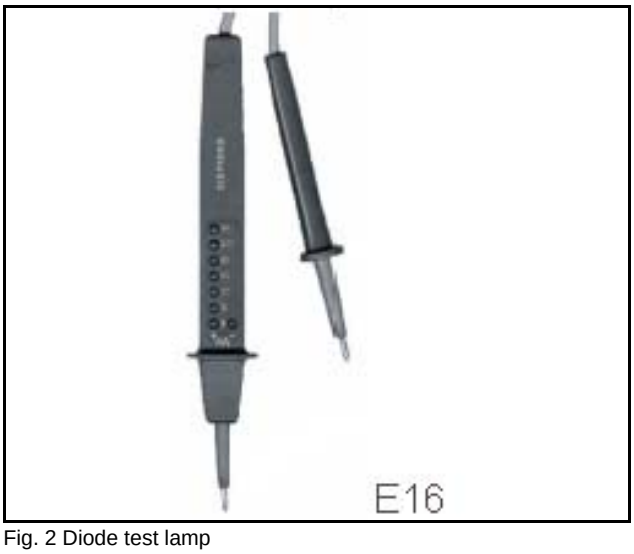


Fig. 2 Diode test lamp

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

Multimeter

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

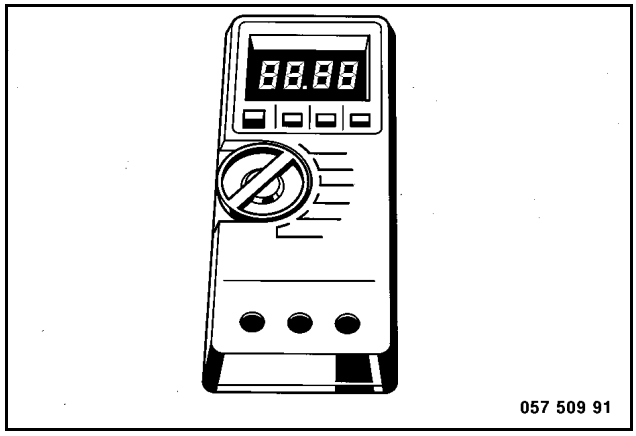


Fig. 1 Multimeter

In order to avoid damage:

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

Resistance and continuity measurement with multimeter

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

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

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Voltage and voltage drop measurement with multimeter

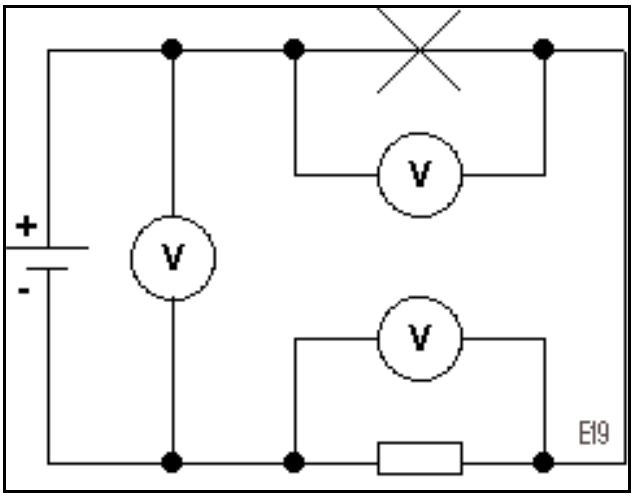


Fig. 2

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

Current measurement with the multimeter

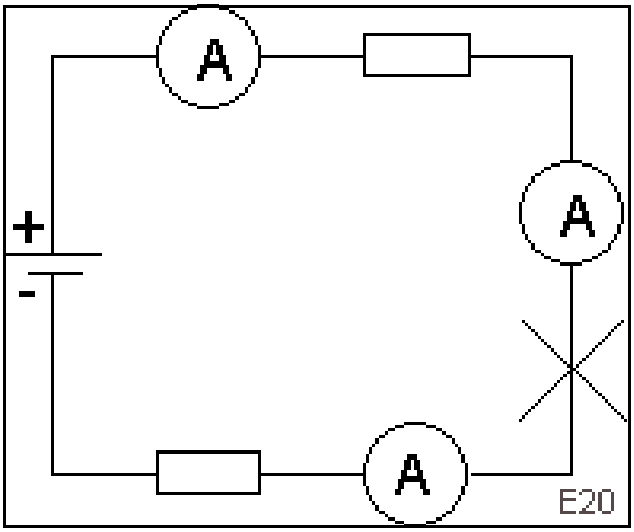


Fig. 3

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

Advice

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

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

Clip-on measuring instrument

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



Fig. 1 Clip-on measuring instrument

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

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Magnet tester



Fig. 1 Magnet tester

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

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

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

3.10 Diodes, relays, fuses

Diodes

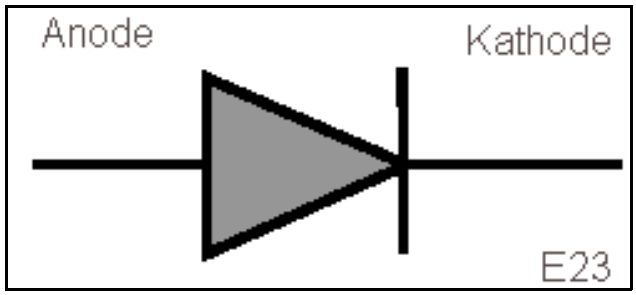


Fig. 1

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

Plus-voltage on diode:

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

Negative voltage on diode:

- The diode does not allow current to pass through.



Fig. 2 Marking of the cathode

Diodes are used:

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

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Diode logics and free-wheeling diode

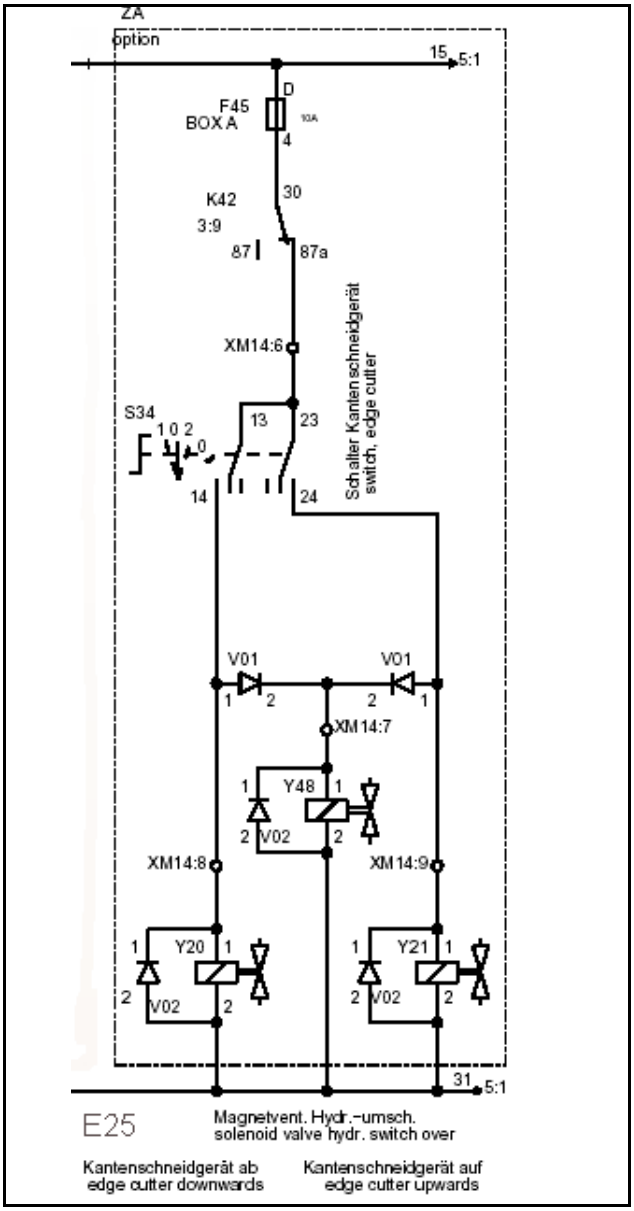


Fig. 3 Diode circuitry

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

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

Relays

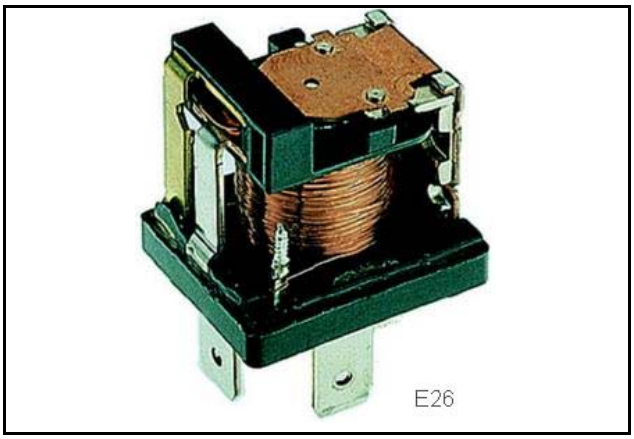


Fig. 1 Relays

Relays are commonly used to realize switching processes.

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

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

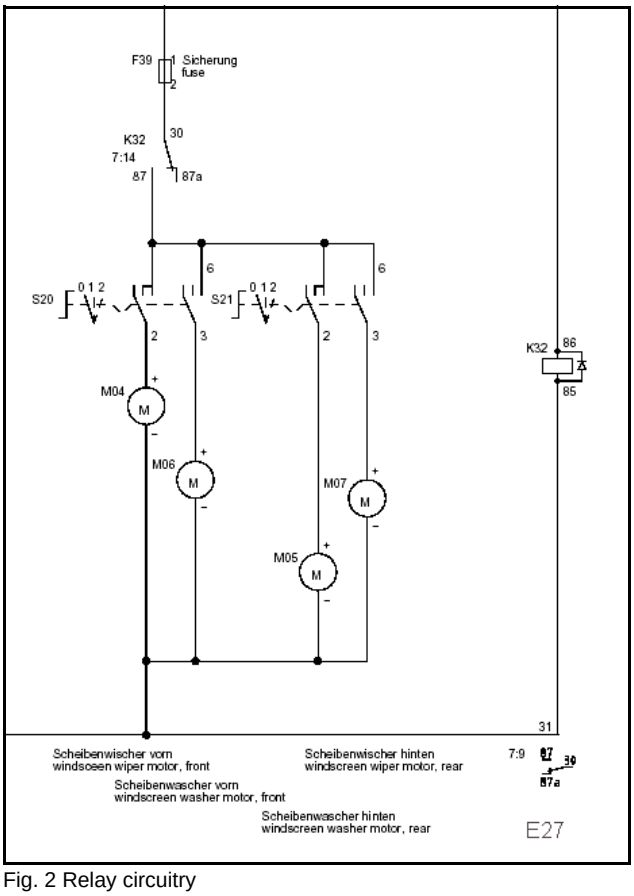


Fig. 2 Relay circuitry

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

86 = Positive supply for coil

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85 = Ground supply for coil

30 = Supply voltage

87 = Normally open contact

87a= Normally closed contact

Fuses



Fig. 1

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

⚠ Caution

Fuses must not be repaired or bridged.

The melting time at 23 °C is:

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

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

Yellow = 5 A

Brown = 7.5 A

White = 8 A

Red = 16 A

Blue = 25 A

3.11 Batteries

Battery – accumulator

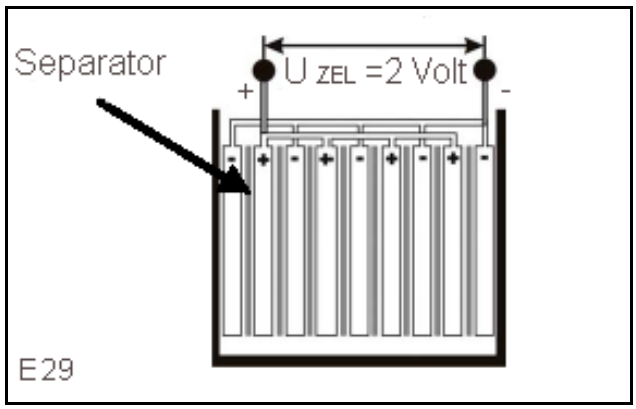


Fig. 1

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

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

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

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

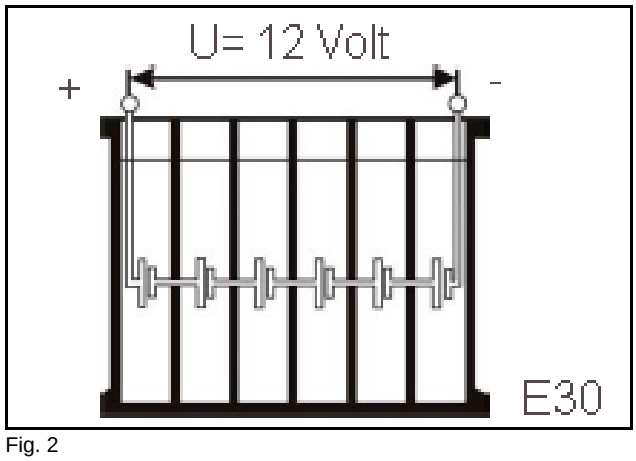


Fig. 2

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

Capacity

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

Rules for the handling of batteries

Even though it may be conveniently installed in the engine compartment, it should never be used as a rest

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for tools. If the poles are connected e.g. by a spanner, the battery will become an electric welder.

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

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

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

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

Safety precautions:

- Wear goggles and face protection (acid).
- Wear suitable clothes to protect face, hands and body (acid).
- Work and store accumulators only well ventilated rooms. (Development of oxyhydrogen gas).
- Do not lean over the battery while it is under load, being charged or tested. (Danger of explosion).
- Burning cigarettes, flames or sparks can cause explosion of the accumulator
- Keep ignition sources away from the battery.
- Always shield eyes and face towards the battery.
- Do not use battery chargers or jump leads without following the operating instructions.
- Keep the cell plugs closed.
- After an accident with acid flush the skin with water and seek medical advice.
- Do not allow children access to batteries.
- When mixing battery fluid always pour acid into water, never vice-versa.

Battery maintenance

i Note

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

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

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

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

The following therefore applies for longer downtimes:

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

i Note

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

Battery test in general

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

Testing batteries with screw plugs

Checking the acid density:

- The cells are filled with diluted sulphuric acid as electrolyte (approx. 25 Vol% sulphuric acid in distilled water), also referred to as accumulator acid, which has a density of 1.285 kg/dm3 at a temperature of +27° Celsius. This means that one litre of electrolyte has a weight of 1.285 kg. As the cell is being discharged lead sulphate (PbSO4) will form on both electrodes and the electrolyte will increasingly change to water. Since water has a lower specific weight than diluted sulphuric acid the density of the electrolyte will also drop during the discharge and with a fully discharged cell and a temperature of 27°C it will only be 1.18 kg/dm3.
- With a lead cell the acid density is therefore a measure for the charge condition. This characteristic is used to determine the charge condition of a lead battery. The so-called acid tester (hydrometer) is used for this purpose. In a battery of good condition the acid density should be the same in all cells.

Acid density at 27 °C in kg/dm3

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

i Note

If the current consumption during charging is not 1/20 of the nominal capacity (example 100 Ah battery: 100Ah x 1/20 = 5 A) or full charging of the battery results in a final acid density of only 1.24 kg/dm3 or less, the battery shows normal wear by aging. The battery was insufficient charging or exhaustive discharge.

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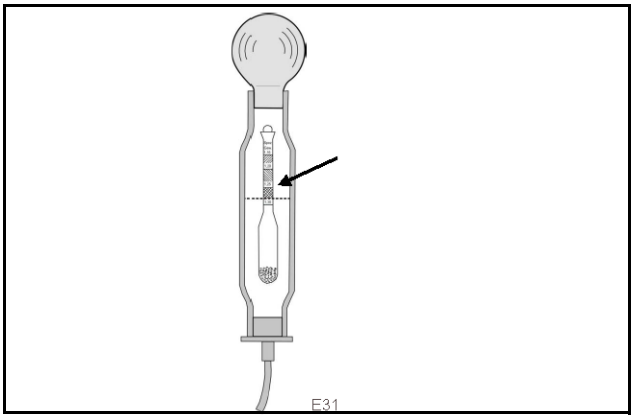


Fig. 3 Reading the acid level

- Maximum permissible tolerance between highest and lowest measuring value of the 6 cells: 0.03 kg/ dm3.

Testing batteries without screw plugs

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



Fig. 4 Battery and generator tester

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

i Note

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

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

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

The starting power can exceed 100%.

Charge condition with hydrometer

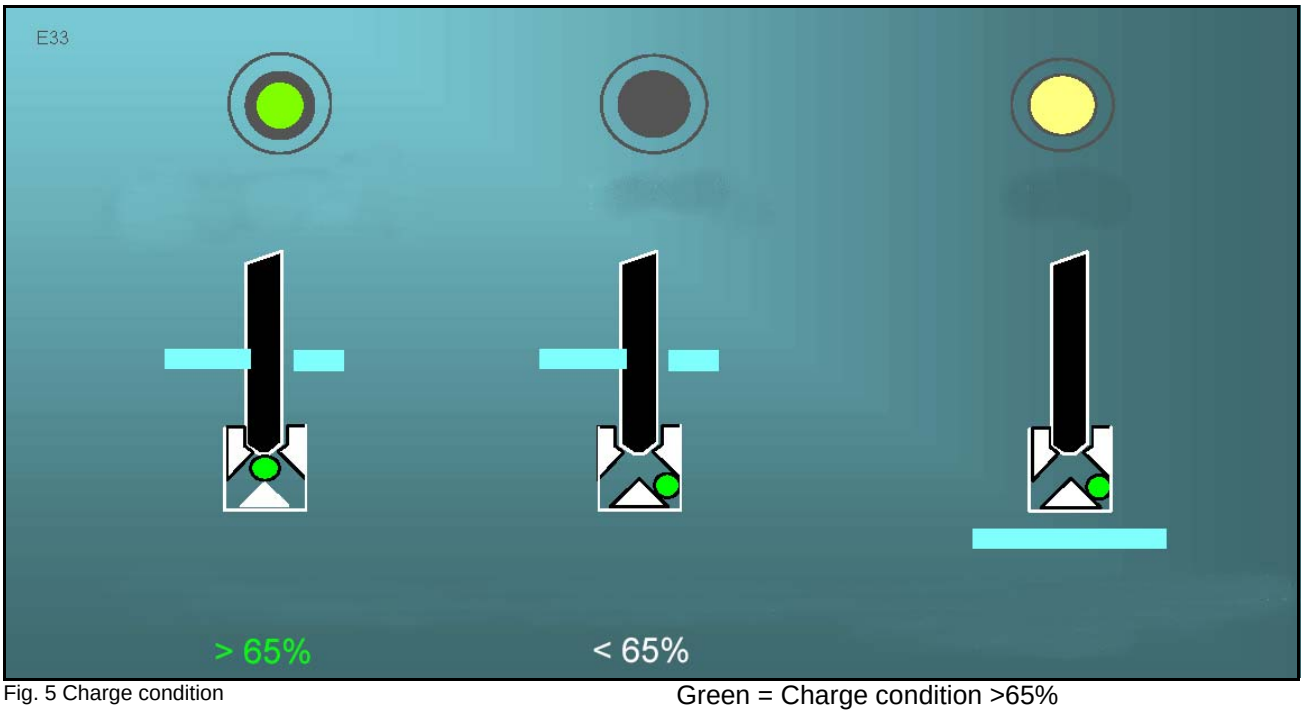


Fig. 5 Charge condition

Green = Charge condition >65%

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Dark = Charge condition <65%

Light = Electrolyte level too low

⚠ Danger

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

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3.12 Three-phase generator

General

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

⚠ Caution

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

Reason: In case of an inductance electric current has the tendency to continue flowing when it is switched off. For this to take place, a voltage of several thousand Volt builds up (caused by the collapsing magnetic field), which can be noticed by an arc appearing at the point of damage. With direct current this can have severe consequences, because there is no zero crossover at which the arc could tear off.

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



Fig. 6 Rotor with claw poles

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



Fig. 7 Stator with 3 windings

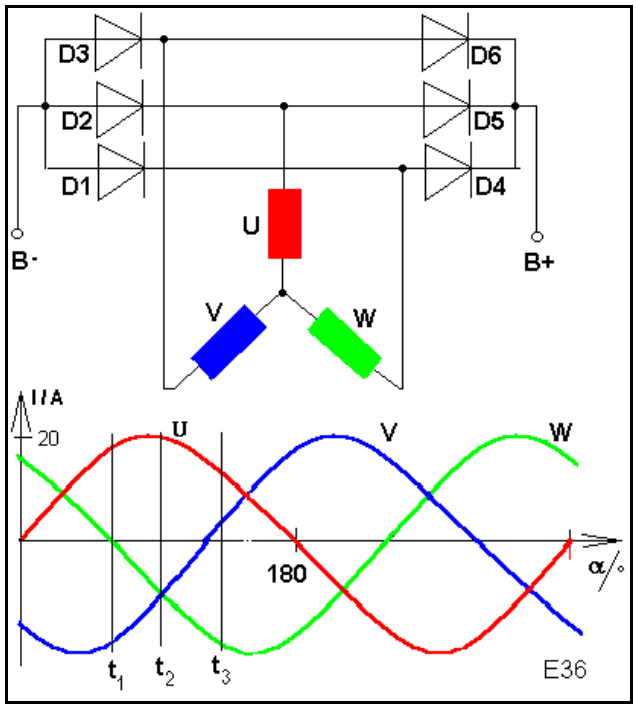


Fig. 8 3-phase current

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

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

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

The other diodes are the plus diodes.

The rectifier diodes have the effect that the negative half-wave is suppressed and only the positive section

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of the wave is allowed to pass, resulting in a pulsating D.C. voltage.

Reverse current protection

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

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

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

This includes :

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

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

This includes :

- Electric motors
- Relays

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

This includes :

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

Voltage regulator

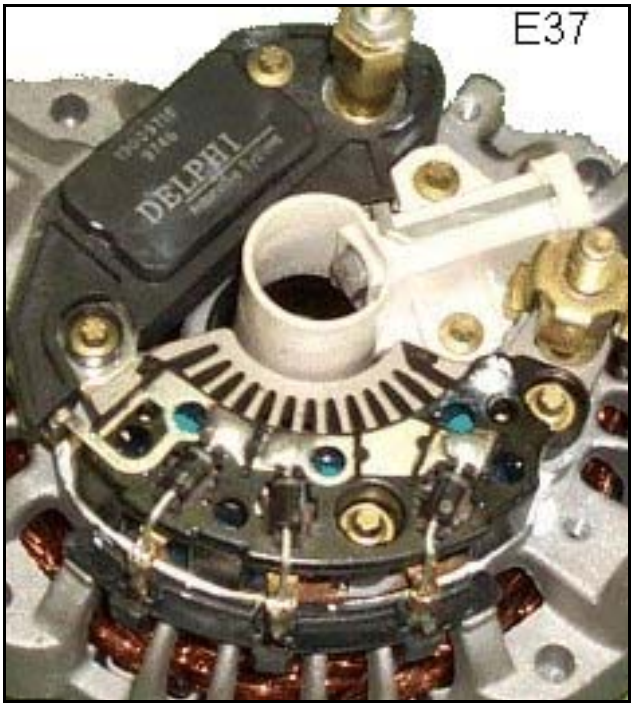


Fig. 9 Governor with diode plate and rectifier diodes

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

The regulator has the following function:

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

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Checking the generator

First one must check whether the generator is actually defective.

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

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

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

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

Measuring the charge current

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

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

56 Gradually increase the engine speed.

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

Checking the rotor

i Note

The rotor coils can only be measured in disassembled state.



Fig. 10 Rotor

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

Checking the stator



Fig. 11 Stator

i Note

The stator coils can only be measured in disassembled state.

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

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Checking the regulator voltage with the generator tester

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



Fig. 12

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

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

Checking the regulator voltage with the multimeter

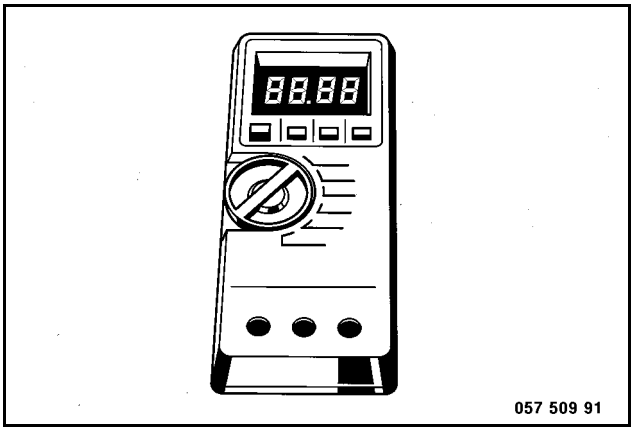


Fig. 13

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

Checking the regulator in disassembled state

i Note

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

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

D+ (vehicle wiring system)

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

DF (Dynamo Field)

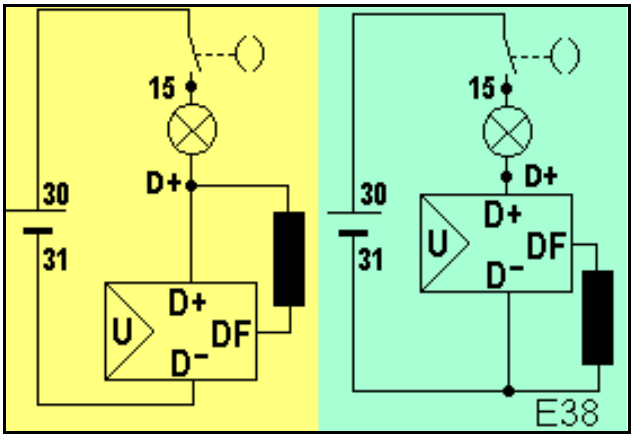


Fig. 14

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

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

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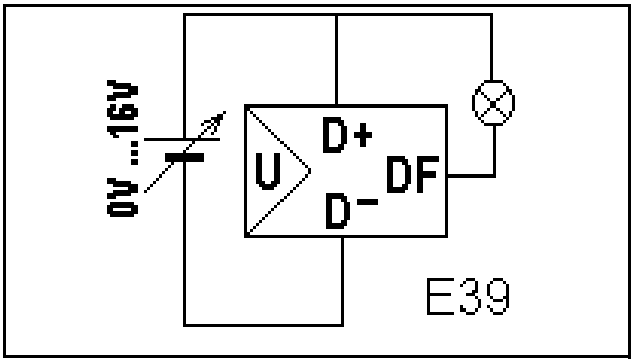


Fig. 15

E.g minus controlled regulator

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

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

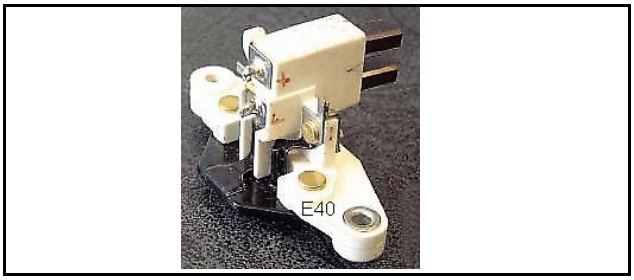


Fig. 16



Fig. 17

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

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3.13 Electric starter

Duties of the starter:

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

After starting the engine:

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

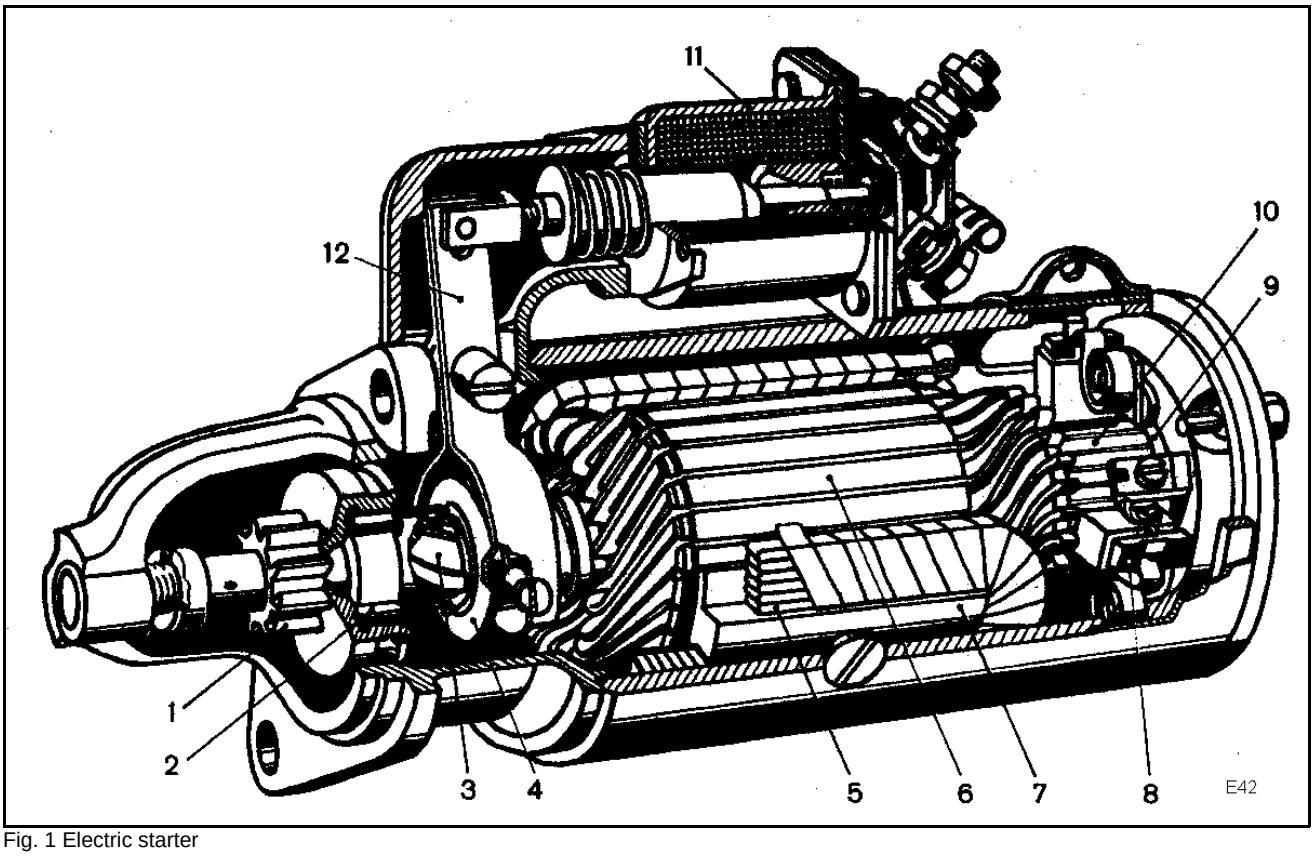


Fig. 1 Electric starter

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

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Magnetic switch

The magnetic switch is normally arranged directly above the starter.

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

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

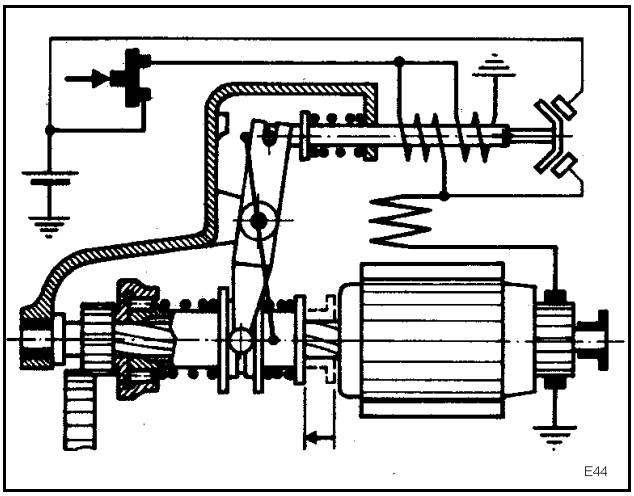


Fig. 2 Switching position during engagement

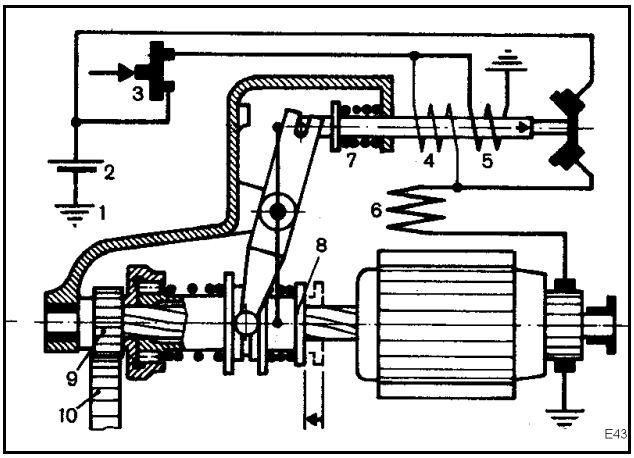


Fig. 3 Switching position during starting

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

Trouble shooting "Starter"

The most frequent fault is definitely a fully discharged battery.

In some cases oxidized electric contacts or a soiled ground connection causing extremely high voltage losses in the overall starter system are the cause of problems.

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

Occasionally worn contacts are found on the magnetic return switch

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

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

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

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

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

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

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Testing and measuring the electric starter

i Note

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

Function test with starter installed

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

Function tests with disassembled starter

⚠ Caution

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

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

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3.14 Telemecanique switch

Terminal designation

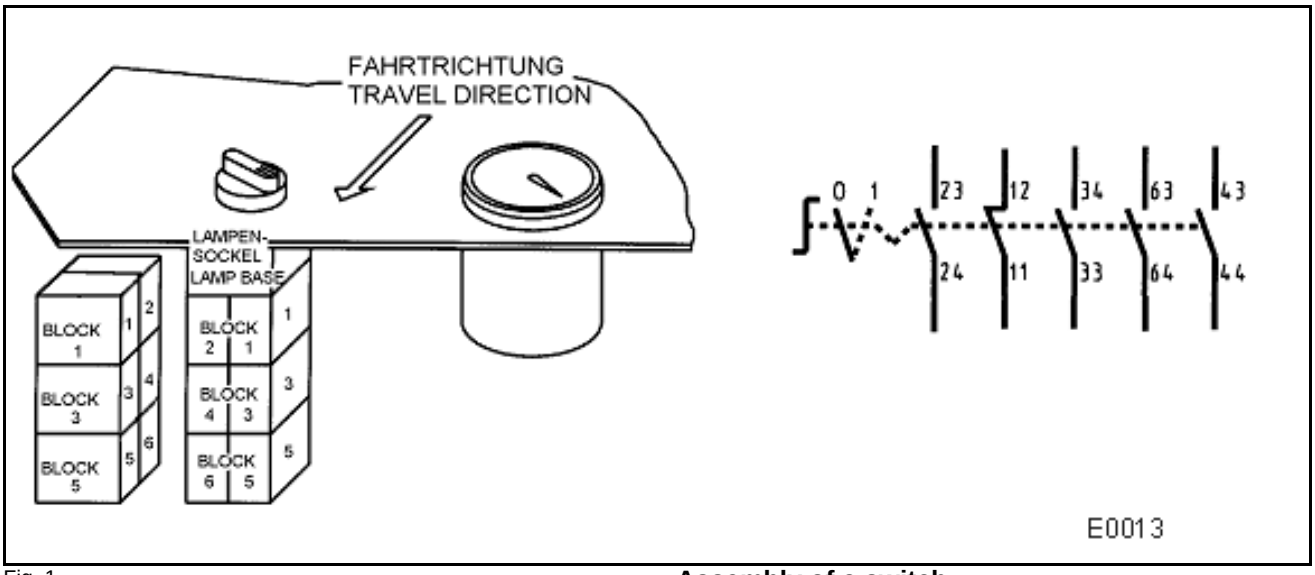


Fig. 1

Example:

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

i Note

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

Assembly of a switch

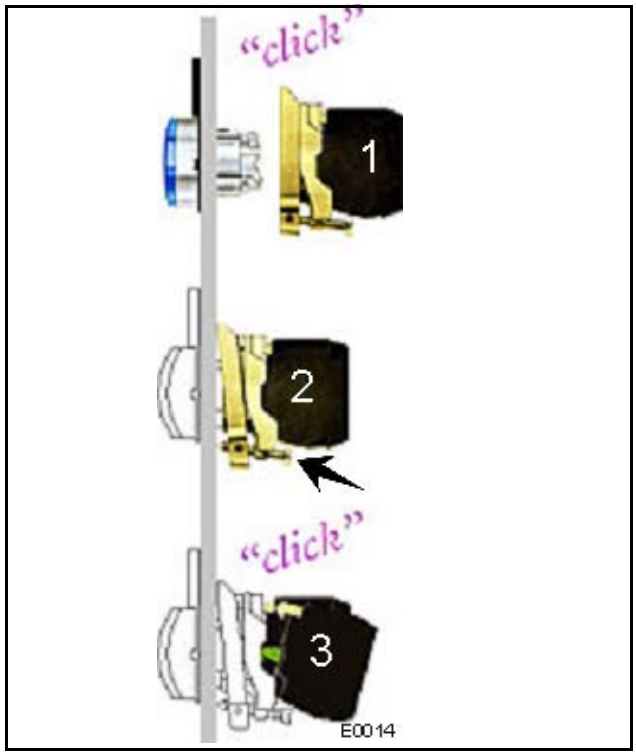


Fig. 2

1 Insert the front element into the bore and open the fastening adapter with the auxiliary switch.

2 Tighten the screw.

3 Click the auxiliary switch into place.

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3.15 Inductive proximity switches

Working principle

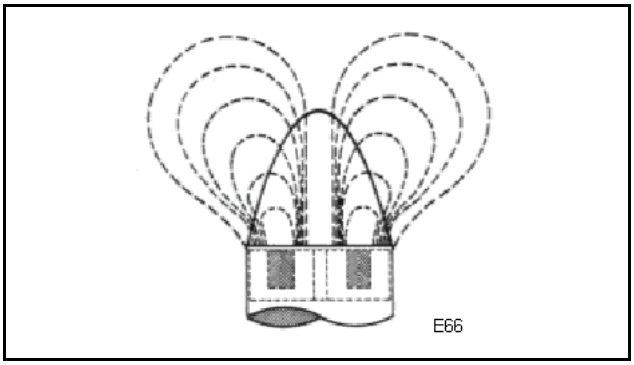


Fig. 1

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

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

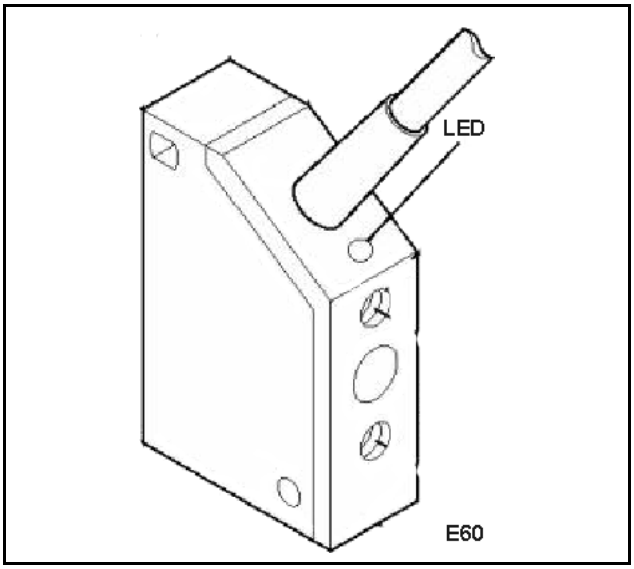


Fig. 2

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

The LED (Fig. 2) lights up, when the initiator has detected metal in its stray field.

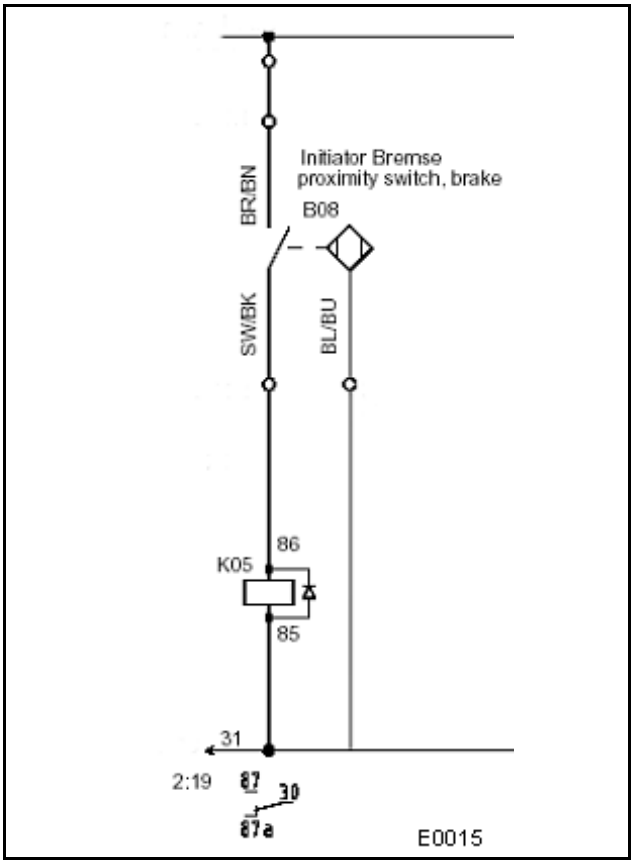


Fig. 3

The circuit diagram (Fig. 3) shows a proximity switch with normally open contact.

Brown = voltage supply

Blue = ground supply

Black = switching output

The initiator in this case switches the relay (K05)

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3.16 Deutsch plug, series DT and DTM

General

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

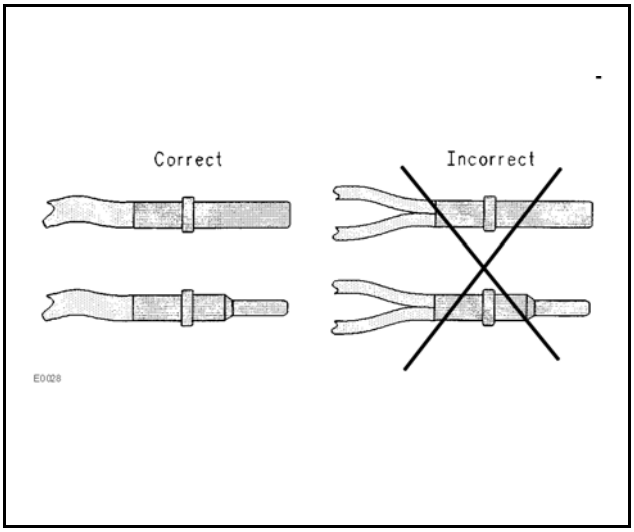


Fig. 4 Crimp connections

⚠ Caution

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

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

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

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

Pulling test

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

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

DT Series



Fig. 1 DT plug connection

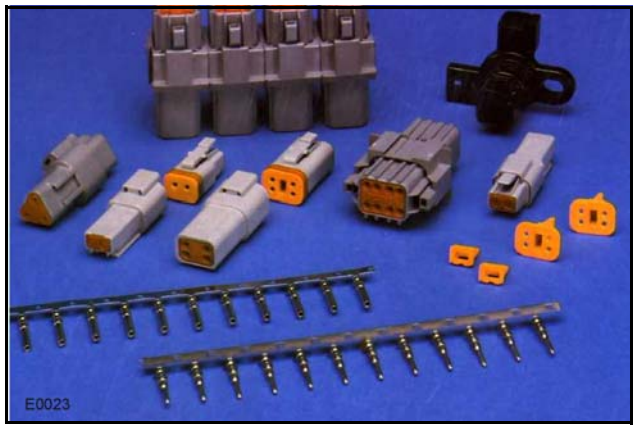


Fig. 2 DT Series

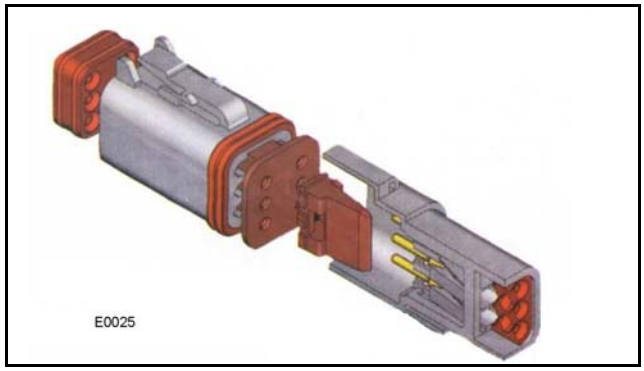


Fig. 3 Sectional drawing

https://truckmanualshub.com/

Installing DT contacts

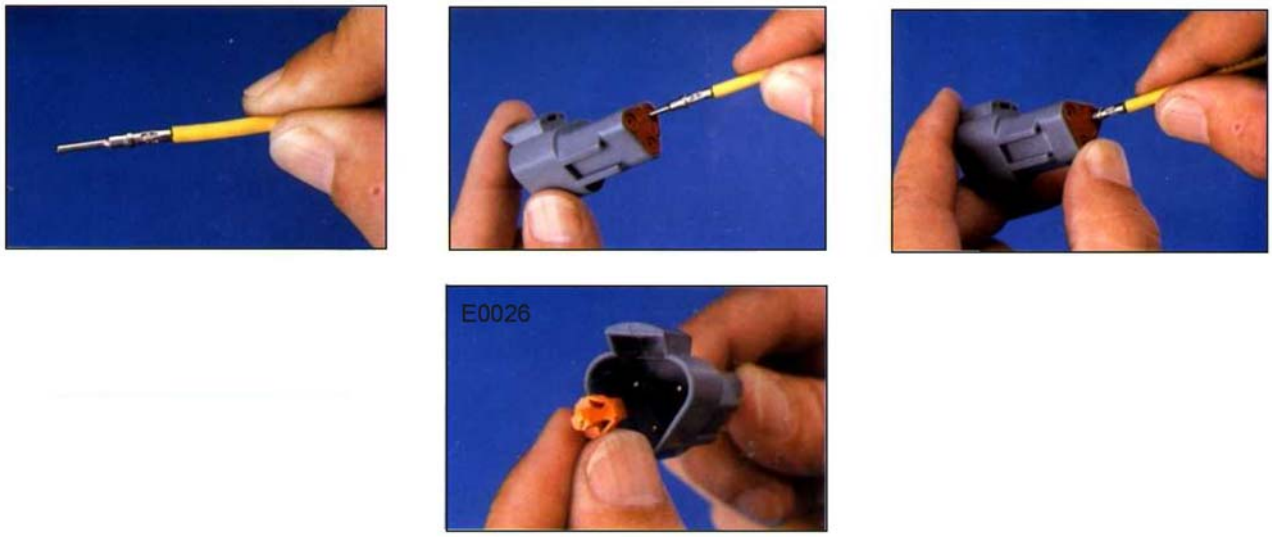


Fig. 4

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

⚠ Caution

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

i Note

Use the same method when assembling the socket.

Disassembling DT contacts



Fig. 5

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

i Note

Use the same method when assembling the socket.

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

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DTM Series

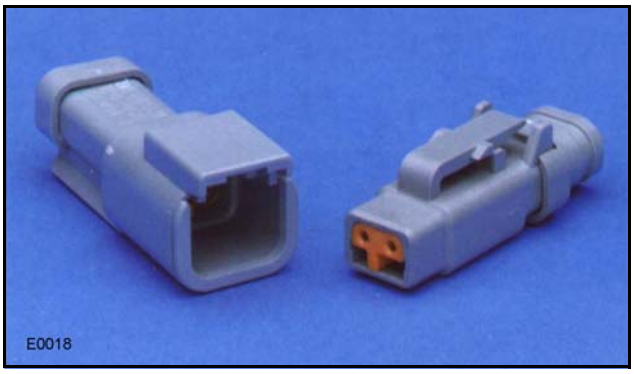


Fig. 1 DTM plug connection

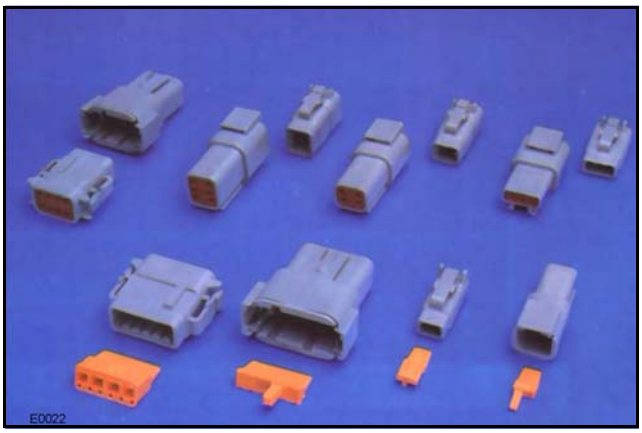


Fig. 2 DTM Series

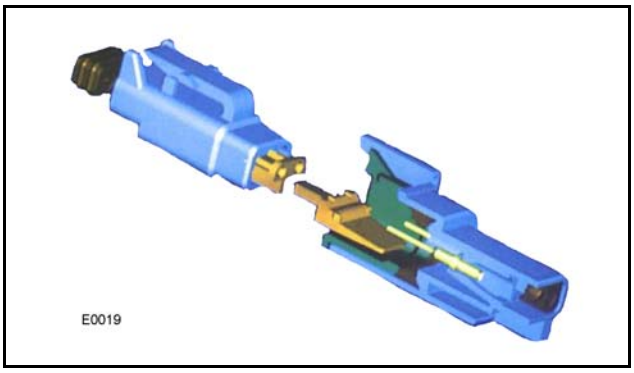


Fig. 3 Sectional drawing

https://truckmanualshub.com/

Installing DTM contacts

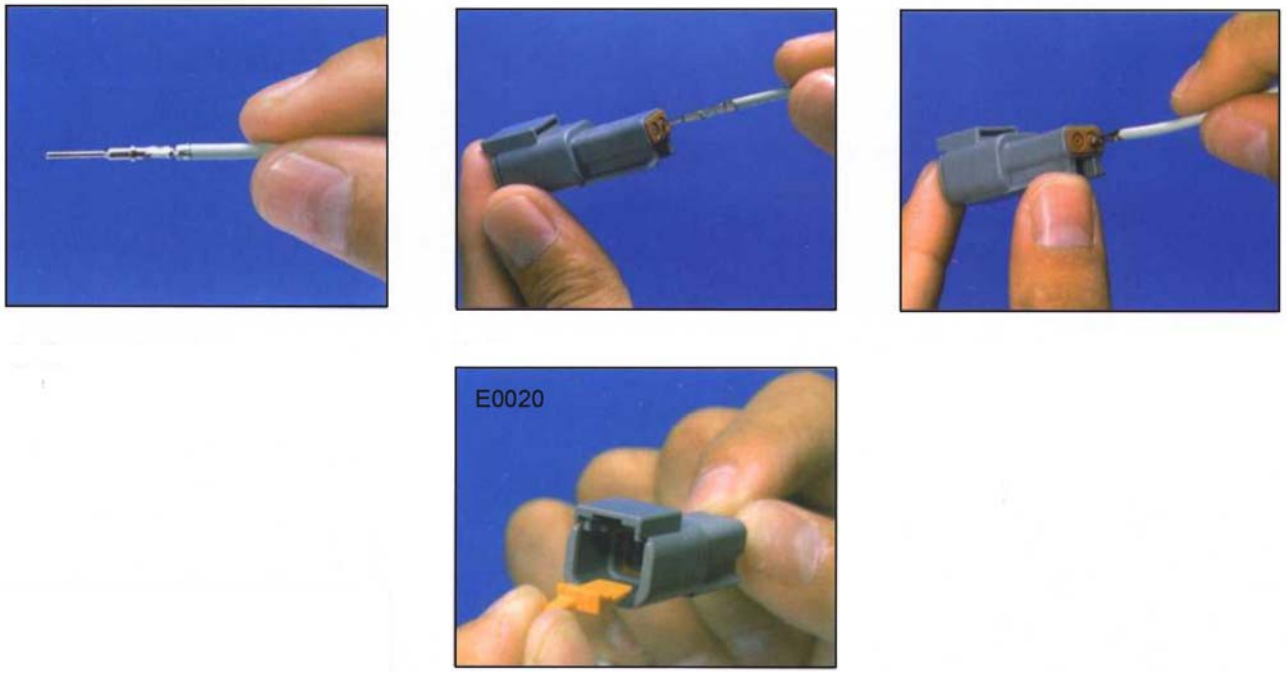


Fig. 4

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

⚠ Caution

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

i Note

Use the same method when assembling the socket.

Disassembling DTM contacts



Fig. 5

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

i Note

Use the same method when assembling the socket.

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

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3.17 Plugs and terminals in spring clamping technology

General

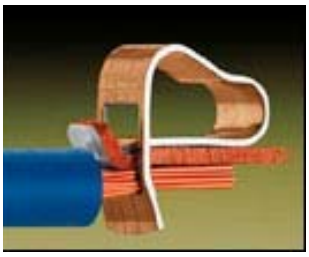


Fig. 1

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

⚠ Caution

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

Connecting terminal for quick repairs

BOMAG part-no.: 057 565 72



Fig. 1 That's how it works

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

That's how it works

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

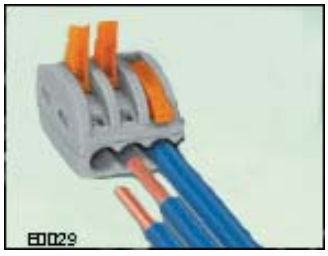


Fig. 2 Connecting clamp

⚠ Caution

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

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Series clamp



Fig. 1 That's how it works

That's how it works

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

⚠ Caution

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

Measuring signals

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

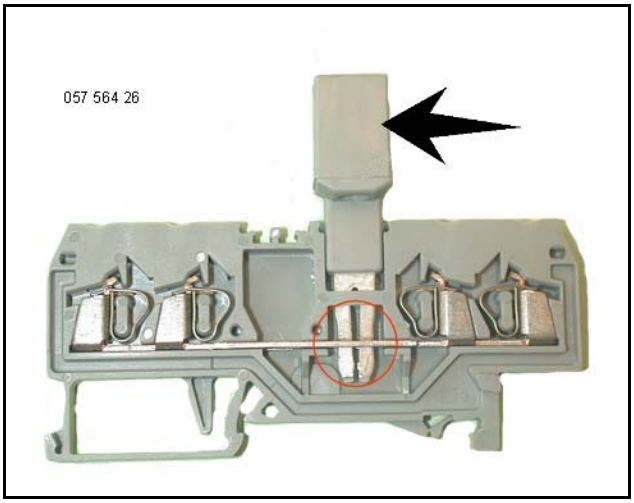


Fig. 2 Test adapter

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X-COM System

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

X-COM plug clamp

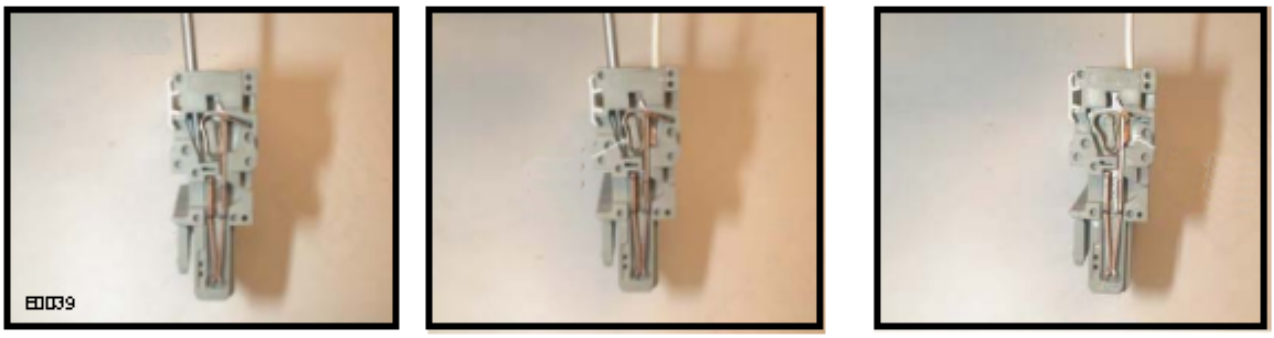


Fig. 1 That's how it works

That's how it works

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

⚠ Caution

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

Measuring signals

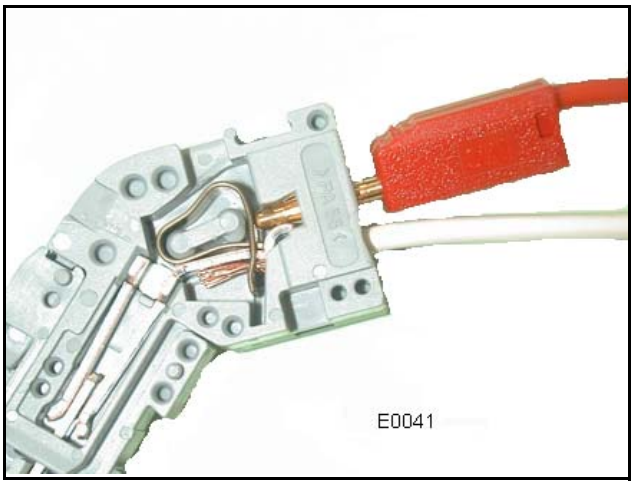


Fig. 2 X-COM plug with measuring cable

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

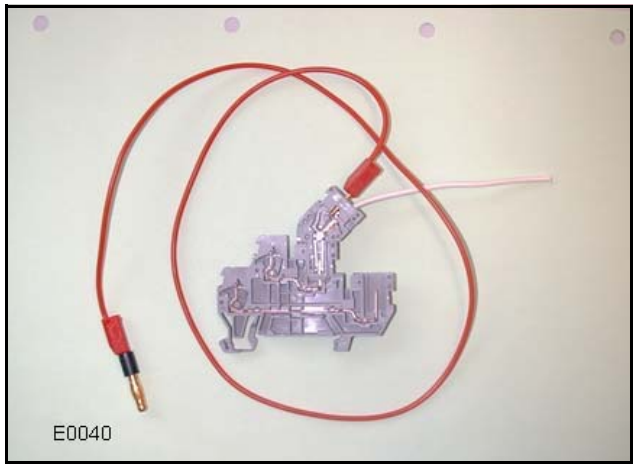


Fig. 3 X-COM plug plugged onto the series clamp

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4 Special tools, electrics

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4.1 Special tools, electrics

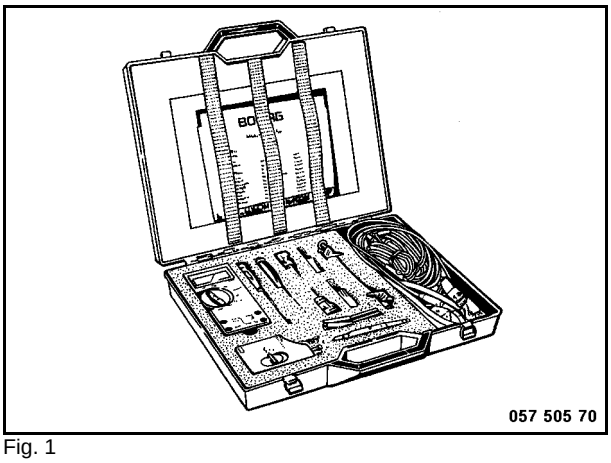


Fig. 1

1. Electric test case

   BOMAG part-no.: 057 505 70

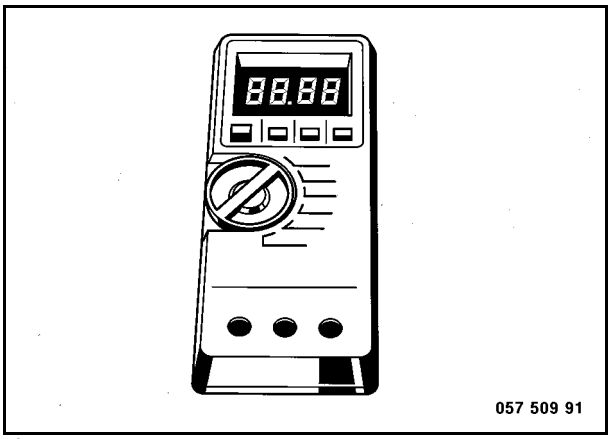
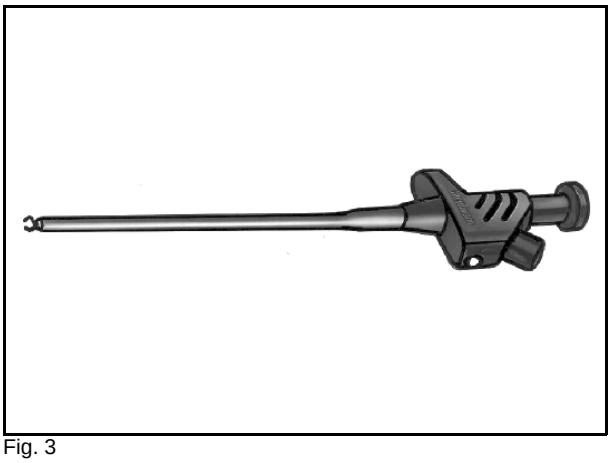


Fig. 2

2. Multimeter

   BOMAG part-no.: 057 509 91

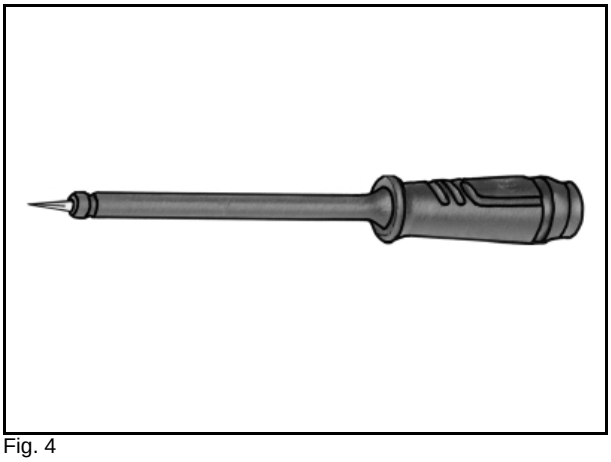

Fig. 3

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

   BOMAG part-no.: 079 900 53

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

   BOMAG part-no.: 079 900 54


Fig. 4

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

   BOMAG part-no.: 079 900 51

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

   BOMAG part-no.: 079 900 52

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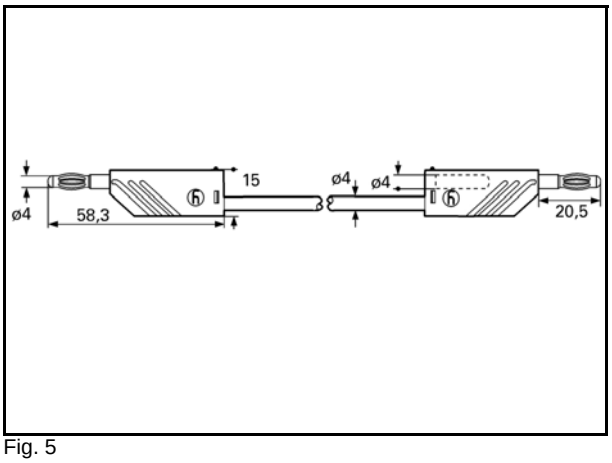


Fig. 5

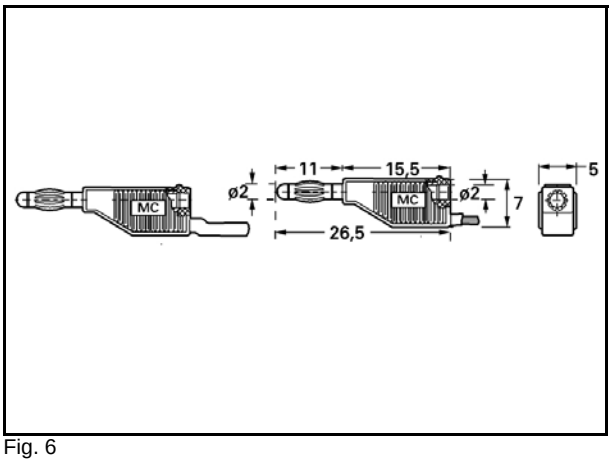


Fig. 6

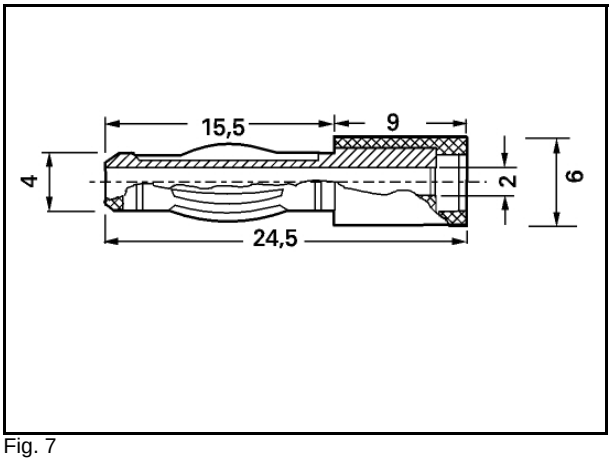


Fig. 7

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

   BOMAG part-no.: 079 900 58

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

   BOMAG part-no.: 079 900 59

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

   BOMAG part-no.: 079 900 60

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

    BOMAG part-no.: 079 900 55

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

    BOMAG part-no.: 079 900 56

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

    BOMAG part-no.: 079 900 57

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

    BOMAG part-no.: 079 900 63

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

    BOMAG part-no.: 079 900 64

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

    BOMAG part-no.: 079 900 61

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

    BOMAG part-no.: 079 900 62

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

    BOMAG part-no.: 079 900 65

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Fig. 8

18. Magnetic coil tester

BOMAG part-no.: 057 555 54



Fig. 9

19. Clip-on measuring instrument

BOMAG part-no.: 079 900 50



Fig. 10

20. Battery - generator tester

BOMAG part-no.: 079 900 91

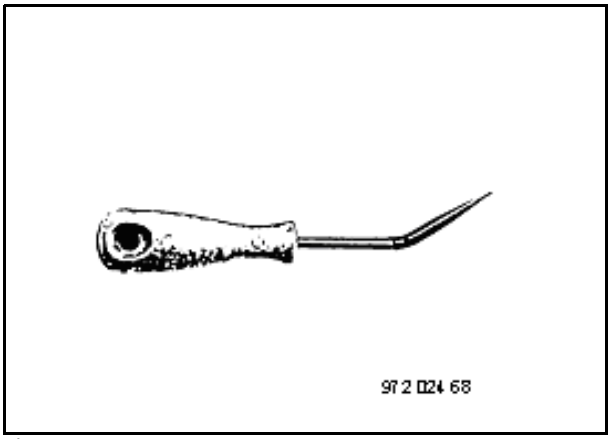


Fig. 11

Spring clamps (Wago or Weidmüller)

21. Cranked screwdriver (Fig. 11) to open spring clamps (Fig. 12).

BOMAG part-no.: 972 024 68

https://truckmanualshub.com/

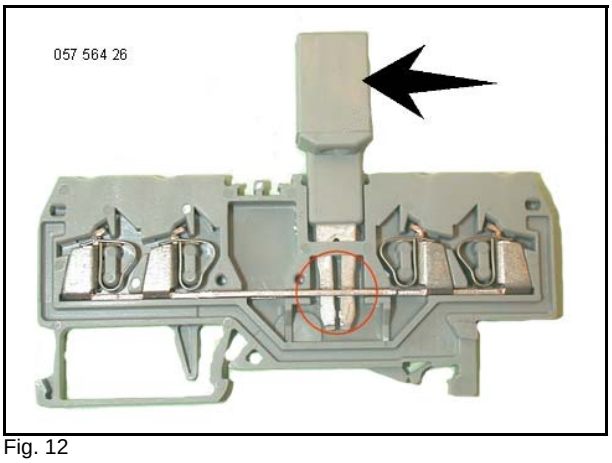


Fig. 12

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

    BOMAG part-no.: 057 564 26

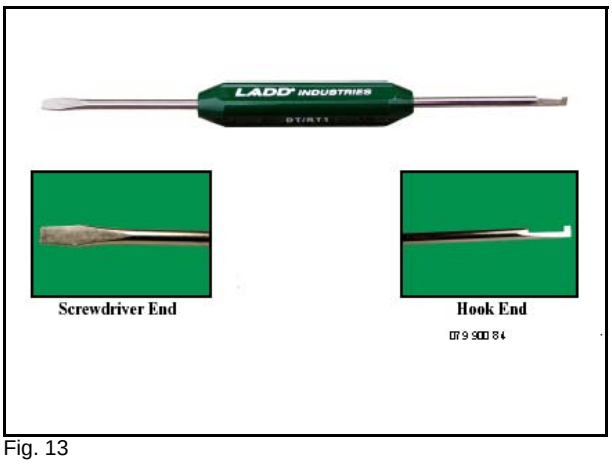


Fig. 13

Deutsch contacts

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

    BOMAG part-no.: 079 900 84

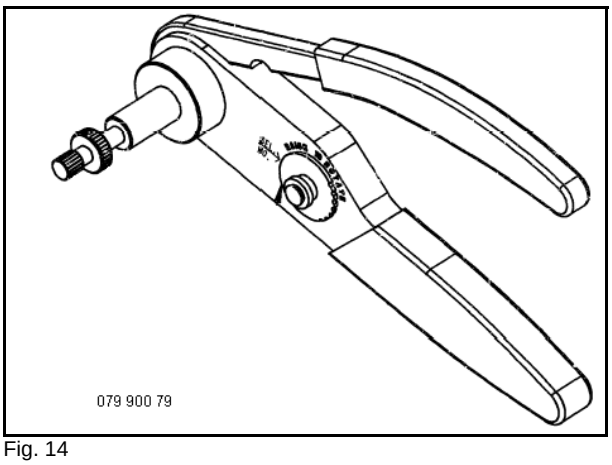


Fig. 14

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

    AWG 20 = 0.5 mm² cable cross-section

    AWG 16 = 1.5 mm² cable cross-section

    AWG 12 = 4.0 mm² cable cross-section

    BOMAG part-no.: 079 900 79

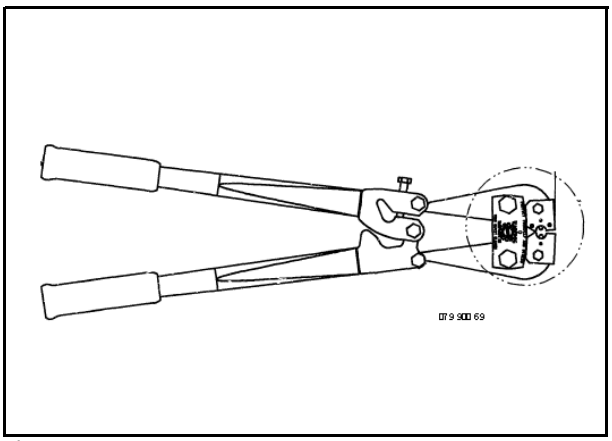


Fig. 15

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

    AWG 8 = 10 mm² cable cross-section

    AWG 6 = 16 mm² cable cross-section

    BOMAG part-no.: 079 900 69

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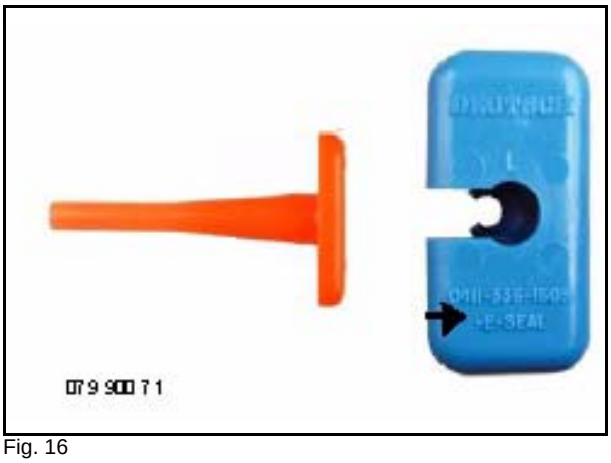


Fig. 16

26. Disassembly tool for Deutsch contacts of series HDP.

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

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

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

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

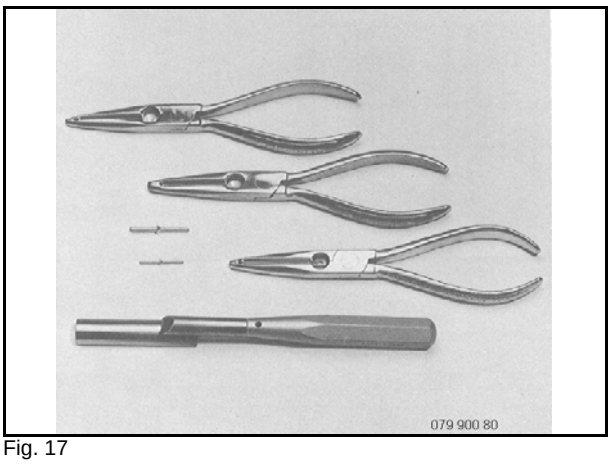


Fig. 17

ITT contacts

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

    BOMAG part-no.: 079 900 80

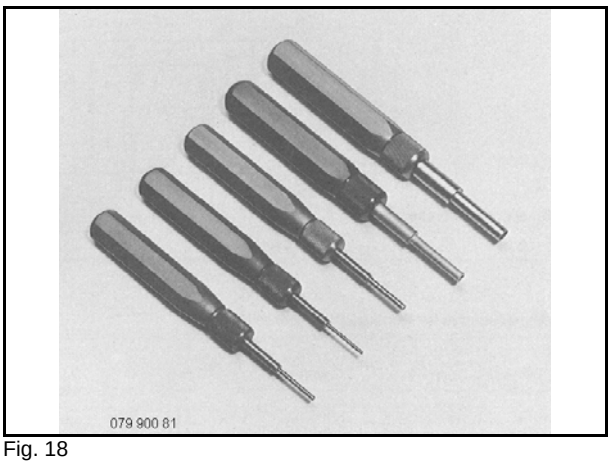


Fig. 18

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

    BOMAG part-no.: 079 900 81

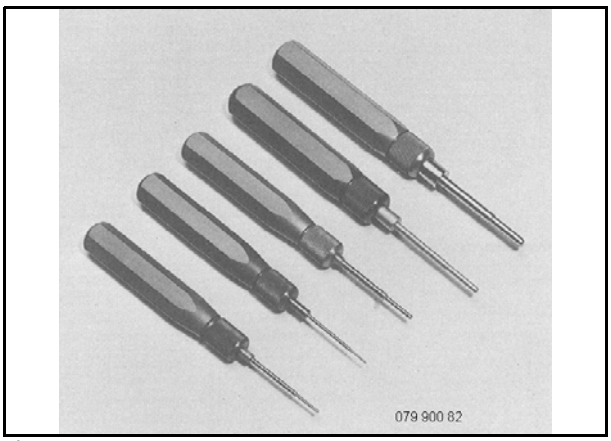


Fig. 19

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

    BOMAG part-no.: 079 900 82

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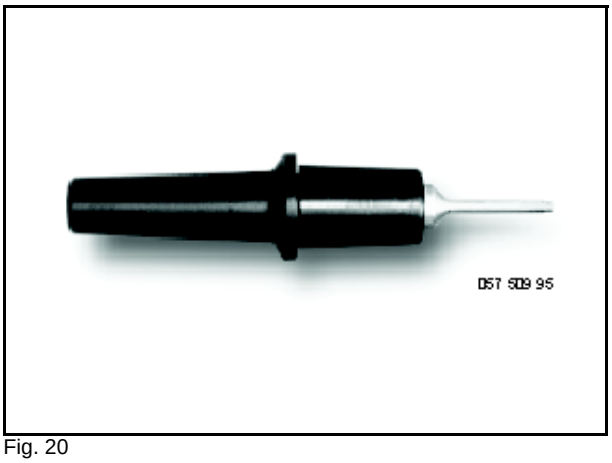


Fig. 20

Schaltbau contacts

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

BOMAG part-no.: 057 509 95

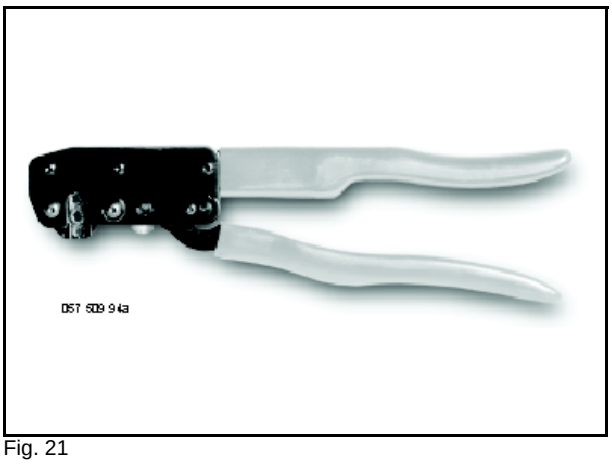


Fig. 21

31. Crimping pliers for Schaltbau contacts of series M1, M2 with connecting cross-section 0.14 mm² to 6 mm².

BOMAG part-no.: 057 509 94



Fig. 22

FCI Burndy contacts

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

BOMAG part-no.: 079 900 00



Fig. 23

33. Universal pressing pliers with toggle lever transmission and adjustable end pressure for Crimping roller connector 0.14 mm² to 1 mm².

BOMAG part-no.: 972 038 47

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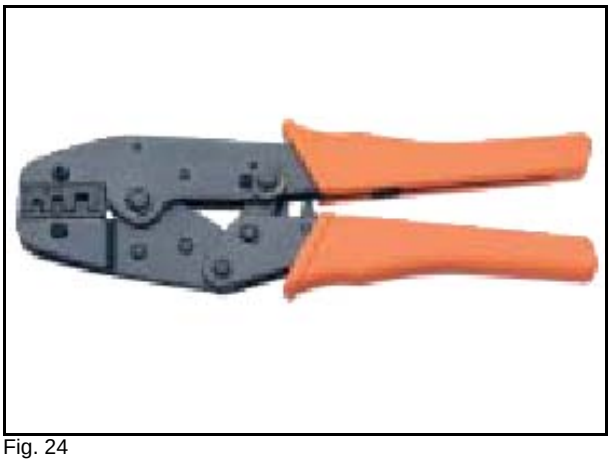


Fig. 24

34. Precision pressing pliers for non-insulated flat male and female connectors 0.50 mm² to 6 mm².

BOMAG part-no.: 079 900 70

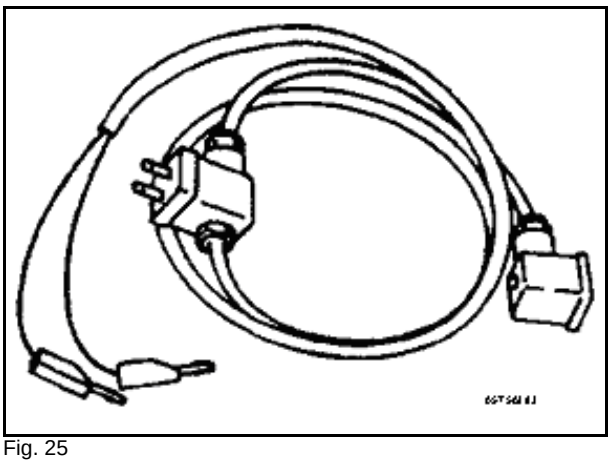


Fig. 25

35. Current measurement adapter for Hirschmann plugs.

BOMAG part-no.: 057 503 83

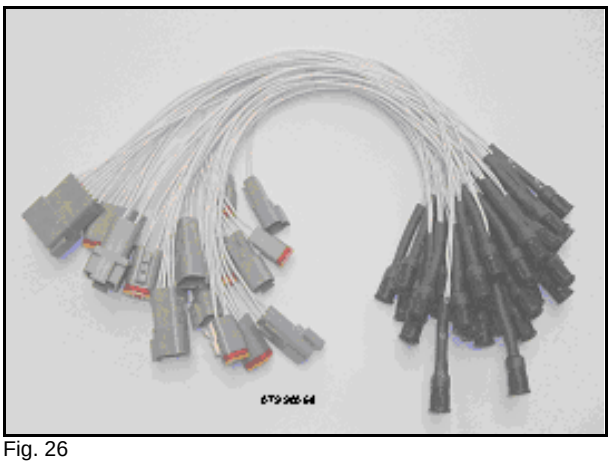


Fig. 26

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

BOMAG part-no.: 079 900 68

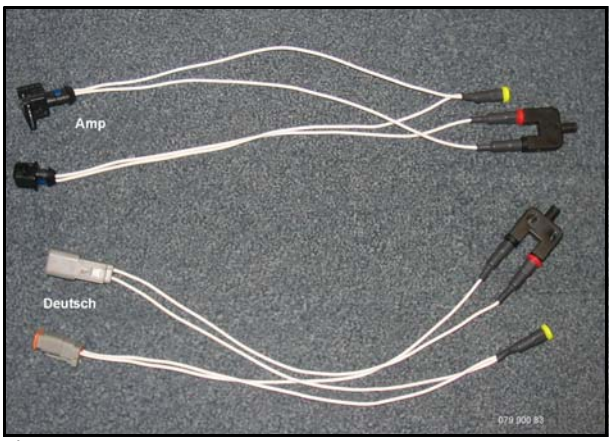


Fig. 27

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

BOMAG part-no.: 079 900 83

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5 Workshop Manual

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5.1 Speedometer Module

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Speedometer Module

Description of function

With the programmable module BM UPM the software realizes a speedometer function. To ensure that the tachometer function is not only realized for one special roller, there is a possibility to adapt the module to any machine with the help of a self-teaching mode.

- Whenever the module is switched on the system runs a self-test by passing through the entire display range in both directions. The display self-test takes approx. 15 seconds.
- After this the module changes to measuring mode. The frequency of the travel pulses of the roller is detected and converted to a proportional output voltage that triggers the display.
- The travel speed display is based on a PWM signal.

Manual testing of the speedometer

When the module is in measuring mode a manual display test can be performed via the input **"Test".** For this purpose the input must be energized with 12 Volt, whereupon the speedometer is constantly triggered with 3 Volt.

Plug assignment of the module

Pin-no. module	Pin name	Description
Test	E_ANZEIGENTEST	Input HIGH active: Activate manual display test
IN	E_WEGIMPULSE	Input: Path pulses
Lern	E_LERNMODUS	Input: HIGH active: Activate teach mode
OUT -	Display -	Output: Ground connection for speedometer
OUT +	Display +	Output: Output voltage for speedometer
⊥ (2x)	Ground	Input: Module ground connection
15/54 (2x)	15/54	Input: Module voltage supply

Tacho_Modul

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Part-no.: 580 033 87

Teaching the module

In self-teach mode the number of arriving path pulses is detected at the input (***IN***). The number of recorded pulses is referred to as pulse number per 10m travel distance of the roller.

- Connect the ground cable **(⊥)**.
- Connect the **sensor signal** (speed sensor) to frequency input (***IN***).
- Install a cable bridge from terminal ***"15/54"*** to the connection ***"Teach"***.
- Connect potential "Ignition / 15" to connection "***15/54"***.
- Switch on the ignition, start the engine and travel a distance of **exactly 10 m**.

Note:
If the module is in teach mode the LED on output **"OUT +"** will flash with the frequency of the path pulses arriving at input (***IN***).

- Disconnect the cable bridge from ***"Teach"*** to "**15/54**".
- Switch the ignition off and on again (Reset).

The module has now learned the pulses of the speed sensor.

- Connect the speedometer (0 to 6 Volt) to "***OUT +***" and "***OUT –***".

Tacho_Modul

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5.2 Removing and installing the engine

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DISASSEMBLY OF THE ENGINE

Perform all work prior to and during disassembly and assembly in accordance with the introductory chapter on Safety, and comply with ecological and health protection rules and regulations.

Preparatory work

- Place the machine horizontally on a firm surface.
- Wedge front wheels on both sides.
- Turn the battery breaker off – brakes are automatically applied.
- Place a sign on the steering wheel "MACHINE BEING REPAIRED".

Remove the protective frame ROPS

- Remove cover plates 1 behind the seat in front of the fuel tank, **Fig. C/1**.
- Install lifting loops on ROPS frame, hook up by hoist of at least 450-kg carrying capacity.
- Unfold lid 2.
- Unscrew nuts 1 on the right and left side that attach ROPS to the frame of the machine, **Fig. C/2**.
- Insert bolts so that they be outside the holes in the machine frame.
- Lift the frame out of the machine.

Remove the cabin

Attention – disconnect electrical wiring between the cabin and the machine, Fig. C/3.

Fig. C/1

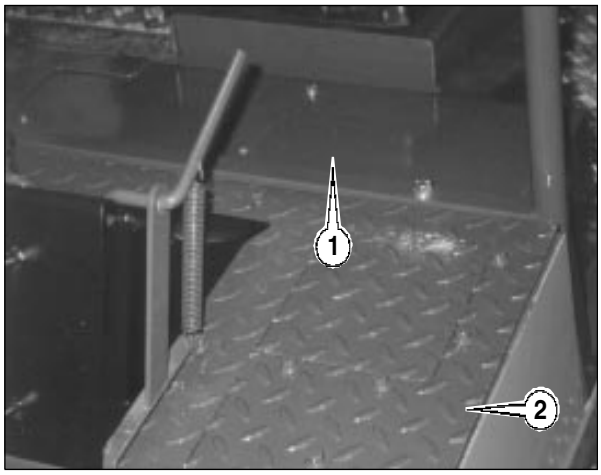


Fig. C/2

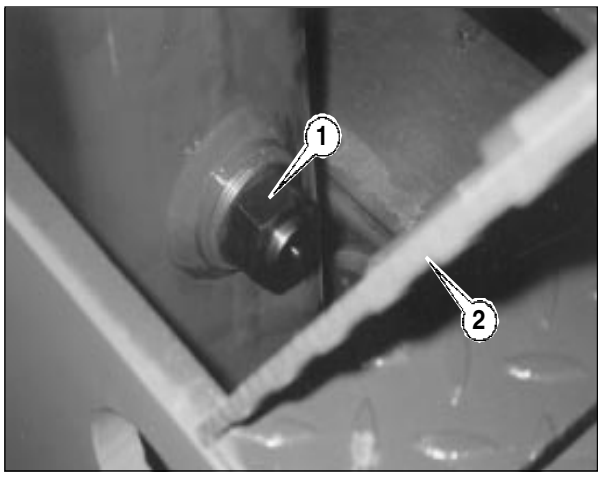
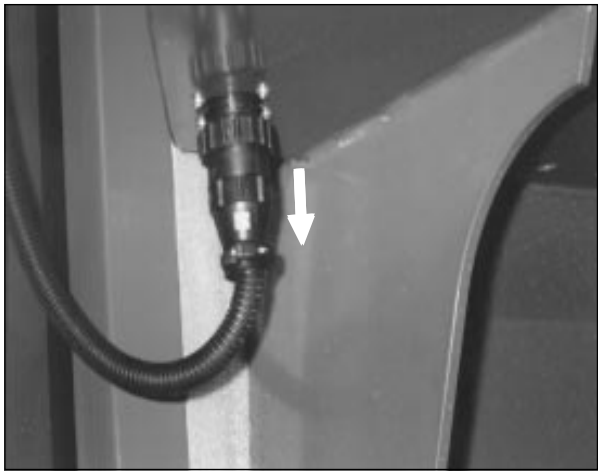


Fig. C/3



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Disassembly within the frame

- Disconnect hoses from the compressor.
- Drain on the right side of the machine, **Fig. C/4**
  - coolant 1
  - motor oil 2
  - gearbox oil 3
- By pulling ring 24, drain pressurized air from the air-tank using the drainage valve, **Fig. C/5**.
- On rollers with cabin, remove floor covering and floor plates.
- Remove engine hood.
- Remove engine suction basket bracket from the frame, **Fig. C/6**.
- Remove propeller shaft from the gearbox, **Fig. C/7**.

Fig. C/5

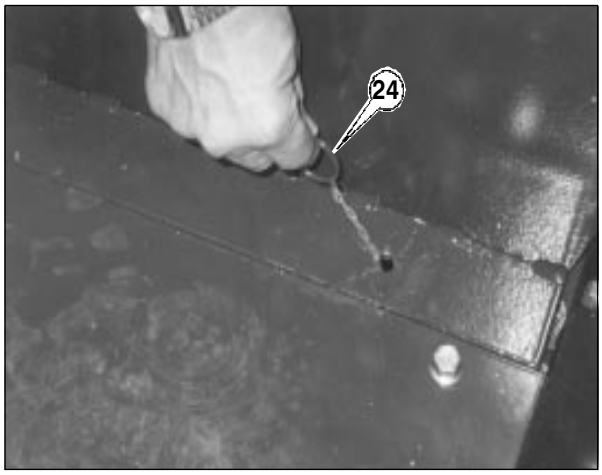


Fig. C/6



Fig. C/4

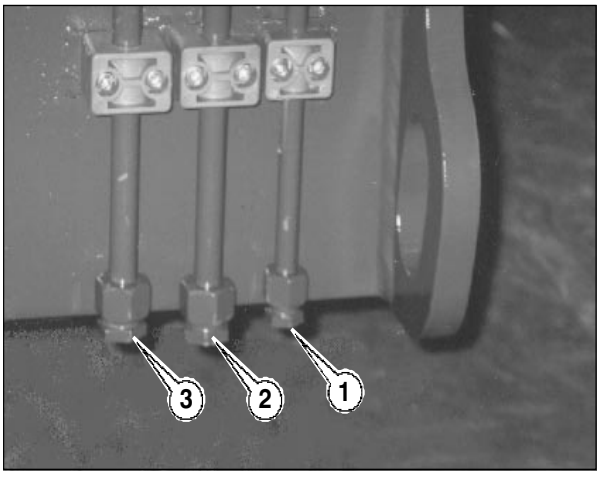
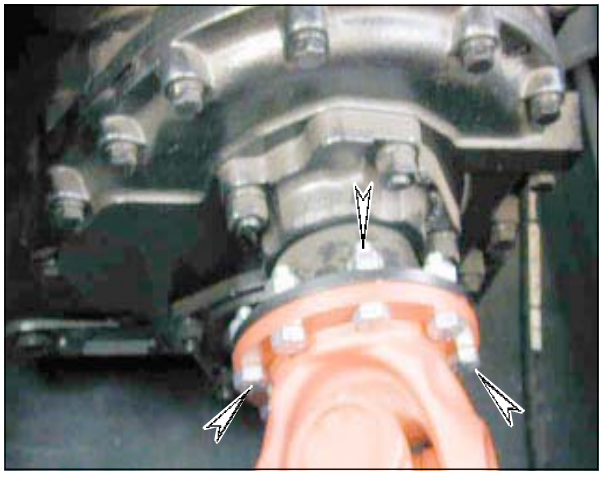


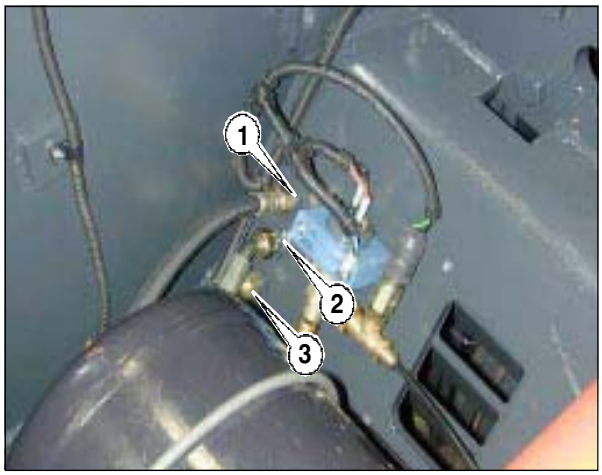
Fig. C/7



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- Remove steering hydraulic generator – do not disconnect hoses, **Fig. C/8**.
- Disconnect from the box in the frame floor, **Fig. C/9**.
  - coolant drain hose from the engine block 1
  - engine oil drain hose 2
  - Gearbox oil drain hose 3
- Disconnect heater hoses
- Disconnect electrical wiring from :
  - Gear shifting
  - temperature sensor
  - starter and breaker
  - pressure oil switch
  - alternator
  - chassis
  - pressure switch

Fig. C/9



- Remove exhaust piping.
- Remove air suction with the filter.
- Remove gas pedal cable with the bowden.
- Disconnect hose from fuel input and overflow pipe from the fuel pump.
- Remove attachment of platform to the frame, and slide platform towards the seats.
- Using fixture no. 1 remove bolts 51and nuts 68 attachment of the front beam assembly 1 to the frame, **Fig. C/10**.
- Remove nuts 30, attachment of the gearbox to the frame, **Fig. C/11**.

Fig. C/10

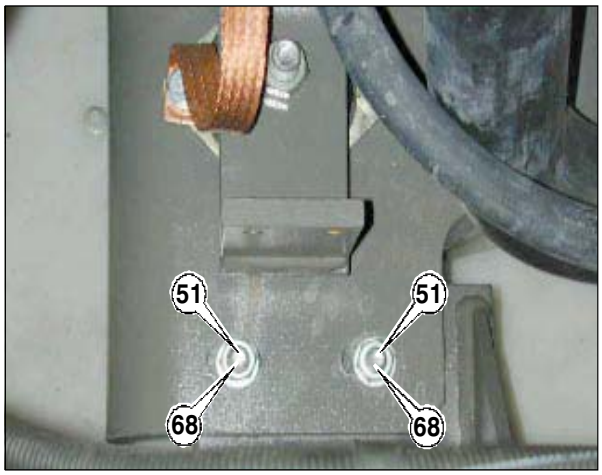


Fig. C/8

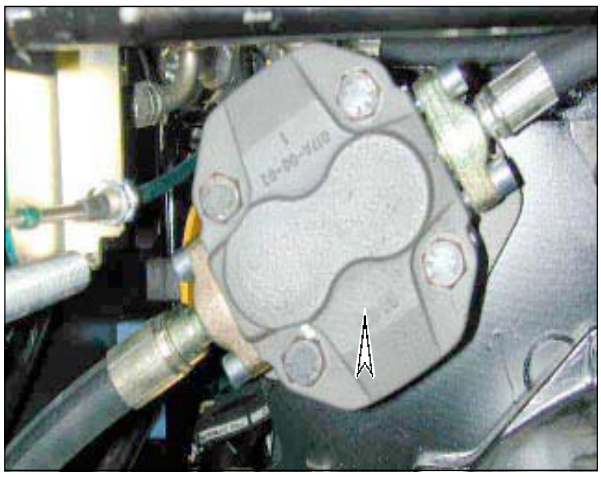
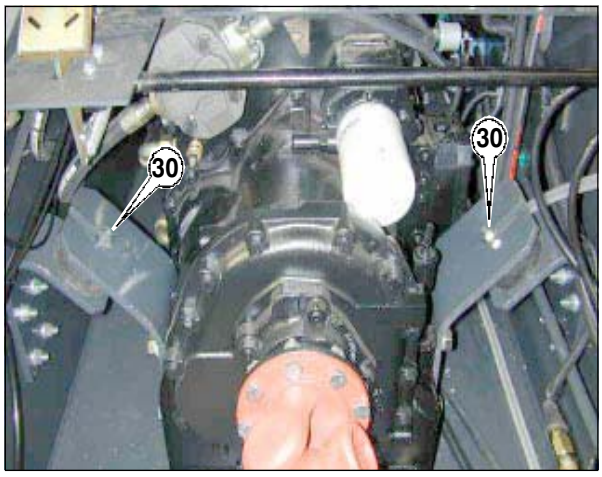


Fig. C/11



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- Attach engine to lift hooks, place a rope underneath the gearbox, hook up using fixture no. 2, lift slowly, remove from frame, and place on support no. 3. Remove the suction basket and radiators.
- Place the engine together with the gearbox on a suitable wooden frame, and secure against tipping over.
- Remove gearbox.
  - Unscrew brackets off the gearbox,
  - disconnect radiator hoses,
  - hook up the gearbox on the hoist using fixture no. 4, **Fig. C/12**,
  - remove lid, **Fig. C/13**,
  - turn the propeller shaft with the flywheel by the belt **Fig. C/14**, and remove eight screw connecting the engine to the gearbox.

  - For reassembly of brackets to the gearbox use torque 300 Nm (221 lb ft).

- Disassembly of the engine.
  - Loosen tightening screw of the alternator, remove belt, then the alternator, the starter, and the fan.
  - Remove brackets, supports and springs from the engine.

Let specialized service disassemble or repair the engine from that point on.

Fig. C/13



Fig. C/12

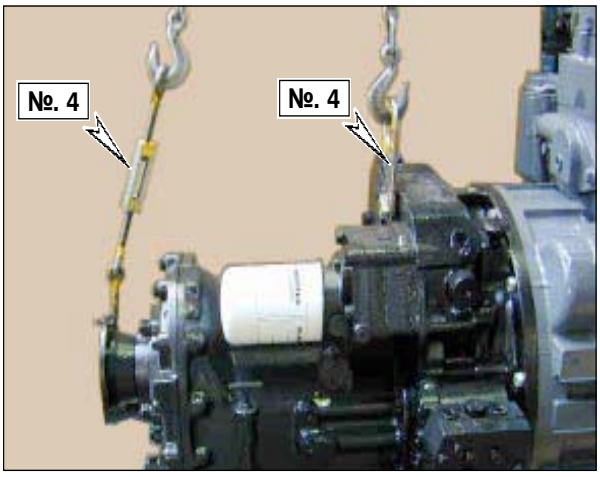
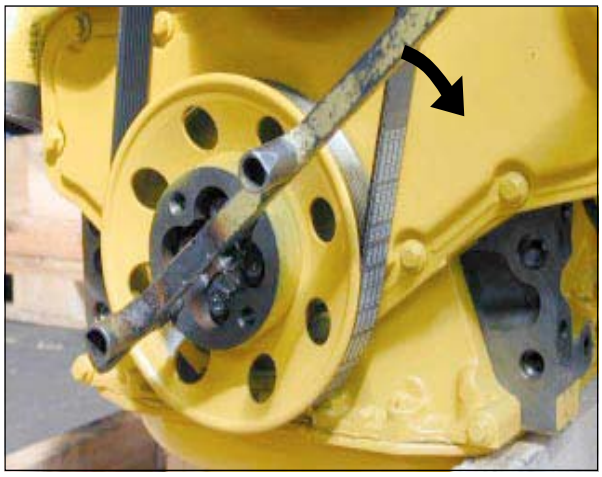


Fig. C/14



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INSTALLATION OF THE ENGINE

- Place the engine on a suitable support and prevent it from tipping over.
- Attach gearbox to the engine, level horizontally using fixture no. 4.
- Place the assembly of the engine and the gearbox on fixture no. 3, attach radiator with the suction basket to the engine.
- Connect radiator hoses.
- Hook up the engine on the hoist using fixture no 2 and install in the machine frame.
- Thereafter install the steering hydraulic generator, connect all electrical wiring, draining assembly on the engine and the gearbox.
- Connect control cable to the injection pump, and fuel lines.
- Connect propeller shaft to the gearbox, hose to the compressor output
- Assemble intake and exhaust manifolds.
- Install dashboard, hood, and cabin.
- Fill up the engine and gearbox with appropriate fluids.
- Install cabin, connect wires, **Fig. C/3**.
- Install safety frame ROPS.
  - Insert attachment bolts into holes of frame ROPS so that the threads of the bolts don't show on the front side of the holes.
  - Place ROPS in the frame using the hoist.
  - Insert bolt in the frame, secure with nuts 1, and tighten with torque of 700 Nm (516 ft lb), see **Fig. C/2**.
  - Install cover plates behind the seats.
  - Remove lifting hooks and insert screws instead.

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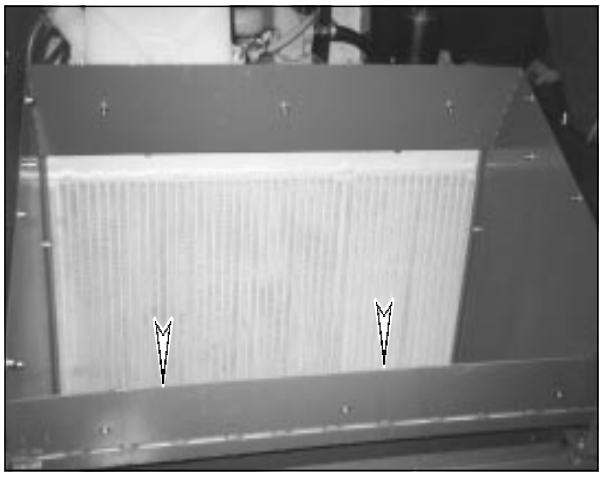
RADIATOR DISASSEMBLY AND ASSEMBLY

- Remove front cover, hood, and grill.
- Disconnect radiator hoses and remove expansion tank.
- Remove suction basket bracket, **Fig. C/15**, and screws at the bottom of the basket **Fig. C/16**.

Fig. C/15



Fig. C/16



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- Remove air collector and move it towards the engine, **Fig. C/17**.
- Remove two screws at the bottom of the radiator, **Fig. C/18**, and two screws attaching the radiators to the frame.
- Lift the radiators using hoist.
- Assemble in reverse order, center the air collector to the cooling fan.

Fig. C/17

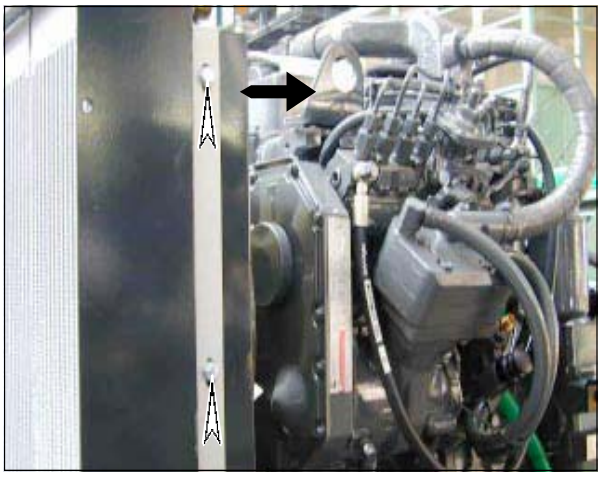


Fig. C/18



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5.3 Rear axle

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REAR AXLE

TECHNICAL DATA - DESCRIPTION

DESCRIPTION

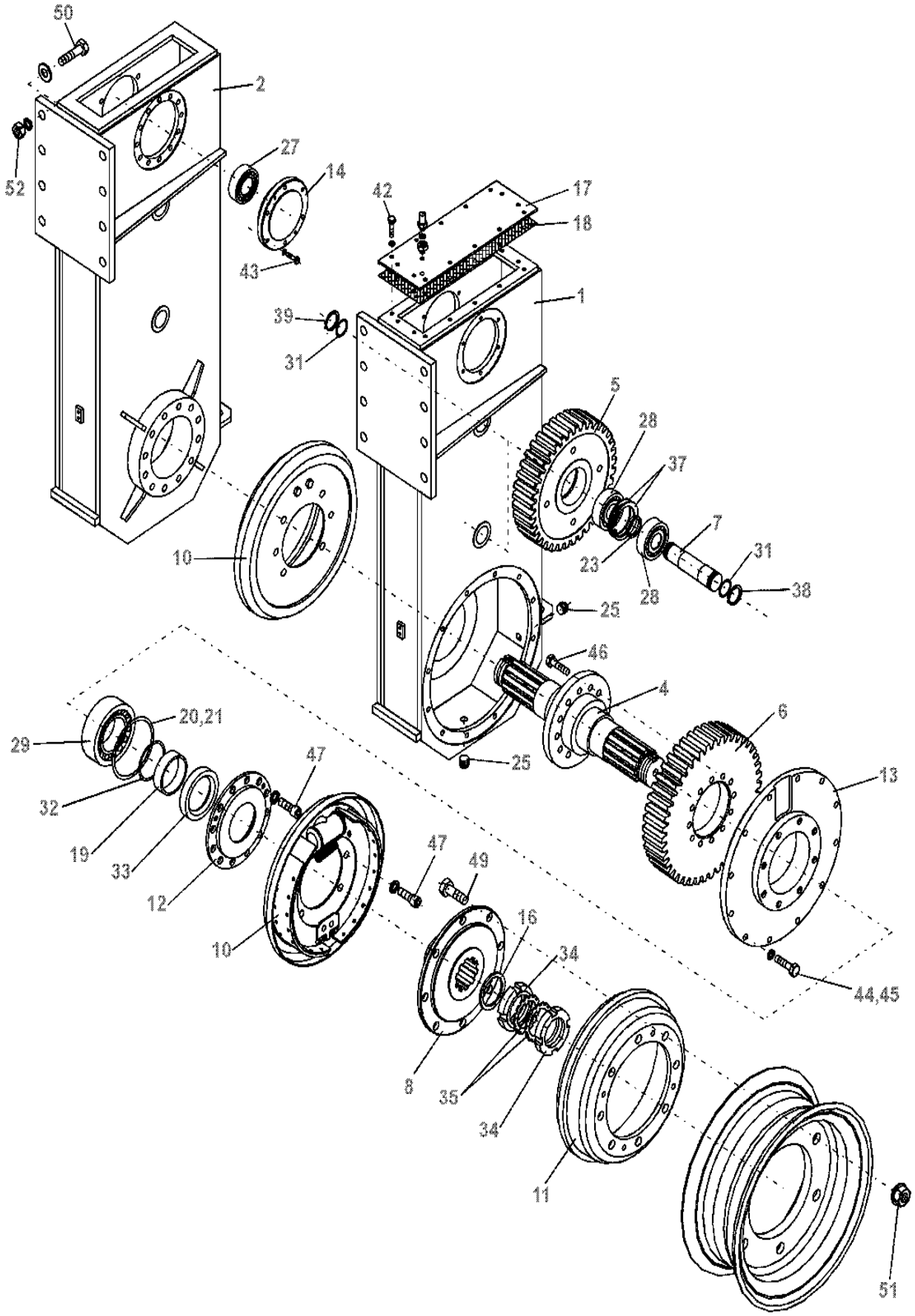
The assembly is fixed to the machine frame and consists of two vertical cabinets connected by the bridging axle and sealing boots.

Torque from the gearbox is transferred by means of an elbow shaft to the transmission and the differential. The main purpose of the transmission is the transfer of power to the two sides as a function of load on both outputs. The input torque is transferred over the bevel gearing of the OERLIKON SPIRO MATIC type, by means of a classical bevel differential to the half-axles and then to the gears in the columnar housings. The drive-wheel hubs and the brake drums are positioned on the grooved output shaft.

To facilitate disassembly and assembly the entire breakdown of the rear axle drive assembly is shown on **Fig. D/1** and **D/2** specifying individual parts. It makes up for speedy and easy identification of parts for their eventual replacement. One should observe the tightness of all screws and nuts, particularly the specified torque.

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Fig. D/1



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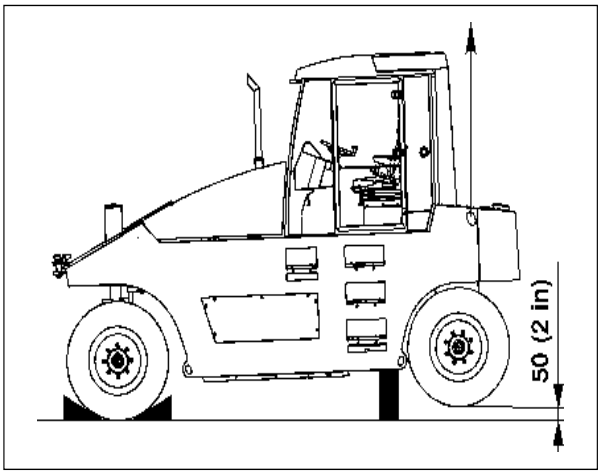
DISASSEMBLY OF AXLE

Perform preparations, disassembly and assembly according to the introductory chapter "Safety precautions and instructions", keep ecological and health precautions.

PREPARATIONS

- Place the machine horizontally on a firm surface.
- Secure front wheels on both sides with wooden blocks.
- Switch off batteries – the machine is automatically locked.
- Place notice "**MACHINE OUT OF ORDER**" on the steering wheel.

Fig. D/3



AXLE DISASSEMBLY FROM THE MACHINE

- Loosen nuts on wheels 51.
- Attach suitable ties in the hooks, lift the rear of the machine so that the wheels don't touch the ground. Support the frame suitably with hardwood blocks, **Fig. D/3**.
- Disassemble tire inflation, brake hoses, air intake to the control of differential lock, brush holders, sprinkling, wheels, connecting shaft, parking brake, and wiring. Place hooks in the rear section. Remove screws connecting the rear section with the frame **Fig. D/4**. Place the rear end to a suitable work place for further work. Secure brake drums with two nuts 51.
- Hook up the rear axle to the hoist. Remove bolts 50 and nuts 52, **Fig. D/5**.
- Place the axle on fixture no. 1 vertically see **Fig. D/46**.
- Remove drain plug 26 and control plug, possibly also filling plug 25 s. Drain oil into a suitable container, **Fig. D/2**.
- Hook up the rear axle to the hoist.
- Remove plugs 25 from right and left housing, **Fig. D/1**. Drain oil into a suitable container.
- Thereafter reinsert all plugs – do not tighten.

Fig. D/4

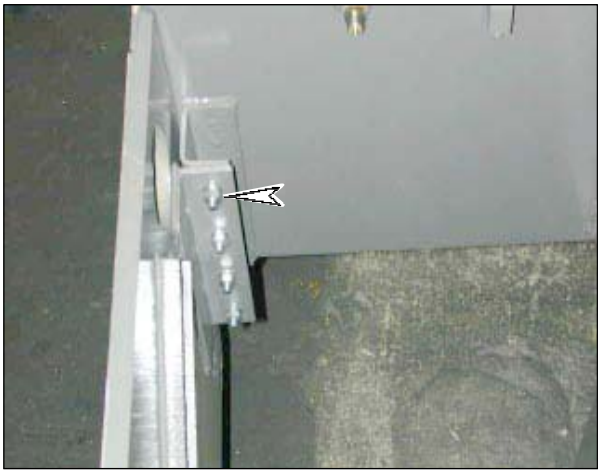
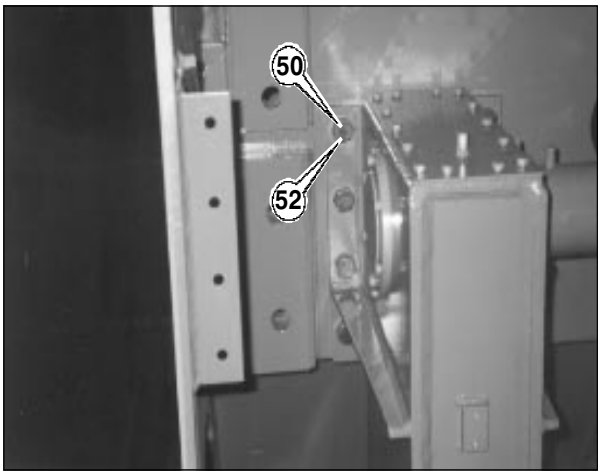


Fig. D/5



DISASSEMBLY OF DRIVESHAFT

- Rear axle to be placed horizontaly.
- Remove all bolts 28 connecting left and right 2, 3 sealing boot with the left housing 1 and the right housing 2, **Fig. D/7**.
- Screw two press-out bolts M12 into M12 holes, and by gradual tightening separate axle bridge from sealing boots and half-axles including pinions 7 from the left and right housings, **Fig. D/7**. Remove disassembled components to a suitable place for further work, using lift. Drive housings 1, 2 to be placed horizontally on a suitable support with flange 13 down.
- Watch for leaking oil during disassembly.
- Remove the assembled half-axle 6, 5. From the center of the axle remove pinions 7 with the inner snap ring 23 using proper spanner (or press out), remove washer 8 and snap ring 19. Remove inner ring of the bearing 23, **Fig. D/7**.

  Note – should the half-axles and pinions be used later again, it is advisable to mark them so that they could be installed in their original positions.
- Remove right and left sealing boot 3, 2. Remove sealing ring 17, and O-ring 18, **Fig. D/7**.
- Turn axle bridge with the differential up.

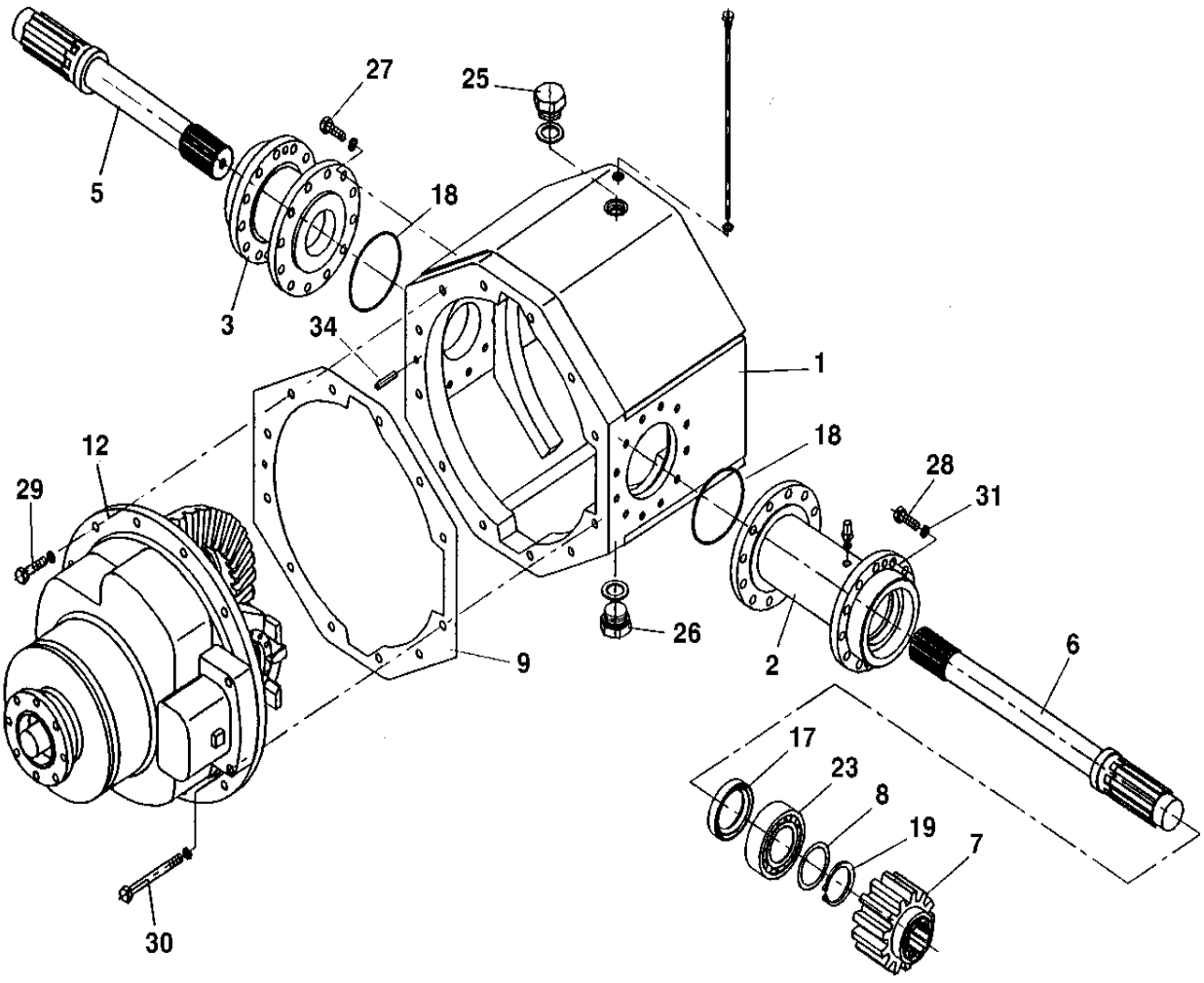
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- Unscrew bolts 29, 30. Thread three press-out bolts M 16 and by gradual tightening remove gearbox from the center bridge opening 1, **Fig. D**/**7**.

Note – watch for leaking oil residuals from the axle during disassembly.

Fig. D/7



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DISASSEMBLY OF DRIVE HOUSING

- Remove two nuts 51 from brake drum 11. Remove brake drum from flange bolts, if necessary use press-out bolts in the holes of the drum. Remove safety washers 35, **Fig. D/8**.
- Remove nut 34 using fixture no. 3 **Fig. D/9**.
- Remove washer 35, unscrew the other nut 34 and spacer 16, **Fig. D/10**.
- Slide flange 8 from the grooved shaft 4 using proper spanner, **Fig. D/11**. Heat flange to 320 .
- Unscrew bolts 47 and remove brake assembly 10, **Fig. D/12**.

Fig. D/10

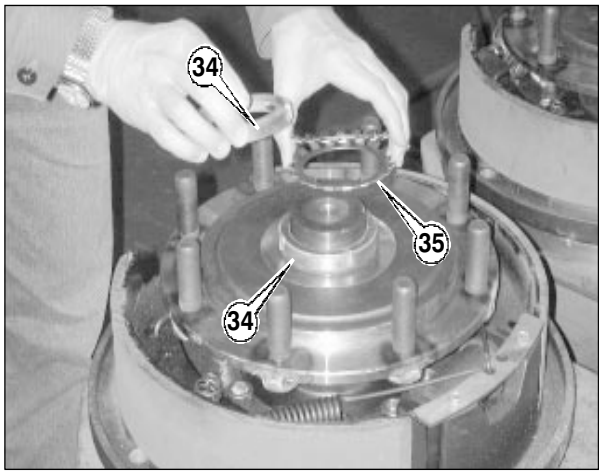


Fig. D/8

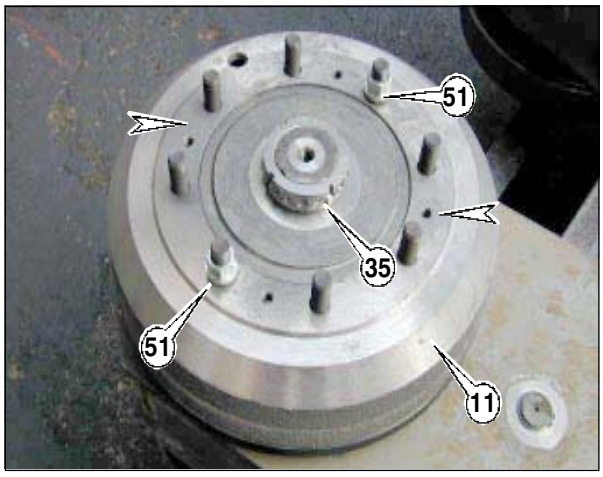


Fig. D/11

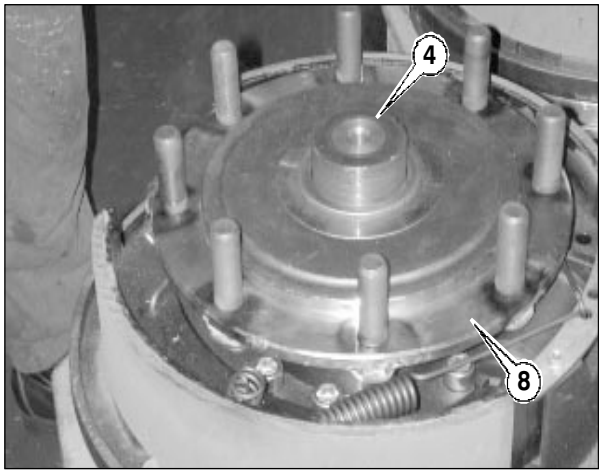


Fig. D/9

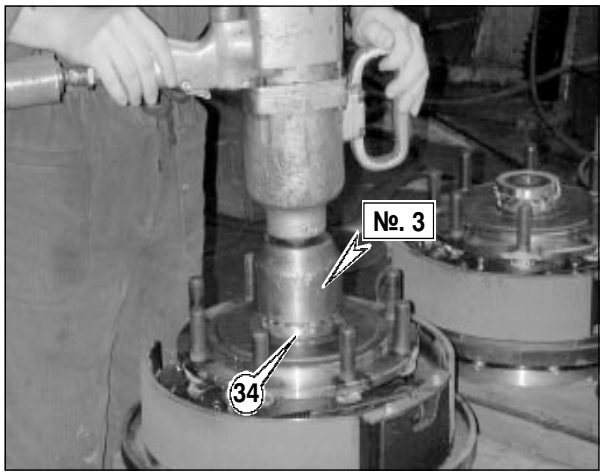
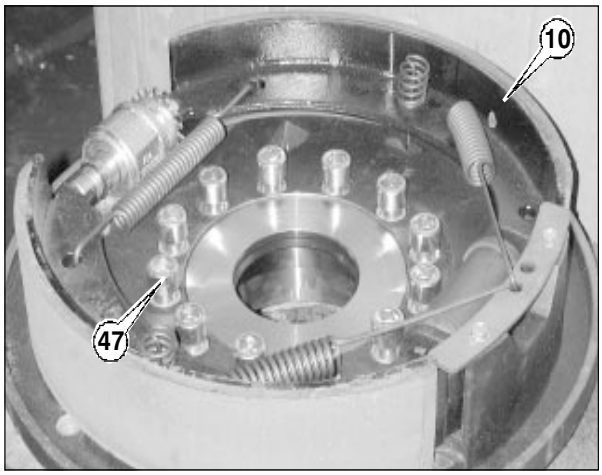


Fig. D/12



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- Insert press-out bolts M 16 into 2 holes M 16, and by their gradual tightening remove cover 12, **Fig. D/13**.
- Remove sealing ring 33 from the cover, washers 20, 21, ring 19, and O-ring 32, **Fig. D/14**.
- Turn the housing using hoist by 180 degrees (cover 13 up), from the opposite side do 1-5. Watch for leaking residual oil.
- Remove bolts 44, 45. Insert two press-out bolts M 16 into holes M 16 and by gradual tightening remove cover 13 **Fig. D/15**. Insert hooks into holes M16 after press-out bolts have been removed, and using a suitable handling device place it on the working bench. While replacing bearing 29, press out or knock out the outer ring of the bearing from cover 13 using a bronze rod.
- On the shaft 4 anscrew fixture no. 4, hook and remove assembly using hoist from the housing, **Fig. D/16**.
- Unscrew bolts 46 and press out gear 6 and inside rings of bearing 29. For replacement of the other bearing 29, knock out from the housing assembly using a bronze rod the outer ring. Remove cover 17 with seal 18, **Fig. D/1**.

Fig. D/14

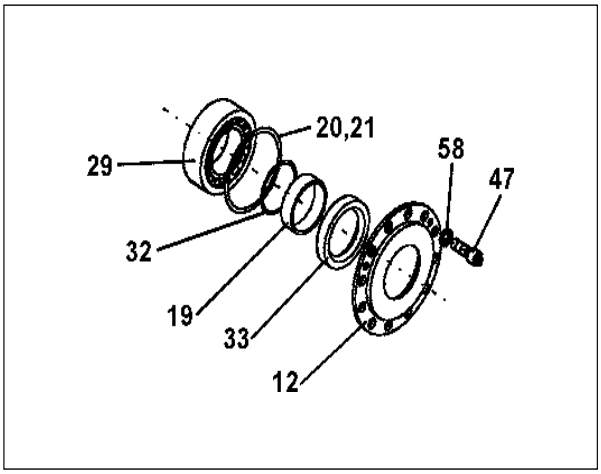


Fig. D/15

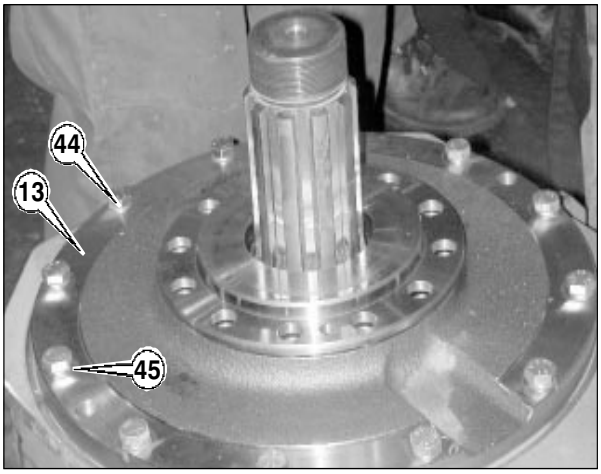


Fig. D/13

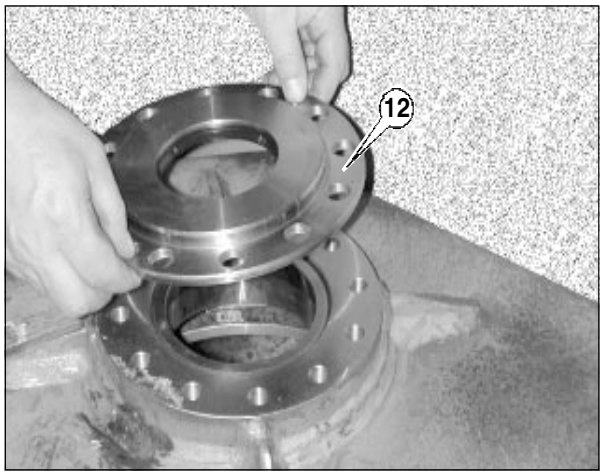
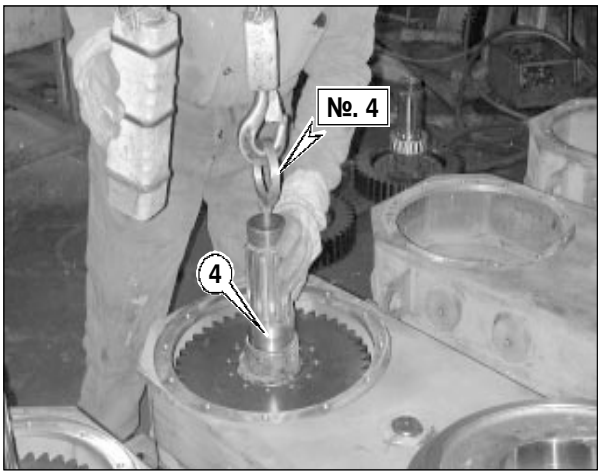


Fig. D/16



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- Remove safety rings 39, by knocking with a bronze rod, remove pins 7, O-rings 31, **Fig. D/17**.
- Slide both idler gears 5 from the housing. One through the rectangular opening in the housing, the other through the large opening for the cover 13.
- Remove entire bearing 28 including rings 37 and spacer 23, **Fig. D/17**.
- Unscrew bolts 43. Screw in holes M8 press-out screws M8 and by gradual tightening remove cover of bearing 14. Remove bearing 27 **Fig. D/1**.
- Should the main components (gears, pinions, splined shaft, and flange) be used further, mark the parts suitably to be able to install them in original positions later.

CLEANING AND INSPECTING PARTS

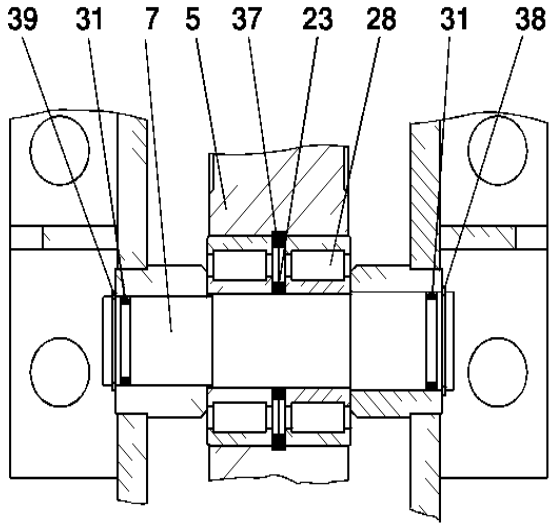
Cleaning

For perfect cleaning of parts use suitable dissolving fluid bath. The bearings must be dipped in several times and the cones or cylinders must be forcefully turned. Completely clean bearings should be dried by forced air. Keep on turning the bearings in hand to speed up drying.

Inspection of individual parts

- Check visually all cones, rollers, cages, and rings of bearings for pitting, breaks, or fissures. If any damage should appear, it is necessary to replace the bearing. It is not recommended to replace only the internal or external rings of cone bearings.
- After checking submerge the bearing in oil and wrap in paper thereafter to keep it clean until usage.
- If no method of flaw detection can be applied, it is necessary to inspect the teeth, polished surfaces, fissures, and overall wear. Small dents may be removed by polishing. In case of more severe damage (fissures, tears in the cemented surface, etc.) it is necessary to replace the unit.
- On shafts, check for eccentricity, straightness of grooves and play in grooves in the matching section (half-axle, carriers, etc.)
- The visual control includes the appearance of dents or frays on meshing surfaces and openings for the bearings. Further, it is necessary to check carefully for tears and deformations. The hub and housing of the differential must be checked for fundamental deviations in geometry, like axial alignment, eccentricity, etc.
- If the check reveals tears in the brake drum, any deep damage and wear (grooves, etc.) that cannot be reworked on the lathe to the maximum value of 402,5 millimeters (15,8 in), the drum must be replaced.
- If the least damage is discovered, the part must be replaced.

Fig. D/17



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AXLE ASSEMBLY

DRIVE HOUSING ASSEMBLY

- Housing 1, 2 to be cleaned of mechanical dirt, blown out by compressed air, and placed horizontally on a firm surface (support), **Fig. D/18**.
- Screw two plugs 33 in the holes of the housing, **Fig. D/19**.
- Place safety rings 37 and bearing 28 into holes of idler gear 5. Turn the wheel and insert ring 23 and the other bearing 28 from the opposite side into the opening, **Fig. D/17**.
- Turn the housing by 90 degrees with the large opening down.
- Press outer ring of bearing 29 in the large hub, **Fig. D/20**.

Fig. D/18

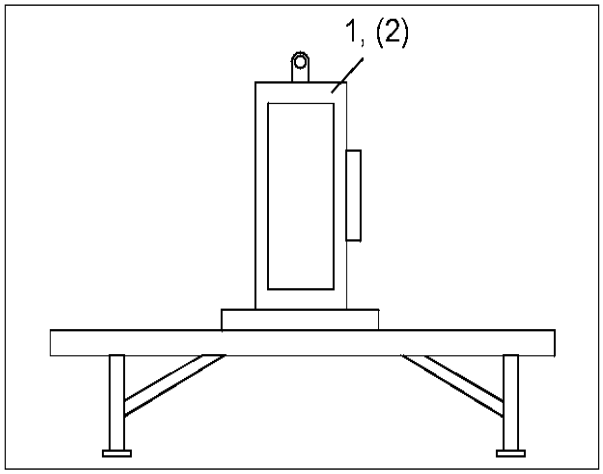


Fig. D/19

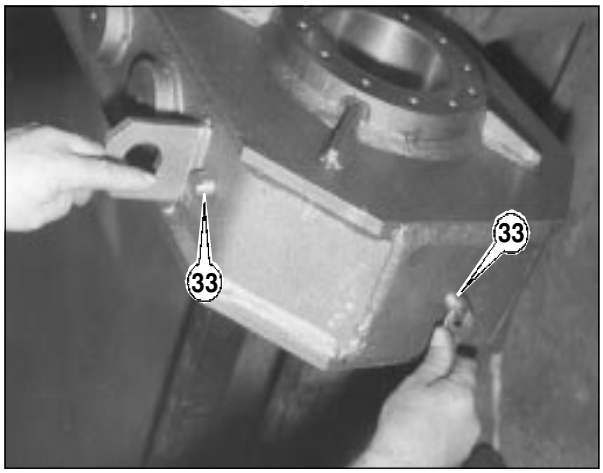


Fig. D/20



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- Press sealing ring 33 in cover 12, **Fig. D/21**.
- Apply LOCTITE 574 on faces of cover 12 and the hub. In steps, place cover 12 **Fig. D/21**. The brake assembly 10 on the hub and fasten with bolts 47, **Fig. D/22**. Apply LOCTITE 577 on threads.
- Turn housing by 90 degrees, **Fig. D/18**.
- Slide idler gear assembly into the housing, one the rectangular opening **Fig. D/23**, the other through the opening for cover 13, **Fig. D/24**.
- Turn the housing by 90 degrees, the large opening up.

Fig. D/22

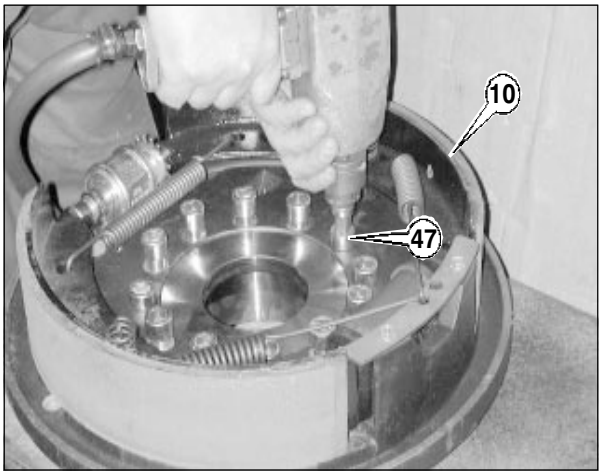


Fig. D/23

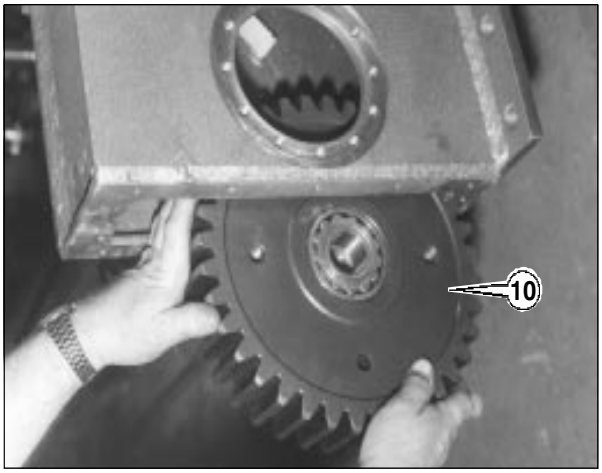


Fig. D/21

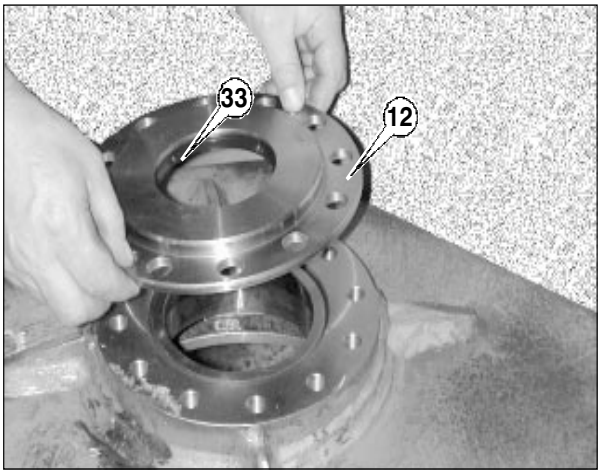


Fig. D/24



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- Center holes in bearings 28 and idler gears 5 against openings in the housing **Fig. D/25**.
- Slide O-rings 31 and snap ring 38 on the pins of inserted wheels 7, and press in pins 7, **Fig. D/26**.
- Heat gear 6 to 150 C - 180 C (302-356 F) and set on grooved shaft 8. After cooling off, bolt the assembly together using bolts 46 and correct torque – see table. Heat inner rings of bearings 29 to 100 C (212 F) and set on shaft from both sides 8, **Fig. D/27**.
- On the shaft 4 anscrew fixture no. 4, and set the entire assembly using hoist in the inner ring of bearing 29 in the cover 12, **Fig. D/28**.

Fig. D/26

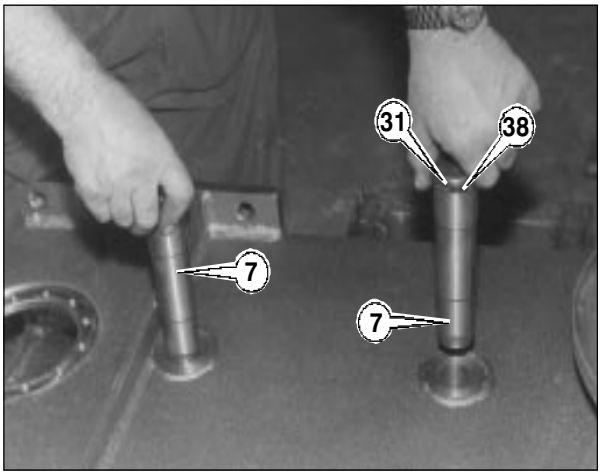


Fig. D/27

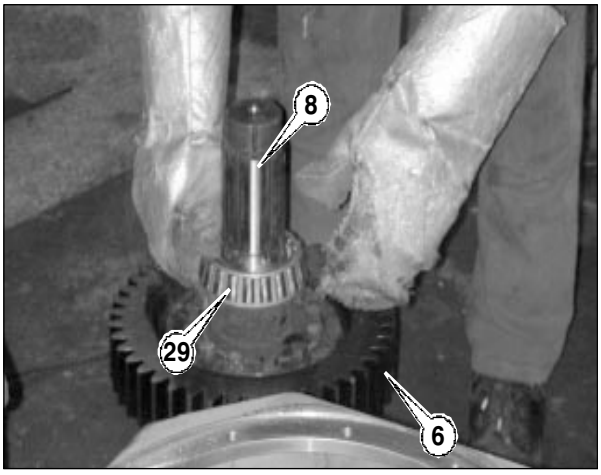


Fig. D/25

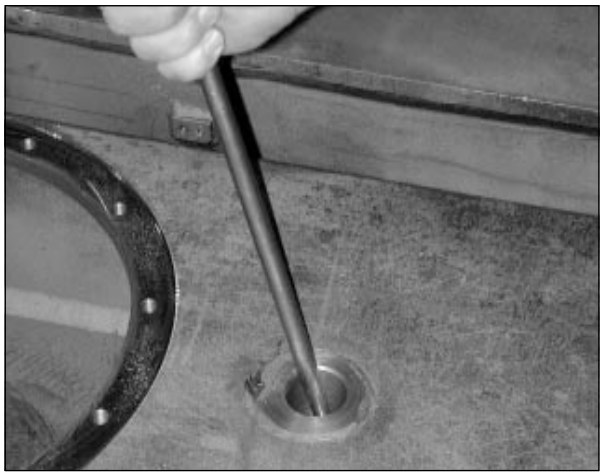
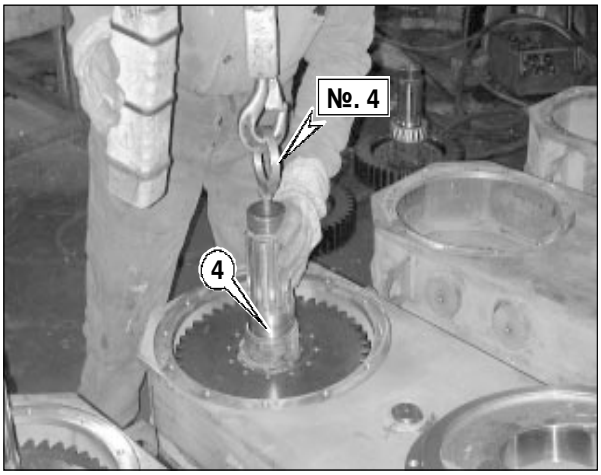


Fig. D/28



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- Smear the touching surface of cover 13 and the opening in the housing with LOCTITE. Screw cable hook (screw M 12) in force-off openings in cover 13 and fit in place – selected position "a" as in **Fig. D/29**. Fix screws 44, 45 by LOCTITE.
- Press in the inner ring of the other bearing 29 in cover 13, **Fig. D/30**.
- Following the installation of cover 13 adjust prestress of bearings 29 by inserting washers 20, 21. The prestress of bearings is given by 0,4 0,6 mm (0,016 - 0,024 in).

Finding the rate of prestress:

- measure "X" - size of step on 2 as in **Fig. D/31**.
- measure "Y" - distance of inner bearing ring 29 from cover face 13 as in **Fig. D/32.**

Calculate rate of prestress of bearings "P":

P = Y – x

Finding the gauge of washers "Z"

Z = P + 0,4

Fig. D/29

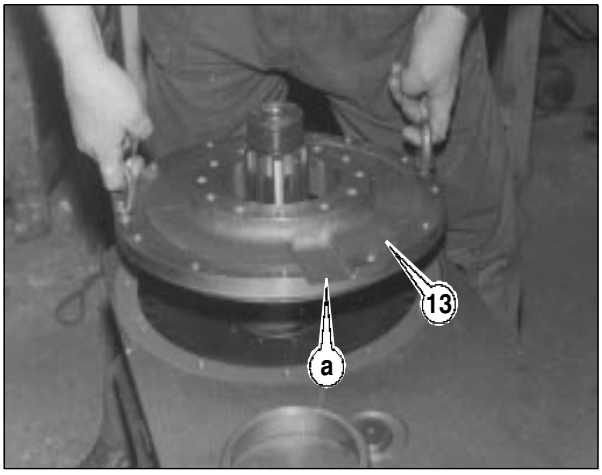


Fig. D/31

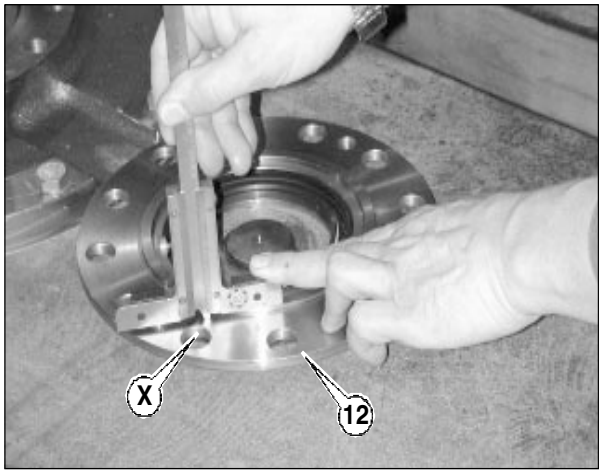


Fig. D/30

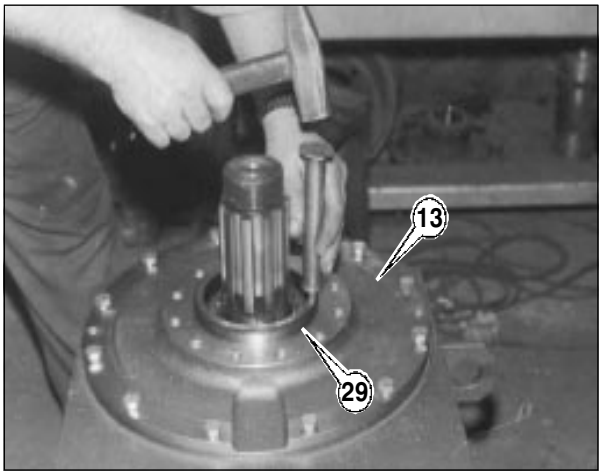
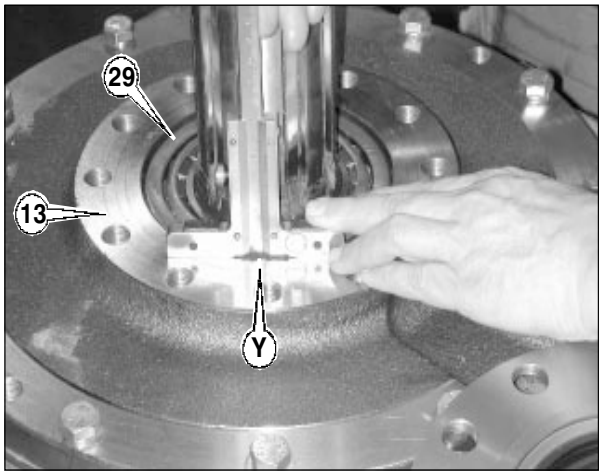


Fig. D/32



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- Smear touching areas of both covers 12 and 13 with LOCTITE. Prepare and insert limiting washers 20 and 21 as calculated for prestress in the opening of cover 13 **Fig. D/33**. Place cover 12 to cover 13. Set brake assembly 10 on cover 12 and tighten bolts 47. Smear thread with LOCTITE, **Fig. D/34**.
- Place sealing O-ring 32 and chrome plated ring 19 on shaft 4 **Fig. D/35**.
- Insert bolts 49 in hubs 8. Slide fixture no.5 on the shank of bolts. Apply nuts 51 and fix bolt to the hub flange using fixture. Preheat hub in an electric oven to 200 – 250 C (392-482 F). In turn, close the heads of bolts on two sides by welding, **Fig. D/36**.

In Czech Republic use electrode. OK 67.45 – made by ESAB Žamberk.

Marking of electrodes to the following standards

SN EN 1600 (05 51 00)	OK 67.45
DIN 8556	E 18 8 Mn B 20+
AWS A/SFA 5.4 – 92	E 307 – 15
EN 1600 (European standard)	E 18 8 Mn B 42

Fig. D/34

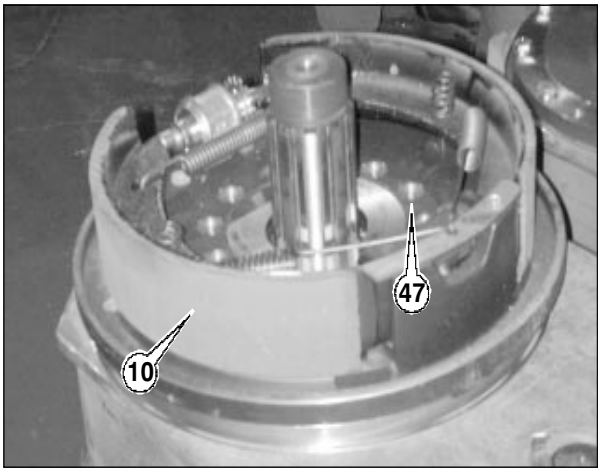


Fig. D/35

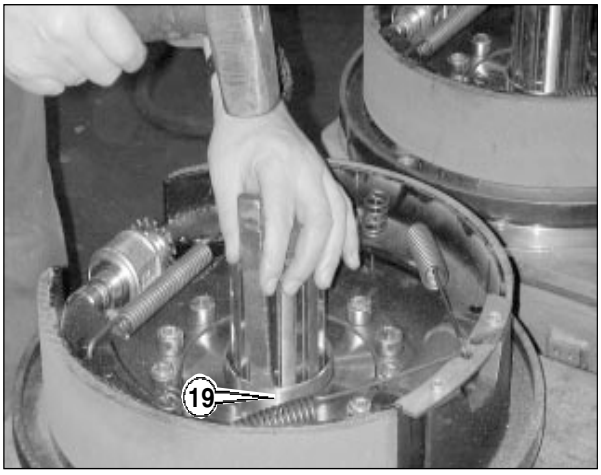


Fig. D/33

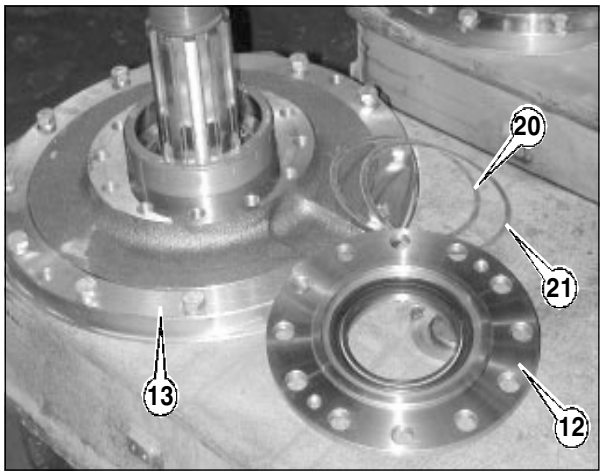
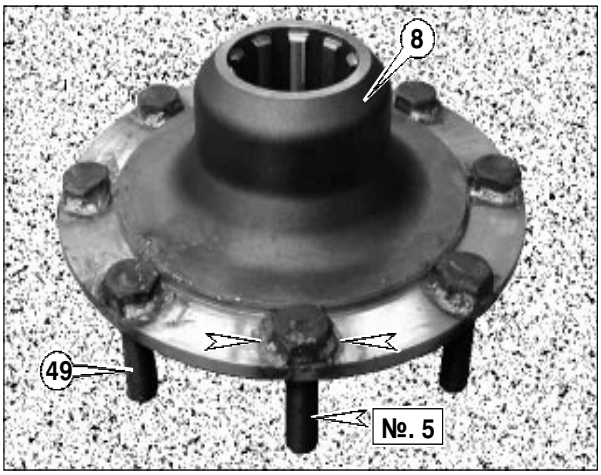


Fig. D/36



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- Heat flange 8 to 200÷250 °C (392÷482 °F) and slide on grooved shaft 4, **Fig. D/37**.
- Slide spacing ring 18 on shaft 4, use nut 34 and tighten. **Fig. D/38**.
- Secure with washer 35. Slide on the other washer 35, screw and tighten the other nut 34, and secure using tab washer 35, **Fig. D/39**.
- Fix brake drum 11 on bolts in flange, and tighten with 2 nuts 51, **Fig. D/40**.

Fig. D/38

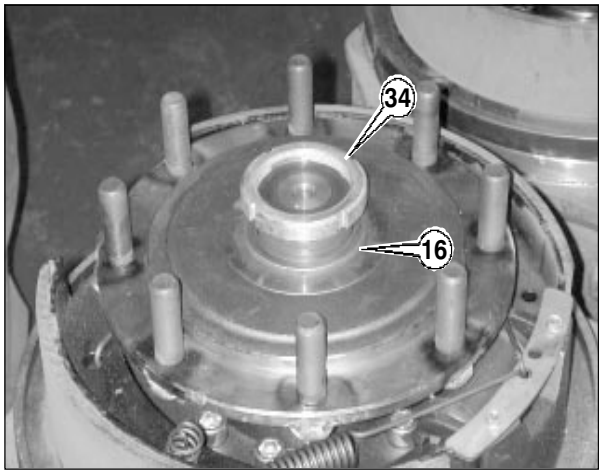


Fig. D/39

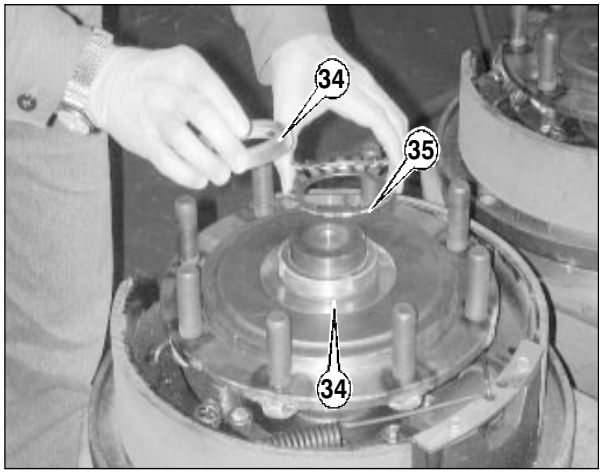


Fig. D/37

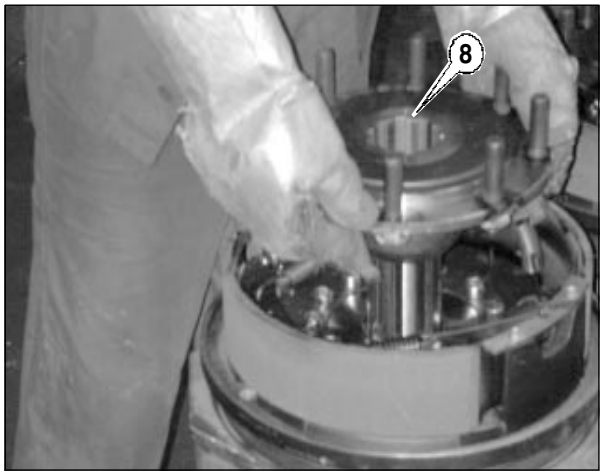
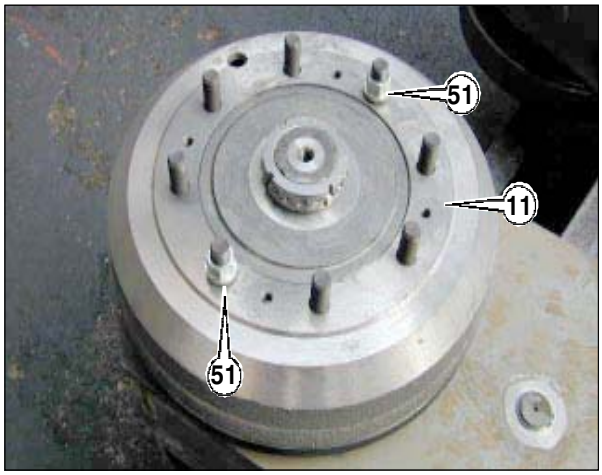


Fig. D/40



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Brake adjustment on both housings:

- Turn brake drum with adjustment hole downwards to the adjustment wheel 2, **Fig. D/41**.
- Turn adjustment wheel 2 until brake shoes touch brake drum – the brake drum cannot be turned.
- Turn adjustment wheel back until brake shoes become loose – the brake drum can be turned freely, without audible friction of the drum on the shoes.

Fig. D/41

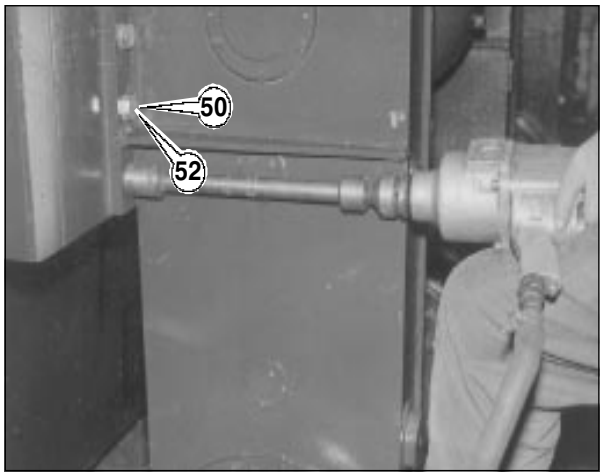


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ASSEMBLING AXLE TO THE MACHINE

- Respect the rules of work safety.
- Hook rear axle on he lift, attach plates to machined areas of the frame and bolt to the frame with 16 screws 50 with washers 59, 57 and nut 52. Tighten with torque as in table, **Fig. D/51**.
- Tighten bolts 27 with torque of table, connecting the left sealing boot 2 to axle bridge 1 **Fig. D/42**.

Fig. D/51



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5.4 Front axle

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E - FRONT AXLE

1. Technical data
   1.1. Description
   1.2. Specifications
   1.3. Torque values
   1.4. Lubricants and glues

2. Defects and remedies
   2.1. Inspection of installation of four front wheels

3. Axle disassembly
   3.1. Preparatory work
   3.2. Disassembly of axle from the equipment
   3.3. Disassembly of guiding pipe of the front axle
   3.4. Disassembly of fork
   3.5. Cleaning and inspection of parts

4. Installation of front axle
   4.1. Installation of guiding pipe and fork
   4.2. Assembly of wheel hubs and shaft
   4.3. Assembly of fork and shaft assembly with wheel hubs
   4.4. Assembly of axle to the machine

5. Fixtures

1. TECHNICAL DATA

1.1. DESCRIPTION

The front axle assembly is fixed to the housing frame of the machine. It consists of two movable arms with a hydraulic cylinder.

For easier disassembly and assembly refer to **Fig. E/1, E/2** to see the entire exploded view of the front axle with specifications of each part for easier orientation when replacements are necessary.

Watch particularly for proper tightening of all screws and nuts and refer to table of applicable torque.

1.2. SPECIFICATIONS

axial (vertical) lift	mm (in)	200 (7,84)
pitch diameter of disc bolts on wheels	mm (in)	275 0,2 (10,83) (0,008)
weight of front axle including tires	kg (lb)	1156 (2549)

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1.3. TORQUE VALUES

Connection	Position	Thread	Nm (lb ft)
Flange 9+shaft 8	KM nut 38	M60x2	500 (369)
Scraper 32+shaft 8	Bolt 64	M10	25 (18,5)
Pin16+shaft 8	Bolt 31	M12	45 (33)
Pin 16+washer 23	Bolt 65	M12	45 (33)
Cover 10+guiding pipe 2	Bolt 62	M10	25 (18,5)
Cover 12+Guiding pipe 2	Bolt 61	M10	25 (18,5)
Cover 11+guiding pipe 2	Bolt 63	M10	25 (18,5)
Disc wheel+flange 9	Disc nut 73	M20x1,5	330 350 (243 258)

other connections see appendix no.1

1.4. LUBRICANTS AND GLUES

Oil fill:

For hydraulic cylinders of the front axle equalization system, the hydraulic oil of series ISO 6743/4 HM or HV with kinetic viscosity of 46 mm^2/s at 40 C (104 F) /ISO VG 46/ is to be used.

This corresponds to DIN 51524 part 2 HLP, or DIN 51524 part 3 HVLP, eventually CETOP RP 91 H.

Type of oil	Quantity l (gal US)
H M or HV 46	6 (1,6)

Lubricating grease

Synthetic grease containing lithium. of consistence to NLGL – 2* - see table.

BENZINA	MOBIL	ESSO	SHELL	CASTROL
P-ML-A2	Mobilgrease MP	Multi-Purpouse	Retinax A	Castrolease LM
	Mobilgrease Special	Grease H	Alvania	Spherol
	Mobilplex EP-1		Grease No.3	Grease RBB2

* - NLGI 2 - **N**ational **L**ubricating **G**rease **I**nstitute; part 2

Glue for fixing bolts and nuts	LOCTITE 577
	Aldurit
Sealing compound for touching faces of parts	Epple 39

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2. DEFECTS AND REMEDIES

Defect	Cause	Remedy
Oil leak	defective seal	replace
	damaged chrome on the fork	replace (or repair)
Axle noisy	mechanical damage to part	replace
	free play in conical bearings	adjust see. 2.1
Free play in steering (mounting of conical pins of the steering rod)	conical holes pressed out	repair bushing

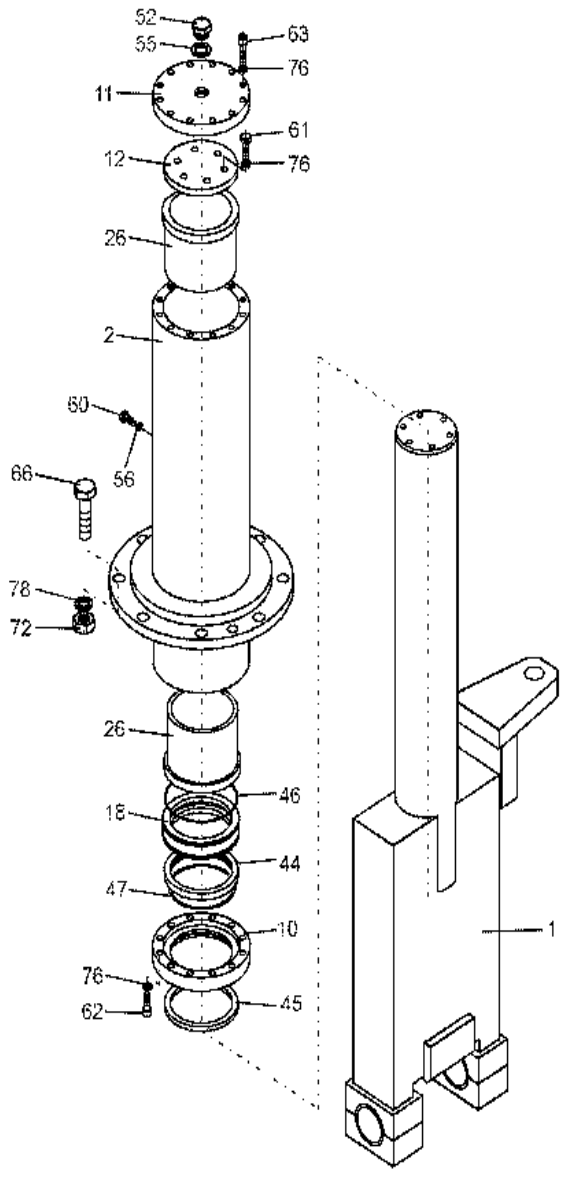
2.1. INSPECTION OF INSTALLATION OF FOUR FRONT WHEELS

- Free play of conical bearings must be checked. Eventually, any noticeable must be adjusted immediately. First inspection after 100 Mh and then every 500 Mh.

Instructions for set-up:

- Remove complete wheel with disc, by loosening nuts 73, washers 39, outer nut 38. Tighten n. 13 up the inner nut using proper wrench with extension. While doing this, position bearings 37 and 41 by tapping the hub of the wheel **Fig. E/2**.
- The front wheel bearings are properly adjusted, when there is no free play in conical bearings, and the wheels may be turned easily without resistance.

Fig. E/1



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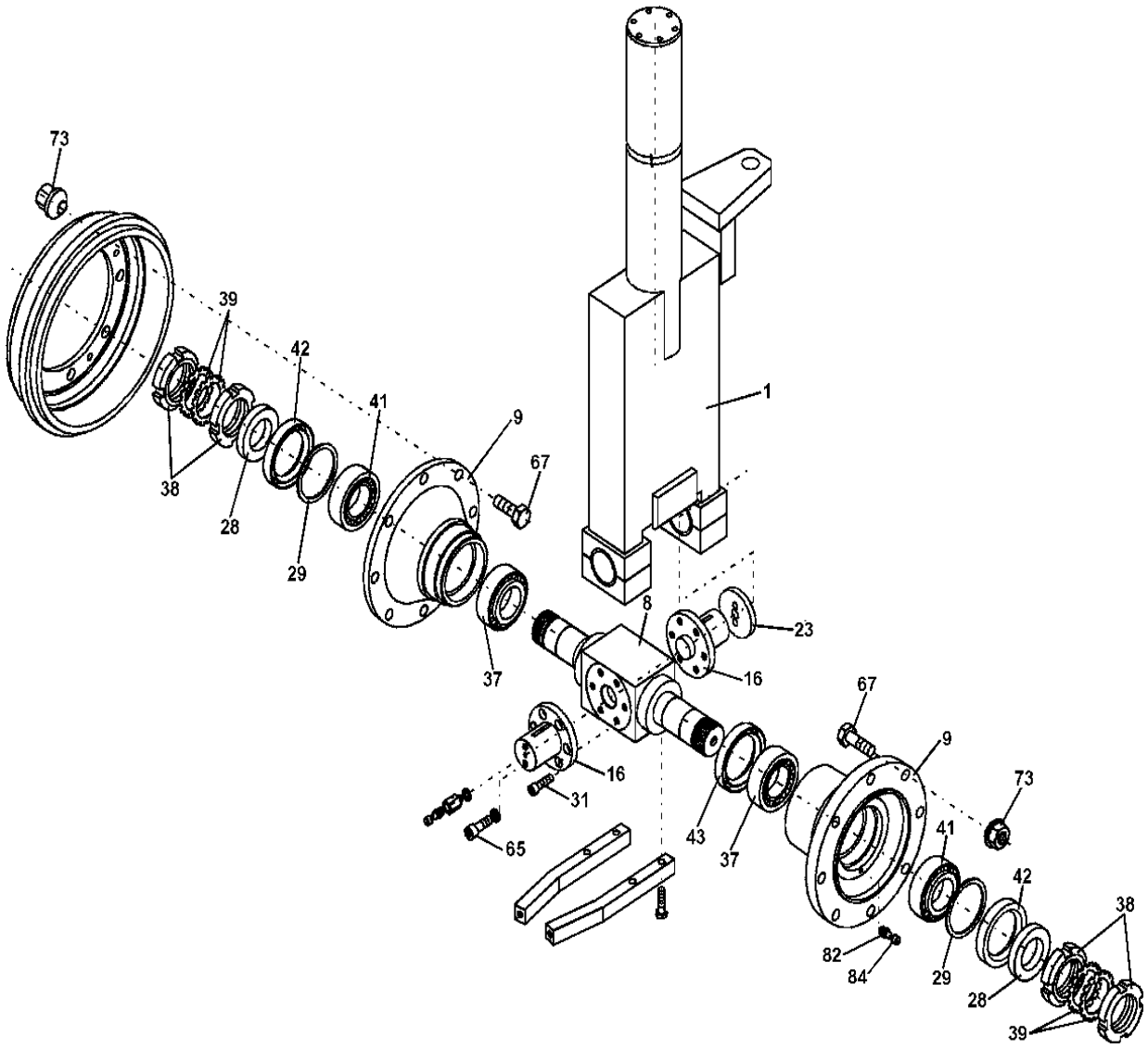
3. AXLE DISASSEMBLY

Preparatory work, disassembly and assembly must be done in line with the Safety Precautions and Instructions chapter. Observe ecological and health regulations.

3.1. PREPARATORY WORK

- Place the machine horizontally on a firm and flat surface.
- Place wooden block under rear wheels on both sides.
- Switch off batteries – the machine's brake has been set automatically.
- Place the sign "**THE EQUIPMENT IS OUT OF ORDER**" on he steering wheel.

Fig. E/2



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3.2. DISASSEMBLY OF AXLE FROM THE EQUIPMENT

- Remove nuts 73, **Fig. E/2**.
- Insert proper ties in the lifting hooks, hoist the front end high enough so that the front wheels are off the ground, see **Fig. E/3**.
- Remove cover off the frame above the front wheels.
- Remove connecting pipe 33 and the connectors, plug up the hole, **Fig. E/4**.
- Further, remove tires inflation attachment, brush holders, wheels, sprinkling equipment, steering (connecting rod), and electrical cables.
- Unscrew plug 52, attach hook No.1, **Fig. E/5**.

Fig. E/4

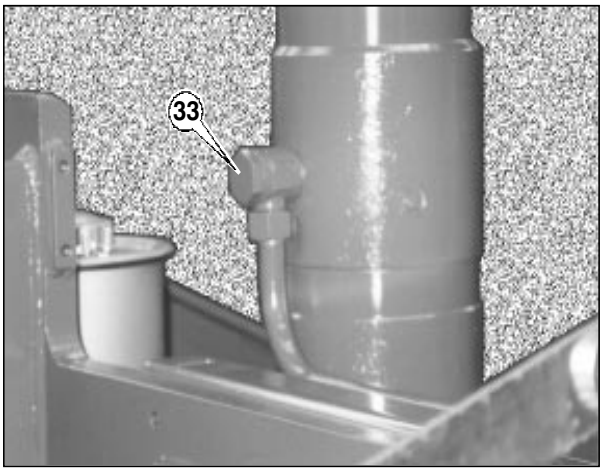


Fig. E/5

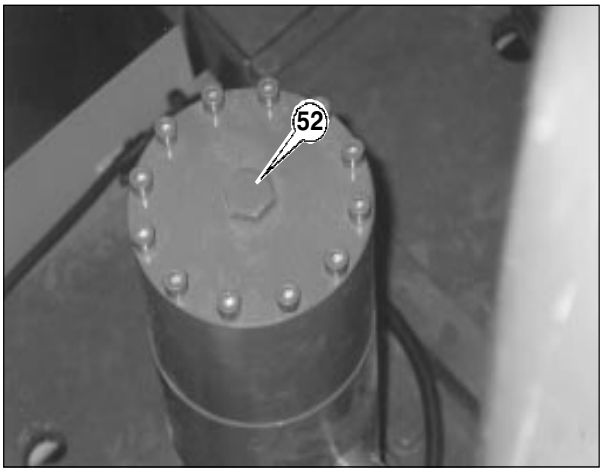


Fig. E/3

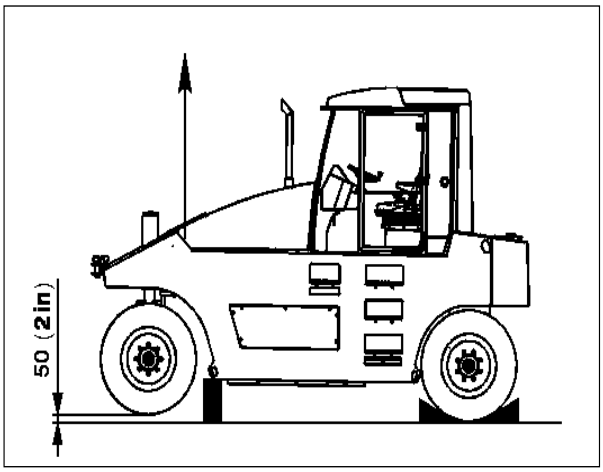
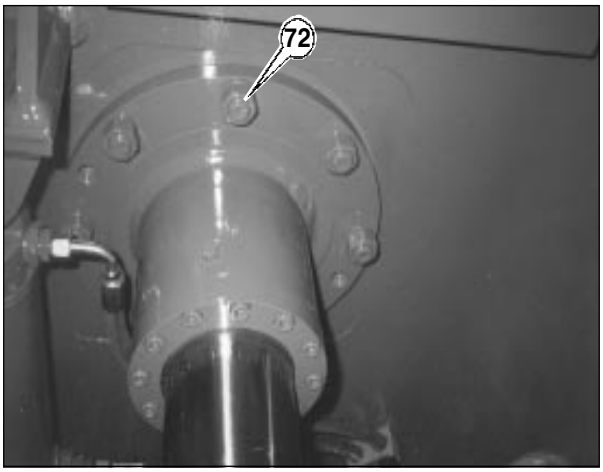


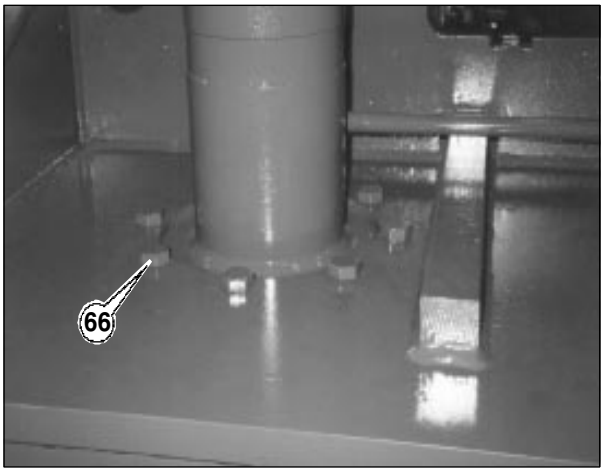
Fig. E/6



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- Remove nuts 72 **Fig. E/6** and, bolts 66, **Fig. E/7**.
- If it isn't possible to remove the axle from the frame, press-out bolts must be used in the holes of guiding pipe 2 flange.
- Slide the axle from the frame forward, disconnect the hoist and remove ropes from frame holes. Hook up again and deposit on fixture No.2. Unscrew hook. Turn the guiding pipe 2 through opening for the connecting pipe, and drain oil into a suitable container.

Fig. E/7



3.3. DISASSEMBLY OF GUIDING PIPE OF THE FRONT AXLE

- Remove cover 11 on the face of the guiding pipe 2. Knock out gently cover 11 and remove by prying it out. Remove O-ring, and cover 12 on the top face of fork 1, **Fig. E/8**.
- Using hoist remove guiding pipe 2.

Note: Watch for leaking residual oil. Protect the chrome-plated part of fork 1 by a suitable cover (by a split rubber hose, for instance) against damage, after the removal of the guiding pipe.

- Remove cover 10 on the bottom face of the guiding pipe 2. Remove washer 18, scraper ring 45 from the cover 11, packing 44 from ring 18, and two O-rings 46 and 47 Remove bolt 60 (fixing the top bushing) **Fig. E/1**.
- Remove bushing 26 with a spanner, **Fig. E/9**.

Fig. E/8

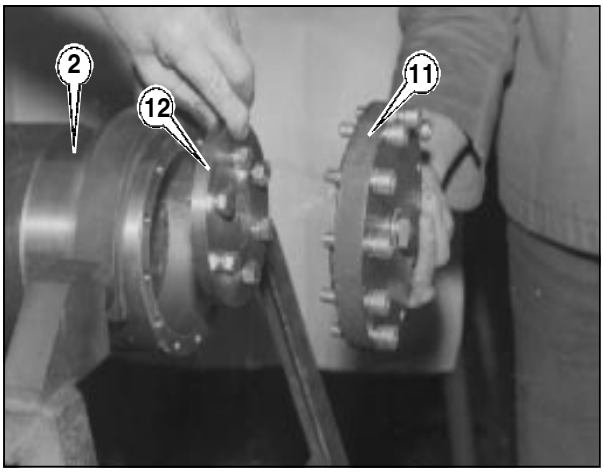
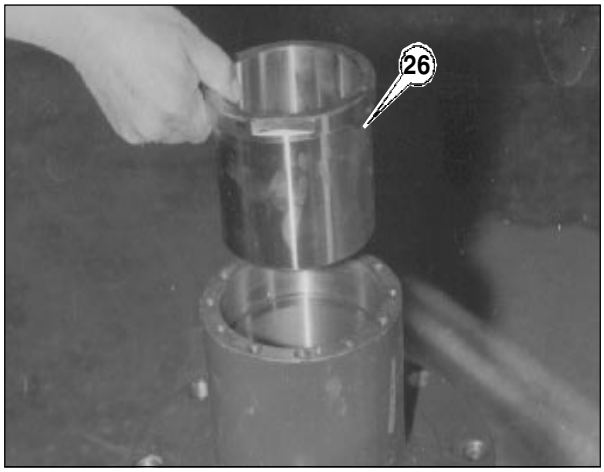


Fig. E/9



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3.4. DISASSEMBLY OF FORK

- Remove shim 23. Remove extension 24 with nipple 84, **Fig. E/10**.
- Attach hook No. 3 in the center hole of the shaft (thread M16x1,5). Attach to hoist, **Fig. E/11**.
- Remove bolts from the yokes of the fork 1. By a gentle knock loosen the yokes Slide bushings off pins 4, **Fig. E/12**.
- Place on bench.
- Remove hook No.3.
- Release lock washer 39 (MB 12), gradually remove nuts 38.

Fig. E/10

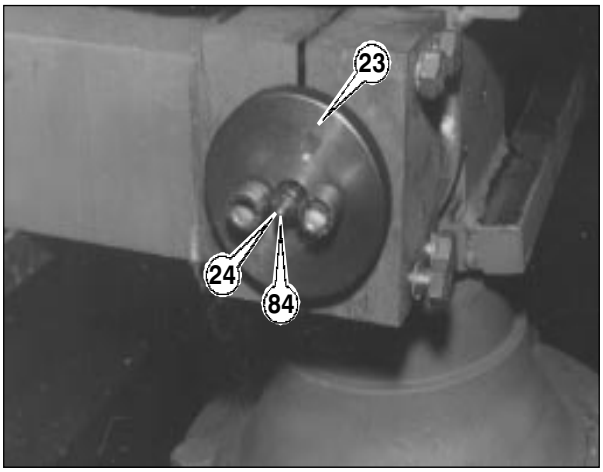


Fig. E/11

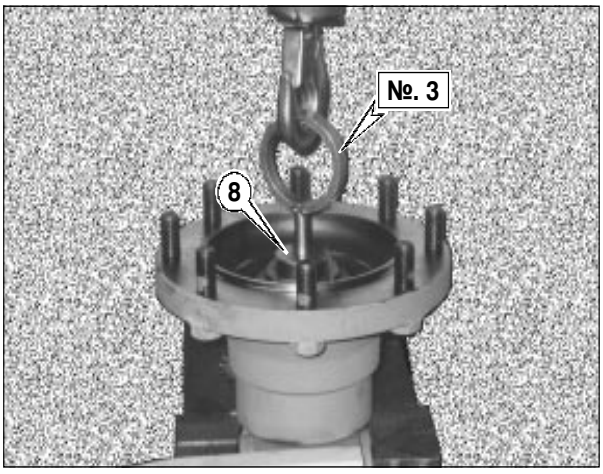
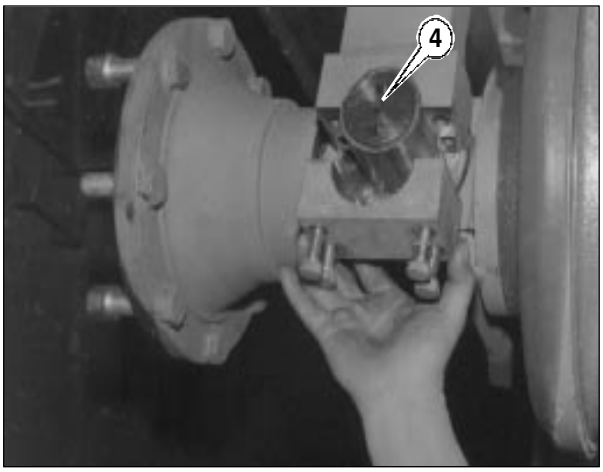


Fig. E/12



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- Remove hub, or a suitable lever (screwdriver) by the lower edge of the hub 9 with spanner, **Fig. E/13**.
- Remove washer 28 and sealing ring 42 from the hub, in case of replacing bearings, also the front bearing 41 and the outer ring of the rear bearing 37. Unscrew nipple 82 **Fig E/14**.

Note: Should the bearing be replaced, the complete bearing must be replaced.

- Turn the fork and remove hub 9 from the opposite side.
- Remove pins 16 from shaft 8. Using spanner attached to the face of the pin 16 by two screws M12, remove pins from shaft 8. Should bearings 37 be replaced from shaft 8 remove inner rings of bearing 37 **Fig. E/2**.

Fig. E/13

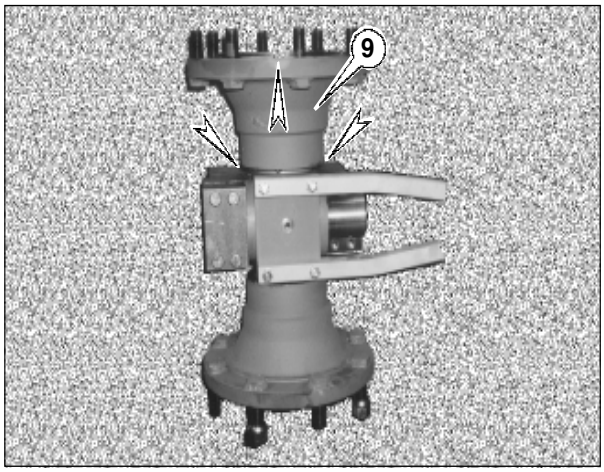
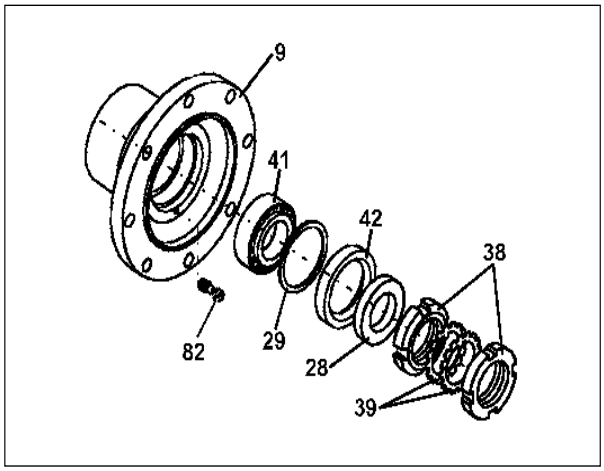


Fig. E/14



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3.5. CLEANING AND INSPECTION OF PARTS

Cleaning of parts

For complete cleaning use adequate solvent fluid bath. The bearings must be taken out of the bath repeatedly, and the cones or rollers must be turned under pressure. Perfectly clean bearings to be dried out with dry compressed air, while turning the bearings by hand to accelerate the process.

CHECKING EACH PART

Bearings

Check visually all cones, cages, and rings for pitting, breaks in material, or dents. Should there be any damage present, the bearing has to be replaced. It is not allowed to replace only the inner or outer rings of conical bearings. Following the inspection dip the bearing in oil and wrap in paper to keep it clean until future use.

Shafts

Check for eccentricity, straight grooves, and general wear.

Castings, bushings

Visual control includes checking for dents, flares on functional surfaces and holes for the bearings. Further, check carefully for the appearance of fissures and deformations.

Piston rod (fork 1), guiding pipe 2

Check for eccentricity, straightness, dents on functional surfaces, and chrome on the fork. In case of non-repairable damage, replace the part. Small dents may be removed by filing.

Rubber seals, O-rings, packing

Should there be any damage observed, replace.

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4. INSTALLATION OF FRONT AXLE

4.1. INSTALLATION OF GUIDING PIPE AND FORK

- Set the guiding pipe in fixture no.2 or on a bench. Press bushing 26 into the guiding pipe 2, **Fig. E/15** using fixture no. 4 **E/16**.

NOTE ! Save bushings by the usable surface, only one half of the pieces is affected, Fig. E/15 Fix the inner bushing by bolt 60, Fig. E/16.

- Turn the guiding pipe 2 with bushings in fixture no. 2 to vertical, secure and clean the inside by air.
- Grind taper on the fork with a whetstone.
- Press ring 18 with O-rings 46, sealing set "Merkel" 44, and scraper ring into cover 10, **Fig. E/17**.

Fig. E/15

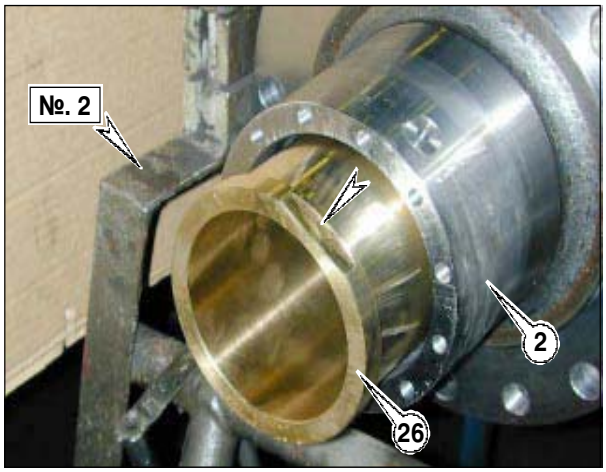


Fig. E/16

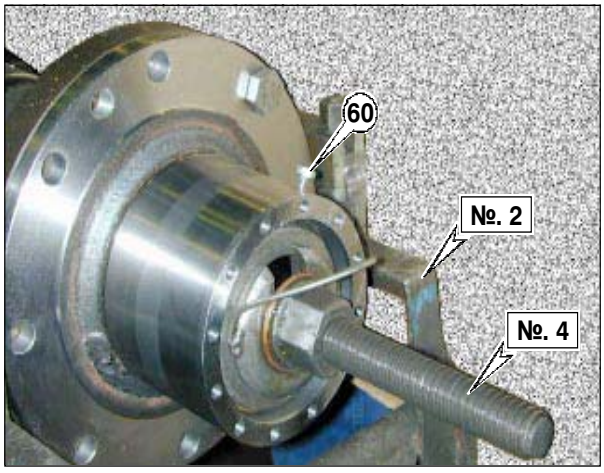
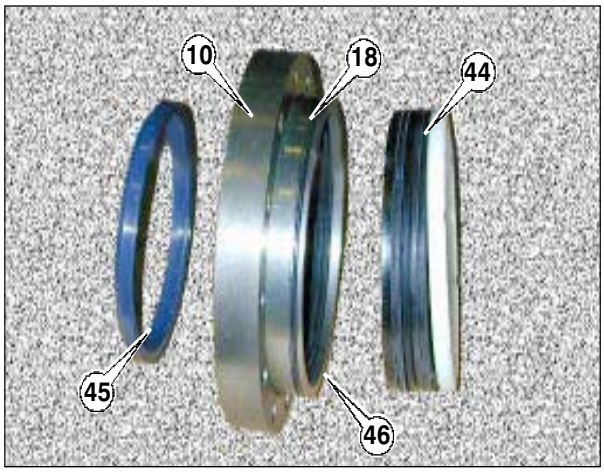


Fig. E/17



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- Install cover 10 with seals on fork 1 into holes for bolts in cover 10, attach fixture no. 5, slide into guiding pipe 2 using hoist and fixture no. 6 inserted in hooks of fork 1, **Fig. E/18** until cover 10 sits on the face of the guiding pipe 2. Pack cover 10 with EPPLE glue.
- Attach cover 10 to guiding pipe 2. Slide fork 1 out and remove fixture no. 5.
- Tilt the assembled guiding pipe with the fork horizontally
- Screw in the opening for the oil pipeline the plug against dust entry.
- Screw cover 12 to the face of the fork. Screw cover 11 to the guiding pipe including ring 47 and apply glue EPPLE **Fig. E/19**.
- Screw hook no.1 in the cover 11. Remove the guiding pipe with the fork from the fixture and place on the workbench.

Fig. E/18

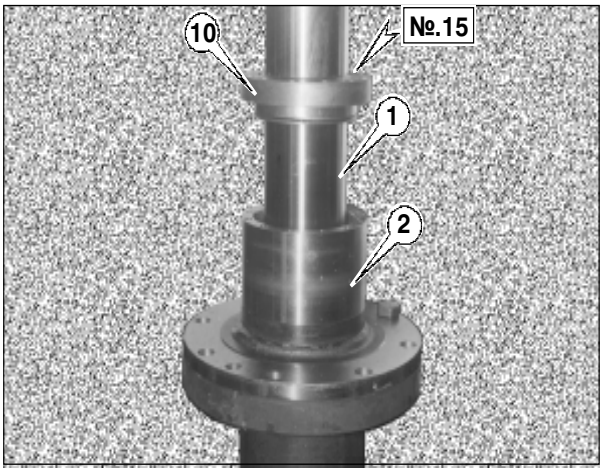
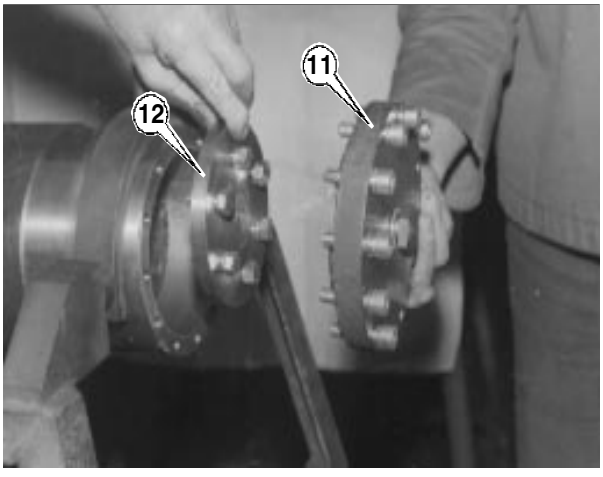


Fig. E/19



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4.2. ASSEMBLY OF WHEEL HUBS AND SHAFT

- Insert bolts 67 in hubs 9. Slide fixture no.7 on the shank of the bolt. Screw nuts 73 and tighten bolt to the hub flange using fixture. Preheat hub in the electric oven to 200 - 250 C. Weld in turn the bolt heads from both sides, **Fig. E/20**.

  Used electrode to SN EN 1600 (05 51 00) - made by ESAB Žamberk OK 67.45 – valid for the Czech Republic.

  The corresponding electrodes according to

DIN 8556	E 18 8 Mn B 20+
AWS A/SFA 5.4 – 92	E 307 – 15
EN 1600 (European standard)	E 18 8 Mn B 42

- Clamp shaft 8 in a vice (protect ground surface), or in fixture no. 8, install brush holders 32.
- Press pins 16 to shaft 8, screw, fix bolts with ALDURIT and degrease threads, **Fig. E/21**.
- Press outer rings of the conical bearing 41 into hub 9 using fixture no.9, ring 29, and sealing ring 42 using fixture no.10. Turn hub 9 and repeat the preceding operation. Screw on nipple 82. **Fig. E/22**.
- Place shaft 8 on the workbench in fixture no.8, preheat inner bearing ring 37 (to a maximum of 100 C), and press on the shaft – hit with fixture no. 11 to end. Place hub 9 on shaft 8, fill space between bearings with grease, and press in the inner ring of the second bearing 41 using fixture no. 11 **Fig. E/23**.

Fig. E/21

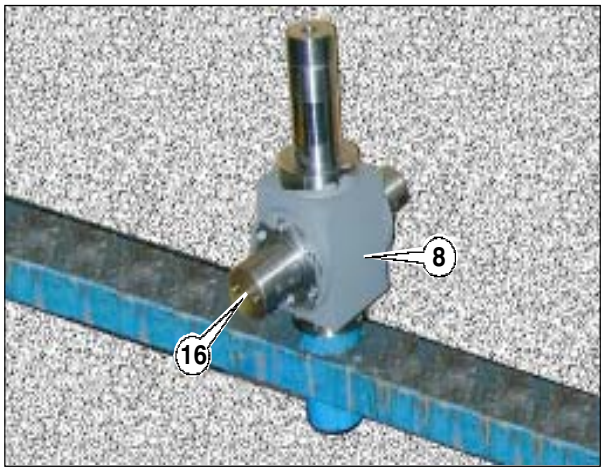


Fig. E/22

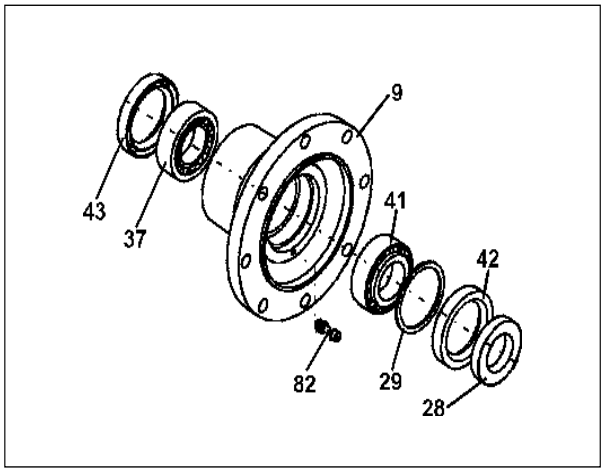


Fig. E/20

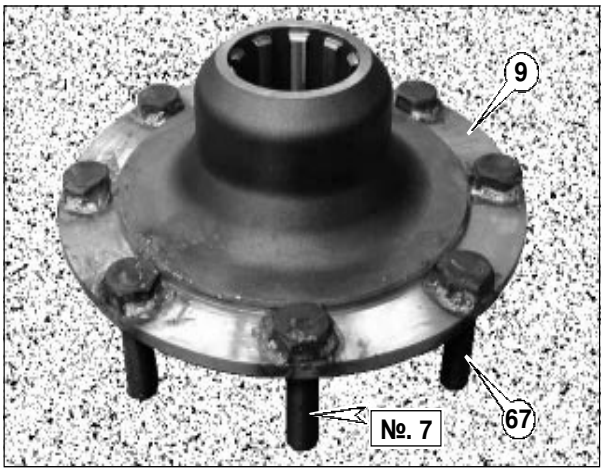


Fig. E/23



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- Place tapered plate no. 12 on sealing ring 42, insert shim 28, **Fig. E/24**.
- Screw on first nut 38 using fixture no. 13, use torque according to table. Knock off the bearing using fixture no.14, retighten the nut with torque, test pre-stress of bearings by turning hub 9 (it may not turn freely). Insert two safety washers 39 and the second nut 38, tighten **Fig. E/25**. Secure nuts with washers.
- Screw hook no.3 in the center hole of shaft 8 **Fig. E/26**, and place the assembly on the workbench with the hub down.
- Heat inner ring of bearing 37 (to a maximum of 100 °C) and place on the shaft – press to dead stop using fixture no.11 **Fig. E/23**.
- Place hub 9 on shaft 8, fill in the space between the bearings with grease, and press in the inner ring of bearing 41 **Fig. E/22**.
- Press tapered plate no. 12 on the sealing ring 42, insert shim 28, **Fig. E/24**.
- Install nuts 38 and washers 39 with limited pre-stress of bearings 37 and 41 as per preceding operation.

Fig. E/24

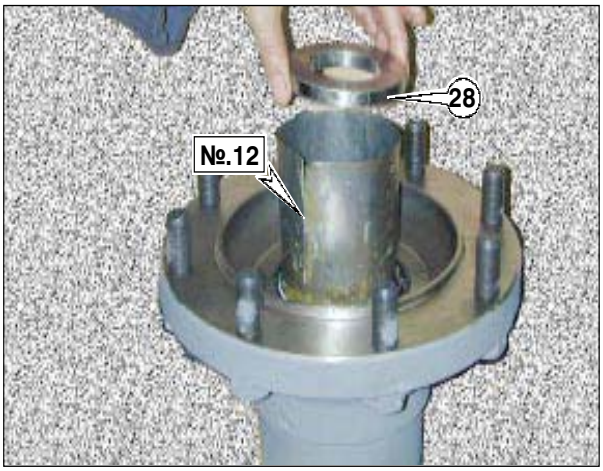


Fig. E/25

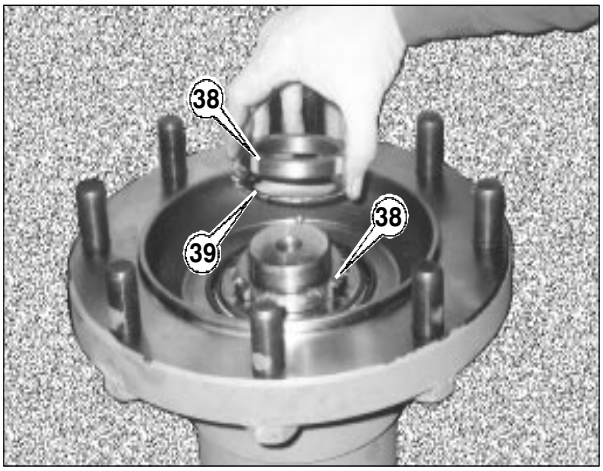
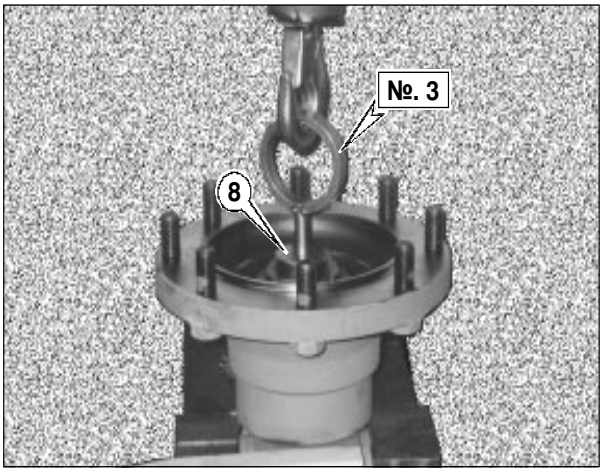


Fig. E/26



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4.3. ASSEMBLY OF FORK AND SHAFT ASSEMBLY WITH WHEEL HUBS

- Remove yokes 1A from the fork, remove bushings 1B and smear with grease, **Fig. E/27**.
- Insert bushings on pins 18, **Fig. E/28**.
- Assemble axle axis (pos. 8+9), hang by hook no.3, **Fig. E/26** on hoist.
- Insert shaft axle on forks into yokes, **Fig. E/29**.

Fig. E/27

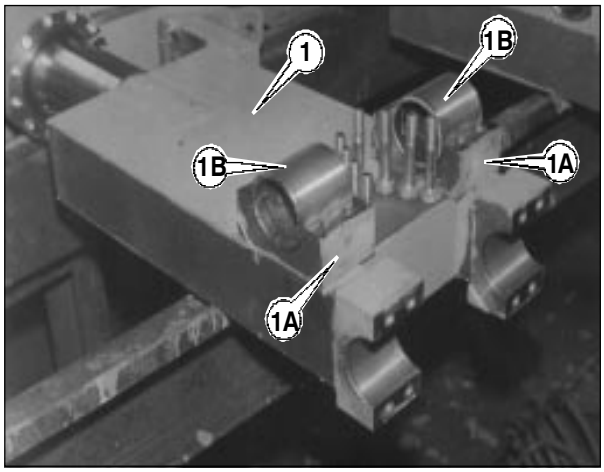


Fig. E/28



Fig. E/29



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- Assemble yokes, **Fig. E/30**.
- Screw on extensions 24 and nipple 84. Insert shim 23, **Fig. E/31**.
- Weld end stops pos. 10 on both sides using fixture no.15. Set the fixture on hub bolts 9 and support the other end (end stop) against piston rod of fork 1 (protect the surface of the piston rod against damage), **Fig. E/32**. The end stop limits the spacing between the tire and the piston rod to 13 mm when the axle is off vertical.

Fig. E/30



Fig. E/31

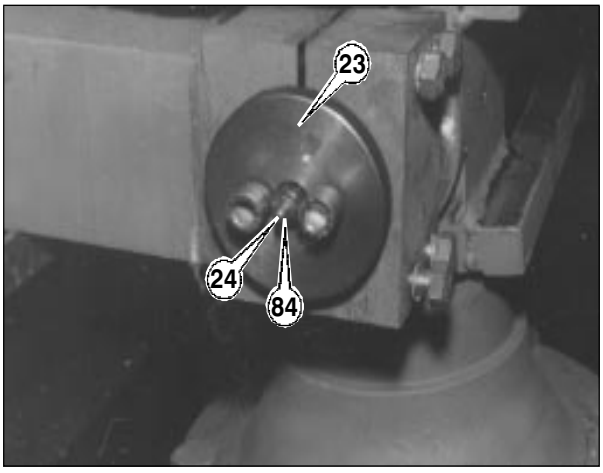
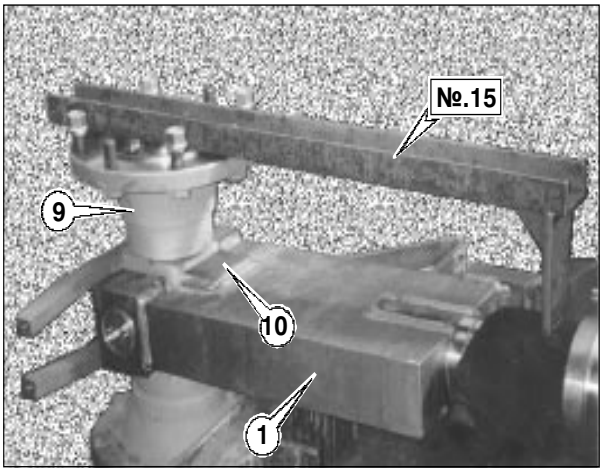


Fig. E/32



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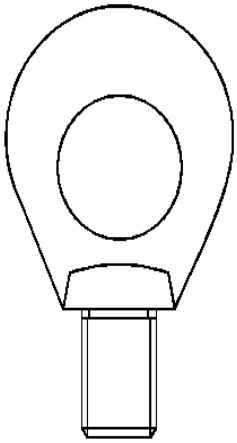
4.4. ASSEMBLY OF AXLE TO THE MACHINE

- Hoist the axle to the frame of the machine, hook up a cable, and attach to hook no.1. Lift the axle to the frame and attach. Remove the hook.
- Connect both guiding pipes with pipe 33 **Fig. E/3**.
- Fill both guiding pipes with oil, see table in 1.3. Screw on plug 52. Following wheel alignment (see chapter ”G”), install complete wheels to flanges. Further install tire inflation assembly, sprinkler, and electrical cables.

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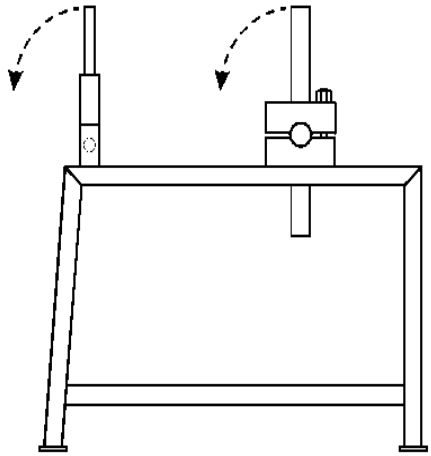
5. FIXTURES

No.1 Hook (92-644-0195) for removal of axle from the machine and thread M 24x1,5 in cover 11

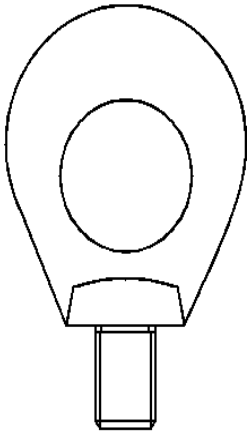


M 24x1,5

No.2 Assembly support (64 373-0470) for placing guiding pipe 2

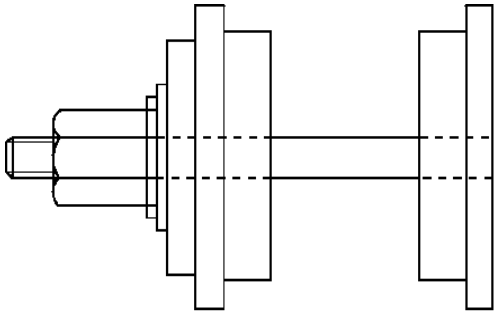


No.3 Hook (65-374-0010) for removal of assembly shaft 8 + hub 9, thread M16x1,5

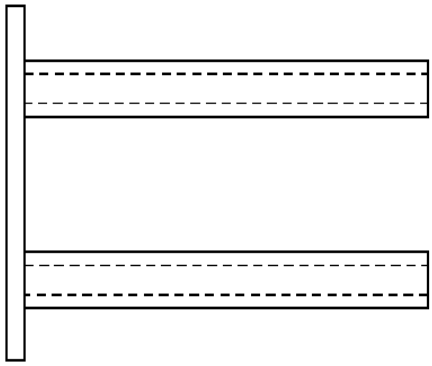


M 16x1,5

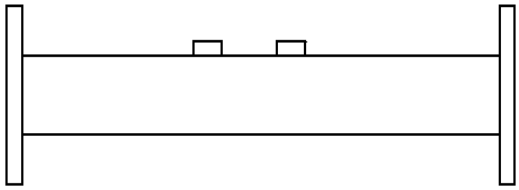
No.4 Installation (64-373-469) - for pressing bushings 26 into guiding pipe 2



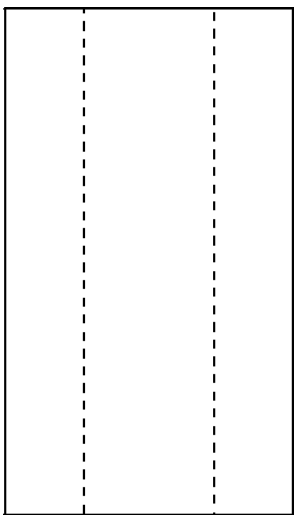
No.5 Installation (64-374-0008) – for installation of cover 10 into holes for screws



No.6 Handling (65-374-0009) – for installation of fork 1 to guiding pipe 2

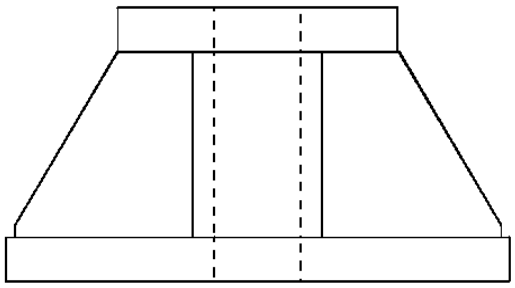


No.7 Welding (54-373-0478) – bushing for placing bolts

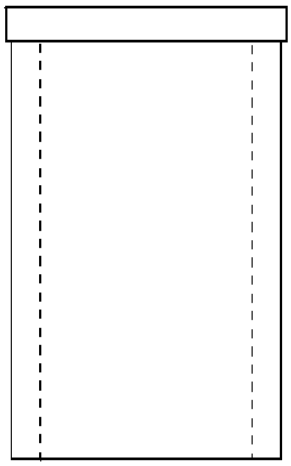


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No.8 Installation (64-373-0473) – support for shaft 8

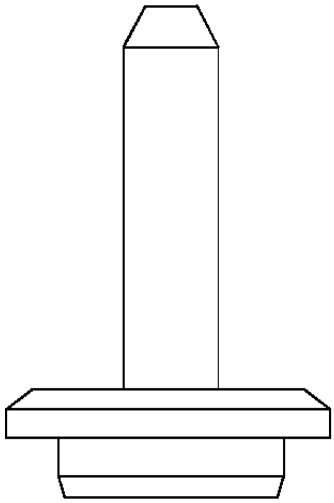


No.9 Pressing (92-631-0006) – ∅ 110/91-130 pipe inner rings of bearings 37, 41

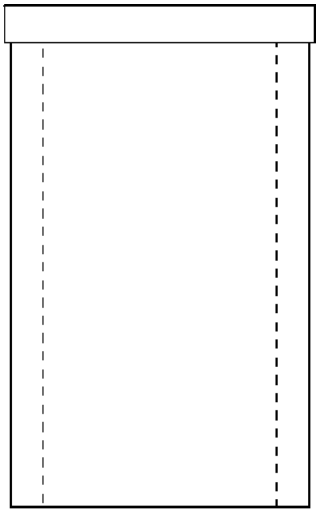


∅ 110/91x130

No.10 Pressing (92-631-0117) - ∅ 120x100x13 pressing tool for sealing ring 42, 43

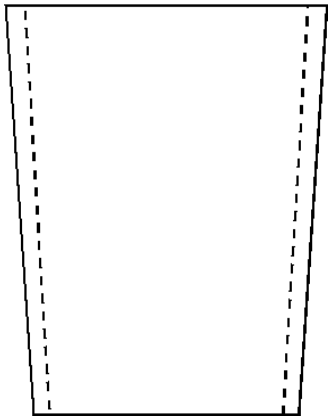


No.11 Pressing (92-631-0006) - ∅ 70/63-200 pipe inner rings of bearings 37,41



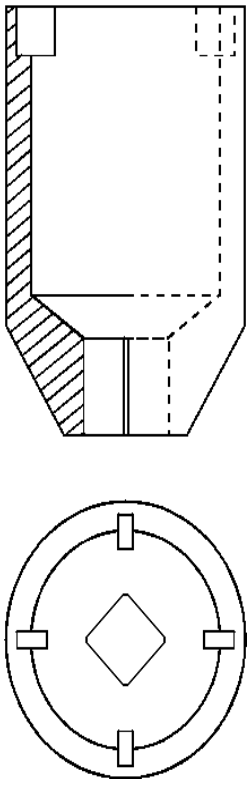
∅ 70/63x200

No.12 Installation (64-374-0004) – tapered plate for sealing ring 42 to install ring 28

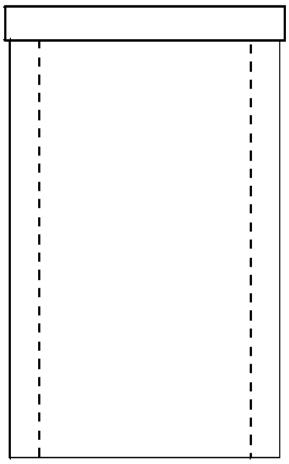


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No.13 Installation (64-373-092) – extension for nut KM 12 pos.38

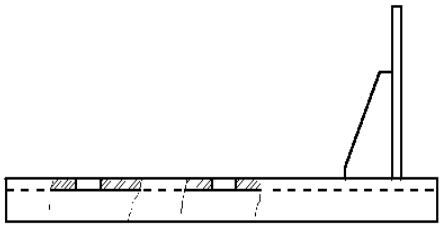


No.14 Pipe (92-631-0006) – Pipe ∅ 81/89-140 for knocking off bearings 37,41



∅ 81/89 x 140

No.15 Welding (64-373-0471) – for placing end stops on the fork 1



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5.5 Drive shaft

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F - FLEXIBLE SHAFT

1. Specifications - description
   1.1. Description
   1.2. Specifications
   1.3. Tightening torque
   1.4. Lubricants and glues

2. Possible defects and remedies

3. Disassembly and re-assembly
   3.1. Preparatory work

1. SPECIFICATIONS

1.1. DESCRIPTION

The flexible shaft serves the purpose of transmitting torque to the gearbox to drive the rear axle (differential).
It consists of two separate parts inserted in each other, and moving in the groves of the axial axis.

1.2. SPECIFICATIONS

Max. transmitted torque	Nm (lb ft)	4500 (3320)
Revolutions	1.min^{-1} (RpM)	2200
Weight of the shaft	kg (lb)	25 (55)

1.3. TORQUE

Tightening torque values are listed in appended table.

1.4. GREASE

Synthetic grease with Lithium added of prescribed consistence NLGI -2* , see table.

BENZINA	MOBIL	ESSO	SHELL	CASTROL
P-ML-A2	Mobilgrease MP	Multi-Purpouse	Retinax A	Castrolease LM
	Mobilgrease Special	Grease H	Alvania	Spherol
	Mobilplex EP-1		Grease No.3	Grease RBB2

* - NLGI 2 - **N**ational **L**ubricating **G**rease **I**nstitute; part 2

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2. POSSIBLE DEFECTS AND REMEDIES

DEFECT	CAUSE	REMEDY
Shaft is vibrating	Mechanical damage of the bearing	Replace shaft

3. DISASSEMBLY AND RE-ASSEMBLY

Do all preparatory work, disassembly, and re-assembly with Chapter on safety in mind. Comply with environmental and health regulations.

3.1. PREPARATORY WORK

- Place the roller horizontally on a firm surface.
- Wedge front wheels on both sides.
- Switch off battery breaker – the machine brakes automatically.
- Place notice ”ROLLER IS BEEING REPAIRED” on the steering wheel.
- Remove rubber mat and insulation off the floor.
- Remove two floor covers.
- Hold the flexible shaft by suitable ties (ropes) in the hoist, or support it.
- Remove bolts on the gearbox side and on the rear axle drive side, **Fig. F/1, F/2**. Remove the shaft and place it outside.
- Install new shaft in reverse sequence – use new safety nuts.

Fig. F/1

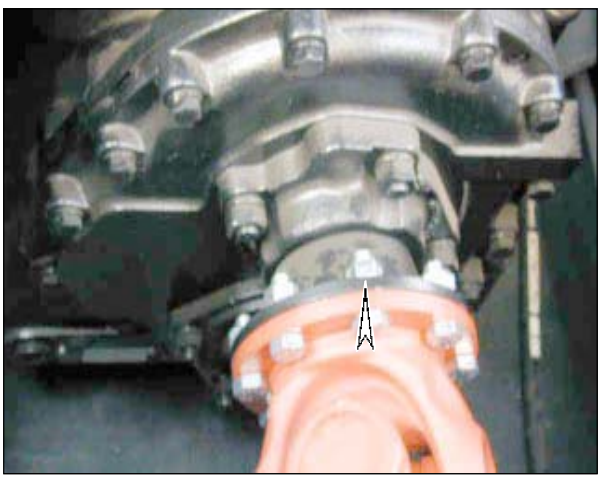
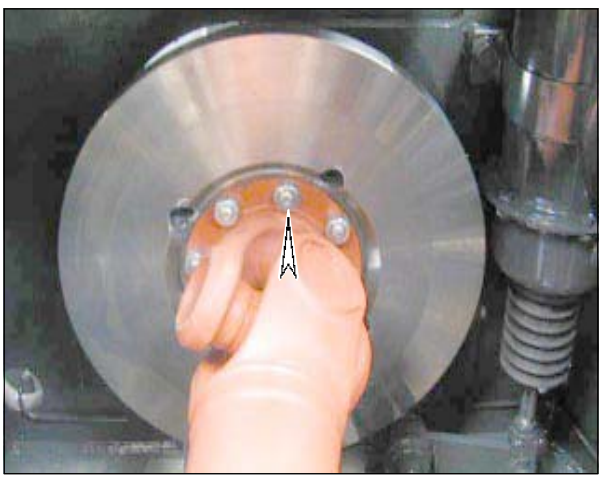


Fig. F/2



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5.6 Steering

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G - STEERING

1. Specifications - description
   1.1. Description
   1.2. Technical data
   1.3. Lubricants and glues

2. Possible defects and remedies

3. Disassembly and re-assembly
   3.1. Preparatory work
   3.2. Geared steering hydraulic generator
   3.3. Power steering
   3.4. Disassembly of linear hydraulic motor
   3.5. Removal of power steering tank
   3.6. Removal and installation of the lever assembly

4. Adjustment of toe-in

5. Fixtures

1. SPECIFICATIONS - DESCRIPTION

1.1. DESCRIPTION

The roller is steered mechanically and hydraulically. The geared hydraulic generator uses hydraulic oil from the oil tank with filter, and pushes it to the steering assembly. By turning the steering wheel, the fluid stream is separated in the power steering assembly, and enters through hoses into the linear hydraulic motor.

The front axle is steered by the linear motion of the hydraulic motor piston, the steering lever, and rods. The surplus fluid is returned to the oil tank. The roller uses dual steering consisting of dual elements in the steering loop, that is, doubled up power steering assembly and steering wheels.

1.2. TECHNICAL DATA

Safety pressure in power steering	MPa (PSI)	12 (1740)
Geared hydraulic generator		2-Q10R.54600-00

Unidirectional, left-turning hydraulic generator (when looking to the driveshaft) changes mechanical energy to pressure. A pair of tooth gears is mounted in the hydraulic generator on sliding bearings, with an automatic equalization of axial free play. The pin of the driving wheel is connected to the mechanical drive.

Seals are of rubber and plastics. It is connected to the CLARK gearbox through a flange.

Volume	cm^3/ot (cu.in/rev)	10 (0,61)
Nominal pressure	MPa (PSI)	20 (2900)

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Power steering LAGC 200LSD 102

The power steering assembly contains various valves like safety, reversing, limiting, shock, and suction valves.

In the neutral position of the steering wheel

- the connection between the pump and the tank is open
- and no force acts on the wheel

Shocks on the wheel during travel are compensated by the unidirectional reversible valve and the shock-absorbing valve.

The motion of the wheel is transferred through the column with a cone for the wheel and a groove leading to the power steering assembly.

Nominal pressure	MPa (PSI)	16 (2320)
Maximum input fluid volume	$dm^3.min^{-1}$ (gal US/min)	50 (13,2)
Through-flow volume	cm^3/ot (cu in/rev)	200 (12)
Weight of power steering assembly	kg (lb)	5,9 (13)
Load on the steering column		
Maximum bending moment	Nm (lb ft)	200 (147)
Maximum axial force	A	1000
Maximum turning moment on the wheel	Nm (lb ft)	160 (118)

Inspection

- Check smooth operation of steering
- Check after each 500 hours of operation:
  - the tightness of steering assembly connections and hoses, sealing faces of the lid and screws on the lid, contacts on the column
  - safety locking screws on the lid
  - steering, while running without power steering, when the source of pressure has failed

Note:

Intrusion into power steering is not allowed. If defective, call service!

Operation in emergency mode is not allowed for extended periods.

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Linear hydraulic motor hv 80/40/200

Hydraulic linear cylinder transforms pressure to mechanical work in the cylinder with a linear motion.

Linear hydraulic motor consists of a cylinder and a piston, see **Fig. G/12**. Piston rings and collars provide sealing of surface inside the cylinder. The motor doesn't require any special maintenance or operation, only lubrication of pins at periods specified in the lubrication schedule.

When replacing seals, cleanliness of all parts is important. Observe ecological rules, should there be leaks of oil, described in chapter "Safety Regulations", section on repairs.

Technical data

Type		HV 80/40/200
Nominal pressure	MPa (PSI)	16 (2320)
Max. operational pressure (max. time 0,1 s)	MPa (PSI)	20 (2900)
Piston speed:		
Minimal	$m.s^{-1}$ (feet/sec)	0,01 (0,033)
Maximal	$m.s^{-1}$ (feet/sec)	0,5 (1,64)
Pushing force	N (lb)	75600 (16994)
Pulling force	N (lb)	55493 (12234)
Lift	mm (in)	200 (7,87)
Weight	kg (lb)	14,7 (32,4)

Tightening torque

	Connection piston rod 2, piston 3	Connection cylinder, lid nuts 1
Thread	M 30x2	M 85x2
Torque Nm (lb ft)	270 (199)	370 (273)

Priority valve

By including the valve in the hydraulic loop, energy saving is achieved. The valve operates as a three-way relieve valve that rectifies oil stream to the tank without any loss, when both steering wheels are idle. It operates independently of pressure in steering.

The loop includes also a logic valve, which opens the hydraulic loop following a signal from power steering when activated by the wheel motion.

Power steering tank no-05-25-5

The tank is made of steel plate, and includes cleaning cartridges, lid, oil level indicator, and venting.

Technical data:

Tank volume	l (gal US)	3 (0,8)
Through-flow, input	$dm^3.min^{-1}$ (gal US/min)	25 (6,6)
Weight of empty tank	kg (lb)	5 (11)
Filtering capacity	m	10

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1.3. LUBRICANTS AND GLUES

Oil content

Only good quality hydraulic oils are used in the hydraulic loop to ISO 6743/4 HM or HV.

like

DIN 51 524 part 2 HLP or DIN 51 524 part 3 HLP

CETOP RP 91 H

Kinetic viscosity 46 $mm^2.s^{-1}$ at 40 C (104 F) - ISO VG 46

Manufacturer	Oil type		
Class	HM (HLP)		HV (HVLP)
Viscosity to ISO 6743/4, DIN 51519	VG 46	VG 68	VG 46
Viscosity to CETOP RP 91H	HM 46	HM 68	HV 46
AGIP	OSO 46	OSO 68	ARNICA 46
ARAL	VITAM GF46	VITAM GF 68	VITAM HF 46
AVIA	AVILUB RSL 46	AVILUB RSL 68	AVILUB HVI 46
BENZINA	OH-HM 46	OH- HM 68	OH- HV46
BP	ENERGOL HLP 46	ENERGOL HLP 68	BARTRAN HV 46
BULGARIA	MX- M/46	MX- M/ 68	MX- B/46
CASTROL	HYSPIN AWS 46	HYSPIN AWS 68	HYSPIN AWH 46
CHEVRON	EP HYDR.OIL 46	EP HYDR.OIL 68	EP HYDR.OIL 46 HV
DEA	ASTRON HLP 46	ASTRON HLP 68	–
ELF	ELFOLNA 46	ELFOLNA 68	HYDRELF 46
ESSO	NUTO H 46	NUTO H 68	UNIVIS N 46
FINA	HYDRAN 46	HYDRAN 68	HYDRAN HV 46
FUCHS	RENOLIN B 15	RENOLIN B 20	RENOLIN MR 46 HV
HUNGARY	HIDROKOMOL P 46	HIDROKOMOL P 68	HIDROKOMOL HV 46
MOBIL	MOBIL DTE 25	MOBIL DTE 26	MOBIL DTE 15
MV	HLP 46	HLP 68	HLP-M46
POLAND	HYDROL 30	HYDROL 40	BOXOL 26
ROMANIA	H 46 EP	H 68 EP	-
RUSSIA	IGP 30	IGP 38	-
SHELL	TELLUS OIL 46	TELLUS OIL 68	TELLUS OIL T 46
TEXACO	ALCOR OIL DD46	ALCOR OIL DD68	ALCOR OIL DD-Z 46
TOTAL	AZOLLA ZS 46	AZOLLA ZS 68	EQUIVIS ZS 46

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Grease

Synthetic grease with Lithium and of consistency to NLGI -2*, see table

BENZINA	MOBIL	ESSO	SHELL	CASTROL
P-ML-A2	Mobilgrease MP	Multi-Purpouse	Retinax A	Castrolease LM
	Mobilgrease Special	Grease H	Alvania	Spherol
	Mobilplex EP-1		Grease No.3	Grease RBB2

* - NLGI 2 - **N**ational **L**ubricating **G**rease **I**nstitute; part 2

2. POSSIBLE DEFECTS AND REMEDIES

Defect	Cause	Locating defect and remedy
Steering is non-functional, the wheel freezes up	Low oil (seepage, broken hose	Check hydraulic loop, repair, add oil
Steering doesn't function in difficult terrain	Low pressure-defective priority valve	Check pressure, should be 14 MPa (2030 PSI) with wheel in extreme position
	Low pressure, defective power steering	Replace or have it repaired
	Low pressure, defective pump (mechanical connection)	1. Check pressure at test point, 14 MPa (2030 PSI) with wheel in extreme position. 2. check mechanical connection of pump to CLARK1 gearbox
Power steering functions only to one side	Faulty reversible valve in valve block of power steering	Let specialists investigate

Test point of the system, see **Fig. G/1**.

Should steering be out of order, stop the engine. Steering pump could be damaged.

Fig. G/1



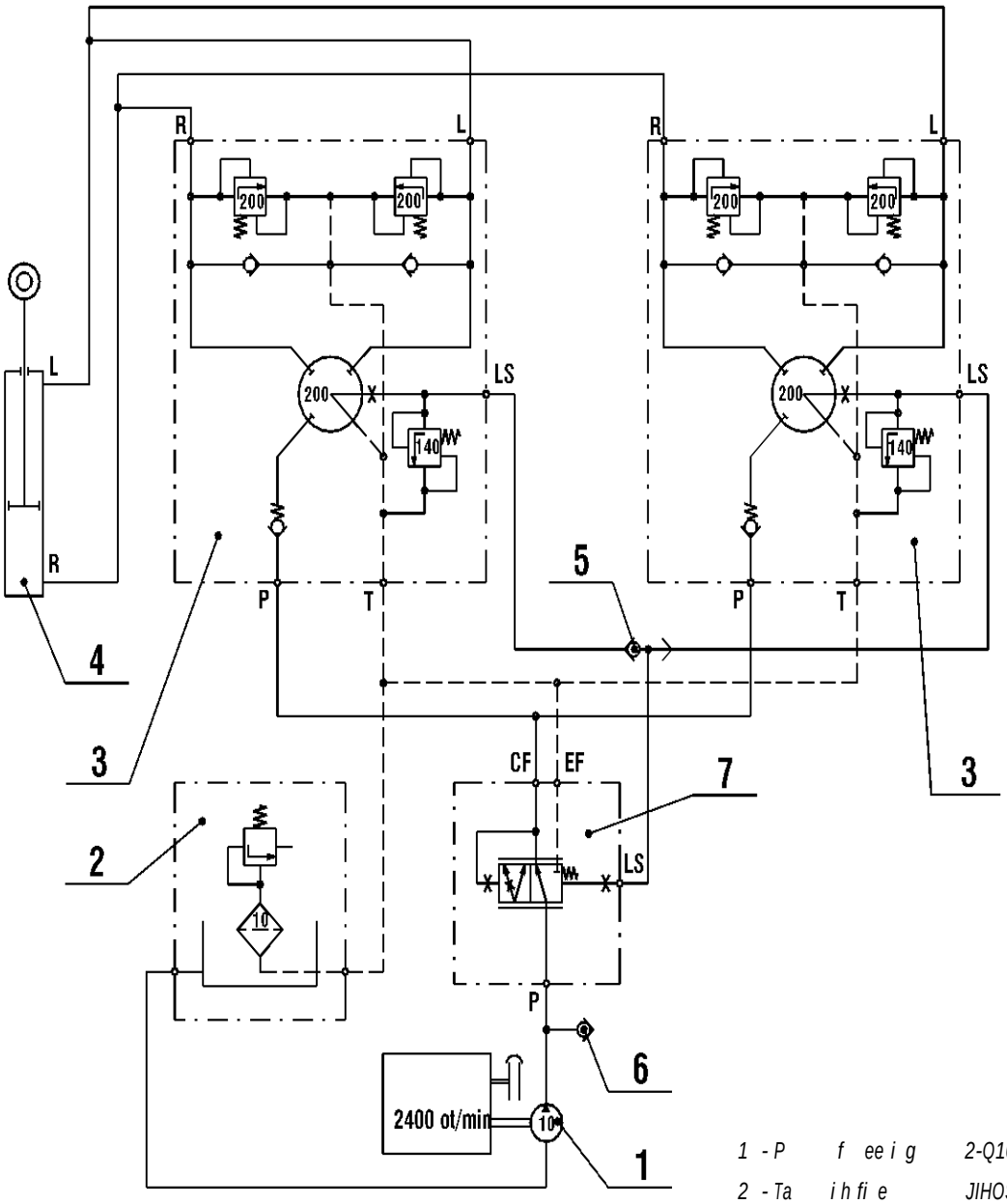
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3. DISASSEMBLY AND ASSEMBLY OF THE STEERING ASSEMBLY

3.1. PREPARATORY WORK

- Preparatory work and the assembly should be performed according to introductory chapter Safety Precautions and Instructions. Observe ecological and health regulations.
- Place the roller horizontally on a firm surface.
- Switch battery breaker off – the roller's brakes are automatically on.
- Place a notice on the steering wheel – "**THE ROLLER IS BEING REPAIRED**".

Fig. G/2



1 - P f ee i g	*2-Q10R JIHOSTROJ*
2 - Ta ih fi e	*JIHOSTROJ*
3 - Se ee i g	*LAGC 200LSD REXROTH*
4 - H d a ic c i de f ee i g	*HV80/40/200 SB INMART*
5 - Va e gica	*XWV8-PL PARKER*
6 - Mea i g ic c e	*SKK20-15L-PK STAUFF*
8 - P i i Va e	*REXROTH*

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- When working on the hydraulic system all hydraulic elements, like hoses, pipes, devices, and assemblies installed onto the cylinder must be kept absolutely clean,

  all open hoses, pipes, and connecting elements must be plugged,

  the installed and vented system must be tested and the filter cartridge in the hydraulic loop must be replaced,

  the entire system must be vented when any of the hydraulic elements has been replaced. Connect completed assembly to the oil tank with filter. Turn the engine over 3x for period of 8 sec. The assembly fills with oil automatically. Oil level in the tanks should be checked.

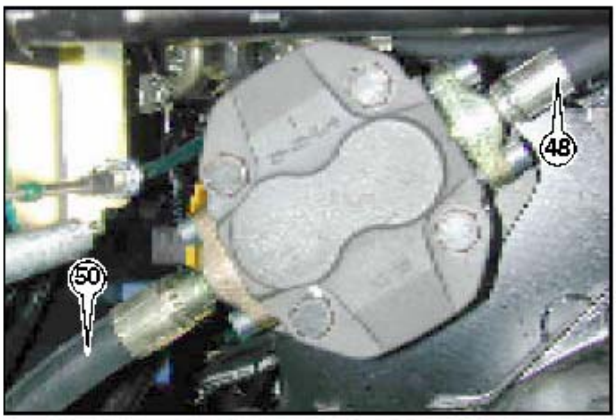
3.2. DISASSEMBLY OF STEERING HYDRAULIC GENERATOR U10

- Remove floor plates in the area of the cylinder.
- Disconnect high-pressure hose 48 to the priority valve, and the low-pressure hose 50 to the oil tank, **Fig. G**/4.
- Remove hydraulic generator together with the O-ring.

Assembly

- Assemble in reverse order. Replace and grease O-rings. Grease the grooved pump shaft before assembly, as in 1.3. Prevent hoses from rubbing each other, the frame, or any other part of the machine during assembly.

Fig. G/4



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3.3. DISASSEMBLY OF O ER STEERING

- Remove lid from the panel.
- Disconnect hoses from power steering, **Fig. G/5** before that, note the connection of hoses.
- Remove power steering from the steering column.
- Re-assemble in reverse order.

3.3.1. DISASSEMBLY OF STEERING COLUMN

- Remove cover in the center of the column.
- Remove nut 1 , insert fixture no.1 under the wheel, **Fig. G/6**, and with the spanner remove the wheel.
- Remove collar of travel control 1 , **Fig. G/7**.
- After screws were removed, separate power steering, and remove steering column from the bottom, **Fig. G/8**.
- Assemble in reverse order. Grease grooved shaft of the column, to 1.3.

Fig. G/5

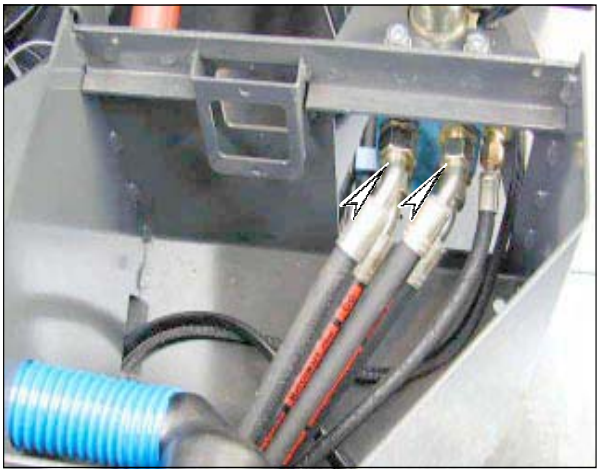


Fig. G/7



Fig. G/6

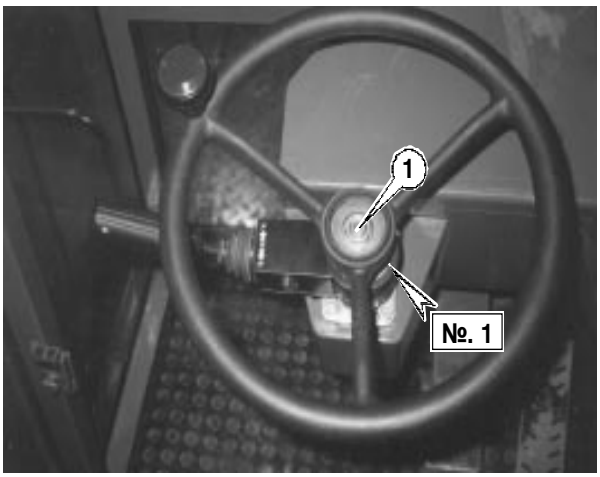
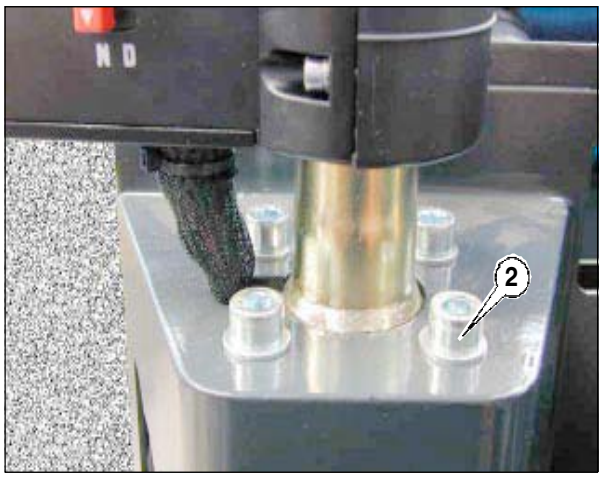


Fig. G/8



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3. . DISASSEMBLY OF LINEAR HYDRAULIC MOTOR

Removal from machine

- Place the roller on firm, flat surface, and a catch basin under the hydraulic cylinder.
- Remove high-pressure hoses, **Fig. G/9.**
- Remove safety rings 5 and nipples 0 on the pins. nock out pins, slide the hydraulic motor from the steering lever and bracket, **Fig. G/10, G/11**.

Removal of hydraulic motor – replacement of seals

Place catch basin under the hydraulic motor, plug openings. Drill out safety pin from the face of the front lid 1 , or bend out the lid holder 1 , as re uired by the type of motor. Remove lid 1 using fixture no , slide piston rod with piston 3 , loosen screw 5 , remove nut 4 , remove piston 3 , and lid 1 , see ig**. G/12**. Replace seals, see. **Fig. G/13** - dip in oil before assembly.

Fig. G/9



Fig. G/10

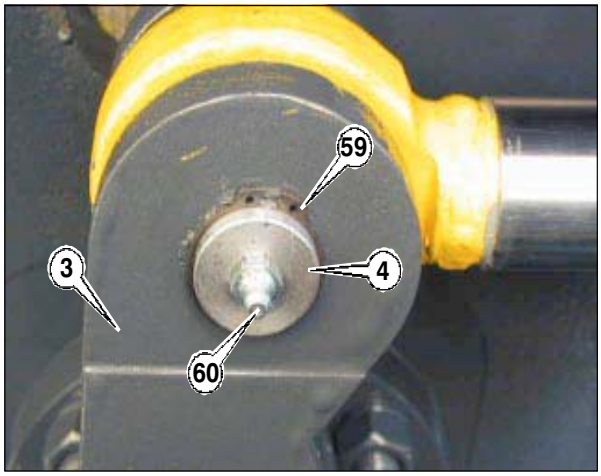


Fig. G/11

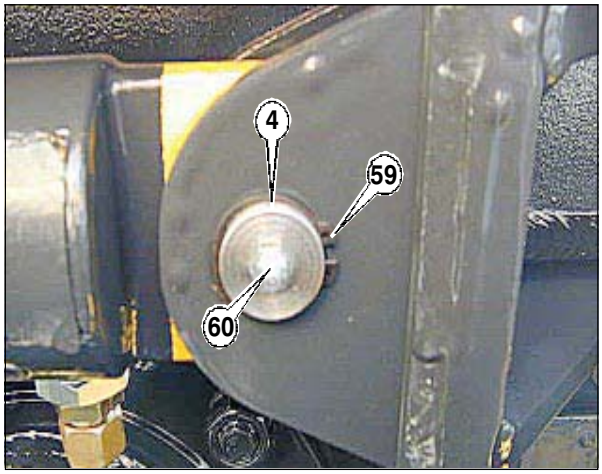


Fig. G/12

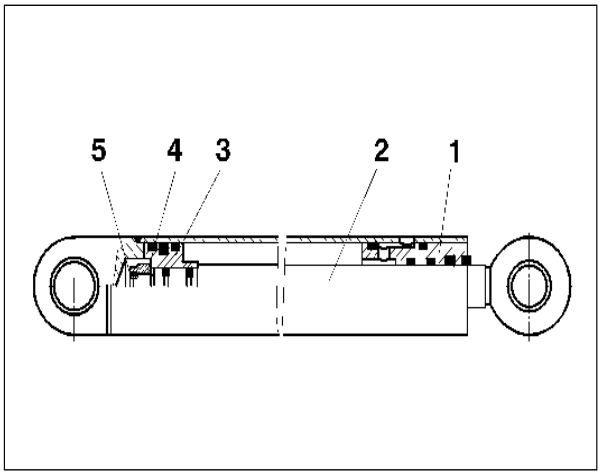
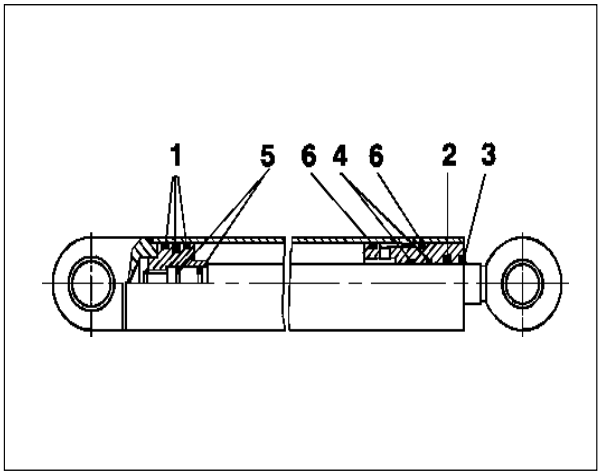


Fig. G/13



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Assembly of hydraulic motor

ubricate sliding faces, watch for damage of sliding faces. evel out seals and install new seals with parts. Wait at least 15 minutes before installing new seals in the hydraulic motor. se fixture no. for mounting the piston rod with the piston in the cylinder. Tighten bolts to tor ue of table.

Tightening torque values

Connection piston rod, piston, nuts		Connection cylinder, lid, nuts	
Thread	Tor ue m lb ft	Thread	Tor ue m lb ft
30x	0 00	85x	3 0 3

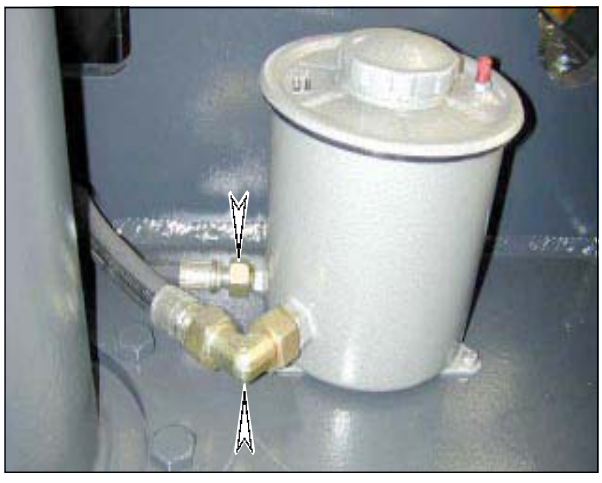
Reassemble in reverse order. ubricate pins with grease of table section 1.3.

3. . REMO AL OF 0 ER STEERING TAN

- Drain oil from steering loop on the leftt side of rear wheels, **Fig. G/3**.
- Drain balance of oil from tank.
- Remove front cover.
- Disconnect high- and low-pressure hoses, **Fig. G/14**.
- Remove fixing screw and the tank.

- Reassemble in reverse order.

Fig. G/14



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3. . REMO AL AND INSTALLATION OF THE LE ER ASSEMBLY

Removal

- Remove linear hydraulic motor, see section 3.5.
- Remove cotter pin , unscrew nuts 3 from ball oint 3 , and knock them out from yoke holes 1, **Fig G/15**.
- oosen and unscrew bolts 30, remove pad and ring 0. Remove from the pin the steering lever 4 together with pull rods, and the other ring 0, **Fig. G/16**.
- Remove nuts , screw 8 from holes on the circumference of pin 3. nock out pin 3 from frame, **Fig. G/17**.
- Press out bron e bushing **Fig. 18**.

Fig. G/15

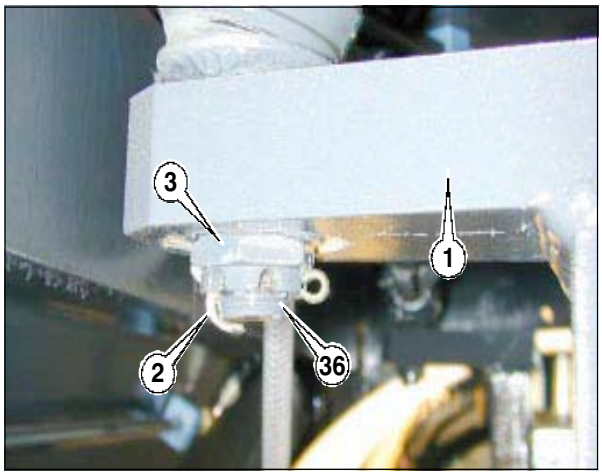


Fig. G/16

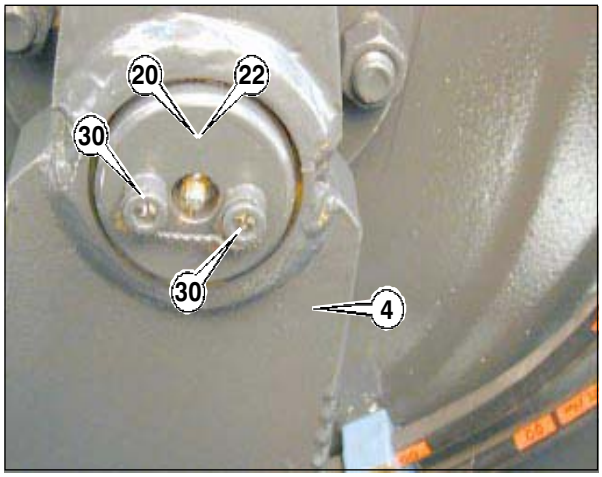
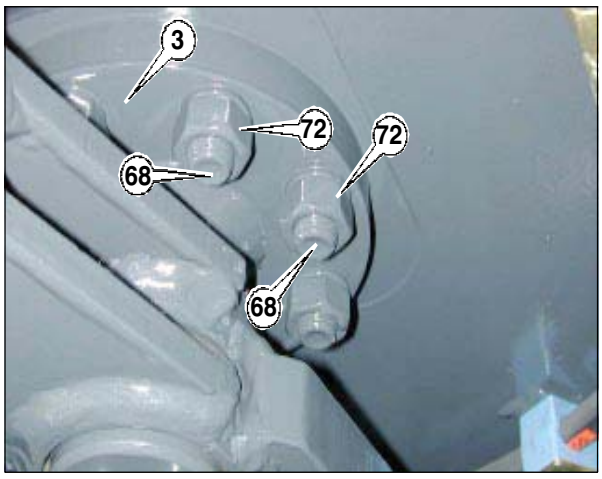


Fig. G/17



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Installation

- Press bushing into the steering lever, **Fig. G/18**.
- Press in and tighten ball oints of connecting rods 3 into the conical openings of the steering lever 4, **Fig. G/19**.
- Press pin 3 into frame, and screw pin 3 to the frame.
- Place ring 0 and steering lever 4 on pin 4, the other ring 0. nsert pad and tighten screws 30, secure screws with safety wire against turning.
- nsert the fixed eyelet of the linear hydraulic motor 54 in the holder on the frame, and two rings. Center out. Press pin 4 in the hole and secure with ring 5 . lide out piston rod and insert rings, center out, press in pin 8, and secure with ring 5 , **Figs. G/10, 11**.

. AD USTMENT OF TOE IN

Installation data

fork extension	mm in	115 4,5
piston rod extension	mm in	4 3,
steering lever swing	deg	3

Fig. G/18

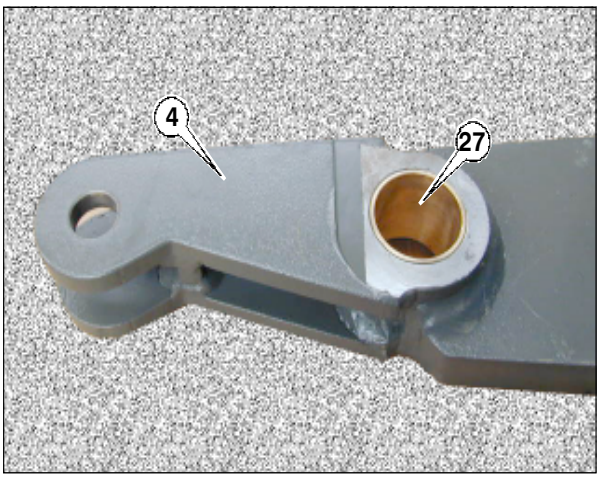
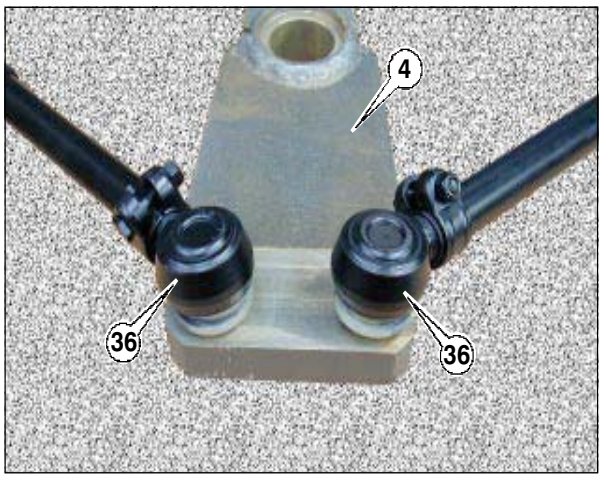


Fig. G/19



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- lide the fork of the front axle 1 out of guiding bushings to a distance of **Fig. G/20**.
- Place a ruler to the hubs of wheels 1, and line up both axles to the ruler, see **Fig. G/21**.
- xtend piston rod of the linear hydraulic motor to - 4 mm 3. from end position as in **Fig. G/22**.
- oosen clamping of ball oints on steering rods 3 , and by turning steering rods ad ust ball oints against conical holes in fork brackets 1, **Fig. G/23**.
- Press ball oints in the conical holes, and secure with a nut and a cotter pin.
- ix steering rods at both ends by tightening the clamp.
- Connect hoses to hydraulic motors. ubricate pins with grease to table in section 1.3.

Fig. G/21

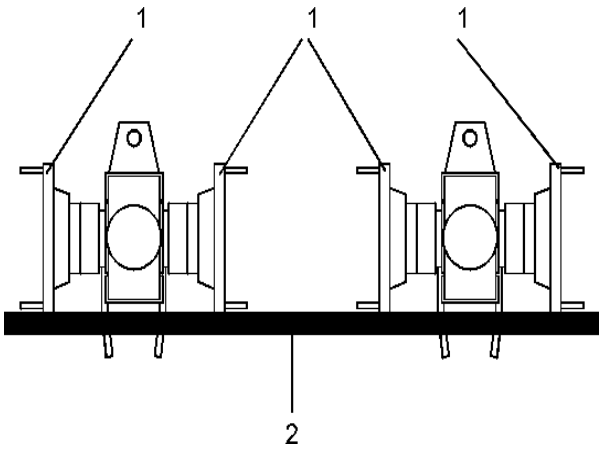


Fig. G/22

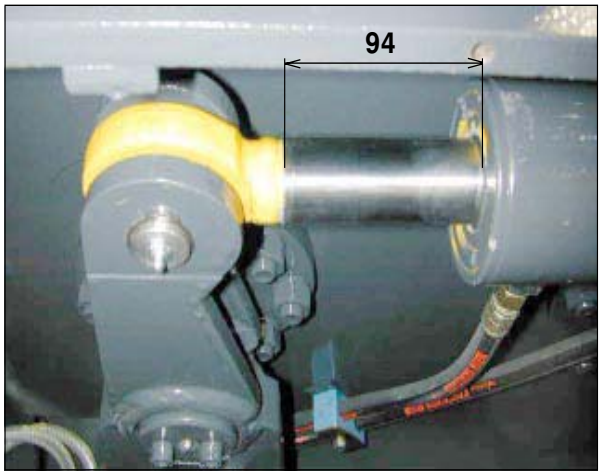


Fig. G/20

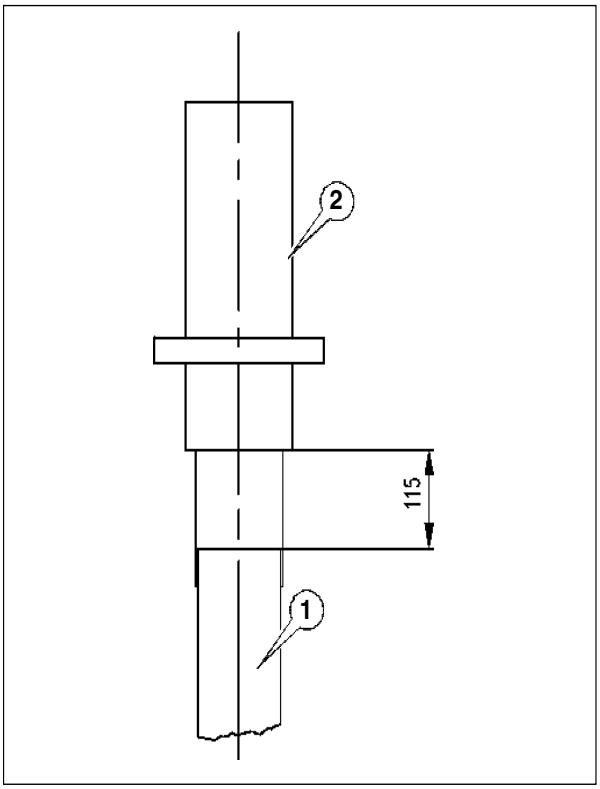
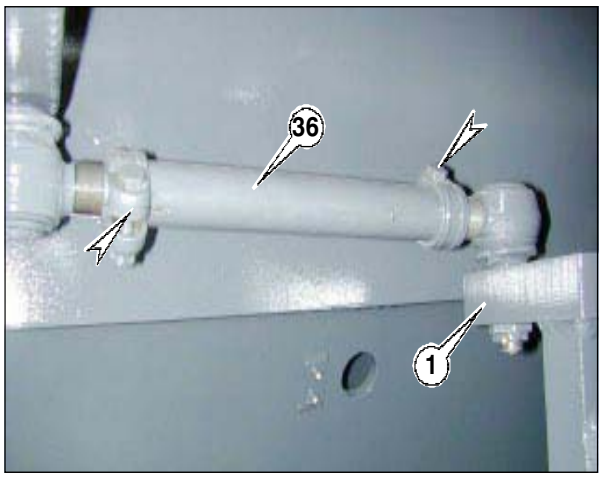


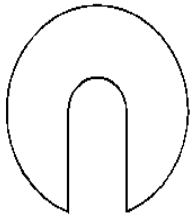
Fig. G/23



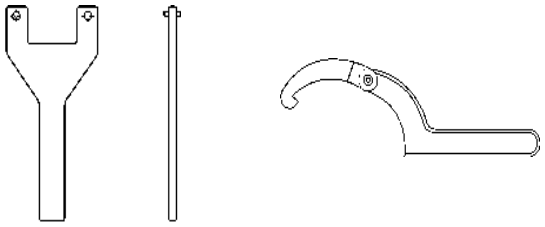
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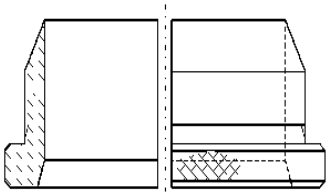
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no. 3 Guiding bushing - 44-031



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5.7 Service Brake

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H - SERVICE BRAKE

1. Specifications
   1.1. Description
   1.2. Specifications
   1.3. Brake fluid

2. Defects

3. Disassembly and assembly
   3.1. Preparatory work
   3.2. Disassembly of pedal brake
   3.3. Disassembly of booster
   3.4. Disassembly of brake system

4. Brake shoes adjustment

5. Service brake venting

6. Machining brake drums

1. SPECIFICATIONS

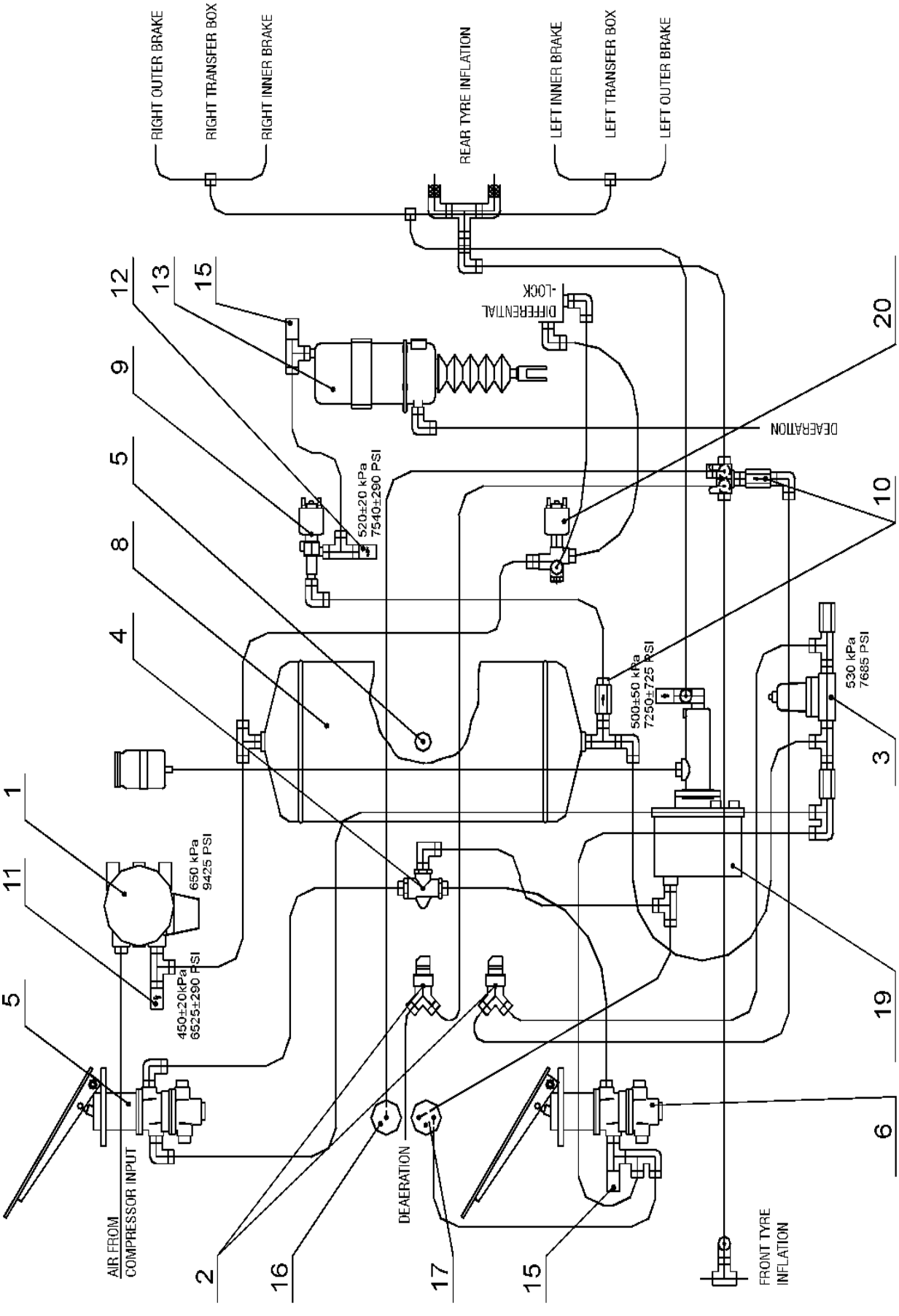
1.1. DESCRIPTION

Service brake is controlled by a pedal from the driver's position. It is a hydraulic-pneumatic loop with a built-in compressor, air dryer, brake pedal, hydraulic-pneumatic boosters, fluid tanks, pipes, and brake assemblies in rear wheels. Pressurized air in the tank has a pressure of 0,65 MPa (94.5 PSI), and is piped to two brake pedals. When one of the pedals is depressed, the air flows from the air-tank through pipes under 0.65 MPa to the two-way valve 4 and the boosters.

In the boosters, the air pressure is transformed to brake fluid pressure, which is then piped to brake cylinders that operate the brake shoes in rear wheels. When the brakes are released, the fluid travels back under pressure to the booster. Air escapes from the air-cylinder back to the brake assembly, and through the middle of the upper release in the open air.

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Fig. H/1



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Lege d:

1 - Ai D e	*WABCO*
2 - C Va e	*WABCO*
3 - Re ief Va e	*WABCO*
4 - D b e chec Va e	*WABCO*
5 - Wa e e a a	*KNORR AUTOBRZDY*
6 - Peda b a e a e	*KNORR AUTOBRZDY*
8 - Ai e e i	*35 GASTEC*
9 - Va e e ec ic	*EV68 AIR PRODUCTS*
10 - Va e - e	*KNORR AUTOBRZDY*
11 - S i ch e e	*APS*
12 - S i ch e e	*APS*
13 - B a e c i de i g	*KNORR AUTOBRZDY*
15 - Mea i g ic c e	*WABCO*
16 - Ma e e Ti e	*MOTOMETER*
17 - Ma e e B a e	*MOTOMETER*
*18 - Ai e e i **	*5 GASTEC*
19 - B e	
20 - Va e e ec ic	

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1.2. SPECIFICATIONS

BRAKE CIRCUIT

Brake cylinders	mm (in)	38 (1,5)
Air service pressure	MPa (PSI)	0,65 (94)
Diameter of brake drums	mm (in)	400 H11 (15,7)
Brake lining – gauge	mm (in)	8 (0,314)

Brake pedal

Funktion

By depressing the pedal, the force is transferred over a spring to the upper discharge that moves downwards until it rests on a cap in the pressure chamber of the centerpiece. The opening for the release of pressurized air from brake cylinders is closed. With further shifting, the cap is removed from the seat of the first loop, and air under pressure from the air-tank is released in the space under the upper discharge and the brake cylinders. The other loop is plugged.

Specifications

Nominal pressure	MPa (PSI)	0,6 (87)
Maximal force on the pedal	N (lb)	250 (55)
Total play of the pedal	(deg)	28
Free travel	(deg)	8
Smooth braking	(deg)	14
Emergency braking	(deg)	6
Service pressure	MPa (PSI)	0,8 (116)
Weight	kg (lb)	3,5 (7,7)

AIR-FLUID BOOSTER

Description

The booster consists of its air section and the hydraulic main brake cylinder. The boosting air section is controlled by the main brake of the air loop. When the brake pedal is depressed, air under pressure enters the space of the air cylinder, and pushes the piston that exercises pressure on the main brake cylinder.

Specifications

Main cylinder	mm (in)	∅ 39 (1,53)
Air cylinder	mm (in)	∅ 170 (6,69)
Force of air cylinder	N (lb)	12250 (2754)
with pressure	kp/cm²(lb/sq.in)	6 (85,3)
Maxim.lift of main cylinder	mm (in)	45 (1,77)
Maximum delivered volume	cm³ (cu.in)	51 (3,11)
service air pressure	kp/cm²(lb/sq.in)	6 (85,3)
Residual pressure in main cylinder within	kp/cm² (lb/sq.in)	0,8-1,3 (11,38-18,48)

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COMPRESSOR

is the source of compressed air for the loop of brakes. The input is connected to the engine intake manifold.

Use only metal (copper) connectors.

When during manual venting of the air tank oil appears mixed with water, check

- oil consumption in the compressor
- regeneration to an excessive contra-pressure
- whether switching off pressure has been reached, and thus, the time for the compressor to switch on.

Check oil consumption

With the engine warmed up to service temperature

- disconnect input and output hoses from compressor
- let the engine run for about 2 minutes at half RPM of full range (cleaning mode)
- Place a white piece of paper on a firm pad in the air stream for about 5 minutes at about 1500 RPM.

At low oil consumption of less than 1,5 g/hod.(low wear), the compressor will leave an oily fog on the paper.

At high consumption – high wear – a black field will appear on the paper.

With insufficient compressor output, check

- narrowing of pressure piping (carbon deposits)
- tightness of the assembly
- If no defects found, remove cylinder head and recheck intake and pressure blade, and seals,
- With high deposits of carbon, check temperature and oil consumption of the compressor.

When replacing the compressor, check output piping for possible carbon deposits. If necessary, replace it, as well as the pressure regulator and air dryer.

AIR DRYER

Function

Cleans and dries air to the compressor. Prevents corrosion and break up of lubrication films.

Drying is based on the absorption in the molecular sieve (drying, high porosity, granulated desiccant) through which pressurized air flows into the compressor. Air humidity is absorbed by the desiccant. To regenerate the desiccant, part of the dried air is released at atmospheric pressure and blown in the opposite direction through the desiccant. The drop in pressure causes the vapor pressure drop in the regenerated air (= extremely dry air). This way, the regenerated air is capable of absorbing moisture in the desiccant.

Specifications

Service pressure max.	bar (PSI)	13 (188,5)
Air flow max.	l.min^{-1}(gal US.min^{-1})	1000 (264)
Operation at temperature	C (F)	–40 +80 (–40 +176)
Exhaust noise level	dB (A)	78
Switching off pressure	bar (PSI)	6,5 (94)

BRAKE SWITCH

Switches on brake lights with the increased pressure of brake fluid.

Specifications

Nominal voltage	V	6, 12, 24
Max. power	W	60
Max. service temperature	C (F)	85 (185)
Pressure for switching on	kPa (PSI)	300-600 (43,5-87)
Max. service pressure	kPa (PSI)	35000 (5075)

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1.3. BRAKE FLUID

Fluid is according to International standards ISO 4925, SAE J 1703 f, DOT 3, and is not suitable for arctic conditions. It may be mixed with fluids of same standards The fluid may be used in systems working at –50 C (–58 F) to 60 C (140 F), and service temperatures from –50 C (–58 F) to 205 C (400 F). Also a fluid to DOT 4 (Syntol HD 260) standard may be used. The fluid should be changed within 2 years or after 2000 service hours, whichever occurs first.

2. DEFECTS

Loop defect	Cause	Determination (remedy) of defect
Low efficiency of braking	Low pressure in air system	Adjust regulator to 0.65 Mpa (94 PSI)
	Defective booster	Test pressure in hydraulic section- 1.2 Mpa
	Air locks	Vent per par. 3.5.
	Lining wear	Check, replace shoes, per 3.4.
	Soiled lining (grease)	Check per 3.4.

Brake assembly defect	Cause	Remedy
With depressed pedal, pressure is escaping through venting holes	Faulty seal of the cap and the upper release	Defect remedy is not urgent. First depress pedal several times fast. The deposits will blow off. Should this not help, disassemble, clean contact areas and inspect seats and seal, and/or apply emery paper to cap evenly, or replace.
With released pedal, pressure escapes through venting holes out.	Faulty contact of caps with seats in the body	Correct defect in the same manner as above
With released pedal, pressure escape from piping and cylinders is too slow	Plugged filter cartridge or stiff guides of releases (dried out grease, dirt, ground in)	Disassemble, wash filter cartridge, clean release, and/or clean with fine emery and apply a light film of anti-freezing grease.

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Test point of brake system air loop

Brake assembly - pressure 0÷ 0,65 MPa (0 ÷ 94 PSI) according to pressure on brake, **Fig. H/2**.

Spring-loaded cylinder - pressure 0,53 ÷ 0,65 MPa (77 ÷ 94 PSI), **Fig. H/3**.

Fig. H/2

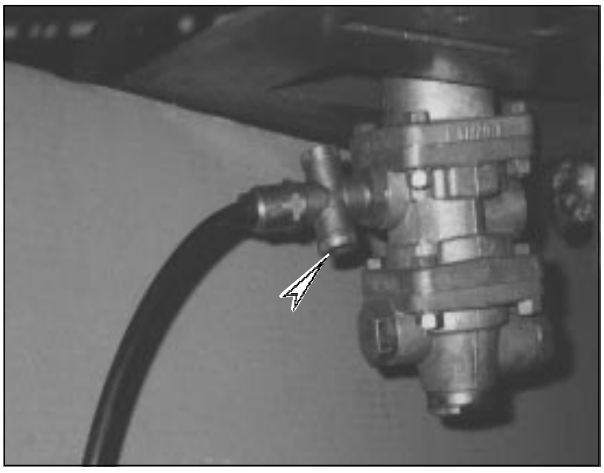
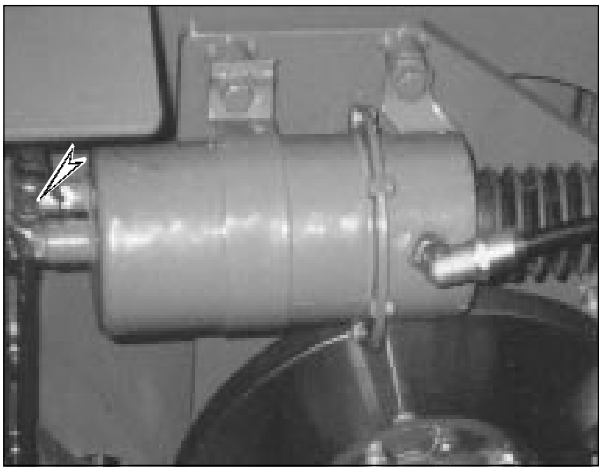


Fig. H/3



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3. DISASSEMBLY AND INSTALLATION

Perform preparations, disassembly and assembly according to the introductory chapter "Safety precautions and instructions", keep ecological and health precautions.

3.1. PREPARATIONS

- Place the machine horizontally on a firm surface.
- Secure front wheels on both sides with wooden blocks.
- Switch off batteries – the machine is automatically locked.
- Place notice "**MACHINE OUT OF ORDER**" on the steering wheel.

3.2. DISASSEMBLY OF PEDAL BRAKE

- Release pressurized air from the air loop by pulling on the chain of the venting valve on the air tank.
- Remove floor cover plates at the service place.
- Unscrew fillers on both sides of the brake outlets, **Fig. H/4**.
- Remove 4 screws and remove the brake, **Fig. H/5**.

Installation

in reverse order.

Fig. H/4

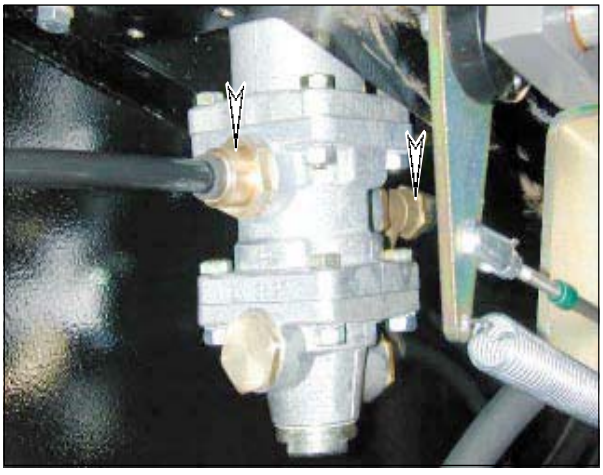
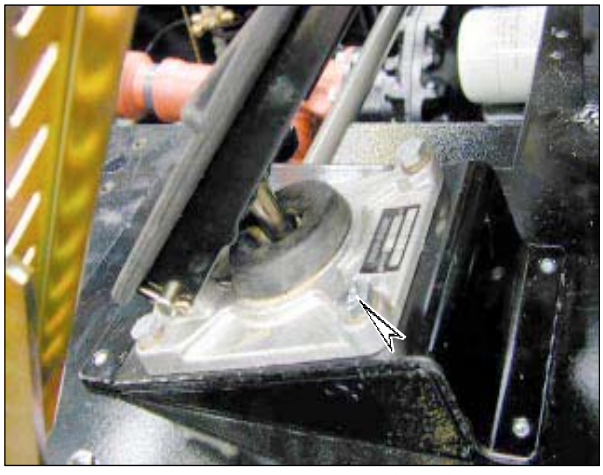


Fig. H/5



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3.3. DISASSEMBLY OF BOOSTER

- Remove floor cover plates at the service place.
- Drain brake fluid into a ready basin by unscrewing plug 8 at the output of the booster and by stepping on the pedal several times.
- Remove hose 11 of the brake fluid input from the tank to the brake cylinder, disconnect wiring from switch 22.
- Remove bolts of input 58 from the brake to the booster, **Fig. H/6**.
- Remove booster from the frame.
- Remove brake fluid splitter 25 and reduction 5, **Fig. H/7**.

Installation of booster

- Install splitter and reduction on the booster.
- Screw booster on brackets on the frame.
- Screw fitting of air intake between the booster and the brake.
- Attach input hose of brake fluid.
- Pour brake fluid in the container, and vent the entire system, see 3.3.

Fig. H/6

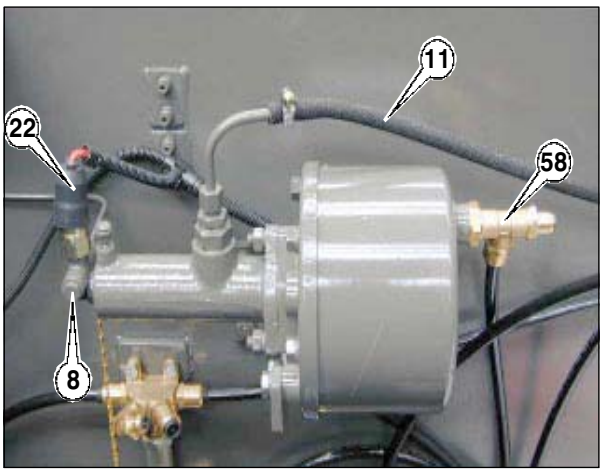
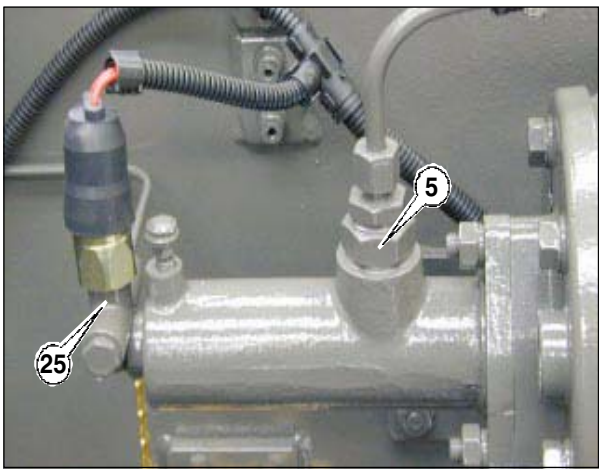


Fig. H/7



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3.4. DISASSEMBLY OF BRAKE SYSTEM

Disassembly of shoes

- If the thickness of lining is less than 2 mm (0,08 in),or if the lining is considerably soiled by grease, replace the lining.
- Remove wheel (see Chapter. D).
- Remove pipes to brake cylinders in the wheels. Catch escaping fluid in a ready basin.
- Remove brake drum off flanges, use forcing-off screws in the holes of the drum, **Fig. H/8**.
- Remove springs and shoes, **Fig. H/9**.

Disassembly of brake cylinders in wheels

- The wheel and brake drum should be off.
- Remove leaking brake cylinders.
- Clean the surface of the brake cylinders and pistons.
- Remove seal collars.
- Inspect carefully inside surfaces of cylinders.
- Replace complete wheel cylinder, if damage to the active face discovered (grooves, corrosion, etc.).
- For cleaning the wheel brake cylinder (the main brake cylinder) use wood alcohol - **never clean with cleaners containing mineral oils!**

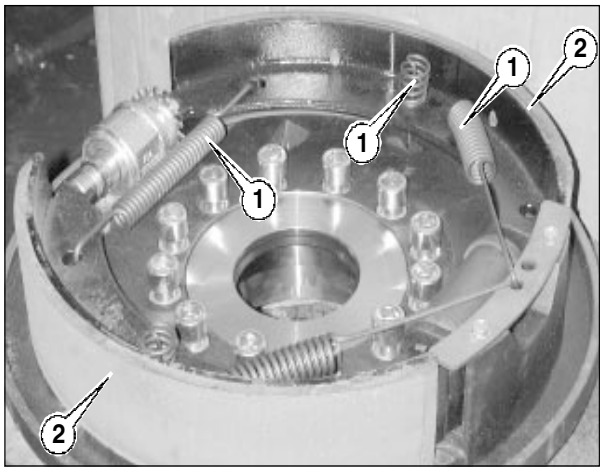
Installation of brake system

- Install in reverse order.
- Keep sliding faces clean and degreased. Brake components may not be exposed to oily matters.
- Following the reconnection of pipes to the brake cylinder, fill loop with brake fluid, and vent. Adjust brakes thereafter, and replace wheel.

Fig. H/8



Fig. H/9



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4. BRAKE SHOES ADJUSTMENT

- This hydraulic power brake is self-adjustable in both brake shoes by means of a float (1). The adjustment free play between the shoe and the drum is done by the adjusting ratchet (2), **Fig. H/10**.
- With the wheel removed, see Chapter “D”, and installed brake drums.
- With low pressure in the brake loop, release mechanical brake cylinder of the disk brake (park brake) by turning the release screw (1), following the removal of plug (2) and the application of fixture (1) in the spring loaded cylinder (3), **Fig. H/11**.
- Turn the drum through the adjustment opening downwards to the adjustment ratchet (2), **Fig. H/12**.
- Turn ratchet wheel (2), **Fig. H/10** until the shoe rests on the drum, and the drum cannot be turned.
- Return the ratchet wheel until the drums are released. The drum can be turned freely without any audible friction of the drum against the shoes.
- Replace the wheels.

Adjust only when the brakes are cold.

For equal braking effect replace all shoes together.

Always replace damaged adjustment assembly.

Let only professionals glue lining on shoes.

As replacement, use original shoes with KNOTT lining only!

Warranty lapses, if other than original spare parts were used.

Fig. H/11

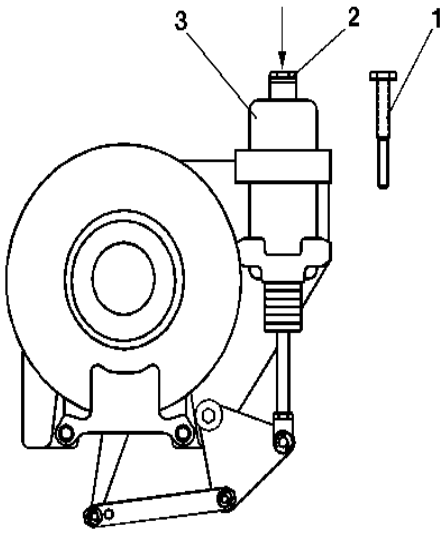


Fig. H/10

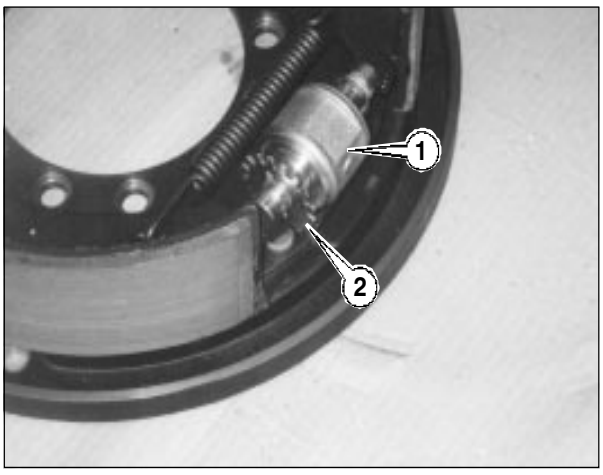
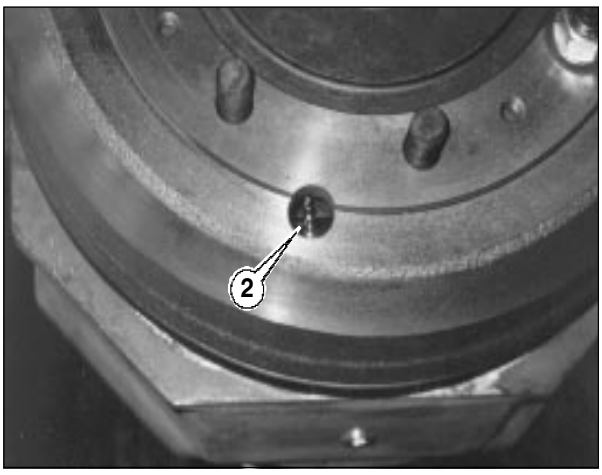


Fig. H/12



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5. SERVICE BRAKE VENTING

- Pour specified brake fluid in the equalizing container of the brake loop, and maintain level above "MIN" during venting.
- Loosen venting screw on the booster by two turns, **Fig. H/13**.
- When the booster is full, tighten the vent screw.
- Loosen venting screw on the brake cylinder and attach a hose to its head. Insert the other end in a glass containing fluid (the end must be submerged).
- Start the engine and pressurize the brake system to maximum value of 0,65 MPa (6,5 bar) (94 PSI), then switch the engine off.
- Fill the loop completely by repeated stepping on the pedal and simultaneous addition of fluid in the equalizing container.
- When bubbles stop coming out of the submerged hose, tighten the venting screw and remove the hose.
- Venting can be done on all drums simultaneously, **Fig. H/14**.
- Add fluid in the equalizing container to specified level.
- **Before the engine is started, the travel control must be in position "N", and the roller must have park brakes on.**

Fig. H/13



6. MACHINING BRAKE DRUMS

- Brake drums may be machined only if worn out or if damaged by deep grooves on the friction surface.
- Install brake systems on drums machined to identical diameters. It is not allowed to install brake drums of different diameters on the individual pairs of the brake system.
- The diameter of machined brake drum may not exceed the maximum allowed diameter.

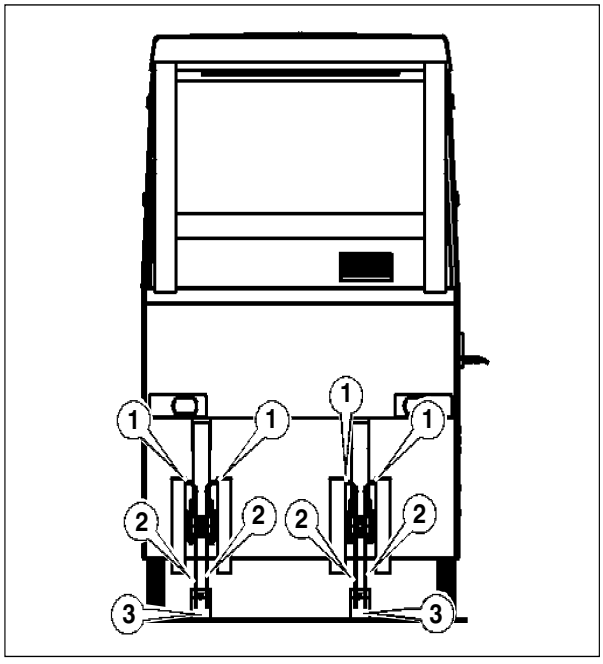
Original diameter mm (in)	Maximum diameter after machining mm (in)
400 H11 (15,7)	402,5 (15,8)

The friction faces are coaxial to the drum axis to ± 0,10 mm.

All drums must be machined to the same diameter.

In machined drums, brake shoes of thicker lining must be used – contact the manufacturer of the cylinder or the brakes.

Fig. H/14



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5.8 Parking brake

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I - PARKING BRAKE

1. Specifications - description
   1.1. Description
   1.2. Specifications

2. Maintenance
   2.1. Disassembly and installation of the disk brake
   2.2. Removal and installation of the spring-loaded cylinder

1. SPECIFICATIONS - DESCRIPTION

1.1. DESCRIPTION

The brake is used as parking or emergency brake.

When the roller stops and the engine is switched off the brake is applied automatically. The brake is released when the engine is started and the air in the loop is compressed to 0,53 MPa (5,3 bar; 77 PSI). It is signaled by the indicator going off.

Braking of the roller is accomplished by depressing the button on the dashboard. This causes the solenoid to open, air escapes from the spring-loaded cylinder and the pressure on the spring drops. The spring returns to its original position. The lever mechanism contracts the jaws on the disk of the brake, and the roller is stopped.

The roller can be stopped in case of emergency by the service brake when the push-button is depressed on the dashboard. The roller and the engine stop.

1.2. SPECIFICATIONS

Nominal pressure	MPa (PSI)	0,8 (116)
Lift	mm (in)	70 (2,76)
Pressure with piston rod extended (brake off)	kN	3,8
Pressure with piston rod retracted (brake on)	kN	2,5
Weight	kg (lb)	5,75 (12,7)

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2. MAINTENANCE

After 1000 hours of service, the collars should be inspected and the sliding parts greased. Inspect the piston rod lift. It is not recommended to use more than 2/3 of the full lift of the rod.

Attention! When disassembling the base of the chamber with the spring, be careful not to get hurt, since the spring is installed in the depressed state and loaded by about 4000 N.

2.1. DISASSEMBLY AND INSTALLATION OF THE DISK BRAKE

- Position the roller on a firm, flat surface, the front and rear wheels wedged on both sides.
- Remove the center floor cover.
- Unload the lever by screw (1) (accessory) into the cylinder (2) **Fig. I/1**.
- Remove the flange of the crankshaft (146) from the side of the brake disk (6), slide in and fold to side, **Fig. I/2**.
- Loosen and remove nut (1), **Fig. I/3**.
- Remove nuts (24) on yoke (20), pull-rod (7) from brake yoke (20), **Fig. I/4**.
- Slide disk (6) with the yoke (28) off the groove off the differential pinion.
- Assemble in reverse order. The safety nut may be reused, but it must be knocked into the other differential pinion groove.

Fig. I/1

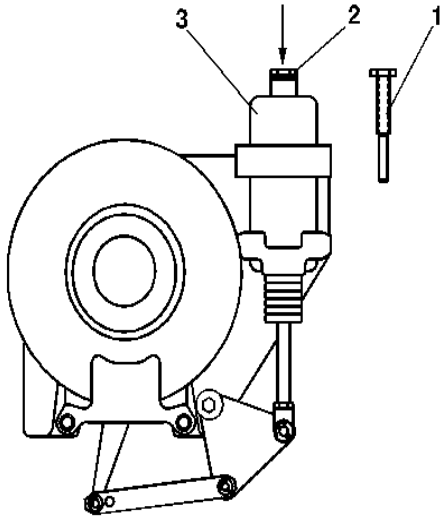


Fig. I/2

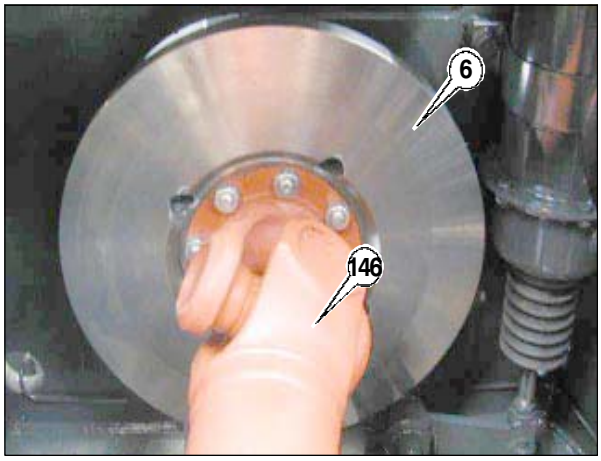
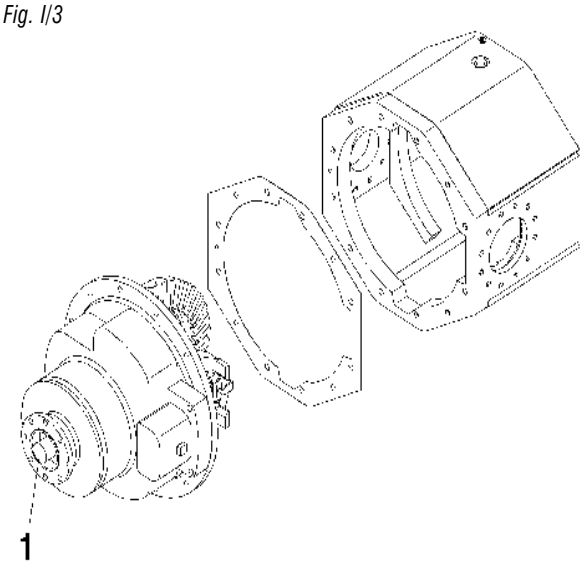


Fig. I/3

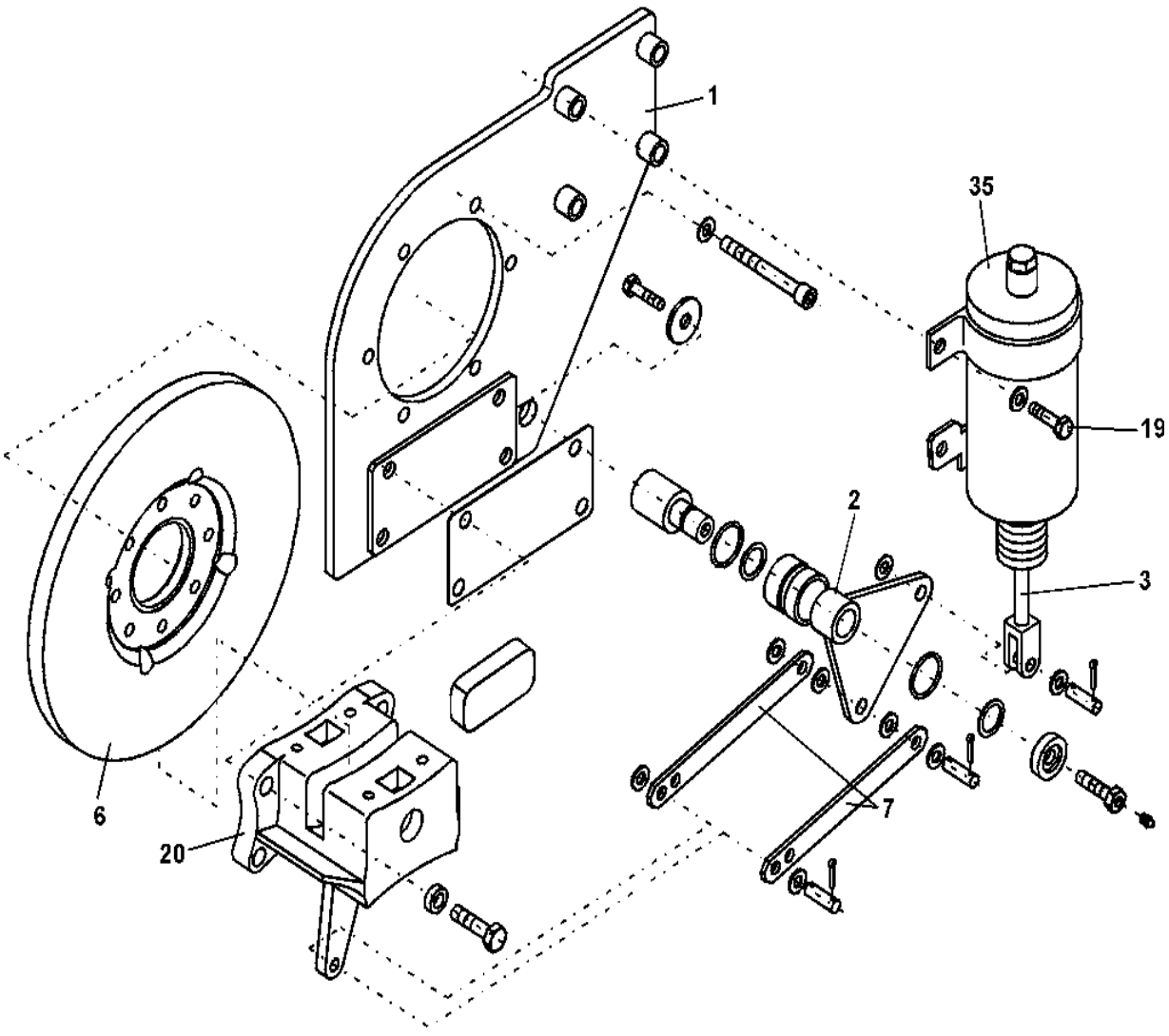


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2.2. REMOVAL AND INSTALLATION OF THE SPRING-LOADED CYLINDER

- Unload the lever by the screw (accessory) in the cylinder, **Fig. I/1**.
- Disconnect the yoke (3) of the cylinder (35) from the lever (2), **Fig. I/4.**
- Disconnect air hose.
- Install in reverse order.

Fig. I/4



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5.9 Wheels

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J - INFLATING THE TIRES

1. Specifications
   1.1. Description
   1.2. Specifications

2. Removal and installation
   2.1. Control valve
   2.2. Rotor

1. SPECIFICATIONS

1.1. DESCRIPTION

Compressed air is led through plastic tubes from the air tank over a by-pass valve to a return valve to the distributor, where it is distributed to the rear and front axles, and then over rotors to individual wheels. Each wheel has a safety valve adjusted so that other tires remain inflated to 0,18 MPa when one of them is punctured. The other control valve connected to the loop through the distributor is used to deflate the tires. The pressure in the loop is read on the manometer on the dashboard. The assembly makes it possible to change pressure in the tires en-route.

1.2. SPECIFICATIONS

Air pressure in the loop	max. 0,6 MPa
Adjustment of the safety valve	0,18 MPa

Observe safety during work with the engine off. Keep individual parts and hoses clean, screws tight. Adjust and test the air loop so that air escapes less than 0,1 atm in12 hours.

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2. REMOVAL AND INSTALLATION

2.1. CONTROL VALVE

Release pressurized air from the inflating loop by opening the release valve before starting dissembling.

2.2. ROTOR

Removal

- The rotor attaches the firm part to the rotary part of the of the conduits, and is located in the fixed center of the wheels.
- Remove hose (2) and rotor (1), **Fig. J/1** - 4x back, 2x in front.
- Remove screw (7), lid (3), safety rings (8, 9), **Fig. J/2**.
- Press out the shaft (1).
- Press out bearings (6), lid (4).

Installation

- Place the lid (4) on the shaft (1), and press in bearings (6) - secure with 2 safety rings (9).
- Insert collar (5) in the collar (3) body, screw into bearings (2) and secure with screw (7).
- Fill bearing (2) with grease.
- Insert shaft (1) with bearings into body (2) and secure with safety ring (8).

Fig. J/1

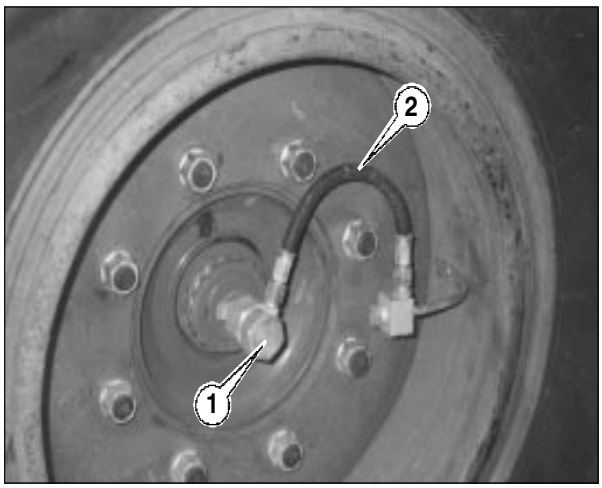
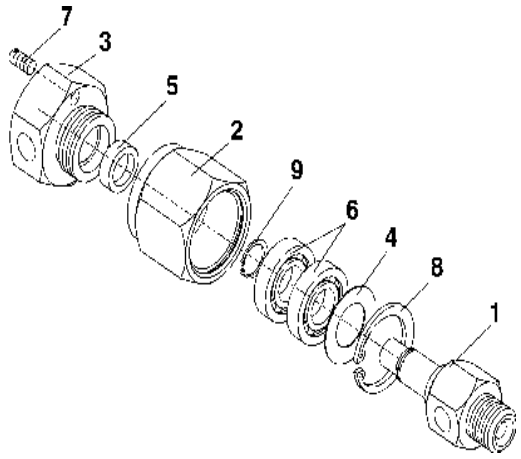


Fig. J/2



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K - WHEELS

1. Specifications
   1.1. Description
   1.2. Specifications

2. Wheel removal
   2.1. Preparation
   2.2. Front axle wheels
   2.3. Rear axle wheels

3. Removal and installation of tires

4. Installation of wheels

5. Adjustment of safety valve

1. SPECIFICATIONS

1.1. DESCRIPTION

All versions of roller VP 2400 have as standard 4 wheels on the front and rear axles. The tires are inflated from the air loop of the machine, centrally. Should any tire be punctured, the other tires maintain air pressure of (0,18 MPa) secured by the safety valve on the tire.

1.2. SPECIFICATIONS

Disk wheel	8,0 - 20 HD
Tire	Compactor without any design 11.00x20" PR16
Tube	11.00x20"
Protective inlay	11.00x20"
Tightening torque of wheel nuts	440 Nm
Tire inflation - see Service Manual VP 2400	

2. REMOVAL OF WHEELS

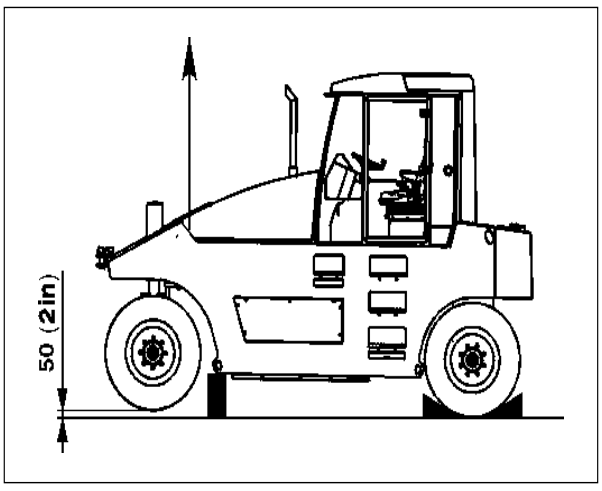
2.1. PREPARATION FOR WORK

- In preparation for work and handling of wheels, follow the introductory chapter on Safety. Observe ecology and health regulations.
- The valve for inflating tires must be closed.
- Place the roller horizontally on a firm surface.
- Switch the battery breaker off – the brakes of the roller are automatically on.
- Place a sign on the steering wheel saying "**ROLLER OUT OF SERVICE**".
- Wedge front wheels on both sides when removing rear wheels.

2.2. FRONT AXLE WHEELS

- Lift the front of the machine by suitable means, **Fig. K/1**.
- Unscrew the rotor from the axle.
- Unscrew hose (2) from the safety valve (3), thereafter also the valve from the tire.
- Remove wheel nuts (4) and take off the wheel, **Fig. K/2**.

Fig. K/1



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2.3. REAR AXLE WHEELS

outside wheels

- Wedge front wheels on both sides.
- Lift the rear end of the machine by suitable means, **Fig. K/3**, and support them on a pad above ground.
- Unscrew hose (2) from the axle shaft.
- Unscrew this hose also from the safety valve (4), thereafter also the valve from the tire.
- Remove wheel nuts and take off the wheel.

inside wheels

- Unscrew hoses (2) and (3) from rotor (1).
- Remove rotor (1) from the center shaft of the axle.
- Remove wheel nuts and take off the wheel.
- Unscrew hose (3) from the safety valve (4), thereafter also the valve from the tire **Fig. K/4**.

Fig. K/2

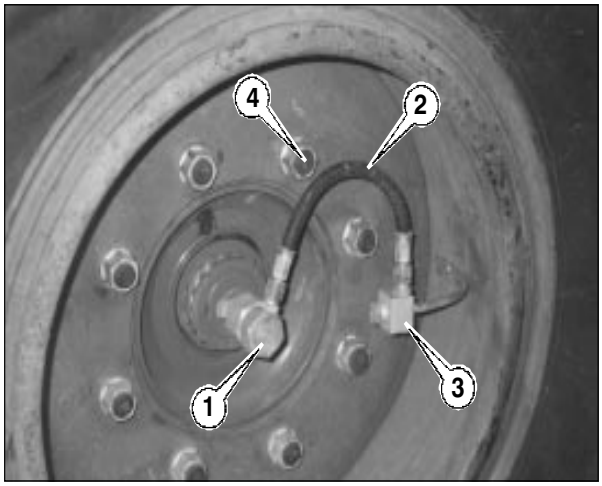


Fig. K/3

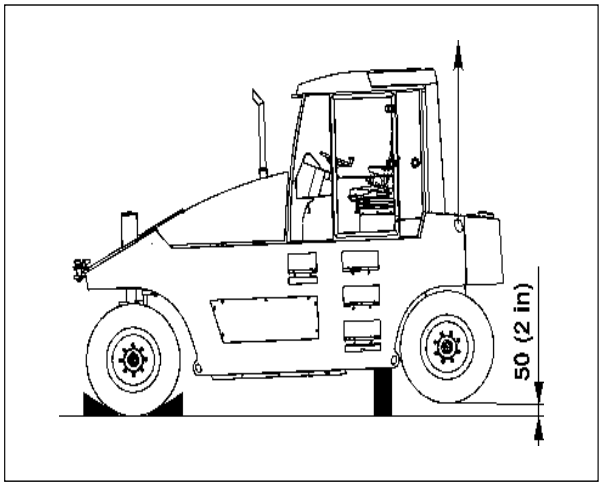
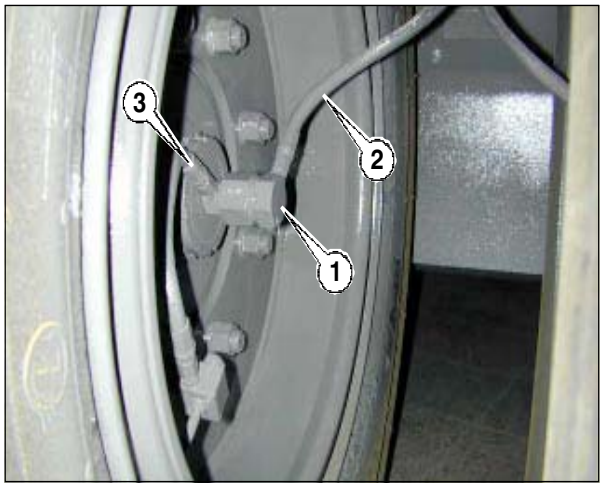


Fig. K/4



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3. REMOVAL AND INSTALLATION OF TIRES

We recommend doing this on special machines in service shops, wheel balancing as well.

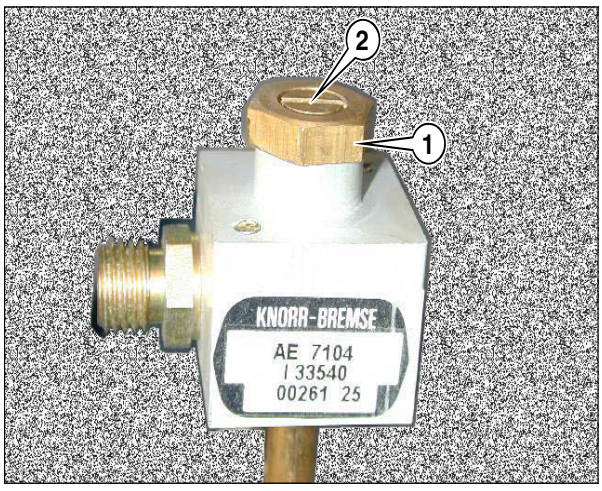
4. INSTALLATION OF WHEEL TO THE MACHINE

- Follow reverse order.
- Place wheel disk on wheel nuts.
- Insert and screw wheel nuts in criss-cross pattern, tighten with torque of 330 ÷ 350 Nm (245 ÷ 260 ft lb).
- In connecting tire inflation assembly, follow reverse order. Tighten all joints well.
- When replacing tubes, check that the original filling valve has been removed before installing a new valve in a tire with a new outlet.

5. SAFETY VALVE ADJUSTMENT

Loosen safety valve nut (1) and adjust the setscrew (2) so that its face is in line with the face of the nut, **Fig. K/5**.

Fig. K/5



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6 Suppliers documentation

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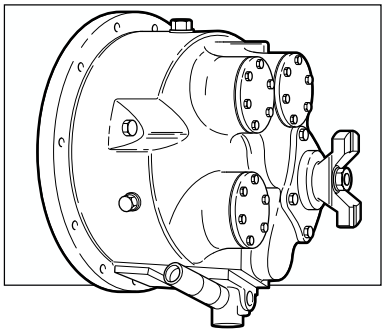
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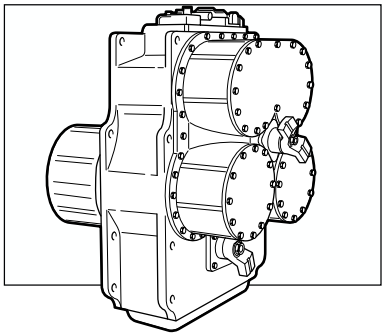
6.1 Powershift transmission

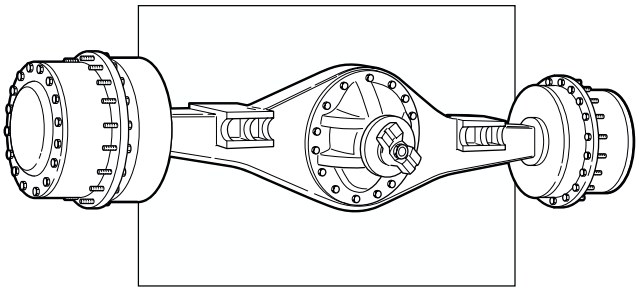
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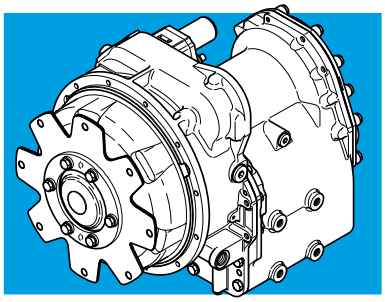
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Maintenance and Service Manual









T20000 Powershift Transmission

2 & 3 SPEED INLINE

SPICER® OFF HIGHWAY-PRODUCTS™

People Finding A Better Way®

814995

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TOWING OR PUSHING

Before towing the vehicle, be sure to lift the rear wheels off the ground or disconnect the driveline to avoid damage to the transmission during towing.

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FOREWORD

This manual has been prepared to provide the customer and the maintenance personnel with information and instructions on the maintenance and repair of the ***SPICER OFF-HIGHWAY PRODUCTS*** product.

Extreme care has been exercised in the design, selection of materials, and manufacturing of these units. The slight outlay in personal attention and cost required to provide regular and proper lubrication, inspection at stated intervals, and such adjustments as may be indicated will be reimbursed many times in low cost operation and trouble free service.

In order to become familiar with the various parts of the product, its principle of operation, troubleshooting and adjustments, it is urged that the mechanic studies the instructions in this manual carefully and uses it as a reference when performing maintenance and repair operations.

Whenever repair or replacement of component parts is required, only ***SPICER OFF-HIGHWAY PRODUCTS*** approved parts as listed in the applicable parts manual should be used. Use of “will-fit” or non-approved parts may endanger proper operation and performance of the equipment. ***SPICER OFF-HIGHWAY PRODUCTS*** does not warrant repair or replacement parts, nor failures resulting from the use of parts which are not supplied by or approved by ***SPICER OFF-HIGHWAY PRODUCTS*** .

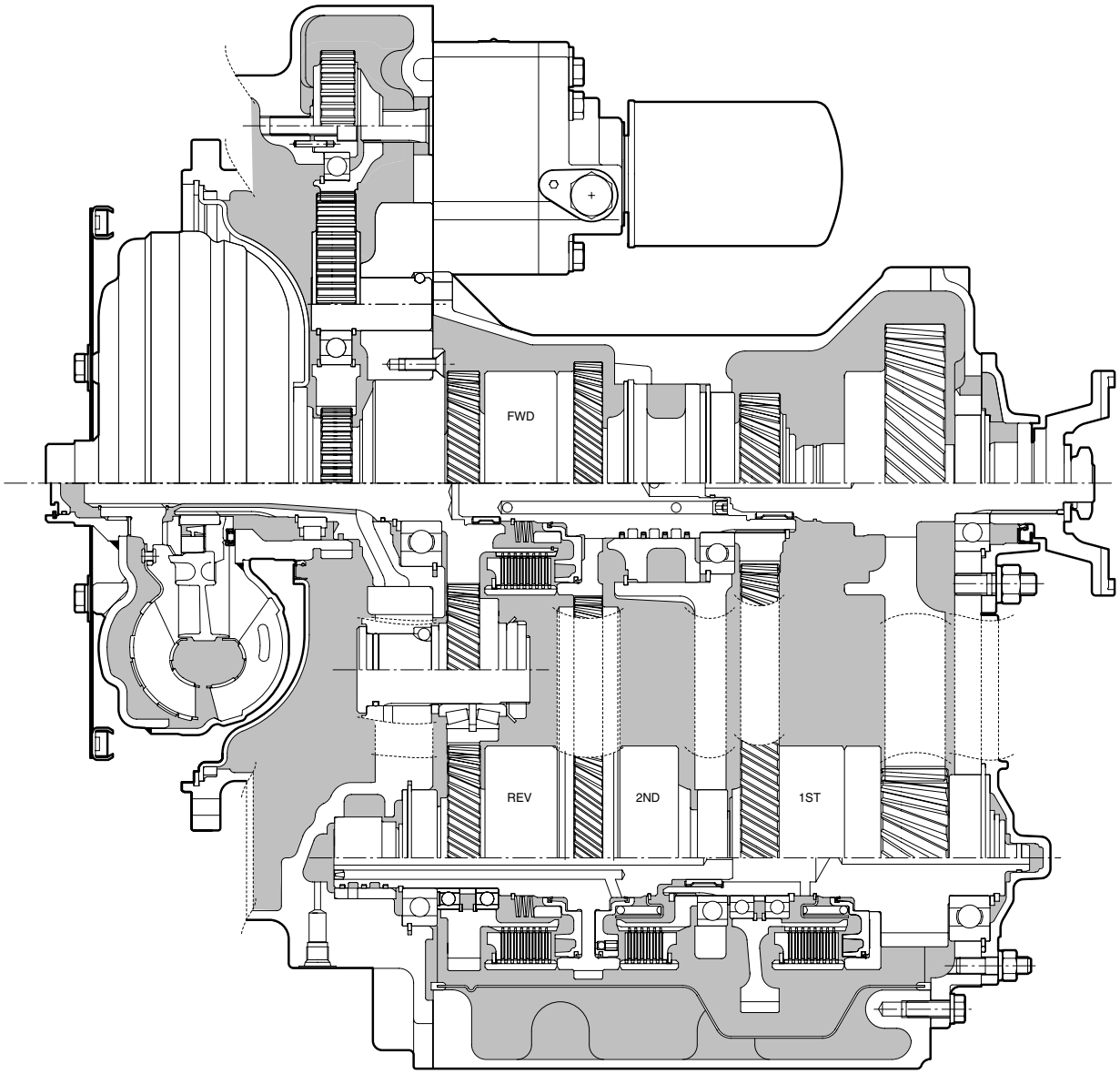


IMPORTANT

ALWAYS FURNISH THE DISTRIBUTOR WITH THE SERIAL AND MODEL NUMBER WHEN ORDERING PARTS.

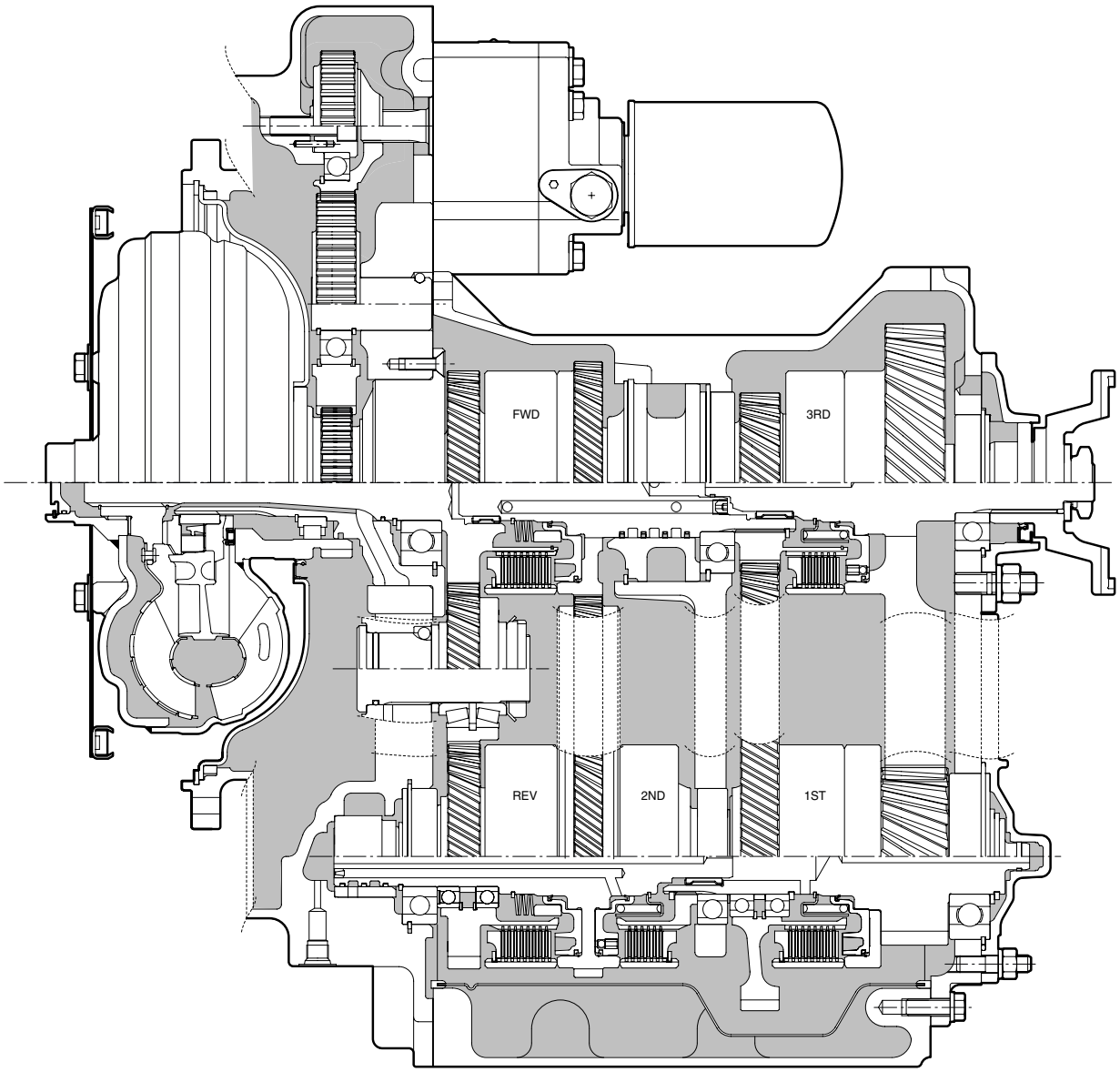
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2 - SPEED TRANSMISSION



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3 - SPEED TRANSMISSION



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1. SAFETY PRECAUTIONS

To reduce the chance of personal injury and/or property damage,
the following instruction must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of the machine.
If replacement parts are required the part must be replaced by a spare part which has the same part number or with an equivalent part. Do not use a spare part of lesser quality.

The service procedures recommended in this manual are effective methods for performing service and repair. Some of these procedures require the use of tools specifically designed for the purpose.

Accordingly, anyone who intends to use a spare part, service procedure or tool,
which is not recommended by ***SPICER OFF-HIGHWAY PRODUCTS***, must first determine
that neither his safety nor the safe operation of the machine will be jeopardized by the spare part, service procedure or tool selected.



IMPORTANT

IT IS IMPORTANT TO NOTE THAT THIS MANUAL CONTAINS VARIOUS 'CAUTIONS' AND 'NOTES' THAT MUST BE CAREFULLY OBSERVED IN ORDER TO REDUCE THE RISK OF PERSONAL INJURY DURING SERVICE OR REPAIR, OR THE POSSIBILITY THAT IMPROPER SERVICE OR REPAIR MAY DAMAGE THE UNIT OR RENDER IT UNSAFE. IT IS ALSO IMPORTANT TO UNDERSTAND THAT THESE 'CAUTIONS' AND 'NOTES' ARE NOT EXHAUSTIVE, BECAUSE IT IS IMPOSSIBLE TO WARN ABOUT ALL THE POSSIBLE HAZARDOUS CONSEQUENCES THAT MIGHT RESULT FROM FAILURE TO FOLLOW THESE INSTRUCTIONS.

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2. CLEANING, INSPECTION AND LEGEND SYMBOLS

2.1 CLEANING

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.



CAUTION

CARE SHOULD BE EXERCISED TO AVOID SKIN RASHES, FIRE HAZARDS, AND INHALATION OF VAPOURS WHEN USING SOLVENT TYPE CLEANERS.

2.1.1 Bearings

Remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

2.1.2 Housings

Clean interior and exterior of housings, bearing caps, etc…, thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.



CAUTION

CARE SHOULD BE EXERCISED TO AVOID INHALATION OF VAPOURS AND SKIN RASHES WHEN USING ALKALI CLEANERS.

All parts cleaned must be thoroughly dried immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal fillings, contaminated oil, or lapping compound.

2.2 INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

2.2.1 Bearings

Carefully inspect all rollers: cages and cups for wear, chipping, or nicks to determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in Automatic Transmission Fluid and wrap in clean lintless cloth or paper to protect them until installed.

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2.2.2 Oil Seals, Gaskets, Etc.

Replacement of spring load oil seals, “O”-rings, metal sealing rings, gaskets, and snap rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency. When assembling new metal type sealing rings, these should be lubricated with coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all “O”-rings and seals with recommended type Automatic Transmission Fluid before assembly.

2.2.3 Gears and Shafts

If magna-flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks, or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

2.2.4 Housing, Covers, etc.

Inspect housings, covers and bearing caps to ensure that they are thoroughly clean and that mating surfaces, bearing bores, etc…, are free from nicks or burrs. Check all parts carefully for evidence of cracks or conditions which would cause subsequent oil leaks or failures.

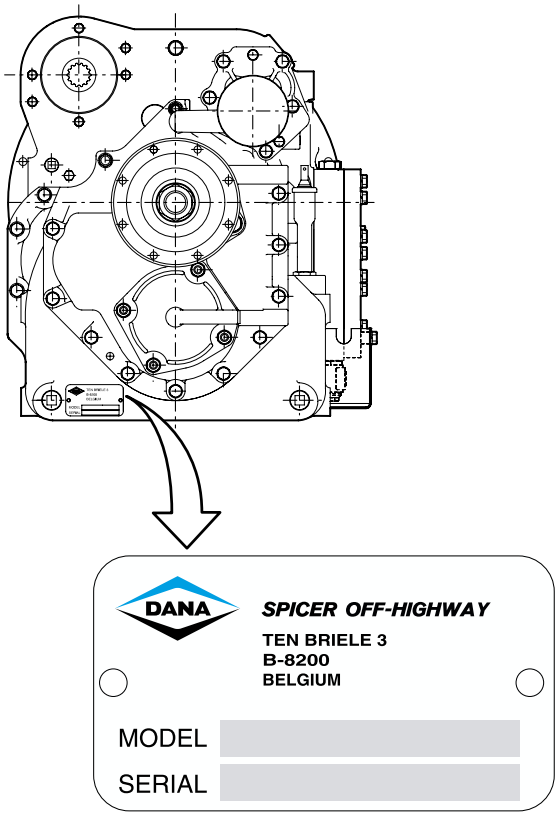
2.3 LEGEND SYMBOLS

	Smontaggio di sottogruppi Disassembly of assembly groups
	Montaggio di sottogruppi Reassemble to from assembly group
	Smontaggio di particollari ingombranti Remove obstruction parts
	Montaggio di particollari ingombranti Reinstall - remount parts which had obstructed disassembly
	Attenzione, indicazione importante Attention! important notice
	Controllare regolare p.e. coppie, misure, pressione etc. Check - adjust e.g. torque, dimensions, pressures etc.
	T = Attrezzature speciali P = Pagina T = Special tool P = Page
	Rispettare direzione di montaggio Note direction of installation
	Controllare esaminare controllo visuale Visual inspection
	Eventualimente riutilizzable (sostituire se necessario) Possibly still serviceable, renew if necessary

	Sostituire con ogni montaggio Renew at each reassembly
	Togliere - mettere la sicura Unlock - lock e.g. split pin, locking plate, etc.
	Mettere la sicura, incollare (mastice liquido) Lock - adhere (liquid sealant)
	Evitare danni ai materiali, danni ai pezzi Guard against material damage, damage to parts
	Marchiari prima dello smontaggio (per il montaggio) Mark before disassembly, observe marks when reasembl.
	Carricare riempire (olio - lubrificante) Filling - topping up - refilling e.g. oil, cooling water, etc.
	Scarricare olio, lubrificante Drain off oil, lubricant
	Tendere Tighten - clamp ; tightening a clamping device
	Insere pressione nel circuito idraulico Apply pressure into hydraulic circuit
	Pulire To clean

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3. TECHNICAL SPECIFICATIONS



3.1 IDENTIFICATION OF THE UNIT

1. Model and type of the unit.

2. Serial number.

3.2 WEIGHT, DIMENSIONS, OIL CAPACITY

Weight (dry): ±380 kg (836 lb.)

	T-model
Maximum length:	810.5 mm (31.91”)
Maximum width:	544.8 mm (21.45”)
Maximum height:	547.7 mm (21.56”)

Oil capacity

±10.3 l (2.8 US Gallon) without cooler and hydraulic lines.

Consult operator’s manual on applicable machine for system capacity.

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3.3 TIGHTENING TORQUES

3.3.1 Torque specifications for lubricated or plated screw threads

NOM. SIZE	GRADE 5			
	FINE THREAD		COARSE THREAD	
	LBF - FT	[N.m]	LBF - FT	[N.m]
.2500	9 - 11	[12 - 15]	8 - 10	[11 - 14]
.3125	16 - 20	[22 - 27]	12 - 16	[16 - 22]
.3750	26 - 29	[35 - 39]	23 - 25	[31 - 34]
.4375	41 - 45	[56 - 61]	37 - 41	[50 - 56]
.5000	64 - 70	[87 - 95]	57 - 63	[77 - 85]
.5625	91 - 100	[123 - 136]	82 - 90	[111 - 122]
.6250	128 - 141	[174 - 191]	113 - 124	[153 - 168]
.7500	223 - 245	[302 - 332]	200 - 220	[271 - 298]

NOM. SIZE	GRADE 8			
	FINE THREAD		COARSE THREAD	
	LBF - FT	[N.m]	LBF - FT	[N.m]
.2500	11 - 13	[15 - 18]	9 - 11	[12 - 15]
.3125	28 - 32	[38 - 43]	26 - 30	[35 - 41]
.3750	37 - 41	[50 - 56]	33 - 36	[45 - 49]
.4375	58 - 64	[79 - 87]	52 - 57	[71 - 77]
.5000	90 - 99	[122 - 134]	80 - 88	[108 - 119]
.5625	128 - 141	[174 - 191]	115 - 127	[156 - 172]
.6250	180 - 198	[224 - 268]	159 - 175	[216 - 237]
.7500	315 - 347	[427 - 470]	282 - 310	[382 - 420]

NOM. SIZE	GRADE 8.8 or 9.8		GRADE 10.9	
	COARSE THREAD		COARSE THREAD	
	LBF - FT	[N.m]	LBF - FT	[N.m]
M8	15 - 20	[20 - 25]	22 - 26	[30 - 35]
M10	30 - 37	[40 - 50]	44 - 48	[60 - 65]
M12	50 - 55	[65 - 75]	74 - 81	[100 - 110]

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3.3.2 Elastic stop nut torque

THREAD SIZE	LB - FT	[N . m]
1" - 20	150 - 200	[203.4 - 271.1]
1 1/4" - 18	200 - 250	[271.2 - 338.9]
1 1/2" - 18	300 - 350	[406.8 - 474.5]
1 3/4" - 18	400 - 450	[542.4 - 610.1]

3.3.3 "O"-ring port plug torque chart

THREAD SIZE	LBF - FT	[N . m]
9/16" - 18	12 - 15	[16 - 20]
3/4" - 16	20 - 25	[27 - 34]

3.3.4 Pipe plug torque chart

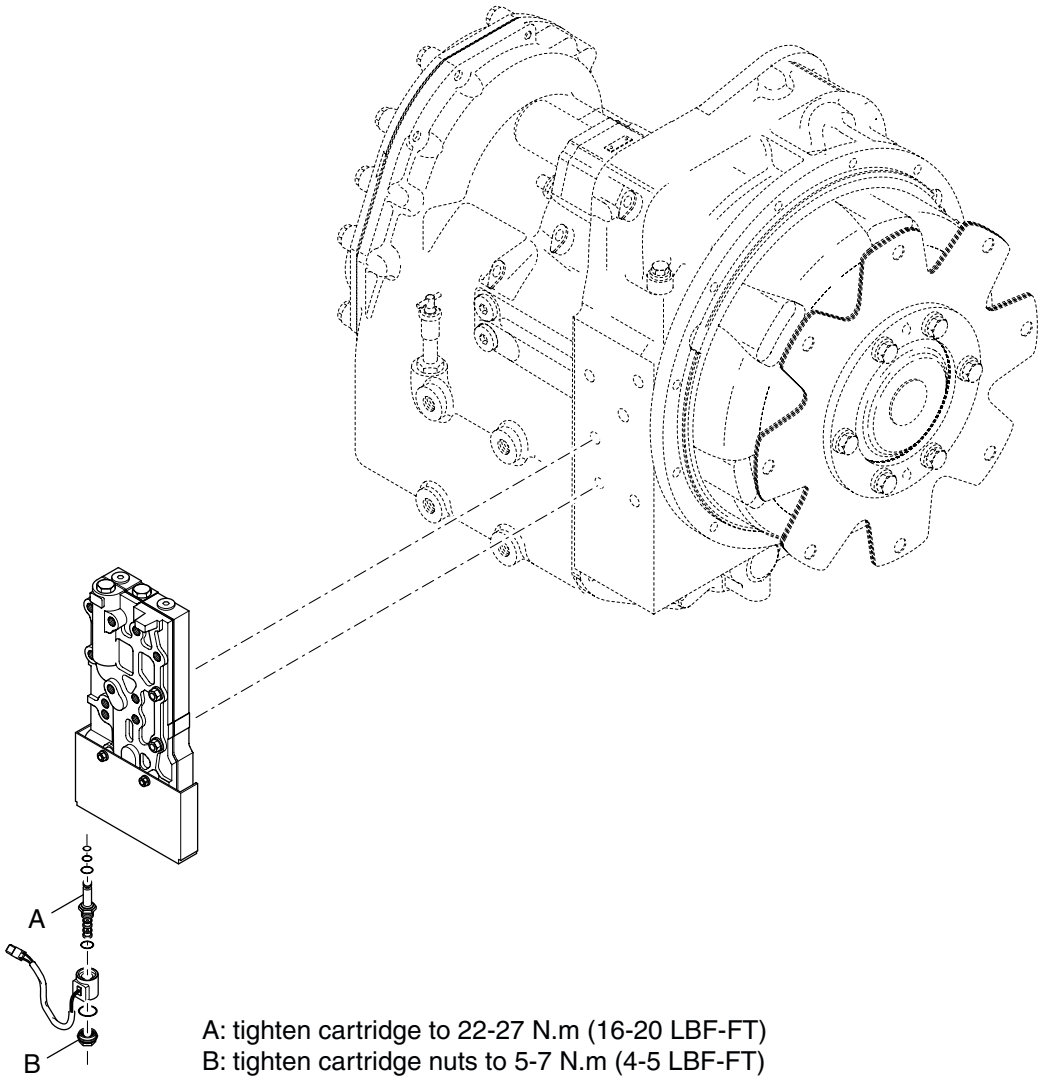
THREAD NPTF	TORQUE	
	LBF - FT	[N.m]
1/16 - 27	5 - 7	[7 - 9]
1/8 - 27	7 - 10	[9 - 14]
1/4 - 18	15 - 20	[20 - 27]
3/8 - 18	25 - 30	[34 - 41]
1/2 - 14	30 - 35	[41 - 47]
3/4 - 10	40 - 45	[54 - 61]
1 - 11 1/2	55 - 50	[68 - 75]
1 1/4 - 11 1/2	60 - 65	[81 - 88]

3.3.5 Permanent metric plug torque chart

THREAD SIZE	TORQUE	
	LBF - FT	[N.m]
M18 x 1.5 6H	25-30	[34-41]
M26 x 1.5 6H	45-50	[61-68]

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3.3.6 Coil and cartridge torque



A: tighten cartridge to 22-27 N.m (16-20 LBF-FT)
B: tighten cartridge nuts to 5-7 N.m (4-5 LBF-FT)

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3.4 PRESSURE AND TEMPERATURE SPECIFICATIONS

- Normal operating temperature 70 - 120 °C (158 - 248 F) measured at temperature check port converter out (port 71 - **).
- Maximum allowed transmission temperature 120 °C (248 F).
- Transmission regulator pressure (*) - (neutral) - port 31 (**).
  - At 600 RPM min. 16.5 bar (240 PSI) minimum.
  - At 2200 RPM: 19.3 bar (280 PSI) maximum.

- Pump flow (*)
  - At 1800 RPM in neutral: 54.9 l/min. minimum (14.5 GPM).

- Clutch pressures (*)
  - 1st clutch: port 41 (**).
  - 2nd clutch: port 42 (**).
  - 3rd clutch: port 43 (**).
  - Forward clutch: port 45 (**).
  - Reverse clutch: port 46 (**).

NOTE

THE 2-SPEED TRANSMISSION HAS NO 3RD CLUTCH.

At 2000 RPM :

- 16.5 - 19.3 bar (240 - 280 PSI) clutch activated.
- 0 - 0.2 bar (0 - 3 PSI) clutch released.

- Filter bypass valve set at 1.5 - 1.7 bar (*) (22 - 24 PSI).
- Lube pressure (*) (port 33) 0.7 - 1.4 bar (10 - 20 PSI) at 54.9 l/min. (14.5 GPM) pump flow (±1800 RPM).
- Safety valve: cracking pressure (*) 8.2 - 12.1 bar (120 - 175 PSI).
- Converter out pressure (*) (port 32) 1.7 bar min. (25 PSI) at 2000 RPM and max. 4.8 bar (70 PSI) at no load governed speed.

(*) All pressures and flows to be measured with oil temperature of 82-93 °C (180-200 F).

(**) Refer to section 7 “Troubleshooting” for check port identification.

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3.5 ELECTRICAL SPECIFICATIONS

- Solenoid (forward, reverse, 1st and 2nd).

  Coil resistance:

  - 12V: 9.79 Ω ±0.5 Ω.
  - 24V: 39.3 Ω ±2 Ω.

- Speed sensor:
  - Type: magneto resistive sensor.
  - Sensing distance: 0 - 1.8 mm (0” - 0.07”).
  - Sensor signal: generates a square current with a fixed amplitude changing between 7 and 14 mA.

3.6 HYDRAULIC COOLER AND FILTER LINE SPECIFICATIONS

- Minimum 19 mm (.75”) internal diameter for lines and fittings.
- Suitable for operation from ambient to 120 °C (248 F) continuous operating temperature.
- Must withstand 20 bar (290 PSI) continuous pressure and with 40 bar (580 PSI) intermittent surges.
- Conform SAE J1019 and SAE J517, 100RI.

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4. MAINTENANCE

4.1 OIL SPECIFICATION

4.1.1 Recommended lubricants

1.	Caterpillar	TO-4.
2.	John Deere	J20 C, D.
3.	Military	MIL-PRF-2104G.
4.	Allison	C-4.
5.	Dexron*	II Equivalent - See note below.

Note

DEXRON* II EQUIVALENT IS ACCEPTABLE; HOWEVER IT IS NOT COMPATIBLE WITH TORQUE CONVERTERS OR TRANSMISSIONS EQUIPPED WITH GRAPHITIC FRICTION MATERIAL CLUTCH PLATES.

Caution

DEXRON* III, ENGINE OIL OR GL-5 OILS ARE NOT RECOMMENDED.

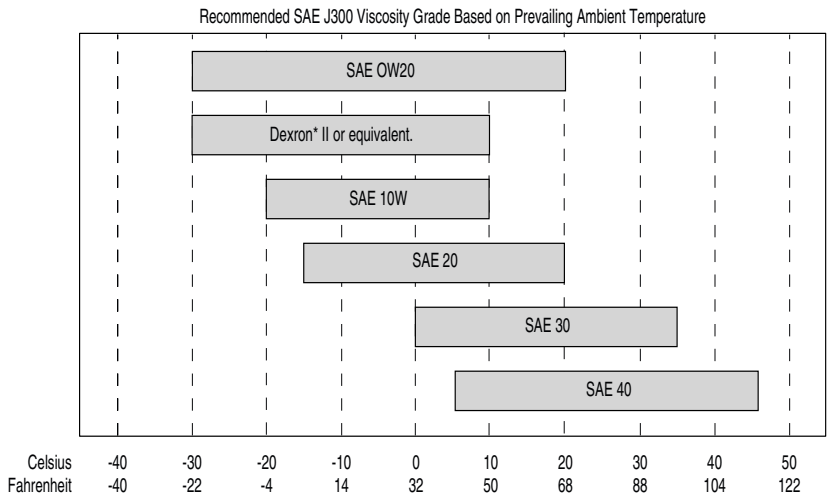
PREFERRED OIL VISCOSITY

It is recommended that the highest viscosity monograde lubricant available be used for the anticipated ambient temperature. Typically this will be a CAT TO-4 qualified lubricant. When large swings in ambient temperature are probable, J20 C, D multigrades are recommended. Multigrade lubricants should be applied at the lower viscosity rating for the prevailing ambient temperature, i.e. a 10W20 should be used where a 10W monograde is used. If a C-4 multigrade is used in stead of J20 lubricant it is recommended that the viscosity span no more than 10 points, i.e. 10W20.

Caution

SYNTHETIC LUBRICANTS ARE APPROVED IF QUALIFIED BY ONE OF THE ABOVE SPECIFICATIONS.
OIL VISCOSITY GUIDELINES APPLY, BUT SYNTHETIC MULTIGRADES MAY SPAN MORE THAN 10 POINTS.

FOR FIRE RESISTANT FLUID RECOMMENDATIONS PLEASE CONTACT ***SPICER OFF-HIGHWAY PRODUCTS***.



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SUMP PREHEATERS

Preheat the transmission fluid to the minimum temperature for the oil viscosity used before engine start up.

NORMAL OIL CHANGE INTERVAL

Drain and refill system every 1000 hours for average environmental and duty cycle conditions. Severe or sustained high operating temperature or very dusty atmospheric conditions will result in accelerated deterioration or contamination. Judgement must be used to determine the required change intervals for extreme conditions.

EXTENDED OIL CHANGE INTERVAL

Extended oil service life may result when using synthetic fluids. Appropriate change intervals should be determined for each transmission by measuring oil oxidation and wear metals, over time, to determine a baseline. Wear metal analysis can provide useful information but a transmission should not be removed from service based solely on this analysis.

FILTERS

Service oil filters element every 500 hours under normal environmental and duty cycle conditions.

*Dexron is a registered trademark of GENERAL MOTORS CORPORATION.

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4.2 MAINTENANCE INTERVALS

4.2.1 Daily

Check oil level daily with engine running at idle (600 RPM) and oil at 82 - 93 °C (180-200 F).

Maintain oil level at full mark.

4.2.2 Normal drain period

Normal drain period and oil filter element change are for average environment and duty cycle condition.

Severe or sustained high operating temperature or very dusty atmospheric conditions will cause accelerated deterioration and contamination.

For extreme conditions judgement must be used to determine the required change intervals.

Every 500 hours

Change oil filter element.

Every 1000 hours

Drain and refill system as follows (Drain with oil at 65 - 93 °C (150 - 200 F)):

1. Drain transmission.
2. Remove and discard filter. Install new filter.
3. Refill transmission to FULL mark.
4. Run engine at 500 - 600 RPM to prime convertor and lines.
5. Recheck level with engine running at 500 - 600 RPM and add oil to bring level to LOW mark. When oil temperature is hot 82.2 - 93.3 °C (180- 200 F) make final oil level check and adjust if necessary to bring oil level to FULL mark.



Note

IT IS RECOMMENDED THAT OIL FILTER BE CHANGED AFTER 100 HOURS OF OPERATION ON NEW, REBUILT OR REPAIRED UNIT.

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4.3 SERVICING MACHINE AFTER COMPONENTS OVERHAUL

The transmission, torque converter, and its allied hydraulic system are important links in the driveline between the engine and the wheels. The proper operation of either unit depends greatly on the condition and operation of the other. Therefore, whenever repair or overhaul of one unit is performed, the balance of the system must be considered before the job can be considered complete.

After the overhauled or repaired transmission has been installed in the machine, the oil cooler, and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several manners and a degree of judgement must be exercised as to the method employed.

The following are considered the minimum steps to be taken:

1. Drain entire system thoroughly.
2. Disconnect and clean all hydraulic lines. Where feasible hydraulic lines should be removed from machine for cleaning.
3. Replace oil filter element.
4. The oil cooler must be thoroughly cleaned. The cooler should be “back flushed” with oil and compressed air until all foreign material has been removed. Flushing in direction of normal oil flow will not adequately clean the cooler. If necessary, cooler assembly should be removed from machine for cleaning, using oil, compressed air, and steam cleaner for that purpose.

IMPORTANT

DO NOT USE FLUSHING COMPOUNDS FOR CLEANING PURPOSES.

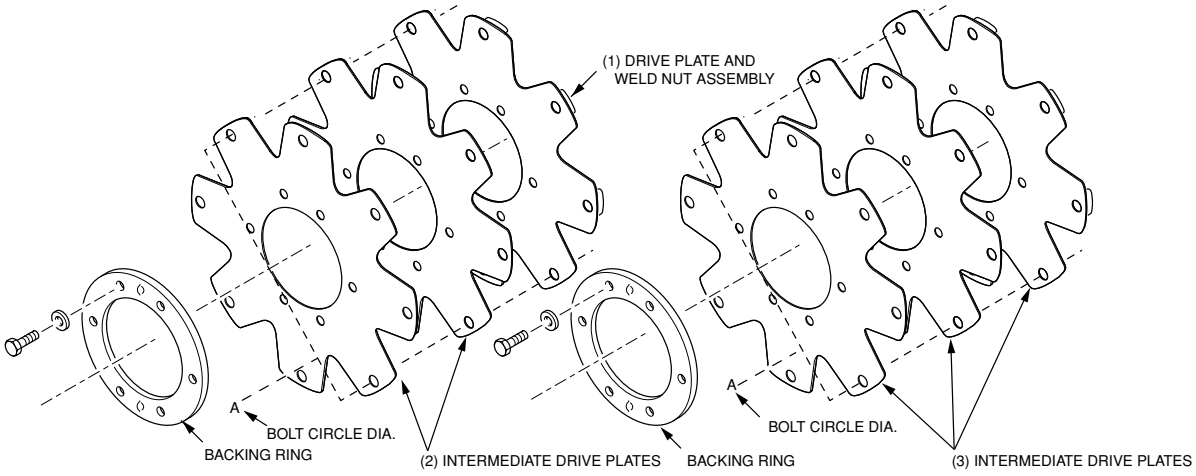
5. Reassemble all components and use only type oil (See chapter 4.1.1 “Recommended lubricants”). Fill the transmission through filler opening until fluid comes up to FULL mark on transmission dipstick.
   - Remove filler plug and fill oil until FULL mark.
   - Run engine two minutes at 500 - 600 RPM to prime torque convertor and hydraulic lines.
   - Recheck level of fluid in transmission with engine running at idle (500 - 600 RPM).
   - Add quantity necessary to bring fluid level to LOW mark on dipstick.
   - Recheck with hot oil 82.2 - 93.3 °C (180 - 200 F).
   - Adjust oil level to FULL mark on dipstick.
6. Recheck all drain plugs, lines, connections, etc.…, for leaks and tighten where necessary.

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5. INSTALLATION DETAILS

5.1 CONVERTER DRIVE COUPLING

Measure the “A” dimension (bolt circle diameter) and order drive plate kit listed below. Note three (3) kits have two (2) intermediate drive plates and one (1) drive plate and weld nut assembly. Three (3) kits with three intermediate drive plates.



“A” Dimension (Bolt circle diameter)

- 11.380” (288.900 mm) diameter
  Kit No. 814978.
- 13.125” (333.38 mm) diameter
  Kit No. 814977.
- 13.500” (342.90 mm) diameter
  Kit No. 814975.

Each kit will include the following parts:

- 2 Intermediate drive plates.
- 1 Drive plate and weld nut assembly.
- 1 Backing ring.
- 6 Mounting screws.
- 6 Lockwashers.
- 1 Instruction sheet.

“A” Dimension (Bolt circle diameter)

- 11.380” (288.900 mm) diameter
  Kit No. 814979.
- 13.125” (333.38 mm) diameter
  Kit No. 814980.
- 13.500” (342.90 mm) diameter
  Kit No. 814981.

Each kit will include the following parts:

- 3 Intermediate drive plates.
- 1 Backing ring.
- 6 Mounting screws.
- 6 Lockwashers.
- 1 Instruction sheet.

Position drive plate and weld nut assembly on torque converter assembly with weld nuts toward converter. Align intermediate drive plates and backing plate with holes in torque converter assembly.

Note

TWO DIMPLES 180° APART IN BACKING RING MUST BE OUT TOWARD ENGINE FLYWHEEL (HOLLOW SIDE FACING TORQUE CONVERTER ASSEMBLY). INSTALL CAP SCREWS AND LOCKWASHERS. TIGHTEN CAP SCREWS TORQUE 40 - 50 N.M. (30 - 37 LBF. FT.).

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5.2 TRANSMISSION TO ENGINE INSTALLATION PROCEDURE

1. Remove all burrs from flywheel mounting face and nose pilot bore. Clean drive plate surface with solvent.
2. Check engine flywheel & housing for conformance to standard SAE No. 3 per SAE J927 and J1033 tolerance specifications for pilot bore size, pilot bore runout and mounting face flatness. Measure and record engine crankshaft end play (Fig. 1).
3. Install two 63,50 mm (2.50") long transmission to flywheel housing guide studs in the engine flywheel housing as shown. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing access hole (Fig. 2).

*4. Install a 101,60 mm (4.00") long drive plate locating stud .3750-24 fine thread in a drive plate nut. Align the locating stud in the drive plate with the flywheel drive plate mounting screw hole positioned in step No. 3.

5. Rotate the transmission torque converter to align the locating stud in the drive plate with the flywheel drive plate mounting screw hole positioned in step No. 3. Locate transmission on flywheel housing.

   Aligning drive plate to flywheel and transmission to flywheel housing guide studs. Install transmission to flywheel housing screws. Tighten screws to specified torque. Remove transmission to engine guide studs. Install remaining screws and tighten to specified torque.

*6. Remove drive plate locating stud.

7. Install drive plate attaching screw and washer. Snug screw but **do not tighten**. Some engine flywheel housings have a hole located on the flywheel housing circumference in line with the drive plate screw access hole. A screwdriver or pry bar used to hold the drive plate against the flywheel will facilitate installation of the drive plate screws. Rotate the engine flywheel and install the remaining seven (7) flywheel to drive plate attaching screws. Snug screws but do not tighten. After all eight (8) screws are installed. Torque each one 35 to 39 N.m. (26- 29ft.lbs.). This will require tightening each screw and rotating the engine flywheel until the full amount of eight (8) screws have been tightened to specified torque.
8. Measure engine crankshaft end play after transmission has been completely installed on engine flywheel. This value must be within 0,025 mm (0.001") of the end play recorded in step No. 2.

* Does not apply to units having 3 intermediate drive plates. See Fig.4.

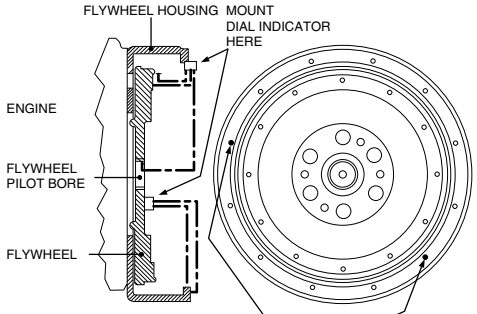


FIG. 1

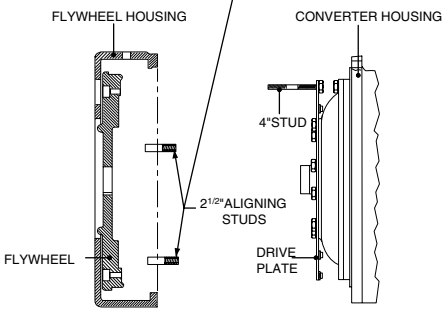


FIG. 2

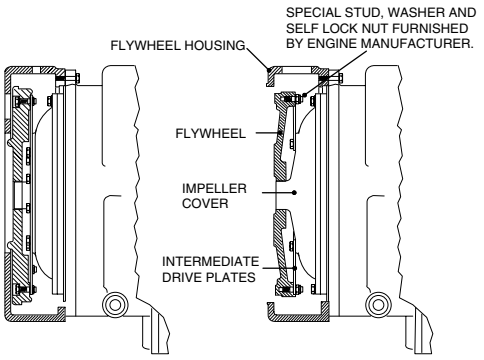


FIG. 3 FIG.4

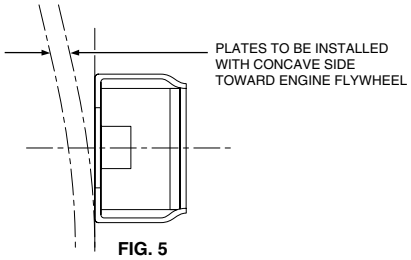
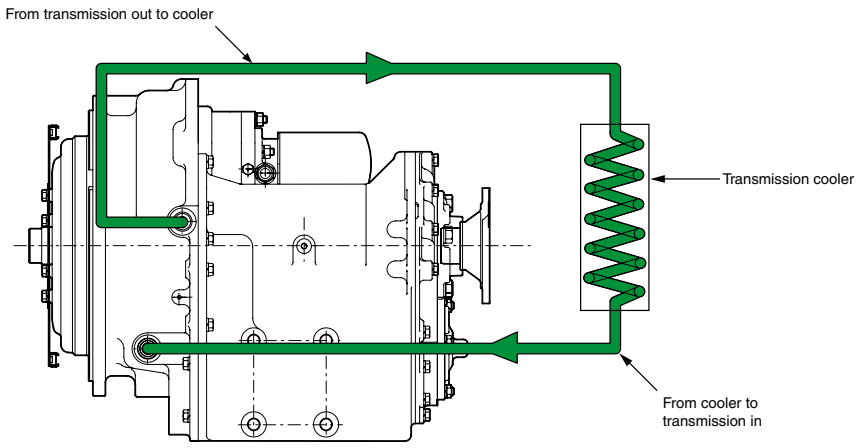


FIG. 5

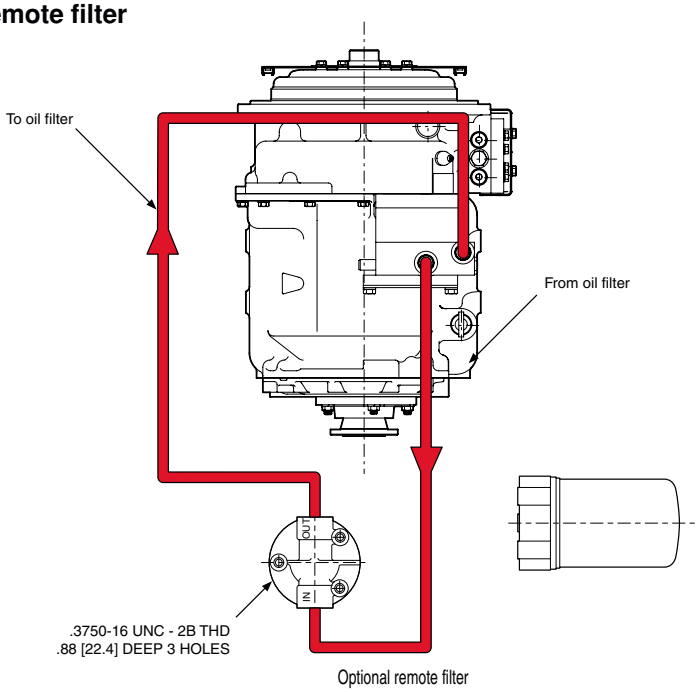
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5.3 EXTERNAL PLUMBING



Left side view

5.3.1 Optional: remote filter



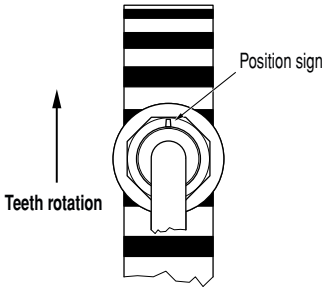
Optional remote filter

5.3.2 Cooler & filter lines specifications

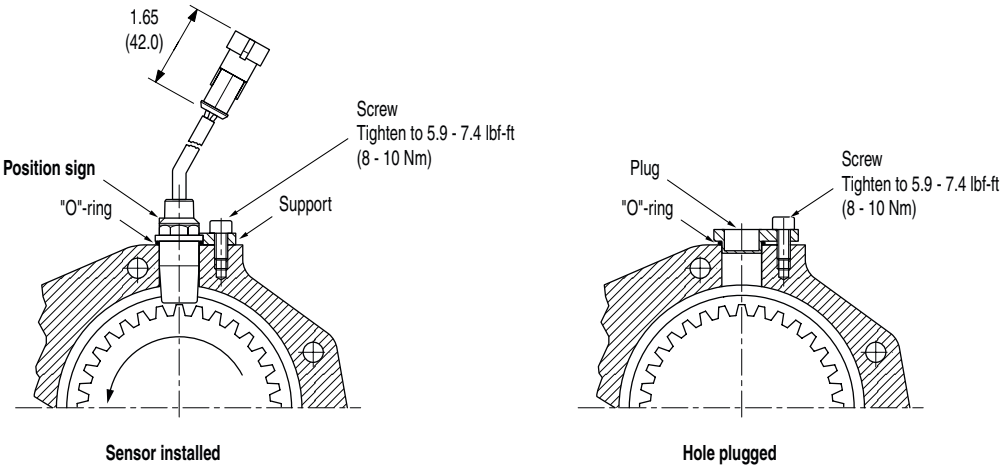
- Minimum 19 mm (.75 inch) internal diameter for lines and fittings.
- Suitable for operation from ambient to 120 °C (248 F) continuous operating temperature.
- Must withstand 20 bar (290 psi) continuous pressure and with 40 bar (580 psi) intermittent surges.
- Conform SAE J1019 and SAE J517,100RI.

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5.4 SPEED SENSOR INSTALLATION



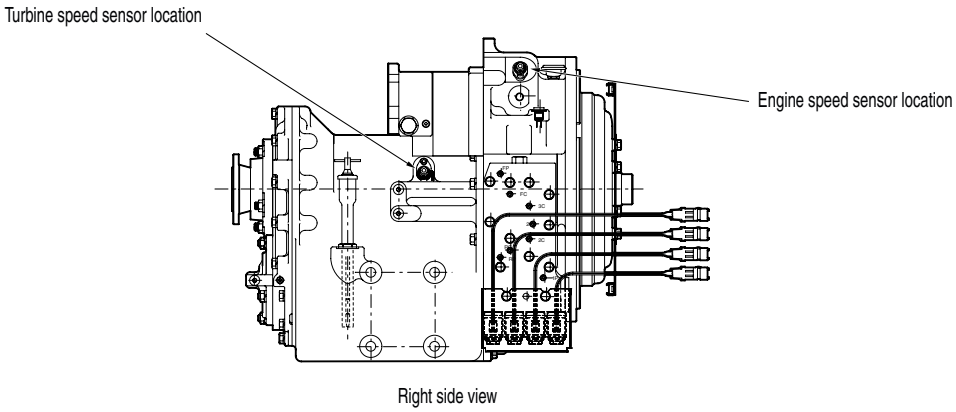
On the sensor body there is a small plastic triangular position sign.
Make sure the position sign on the sensor points as shown below
in the direction of the movement of the gearteeth (Teeth rotation as shown).



Sensor installed

Hole plugged

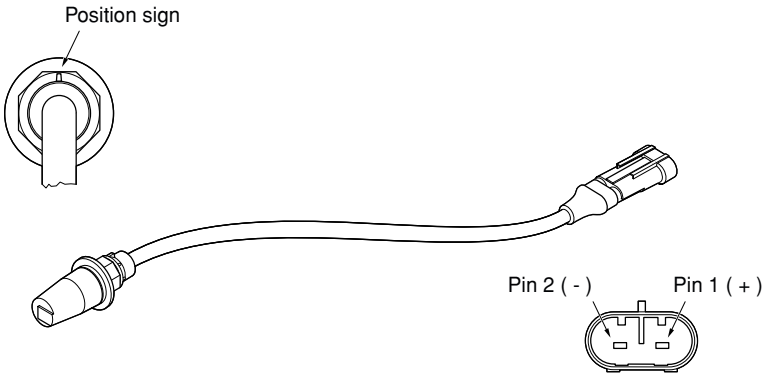
Sensor position on transmission



Right side view

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5.4 SPEED SENSOR INSTALLATION (CONTINUED)



The magneto resistive sensor generates a square wave current with a fixed amplitude changing between 7 mA and 14 mA.

The sensor has an integrated AMP superseal 2 pin connector.
The two pins are numbered 1 and 2.

Following table shows the relation between wire colour, pin number and connection.

COLOUR	PIN NUMBER	FUNCTION	CONNECTION
BROWN	1	Current input	Hot wire
BLUE	2	Current output	Ground wire

Note

THE SENSOR WIRES HAVE A POLARITY.

BE SURE TO CORRECTLY OBSERVE SENSOR POLARITIES, AS WRONG CONNECTIONS WILL DEACTIVATE THE SENSOR !

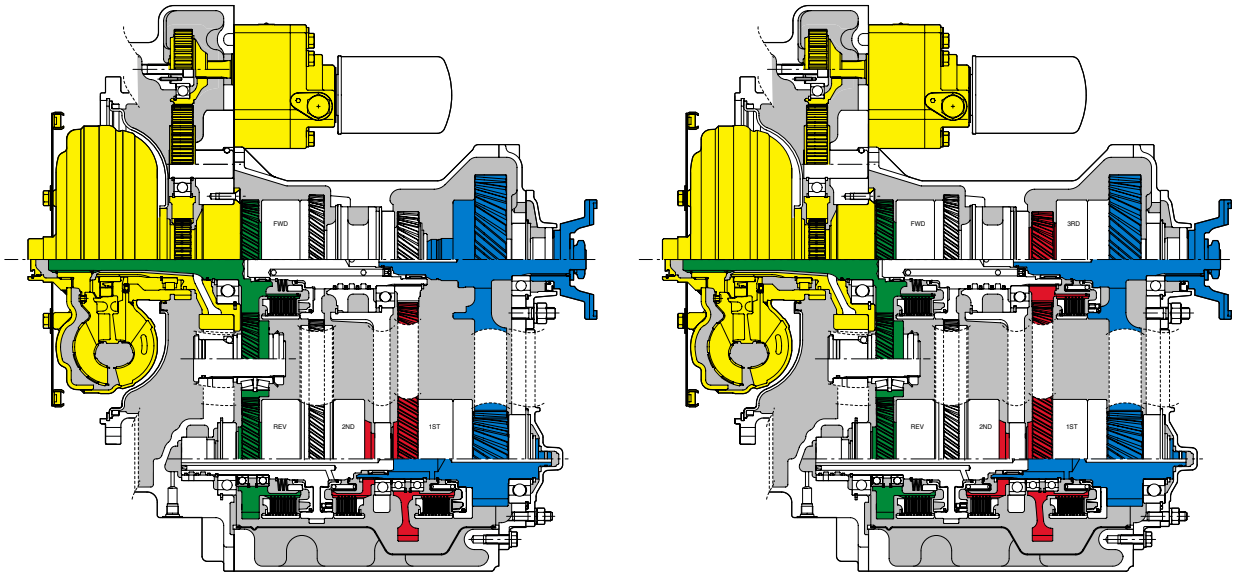
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6. OPERATION OF THE TRANSMISSION

6.1 THE TRANSMISSION ASSEMBLY

Basically the transmission is composed of five main assemblies:

1. The converter, pump drive section and pressure regulating valve.
2. The input shaft and directional clutches.
3. The range clutches.
4. The output section.
5. The transmission control valve.



2-SPEED TRANSMISSION

3-SPEED TRANSMISSION

NOTE

AS THERE IS LITTLE DIFFERENCE BETWEEN THE 2 AND 3-SPEED TRANSMISSION, WE WILL USE THE 3-SPEED TRANSMISSION TO EXPLAIN ITS FUNCTION.

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6.1.1 The converter, pump drive section and pressure regulating valve

Engine power is transmitted from the engine flywheel to the impeller through the impeller cover.

This element is the pump portion of the hydraulic torque converter and is the primary component which starts the oil flowing to the other components which results in torque multiplication. This element can be compared to a centrifugal pump, that picks up fluid at its centre and discharges it at the outer diameter.

The torque converter turbine is mounted opposite the impeller and is connected to the turbine shaft of the torque converter. This element receives fluid at its outer diameter and discharges it at its centre.

The reaction member of the torque converter is located between and at the centre of the inner diameters of the impeller and turbine elements. Its function is to take the fluid which is exhausting from the inner portion of the turbine and change its direction to allow correct entry for recirculation into the impeller element. This recirculation will make the converter to multiply torque.

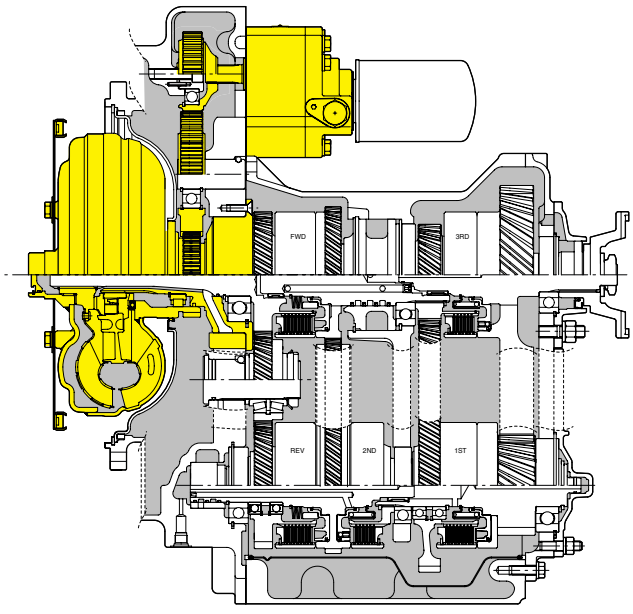
The torque multiplication is function of the blading (impeller, turbine and reaction member) and the converter output speed (turbine speed). The converter will multiply engine torque to its designed maximum multiplication ratio when the turbine shaft is at zero RPM (stall).

Therefore we can say that as the turbine shaft is decreasing in speed, the torque multiplication is increasing.

The hydraulic pump is connected with the pump drive gear. This pump drive gear is driven by the impeller hub gear. Since the impeller hub gear is connected with the impeller cover, the pump speed is in direct relation with the engine speed.

Note

THE PRESSURE REGULATOR VALVE AND SAFETY VALVE ARE MOUNTED BEHIND THE FILTER, IN THE FILTER ADAPTER HOUSING.



THE CONVERTER, PUMP DRIVE SECTION AND PRESSURE REGULATING VALVE

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6.1.2 The input shaft and directional clutches

The turbine shaft driven from the turbine transmits power to the forward or reverse clutch.

These clutches consist of a drum with internal splines and a bore to receive a hydraulic actuated piston. The piston is oil tight by the use of sealing rings. The steel discs with external splines, and friction discs with internal splines, are alternated until the required total is achieved.

A back-up plate is then inserted and secured with a retainer ring. A hub with outer diameter splines is inserted into the splines of discs with teeth on the inner diameter. The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.

To engage the clutch, the solenoid will direct oil under pressure through tubes and passages to the selected clutch shafts.

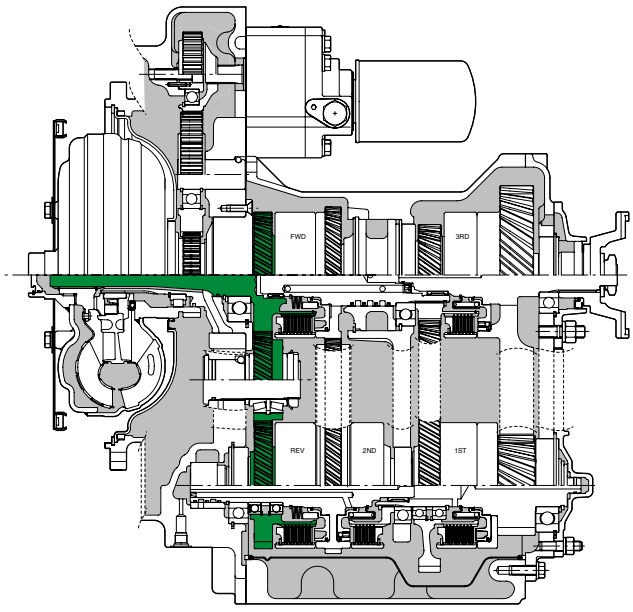
Oil sealing rings are located on the clutch shafts. These rings direct the oil through a drilled passage in the shaft to the desired clutch.

Pressure of the oil forces the piston and discs against the back-up plate. The discs with splines on the outer diameter clamping against discs with teeth on the inner diameter enables the drum and hub to be locked together and allows them to drive as one unit.

When the clutch is released, a return spring will push the piston back and oil will drain back via the shift spool, the bleed valve or holes in the clutch piston into the transmission sump.

These bleed valves will only allow quick escape of oil when the pressure to the piston is released.

As an option the engagement of the directional clutches can be modulated. This means that clutch pressure is built up gradually. This will enable the unit to make forward, reverse shifts while the vehicle is still moving and will allow smooth engagement of drive. The modulation is done hydraulically.



THE INPUT SHAFT AND DIRECTIONAL CLUTCHES

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6.1.3 The range clutches

Once a directional clutch is engaged power is transmitted to the range clutches (1st, 2nd or 3rd).
Operation and actuation of the range clutches is similar to the directional clutches.
The engagement of the range clutches are not modulated.

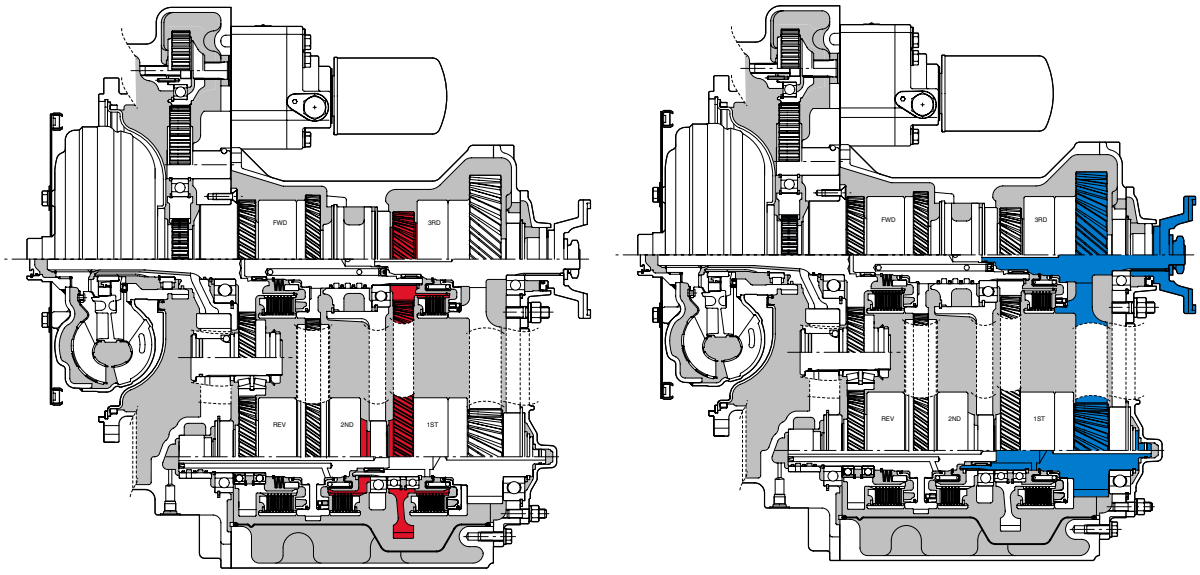
Note

THE 2-SPEED TRANSMISSION HAS NO 3RD CLUTCH.

6.1.4 The output section

With a range clutch engaged, power is finally transmitted to the output shaft.
Output rotation is opposite as the engine rotation when the forward clutch is engaged.

A front and/or rear axle disconnect is optional and is located on the output shaft. The drive to the front and/or rear axle can be disconnected or connected by manual shifting.



THE RANGE CLUTCHES

THE OUTPUT SECTION

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6.1.5 The transmission controls (refer to hydraulic diagram)

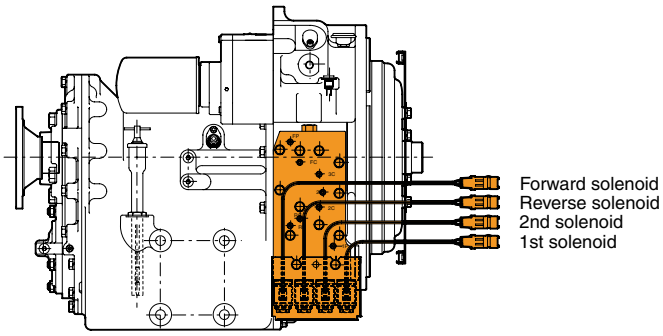
The transmission is controlled by the control valve. The control valve assembly is mounted directly on the side of the converter housing. The function of the control valve assembly is to direct oil under pressure to the desired directional and speed clutch. A provision is made on certain models for inching or declutch when the brakes are applied.
This is accomplished through use of a brake actuated valve.
For the 2-speed transmission, the control valve has 3 solenoids and 3 shift spools.
While for the 3-speed transmission, the control valve has 4 solenoids and 4 shift spools.

Operation of the valve

Forward can be selected by activating the forward solenoid. The forward solenoid will then allow pilot pressure to move the forward shift spool. Due to this movement of the shift spool, the forward clutch is fed with oil pressure.

When the reverse solenoid is activated, pilot pressure will move the reverse shift spool.
The reverse clutch will be fed with oil pressure.

The shift spools of forward and reverse are located opposite each other separated by a return spring. This ensures that only one direction can be selected.



THE TRANSMISSION CONTROLS

Note

THE 2-SPEED TRANSMISSION HAS NO 2ND SOLENOID.

Selection of range

2-speed transmission:

If the range solenoid 1st is activated, regulated pressure is fed through the shift spool to the 1st clutch.

If the range solenoid 1st is not activated, the regulated pressure is fed to the 2nd clutch.

3-speed transmission:

If the range solenoids 1st and 2nd are activated, regulated pressure is fed through the shift spools to the 1st clutch.

If the range solenoid 2nd is activated, regulated pressure is fed through the shift spools to the 2nd clutch.

If no range solenoids are activated, the regulated pressure is fed to the 3rd clutch.

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6.2 ELECTRIC SOLENOID CONTROLS

6.2.1 2-Speed transmission

Transmission gear	Activated solenoids	Activated clutches
Forward 2	Forward	Forward, 2nd
Forward 1	Forward, 1st	Forward, 1st
Neutral 2	-	2nd
Neutral 1	1st	1st
Reverse 2	Reverse	Reverse, 2nd
Reverse 1	Reverse, 1st	Reverse, 1st

6.2.2 3-Speed transmission

Transmission gear	Activated solenoids	Activated clutches
Forward 3	Forward	Forward, 3rd
Forward 2	Forward, 2nd	Forward, 2nd
Forward 1	Forward, 1st, 2nd	Forward, 1st
Neutral 3	-	3rd
Neutral 2	2nd	2nd
Neutral 1	1st, 2nd	1st
Reverse 3	Reverse	Reverse, 3rd
Reverse 2	Reverse, 2nd	Reverse, 2nd
Reverse 1	Reverse, 1st, 2nd	Reverse, 1st

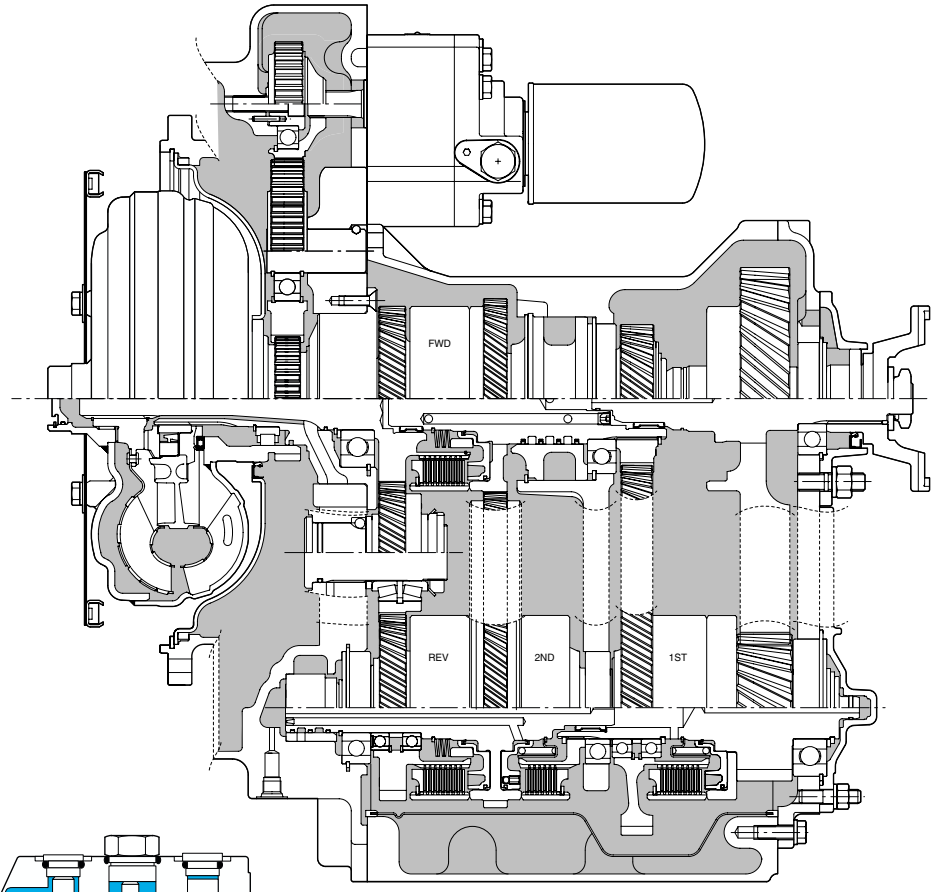
https://truckmanualshub.com/

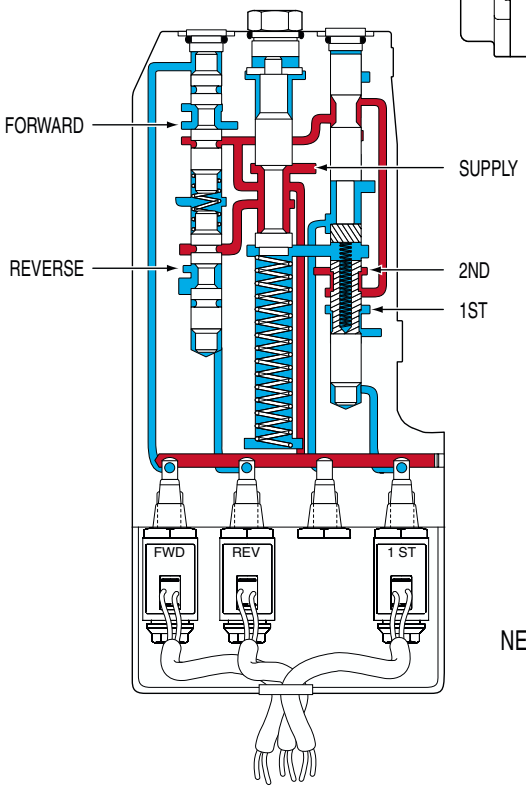
6.3 POWERFLOWS, ACTIVATED SOLENOIDS AND HYDRAULIC CIRCUIT

6.3.1 2-Speed transmission

6.3.1.1 Neutral and 2nd clutch engaged

NEUTRAL 2nd
(POWERFLOW)

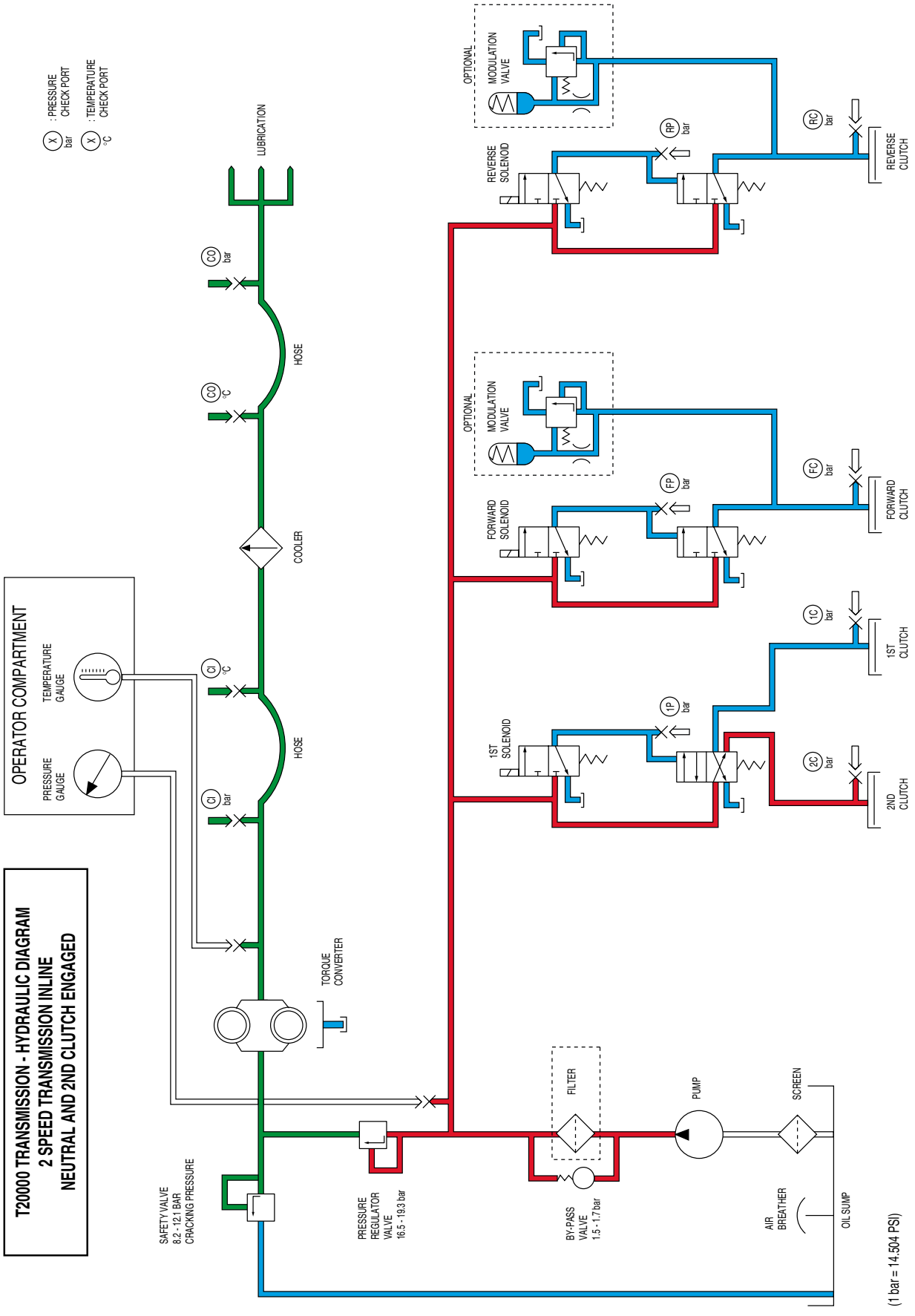




NEUTRAL 2nd (ACTIVATED SOLENOIDS AND SPOOLS)

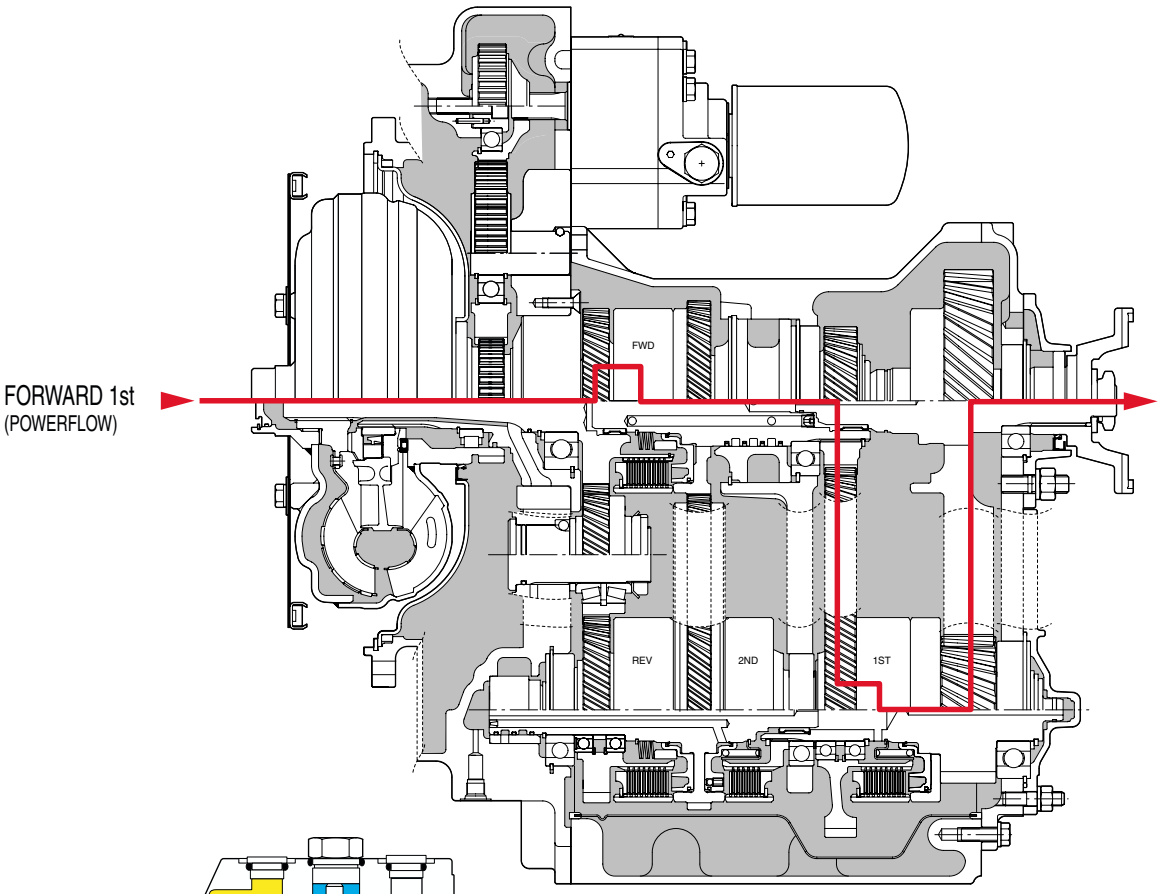
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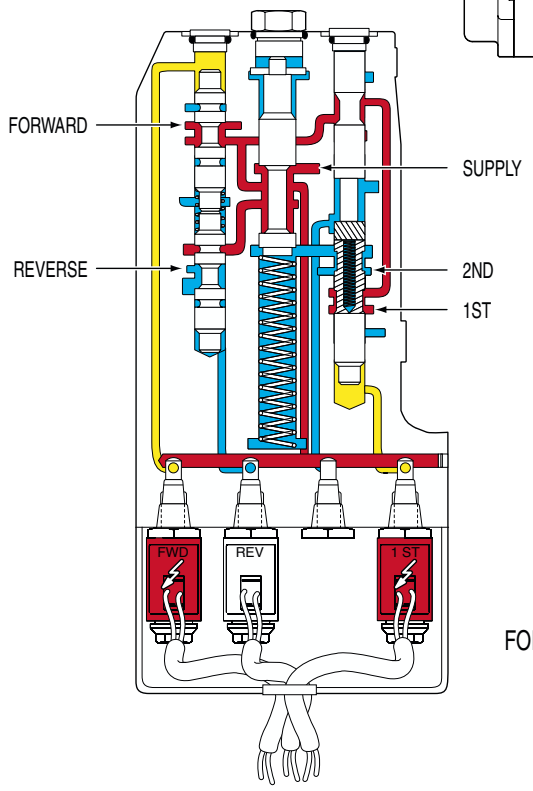
6.3.1.1 Neutral and 2nd clutch engaged (continued)



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6.3.1.2 Forward 1st speed

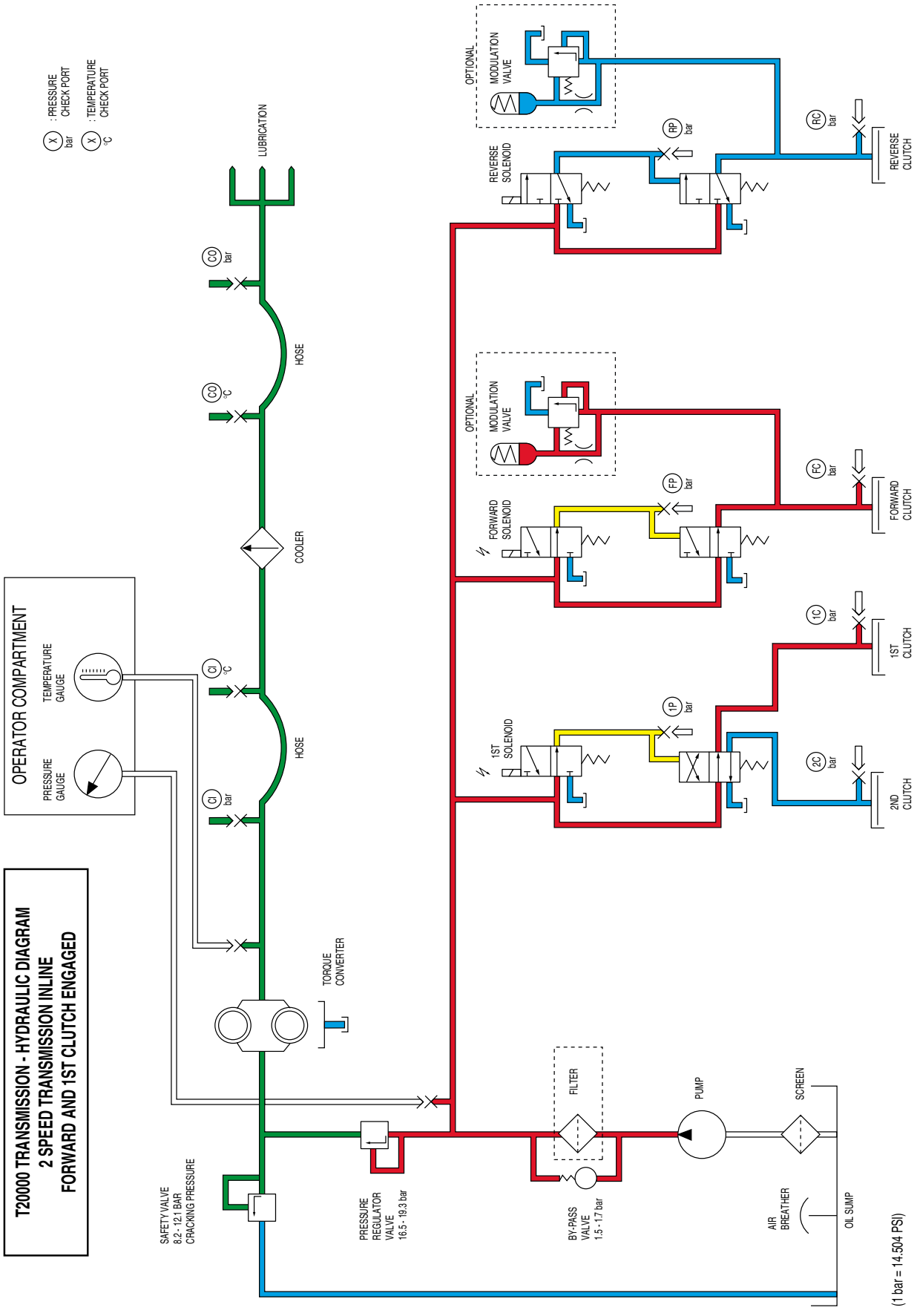




FORWARD 1st (ACTIVATED SOLENOIDS AND SPOOLS)

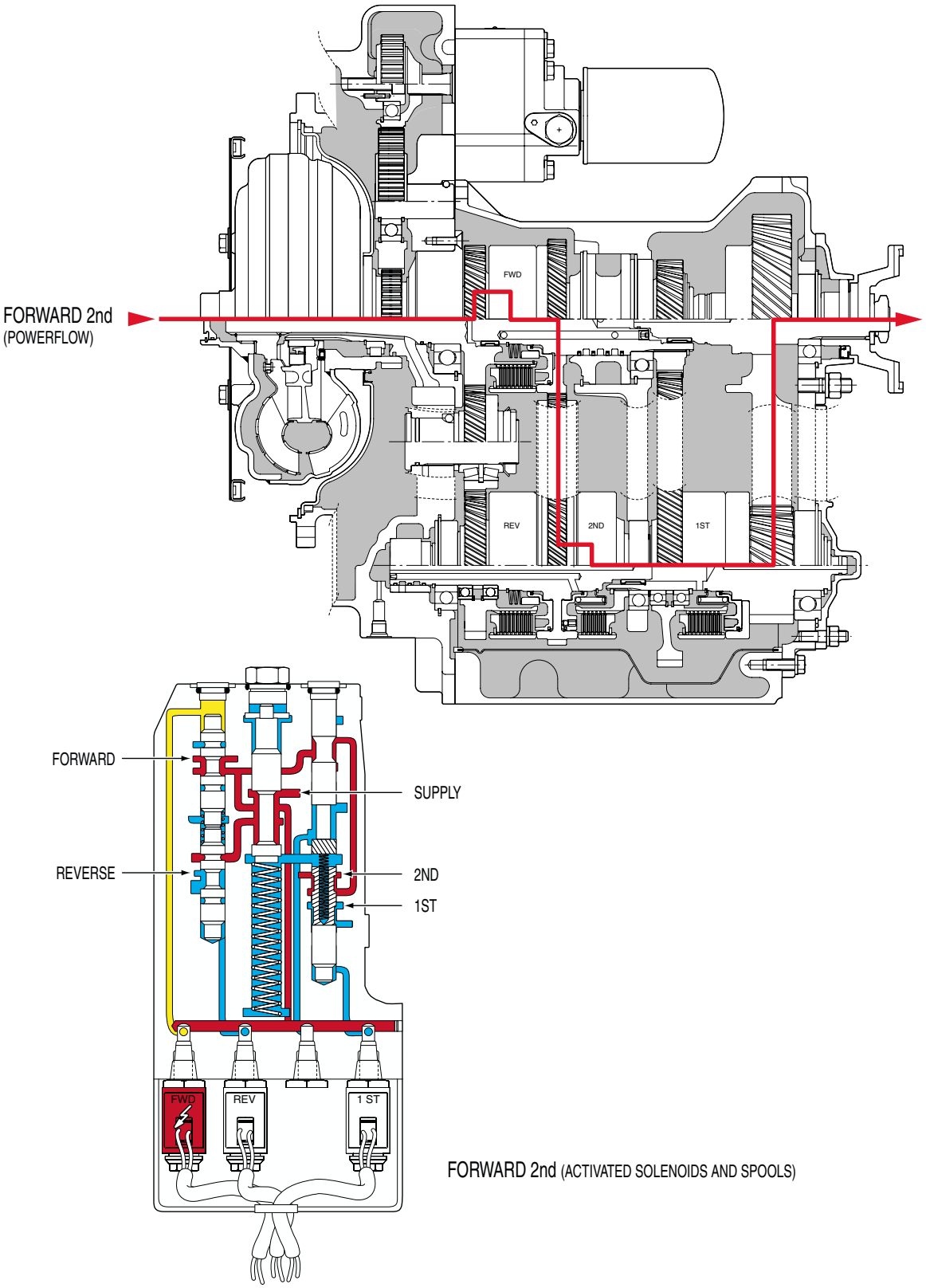
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6.3.1.2 Forward 1st speed (continued)



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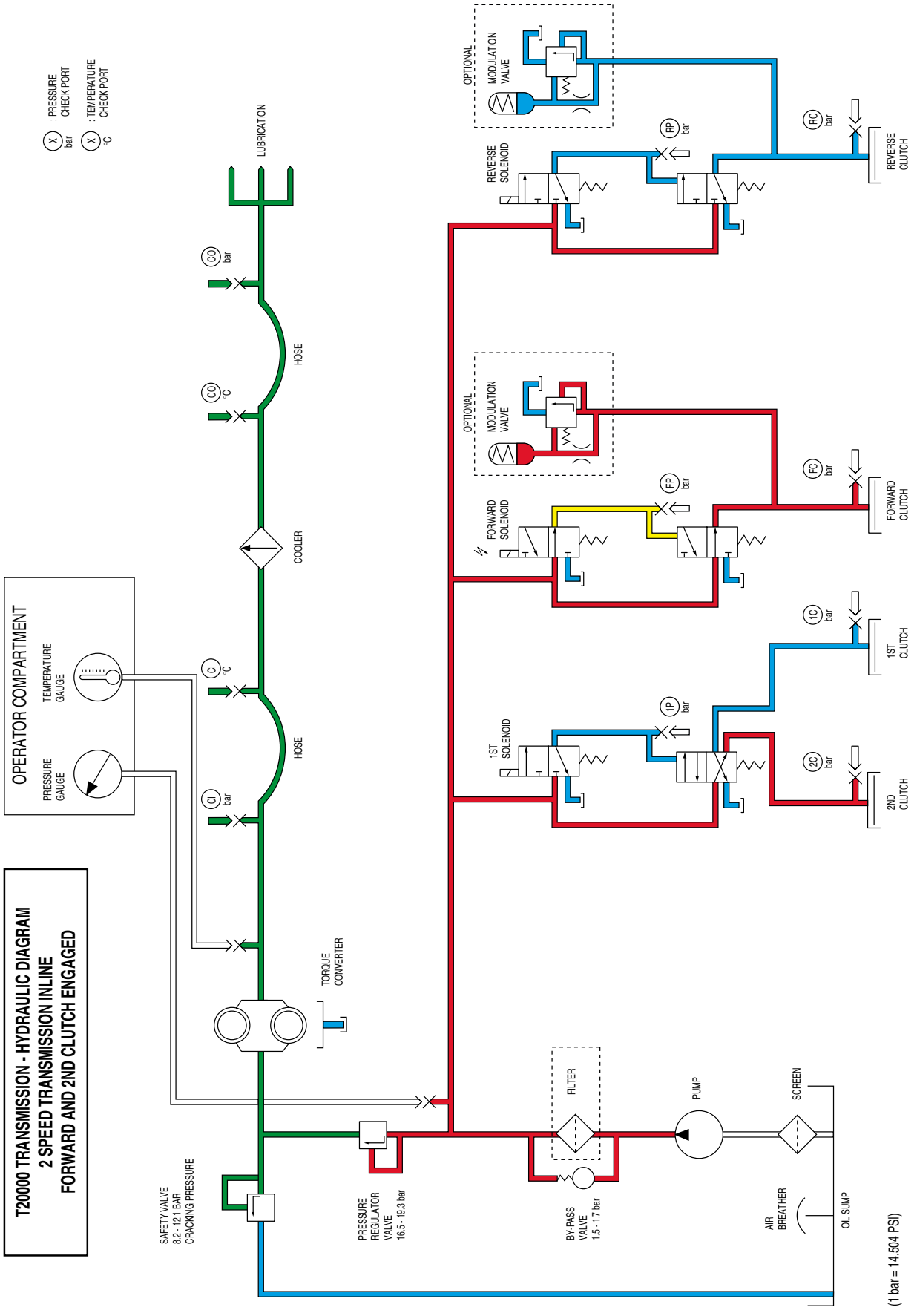
6.3.1.3 Forward 2nd speed



FORWARD 2nd (ACTIVATED SOLENOIDS AND SPOOLS)

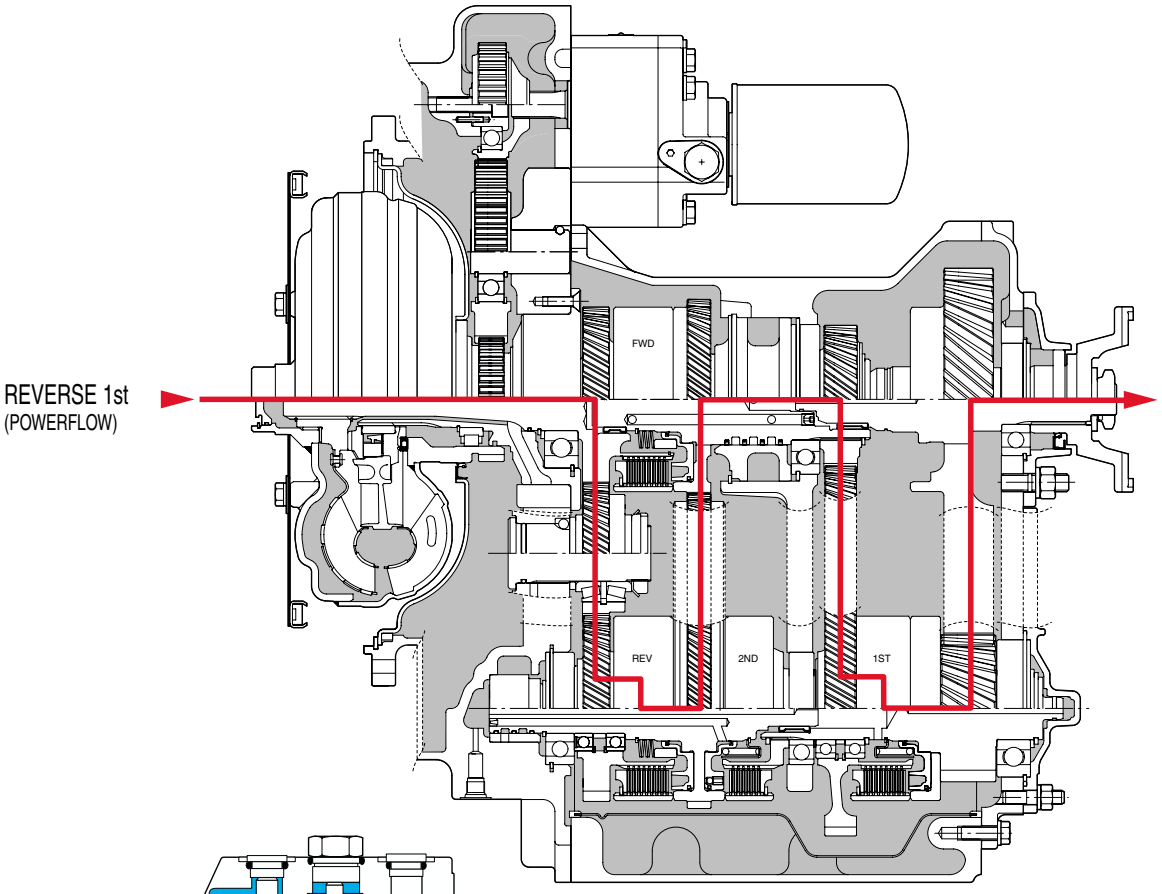
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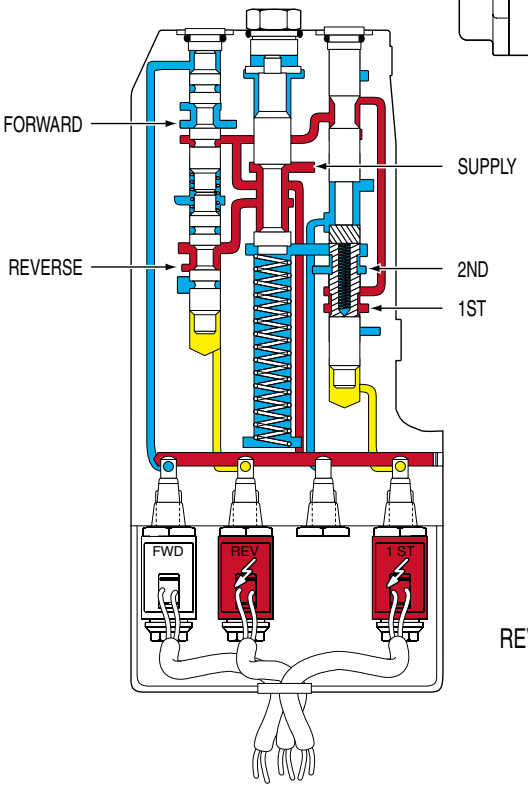
6.3.1.3 Forward 2nd speed (continued)



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6.3.1.4 Reverse 1st speed

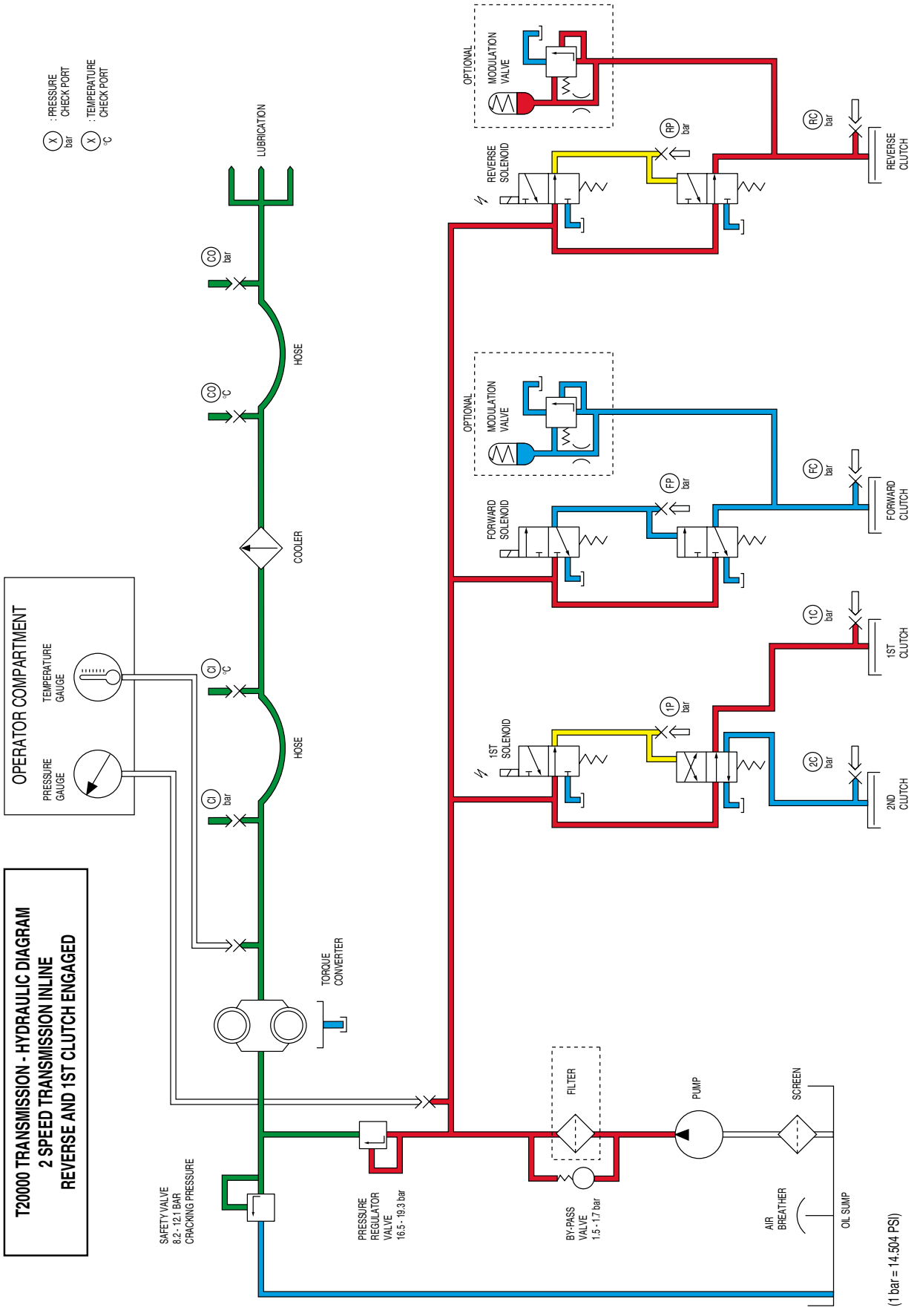




REVERSE 1st (ACTIVATED SOLENOIDS AND SPOOLS)

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6.3.1.4 Reverse 1st speed (continued)

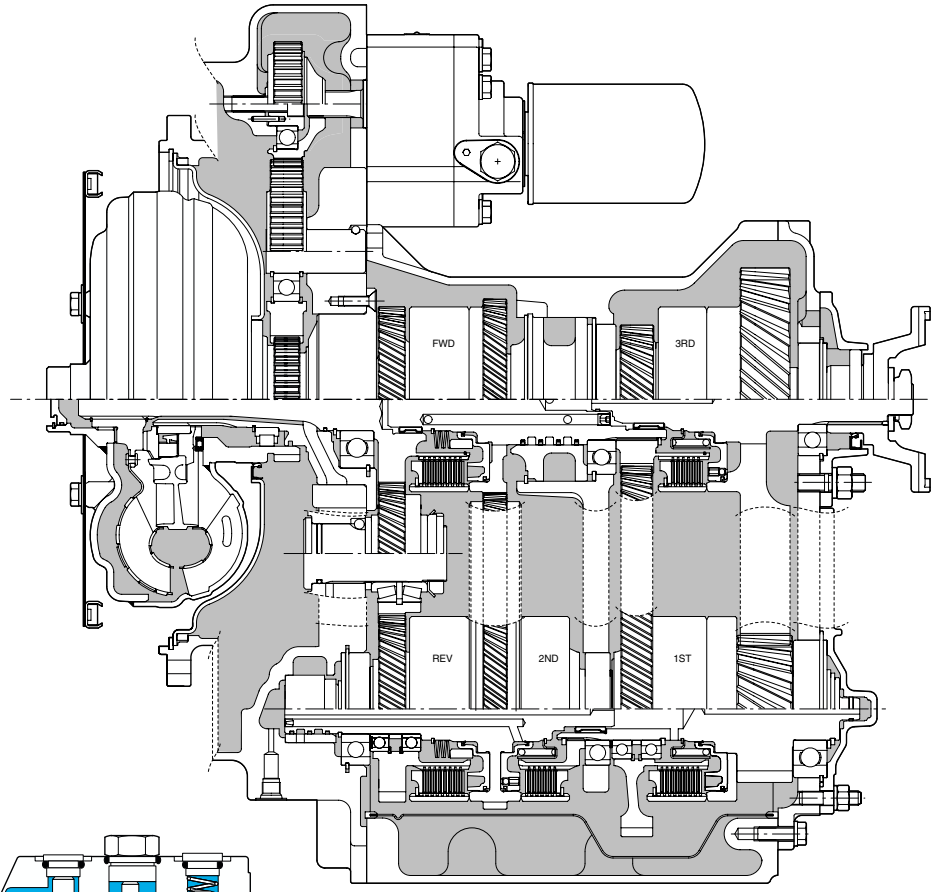


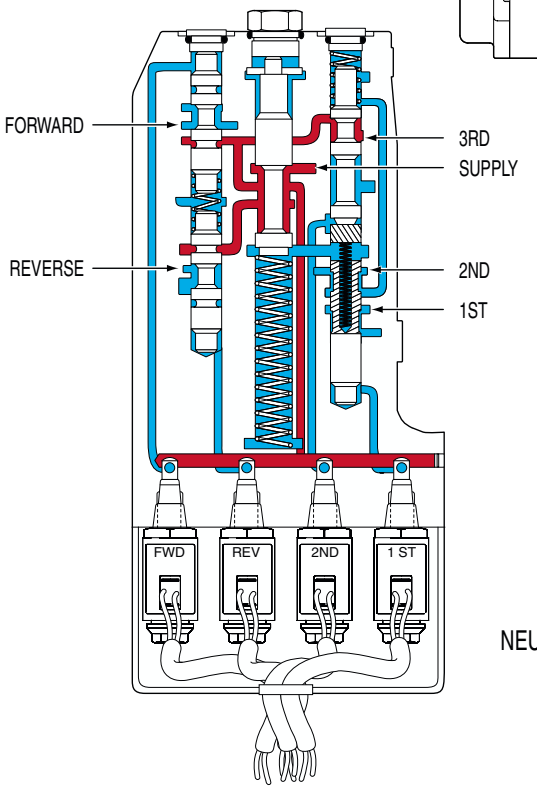
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6.3.2 3-Speed transmission

6.3.2.1 Neutral and 3rd clutch engaged

NEUTRAL 3rd
(POWERFLOW)

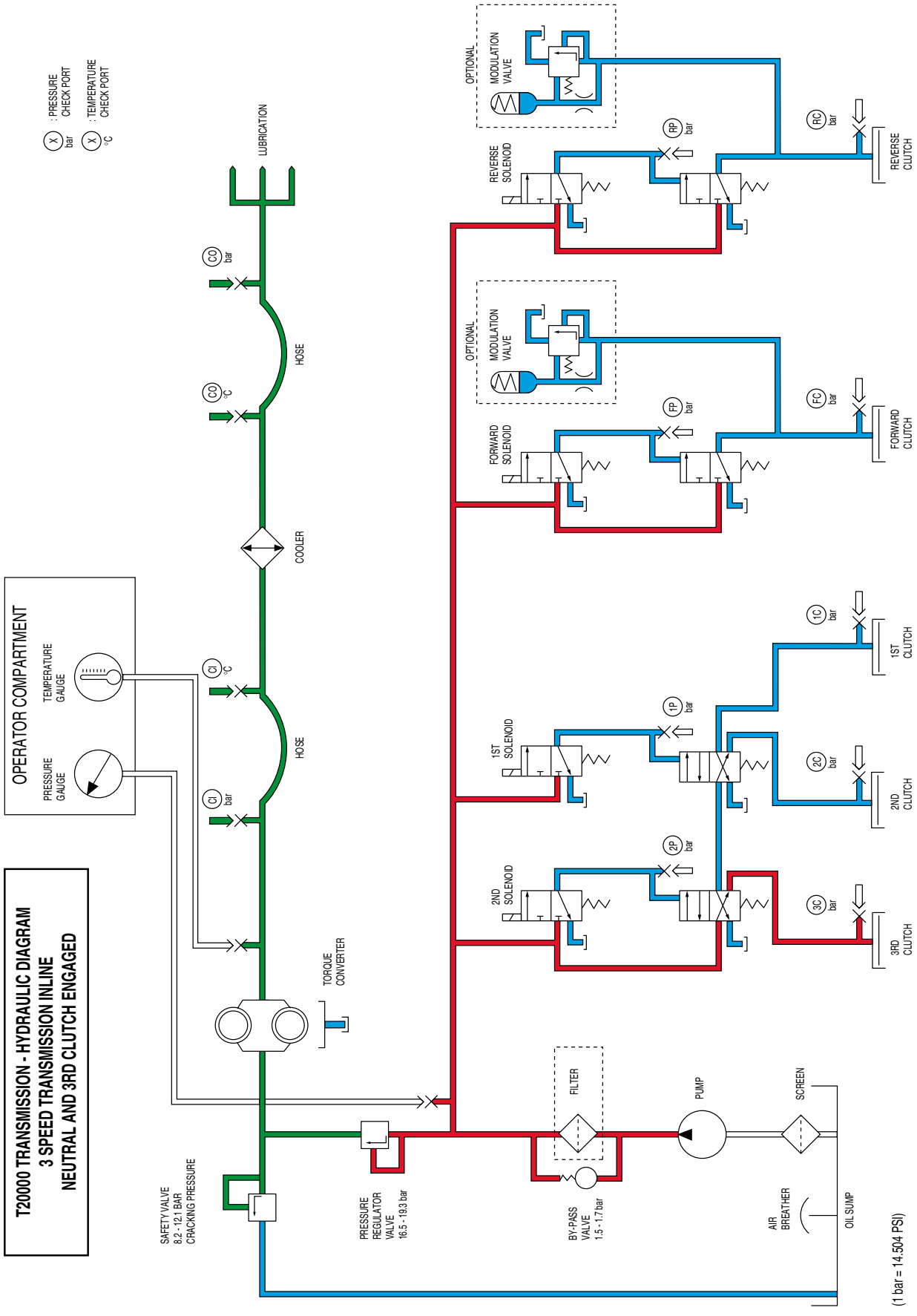




NEUTRAL 3rd (ACTIVATED SOLENOIDS AND SPOOLS)

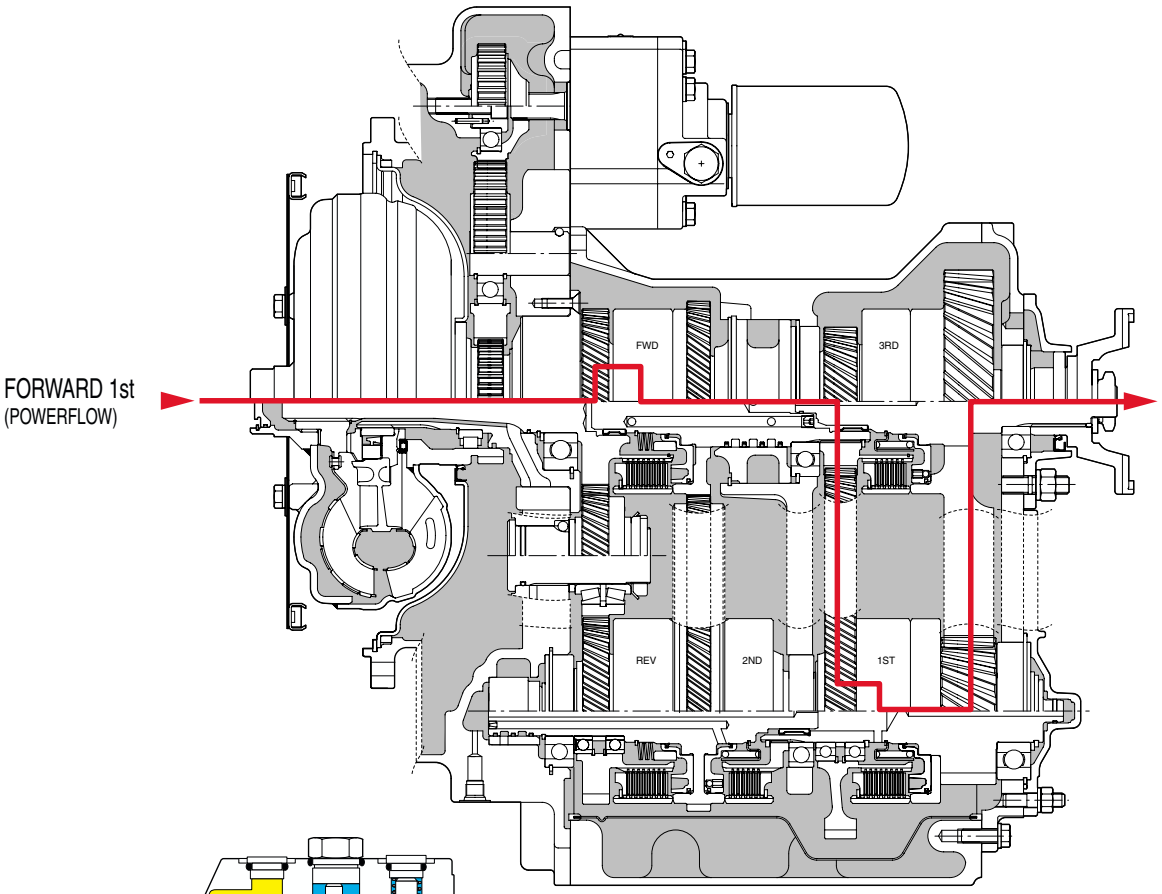
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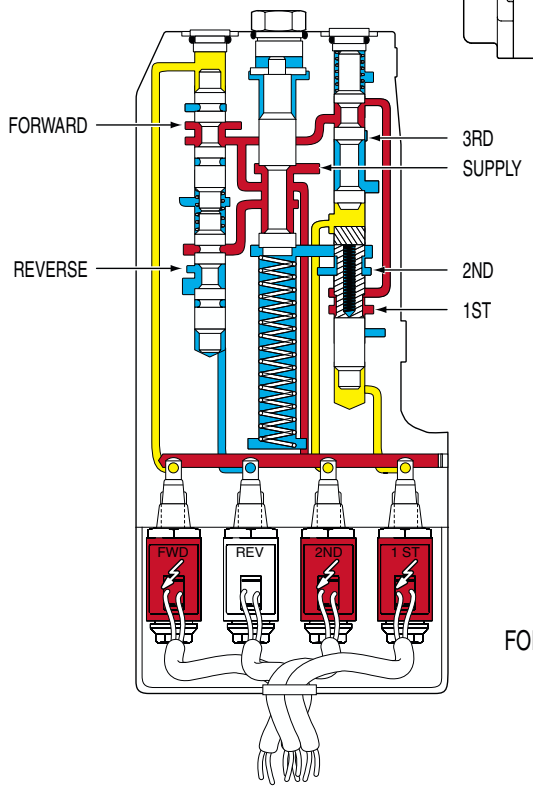
6.3.2.1 Neutral and 3rd clutch engaged (continued)



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6.3.2.2 Forward 1st speed

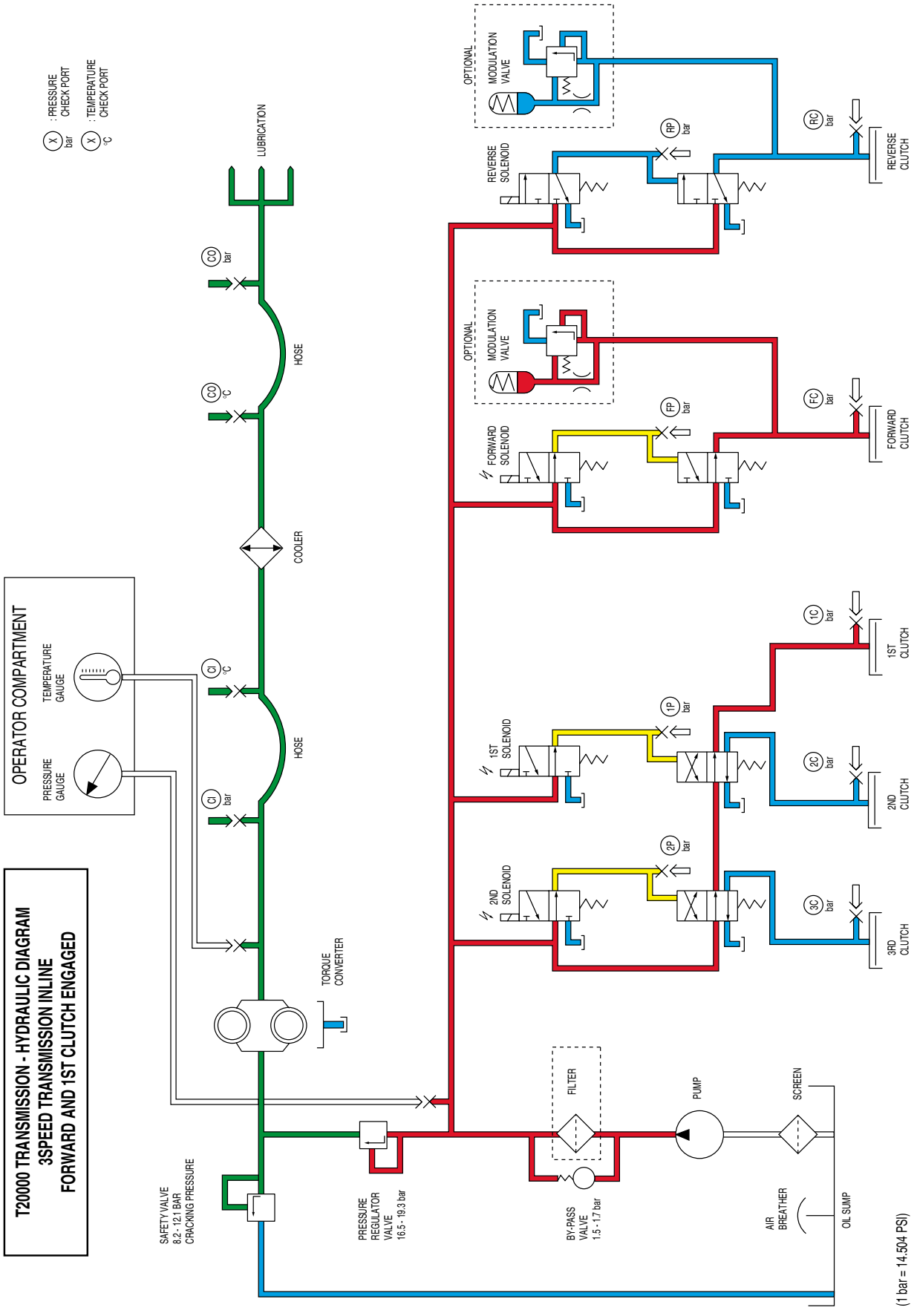




FORWARD 1st (ACTIVATED SOLENOIDS AND SPOOLS)

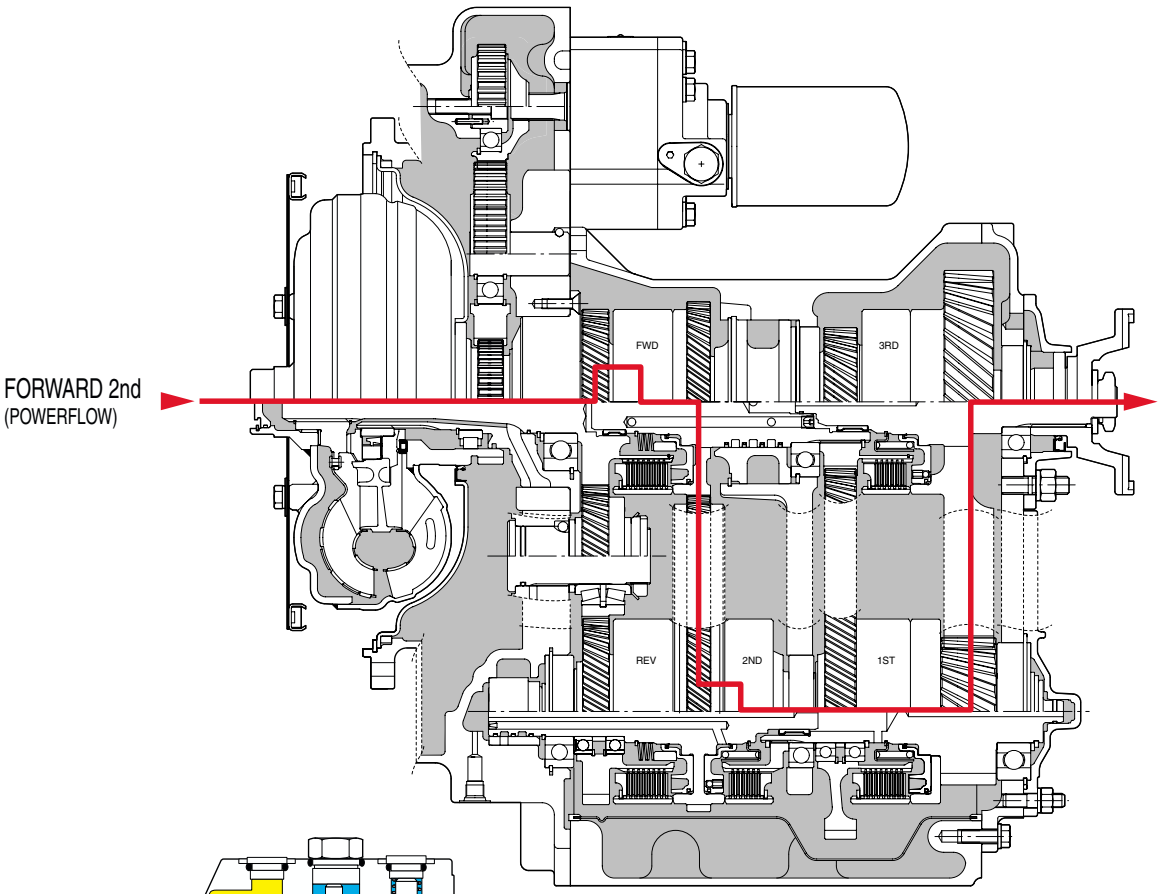
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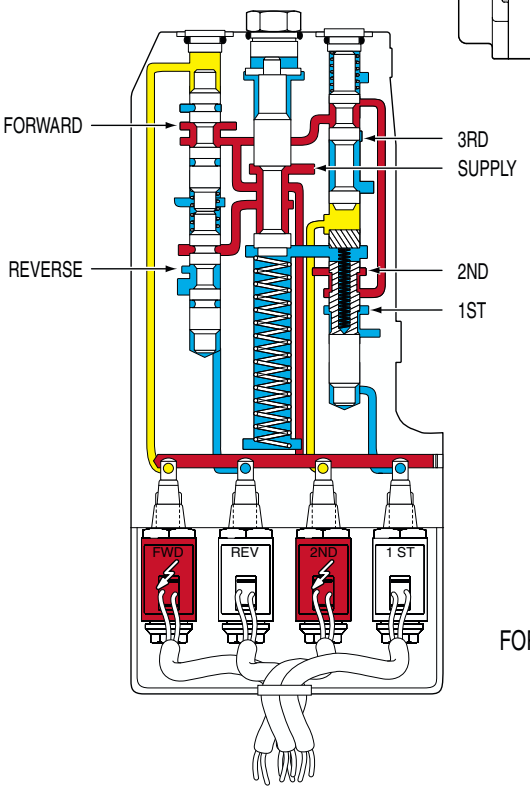
6.3.2.2 Forward 1st speed (continued)



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6.3.2.3 Forward 2nd speed

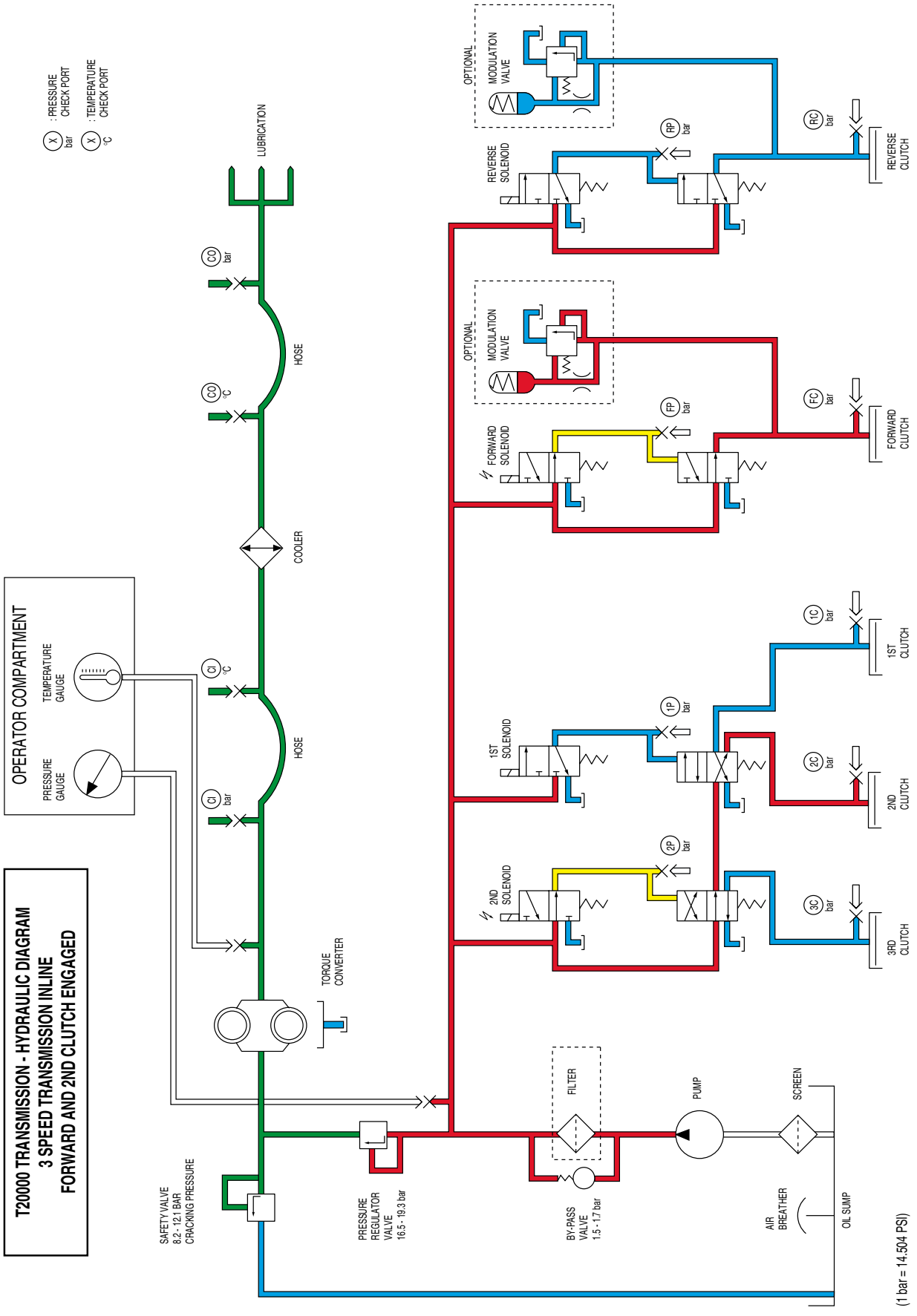




FORWARD 2nd (ACTIVATED SOLENOIDS AND SPOOLS)

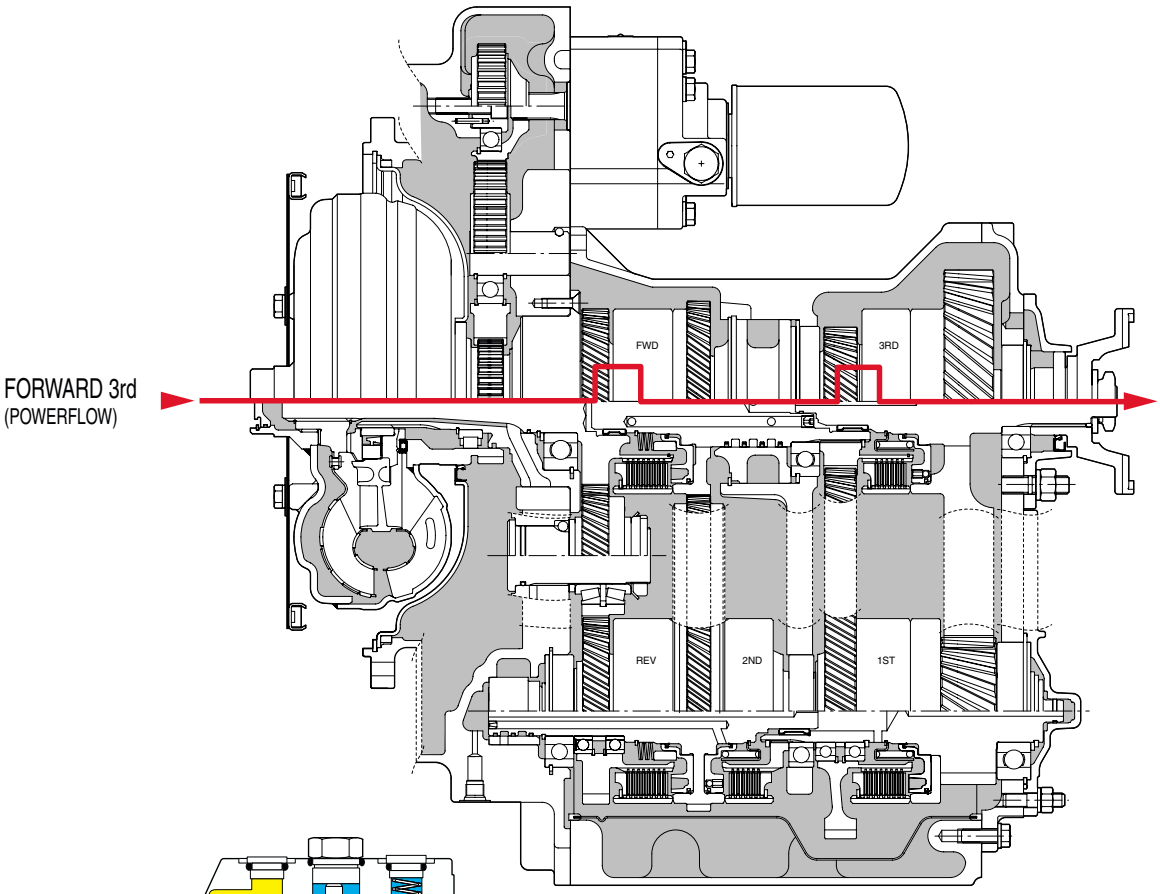
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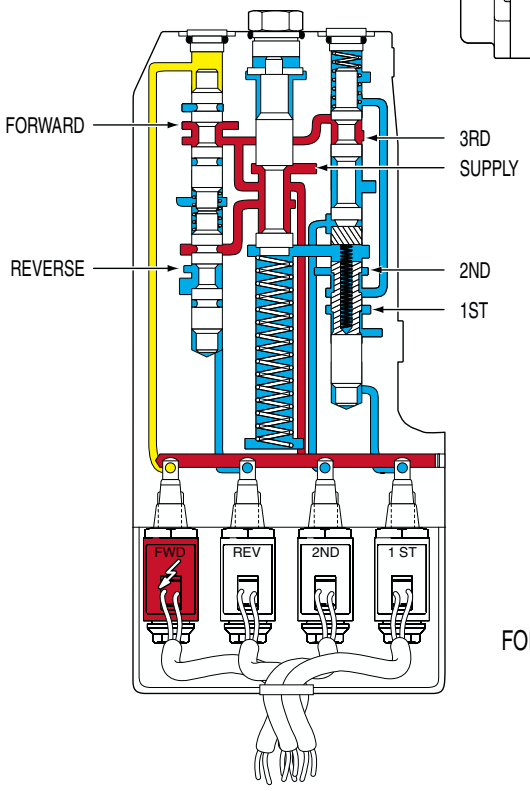
6.3.2.3 Forward 2nd speed (continued)



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6.3.2.4 Forward 3rd speed

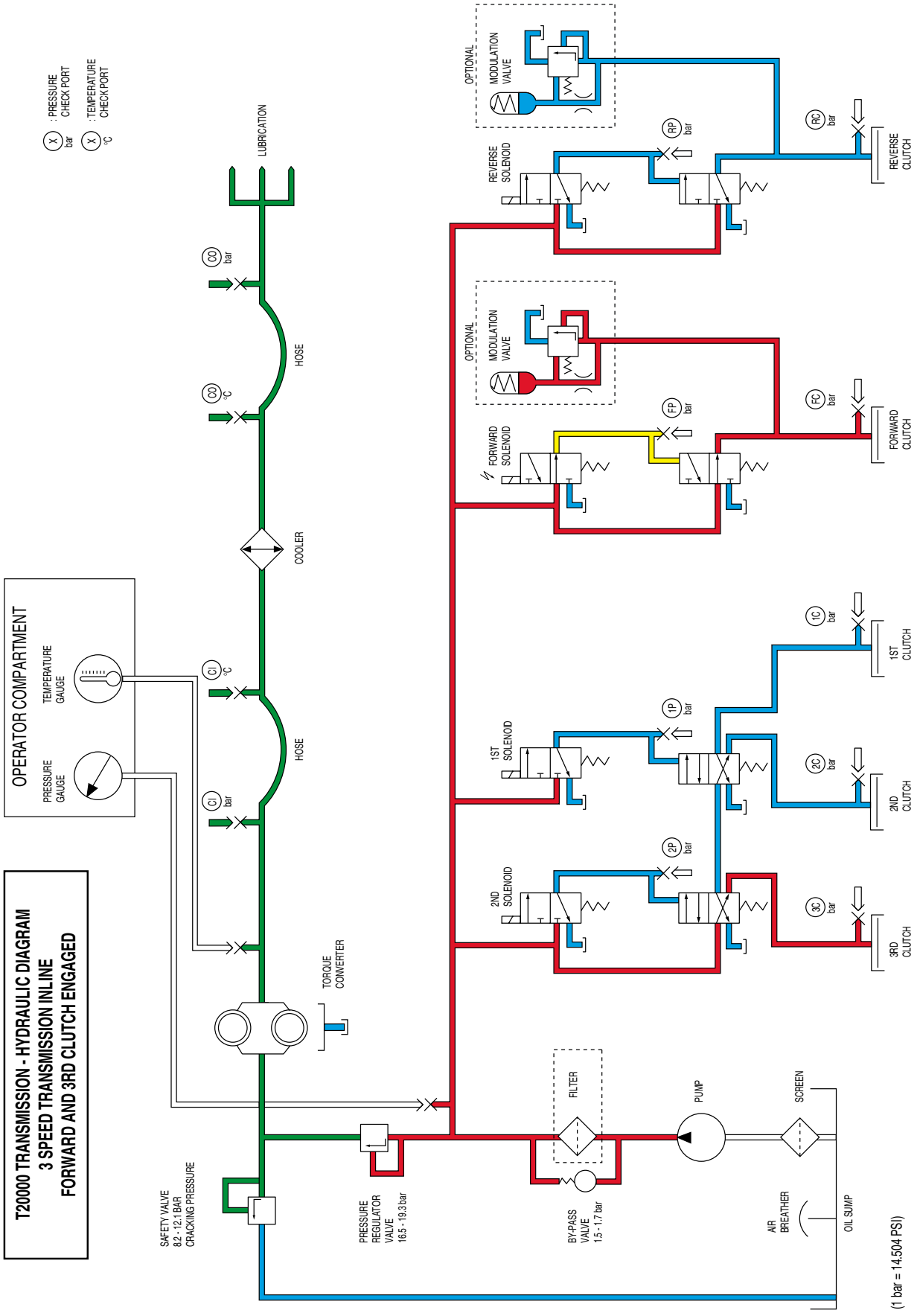




FORWARD 3rd (ACTIVATED SOLENOIDS AND SPOOLS)

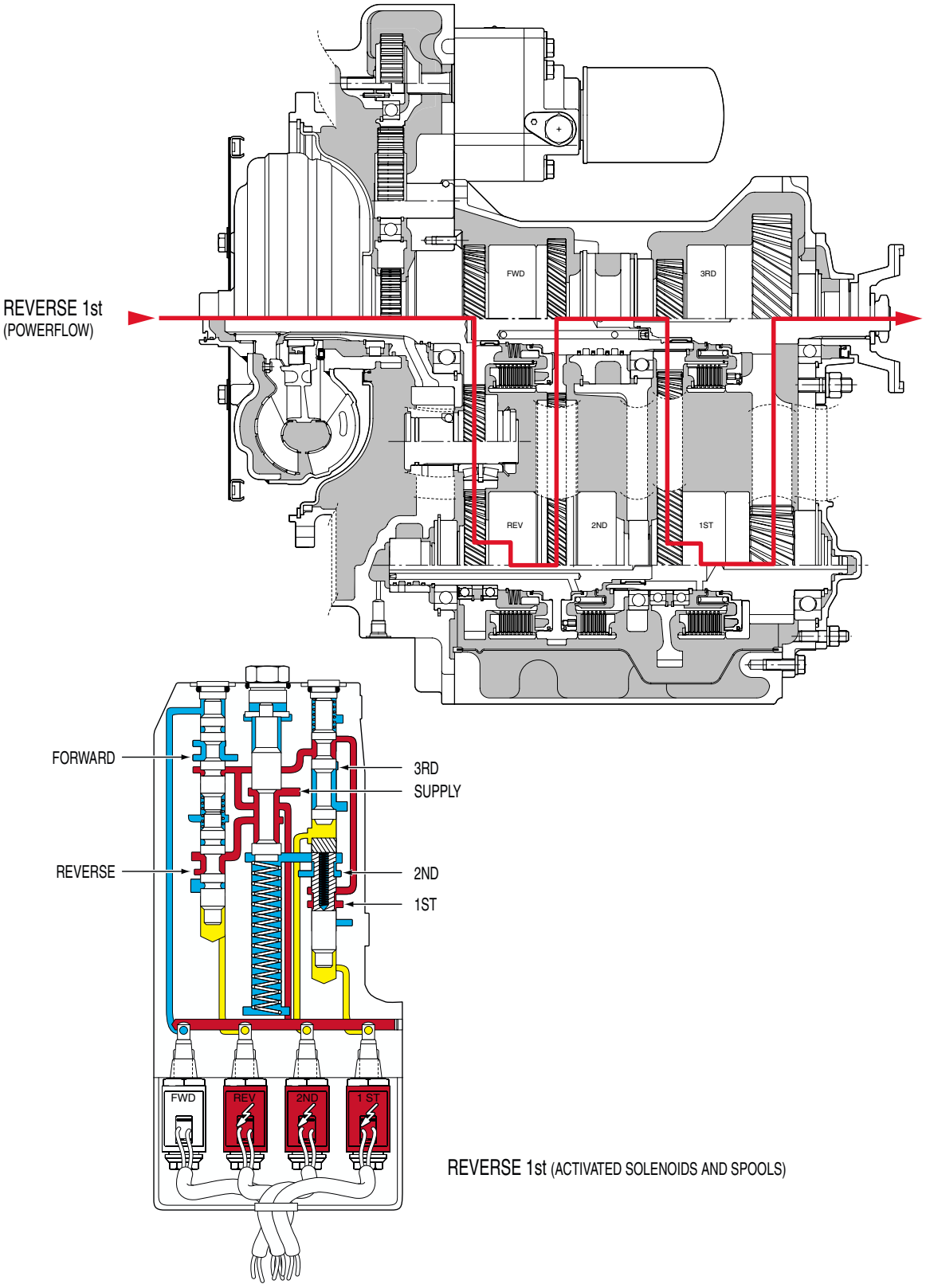
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6.3.2.4 Forward 3rd speed (continued)



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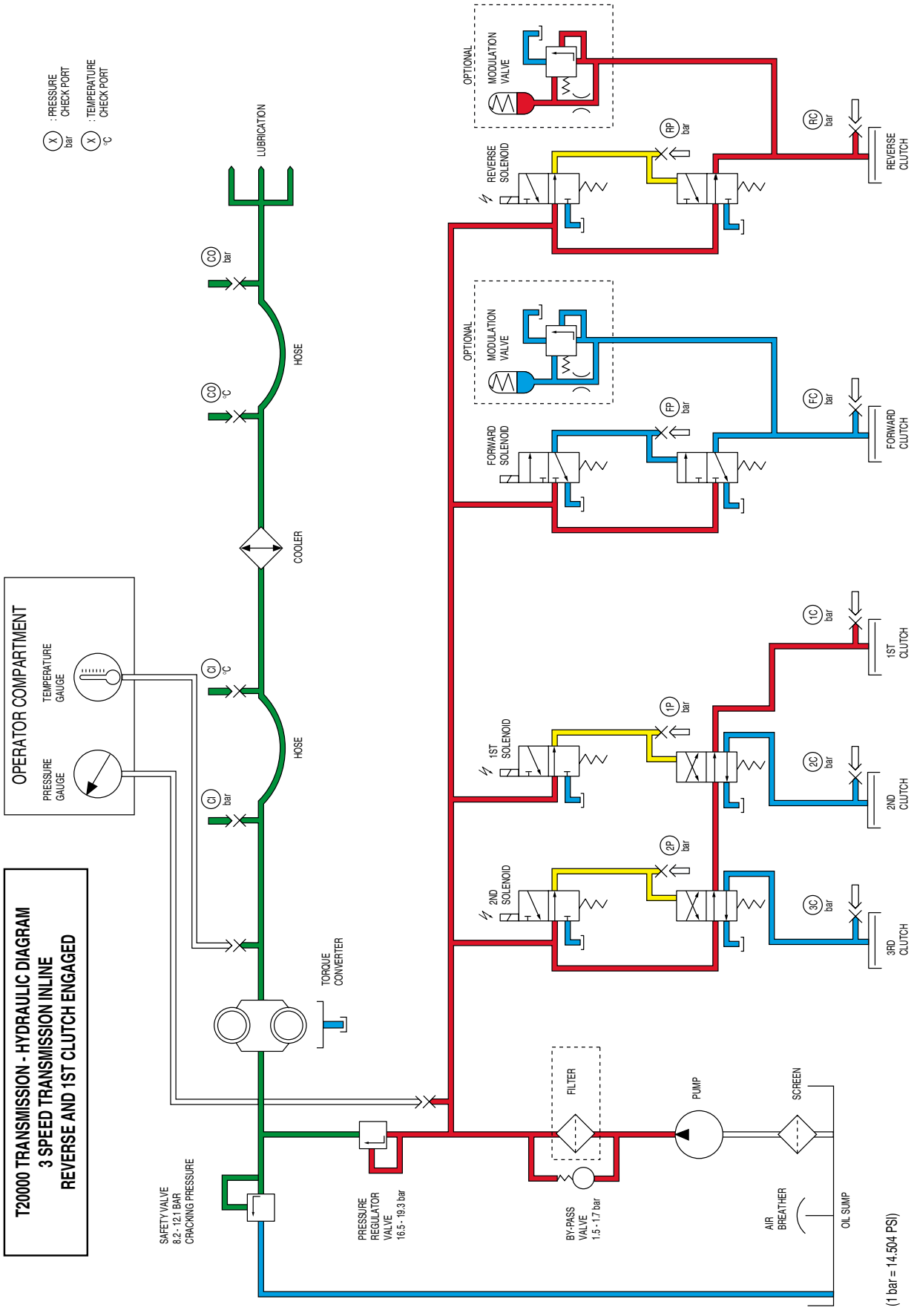
6.3.2.5 Reverse 1st speed



REVERSE 1st (ACTIVATED SOLENOIDS AND SPOOLS)

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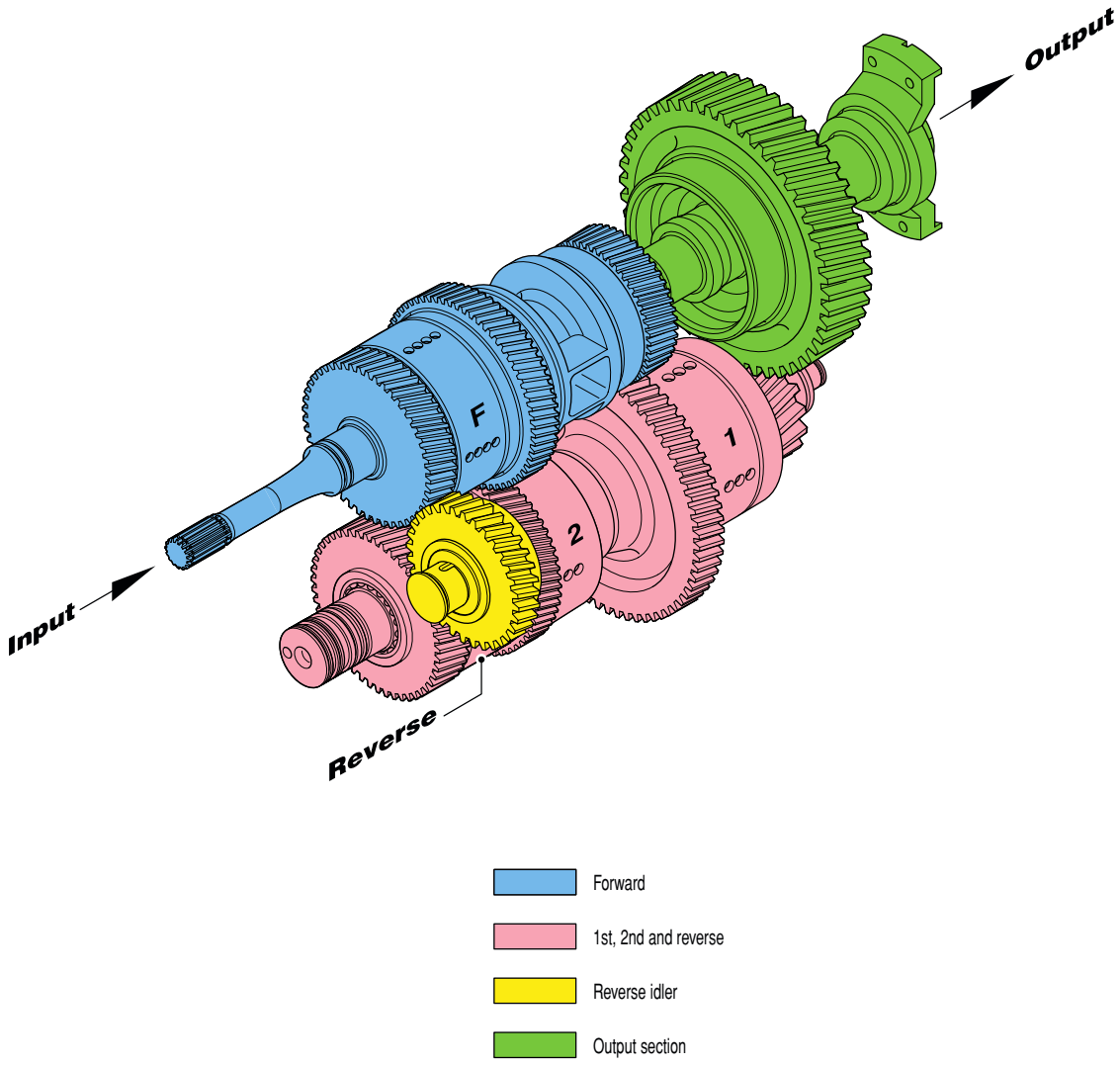
6.3.2.5 Reverse 1st speed (continued)



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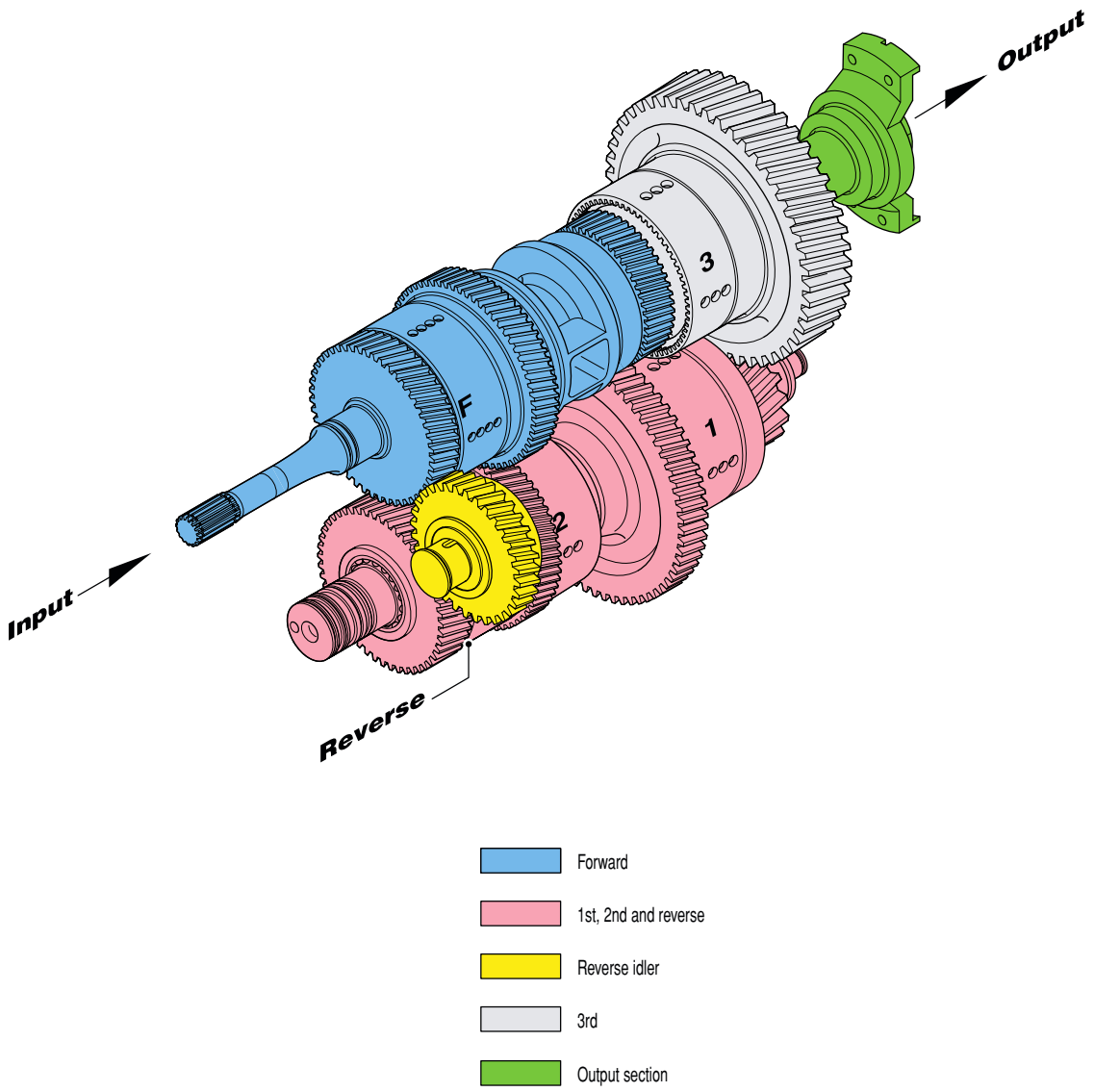
6.4 GEAR AND CLUTCH LAY-OUT

6.4.1 2-Speed transmission



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6.4.2 3-Speed transmission



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7. TROUBLESHOOTING GUIDE FOR THE T20000 TRANSMISSION

The following information is presented as an aid to isolating and determining the specific problem area in a transmission that is not functioning correctly.

When troubleshooting a “transmission” problem, it should be kept in mind that the transmission is only the central unit of a group of related powertrain components. Proper operation of the transmission depends on the condition and correct functioning of the other components of the group. Therefore, to properly diagnose a suspected problem in the transmission, it is necessary to consider the transmission fluid, charging pump, torque converter, transmission assembly, oil cooler, filter, connecting lines, and controls, including the engine, as a complete system.

By analysing the principles of operation together with the information in this section, it should be possible to identify and correct any malfunction which may occur in the system.

7.1 T20000 TRANSMISSION

T20000 (power shift with torque converter transmission) troubles fall into three general categories:

1. Mechanical problems.

2. Hydraulic problems.

3. Electrical problems.

In addition to the mechanical and electrical components, all of which must be in the proper condition and functioning correctly, the correct functioning of the hydraulic circuit is most important. Transmission fluid is the “life blood” of the transmission. It must be supplied in an adequate quantity and delivered to the system at the correct pressures to ensure converter operation, to engage and hold the clutches from slipping, and to cool and lubricate the working components.

7.2 TROUBLESHOOTING PROCEDURES

7.2.1 Stall Test

A stall test to identifies transmission, converter, or engine problems.

Use following procedure:

1. Put the vehicle against a solid barrier, such as a wall, and/or apply the parking brake and block the wheels.

2. Put the directional control lever in FORWARD (or REVERSE, as applicable).

3. Select the highest speed.
   With the engine running, slowly increase engine speed to approximately one-half throttle and hold until transmission (converter outlet) oil temperature reaches the operating range.



CAUTION

DO NOT OPERATE THE CONVERTER AT STALL CONDITION LONGER THAN 30 SECONDS AT ONE TIME, SHIFT TO NEUTRAL FOR 15 SECONDS AND REPEAT THE PROCEDURE UNTIL DESIRED TEMPERATURE IS REACHED.
EXCESSIVE TEMPERATURE 120 °C (250 F) MAXIMUM WILL CAUSE DAMAGE TO TRANSMISSION CLUTCHES, FLUID, CONVERTER, AND SEALS.

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7.2.2 Transmission pressure checks

Transmission problems can be isolated by the use of pressure tests. When the stall test indicates slipping clutches, then measure clutch pack pressure to determine if the slippage is due to low pressure or clutch plate friction material failure.

In addition, converter charging pressure and transmission lubrication pressure can also be measured.

7.2.3 Mechanical and electrical checks

Prior to checking any part of the system for hydraulic function (pressure testing), the following mechanical and electrical checks should be made:

- Check the parking brake and inching pedal for correct adjustment.
- Be sure all lever linkage is properly connected and adjusted in each segment and at all connecting points.
- The controls are actuated electrically. Check the wiring and electrical components.
- Be sure that all components of the cooling system are in good condition and operating correctly. The radiator must be clean to maintain the proper cooling and operating temperatures for the engine and transmission. Air clean the radiator, if necessary.
- The engine must be operating correctly. Be sure that it is correctly tuned and adjusted to the correct idle and maximum no-load governed speed specifications.

7.2.4 Hydraulic checks

Also, before checking the transmission clutches, torque converter, charging pump, and hydraulic circuit for pressure and rate of oil flow, it is important to make the following transmission fluid check:

Check oil level in the transmission. The transmission fluid must be at the correct (full level). All clutches and the converter and its fluid circuit lines must be fully charged (filled) at all times.

Note

THE TRANSMISSION FLUID MUST BE AT OPERATING TEMPERATURE OF 82 - 93 °C (180 - 200 F) TO OBTAIN CORRECT FLUID LEVEL AND PRESSURE READINGS.
DO NOT ATTEMPT TO MAKE THESE CHECKS WITH COLD OIL.

To raise the oil temperature to this specification it is necessary to either operate (work) the vehicle or run the engine with converter at “stall” (Refer to 7.2.1 “Stall test”).

CAUTION

BE CAREFUL THAT THE VEHICLE DOES NOT MOVE UNEXPECTEDLY WHEN OPERATING THE ENGINE AND CONVERTER AT STALL RPM.

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7.3 TROUBLESHOOTING GUIDE

Refer to the following troubleshooting guide for the diagnosis of typical transmission troubles.

7.3.1 Low clutch pressure

Cause	Remedy
1. Low oil level.	1. Fill to proper level.
2. Clutch pressure regulating valve stuck open.	2. Clean valve spool and housing.
3. Faulty charging pump.	3. Replace pump.
4. Broken or worn clutch shaft or piston sealing rings.	4. Replace sealing rings.
5. Clutch piston bleed valve stuck open.	5. Clean bleed valves thoroughly.

7.3.2 Low charging pump output

Cause	Remedy
1. Low oil level.	1. Fill to proper level.
2. Suction screen plugged.	2. Clean suction pump.
3. Defective charging pump.	3. Replace pump.

7.3.3 Overheating

Cause	Remedy
1. Worn oil sealing rings.	1. Remove, disassemble, and rebuild converter assembly.
2. Worn charging pump.	2. Replace charging pump.
3. Low oil level.	3. Fill to proper level.
4. Dirty oil cooler.	4. Clean cooler.
5. Restriction in cooler lines.	5. Change cooler lines.

7.3.4 Noisy converter

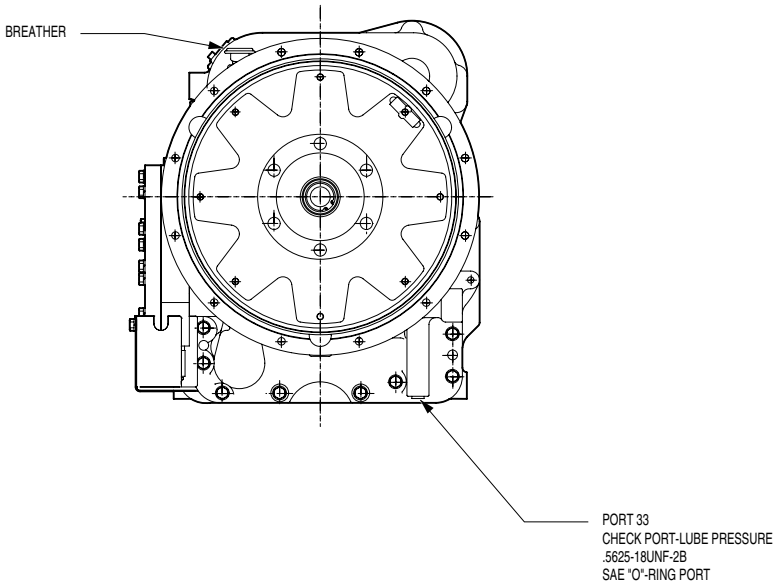
Cause	Remedy
1. Worn charging pump.	1. Replace charging pump.
2. Worn or damaged bearings.	2. A complete disassembly will be necessary to determine which bearing is faulty.

7.3.5 Lack of power

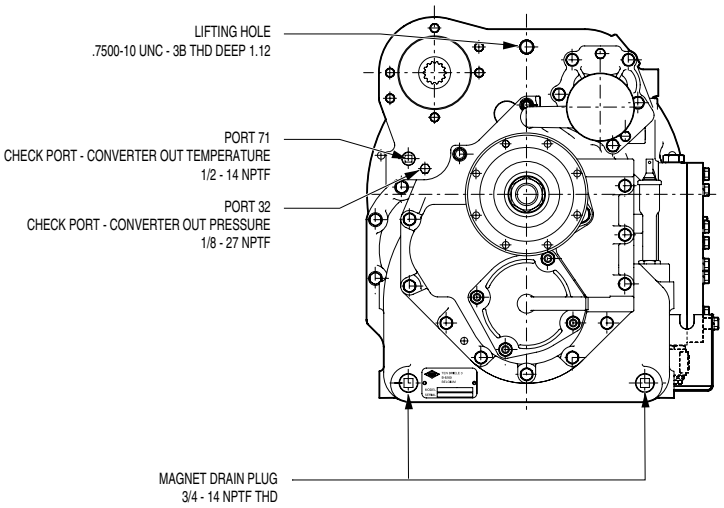
Cause	Remedy
1. Low engine RPM at converter stall.	1. Tune engine check governor.
2. See “Overheating” and make same checks.	2. Make corrections as explained in “Overheating”.

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7.4 CHECK POINTS



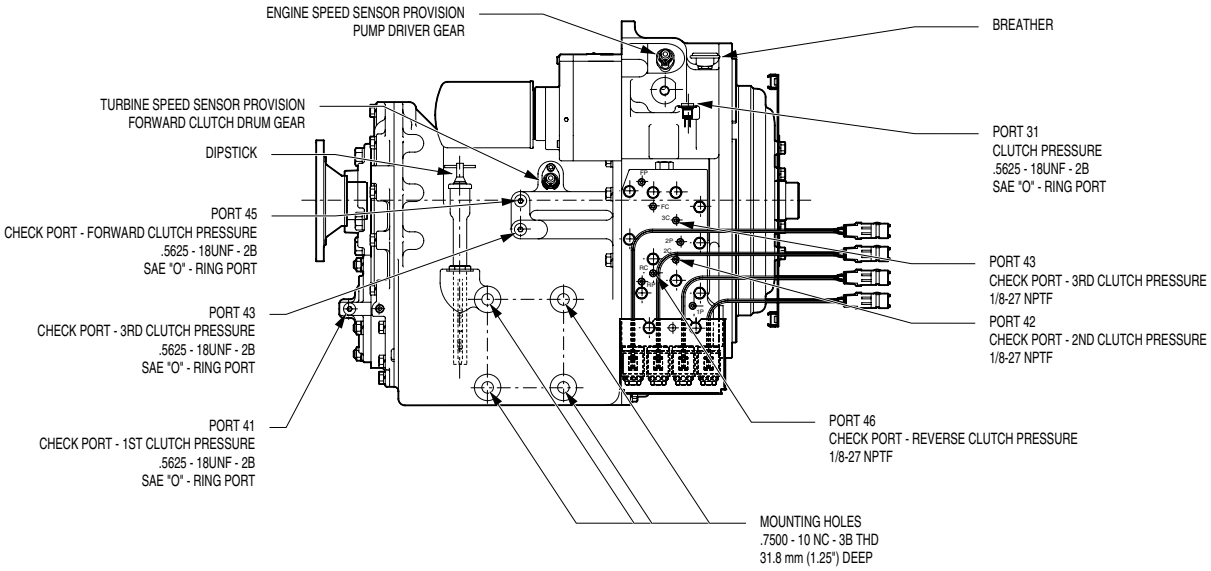
FRONT VIEW



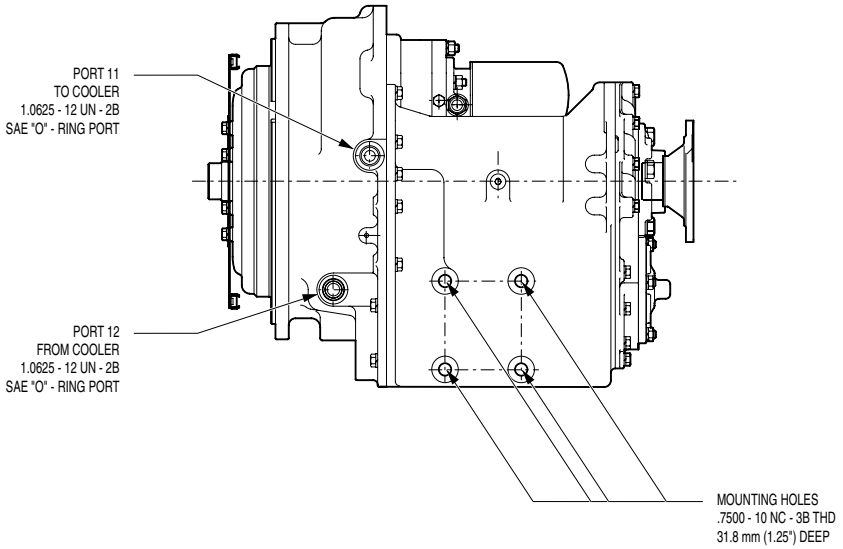
REAR VIEW

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7.4 CHECK POINTS (CONTINUED)



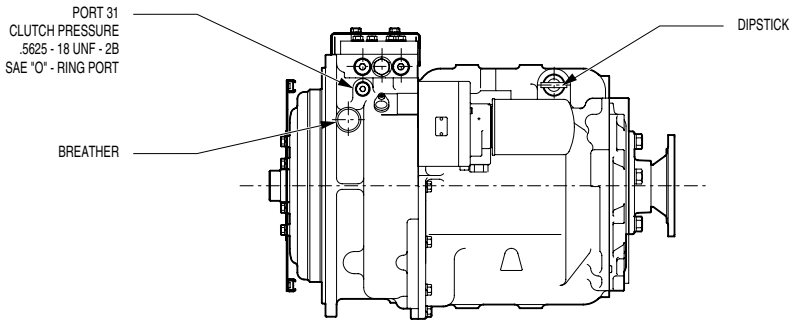
RIGHT SIDE VIEW



LEFT SIDE VIEW

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7.4 CHECK POINTS (CONTINUED)



TOP VIEW

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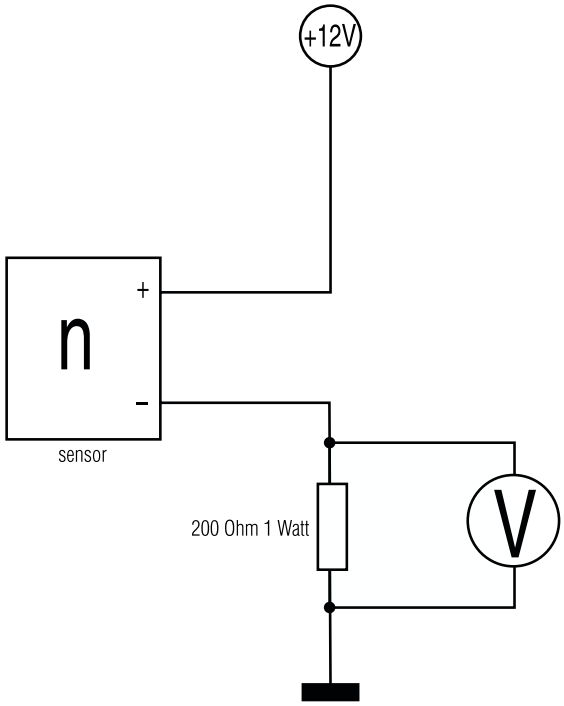
7.5 SPEED SENSOR - STATIC STANDALONE TEST

In order to be able to sense the currents, a series resistor of e.g. 200 Ohms must be used. This resistor is integrated in the controller, but when the sensor is to be tested, it must be connected externally.

The idea is to connect the sensor to an external power source and measure the DC voltage across the series resistor.

The voltage reading should be either 1.2V-1.6V (for the 7mA ± 1mA current level) or 2.6-3.0V (for the 14mA ± 1mA current level)

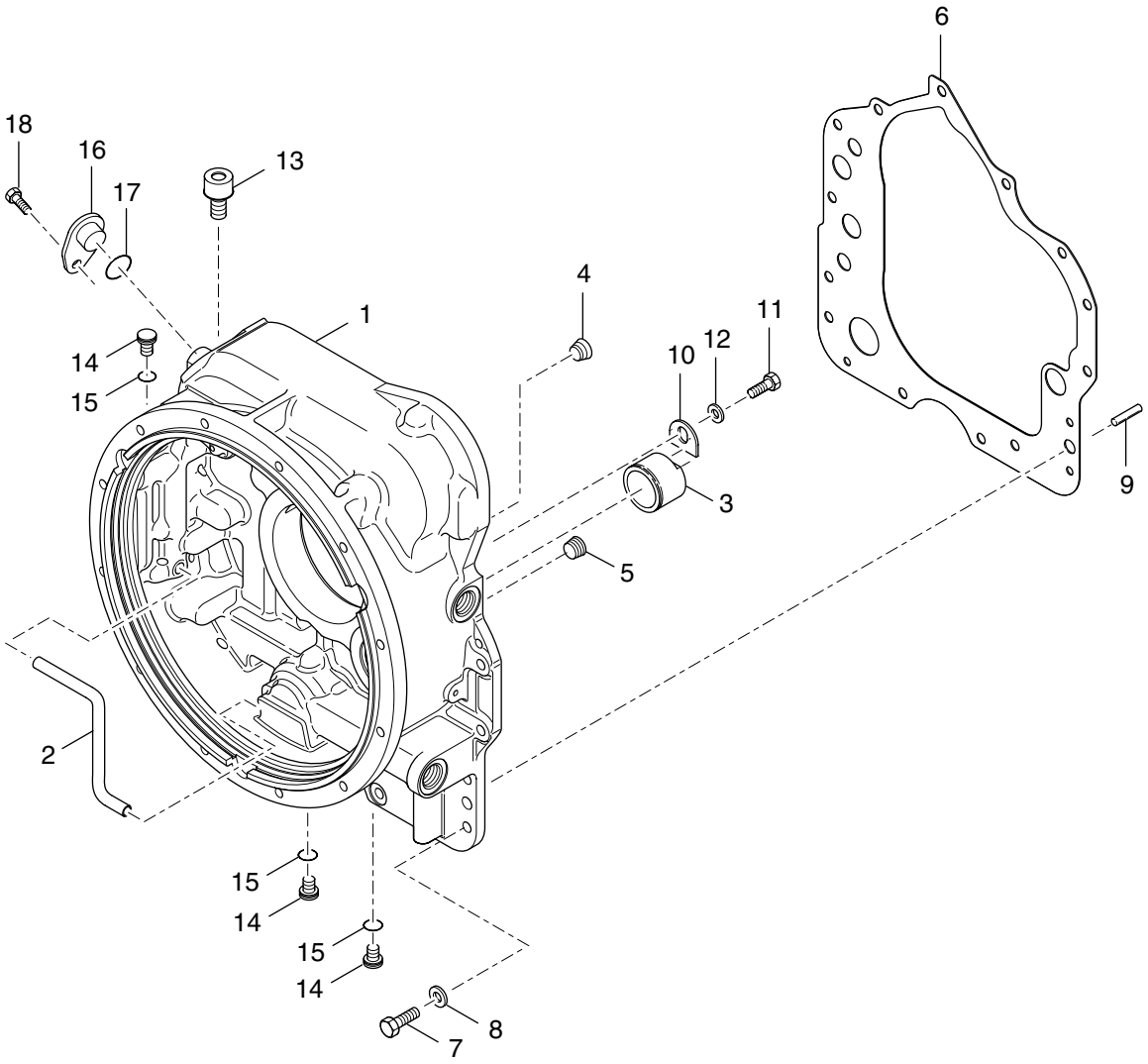
If the teeth can be moved slowly, distinct toggling between the two levels should be noticed.



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8. SECTIONAL VIEWS AND PARTS IDENTIFICATION

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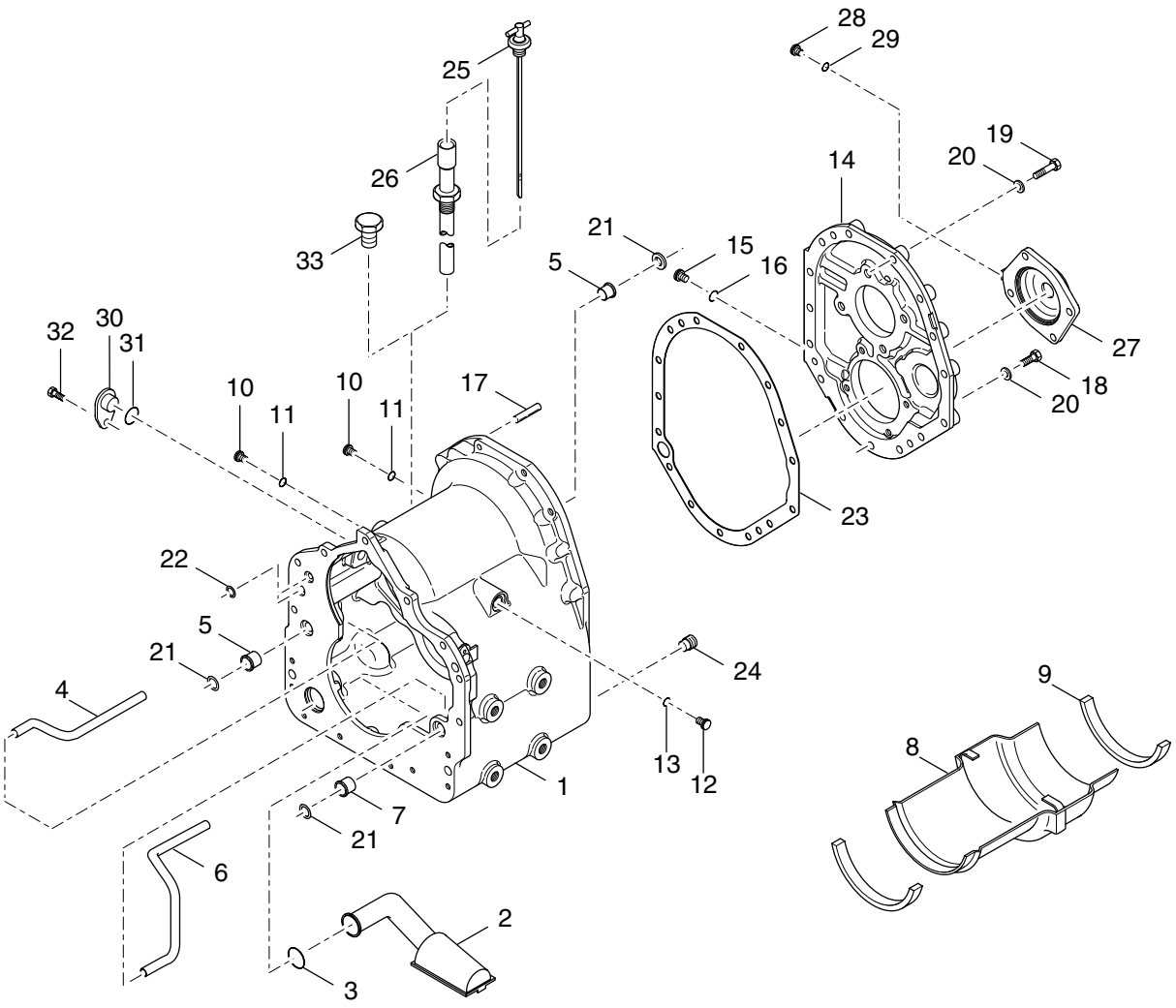


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GROUP - CONVERTER HOUSING

Item	Description	Quantity
1	Housing - Converter	1
2	Tube - Lube	1
3	Sleeve - Converter housing	1
4	Plug - Pipe	1
5	Plug - Pipe	1
6	Gasket - Converter housing to to transmission case	1
7	Screw - Converter housing to transmission case	16
8	Lockwasher - Converter housing to transmission case screw	16
9	Pin - Converter housing to transmission case dowel	1
10	Clip	1
11	Screw - Clip	1
12	Lockwasher - Clip screw	1
13	Air - Breather	1
14	Plug	3
15	“O”-ring	3
16	Plug - Speed sensor port	1
17	“O”-ring - Speed sensor	1
18	Screw - Speed sensor	1

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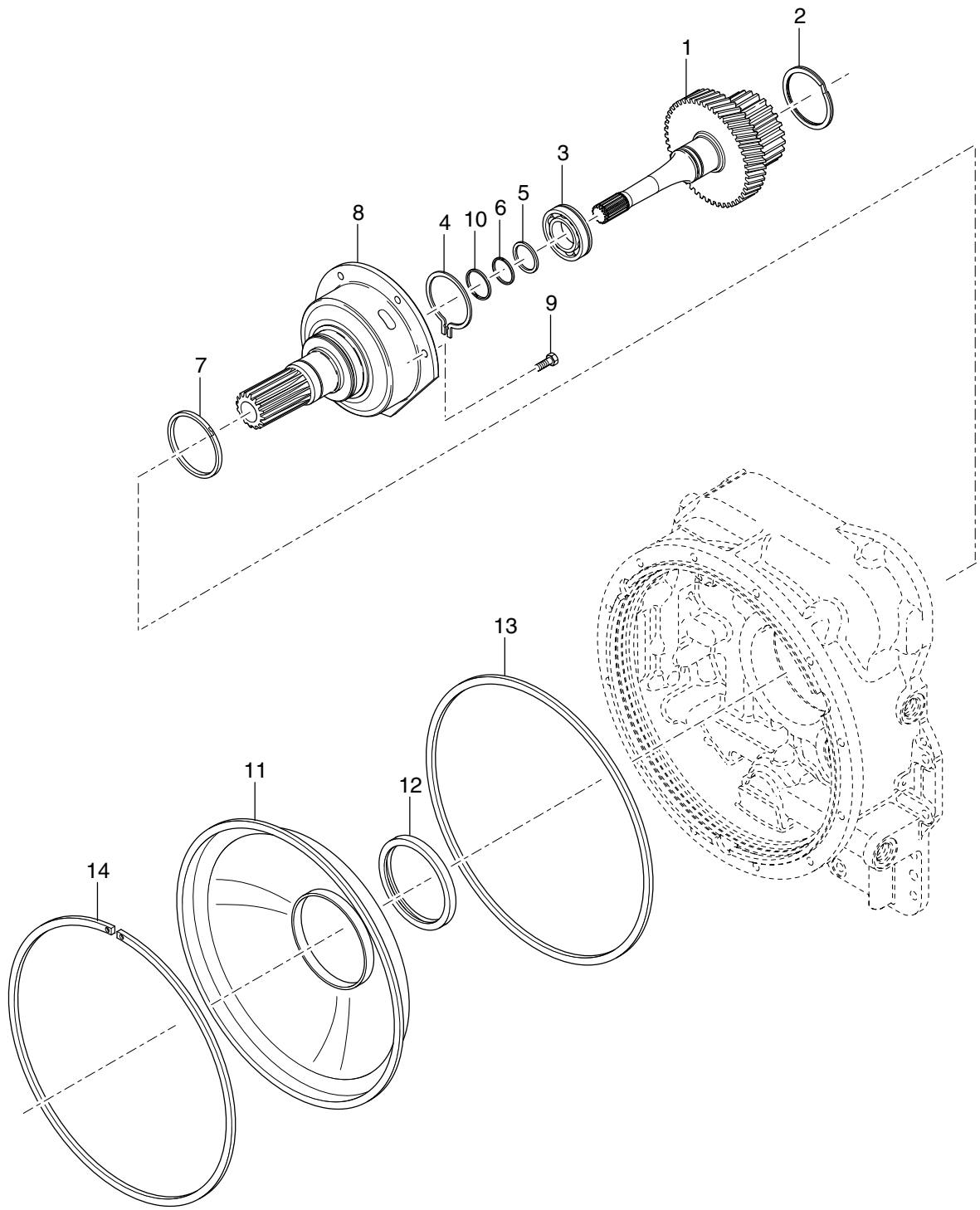


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GROUP -TRANSMISSION CASE AND REAR COVER

Item	Description	Quantity
1	Case - Transmission	1
2	Assembly - Suction tube	1
3	“O”-ring - Suction tube assembly	1
4	Tube - Low speed clutch pressure	1
5	Sleeve - Tube	2
6	Tube - Lube	1
7	Sleeve - Tube	1
8	Oil - Baffle	1
9	Seal - Oil baffle	2
10	Plug	2
11	“O”-ring	2
12	Plug	1
13	“O”-ring	1
14	Cover - Rear	1
15	Plug	1
16	“O”-ring	1
17	Pin - Transmission case to rear cover dowel	2
18	Screw - Rear cover to transmission case	6
19	Screw - Rear cover to transmission case	9
20	Lockwasher - Rear cover to transmission case screw	15
21	“O”-ring - Clutch pressure tube	3
22	“O”-ring - Clutch pressure	2
23	Gasket - Rear cover	1
24	Plug - Magnetic drain	2
25	Dipstick	1
26	Assembly - Dipstick tube	1
27	Cap - Rear bearing	1
28	Plug	1
29	“O”-ring	1
30	Plug - Speed sensor port	1
31	“O”-ring - Speed sensor	1
32	Screw - Speed sensor	1
33	Plug - Dipstick hole	1

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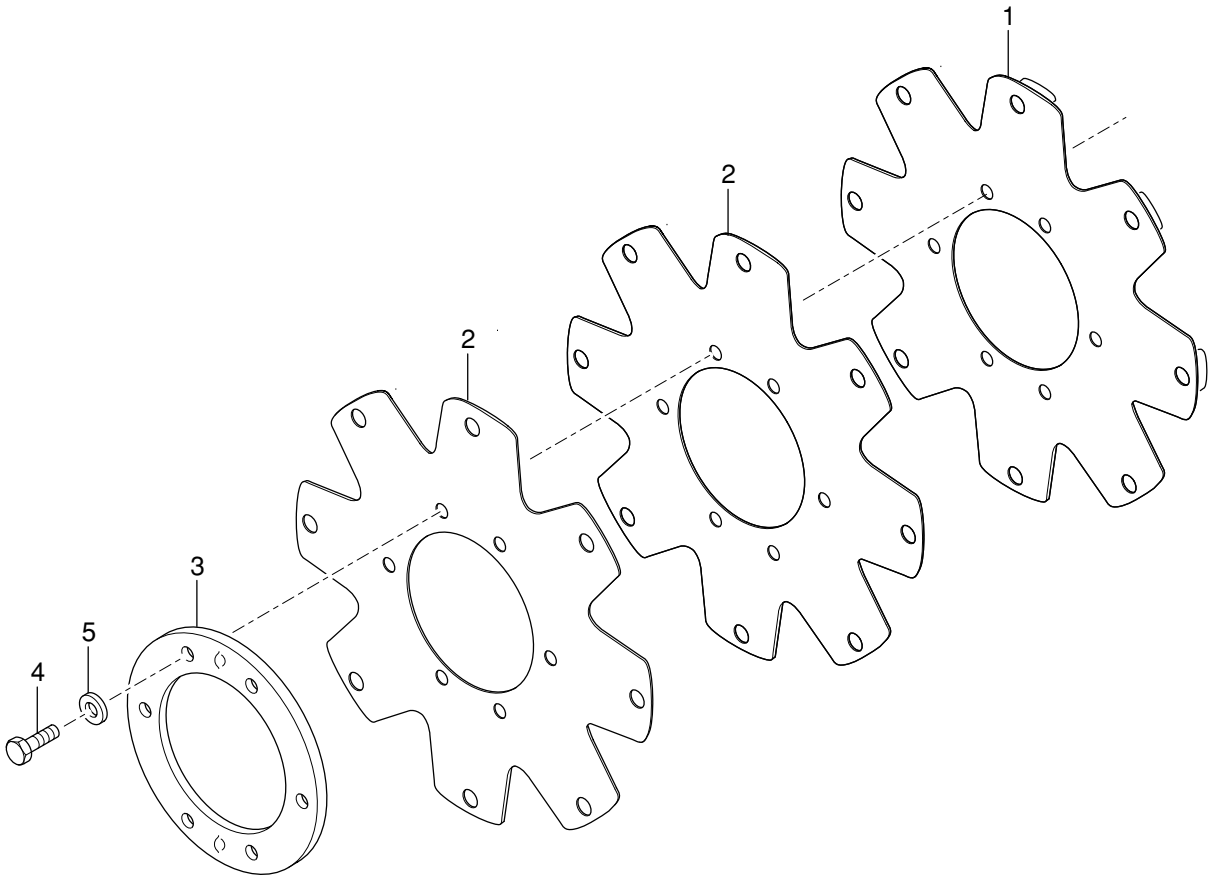


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GROUP - TURBINE SHAFT

Item	Description	Quantity
1	Assembly - Turbine shaft & hub	1
2	Ring - Retaining	1
3	Bearing - Ball	1
4	Snap ring - Bearing	1
5	Washer - Bearing support	1
6	Ring - Bearing retaining	1
7	Ring - Piston	1
8	Support - Stator	1
9	Screw - Stator support	6
10	Ring - Piston	1
11	Baffle - Oil	1
12	Seal - Oil baffle	1
13	Ring - Oil baffle seal	1
14	Ring - Oil baffle retaining	1

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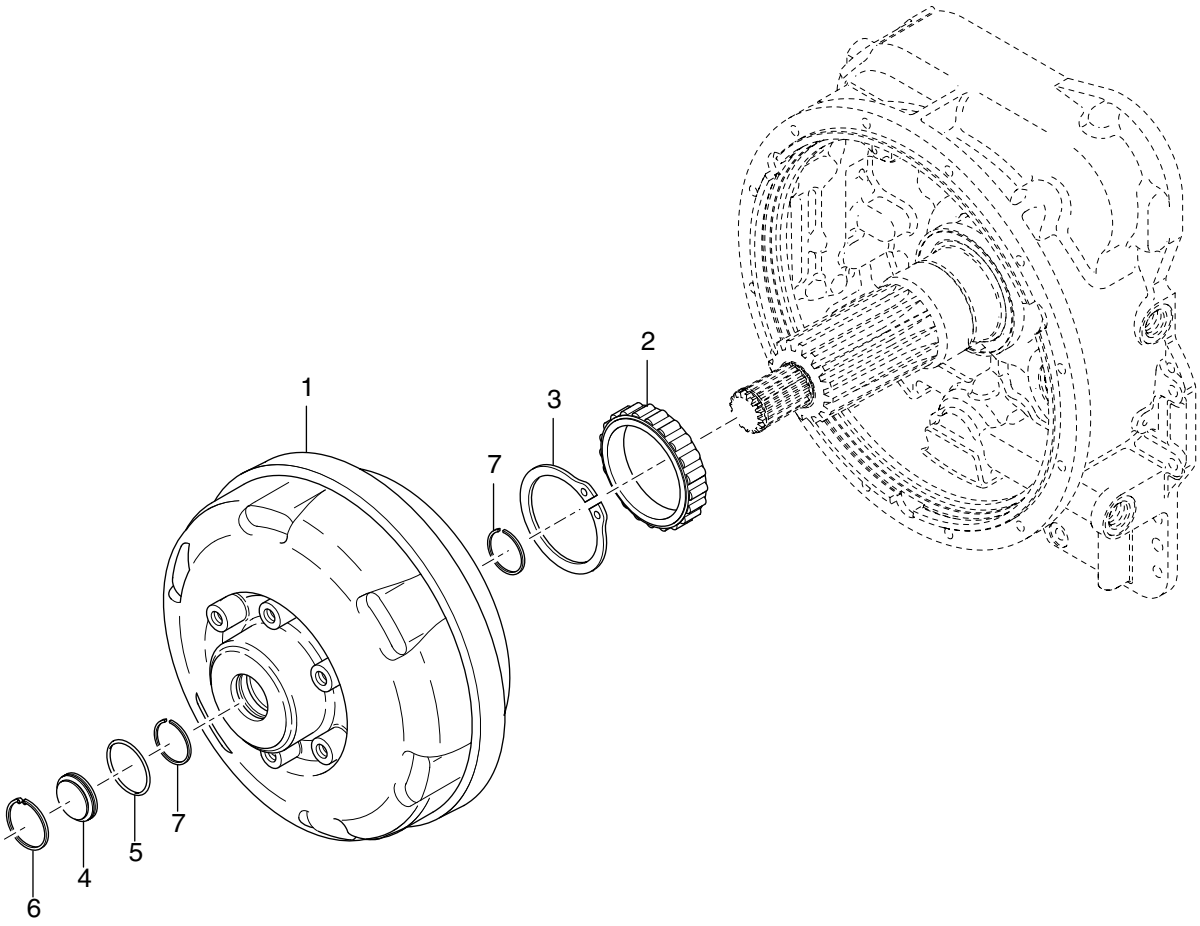


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GROUP - DRIVE PLATE

Item	Description	Quantity
1	Assembly - Drive plate	1
2	Drive - Plate	2
3	Ring - Drive plate backing	1
4	Screw - Drive plate mounting	6
5	Lockwasher - Drive plate mounting	6

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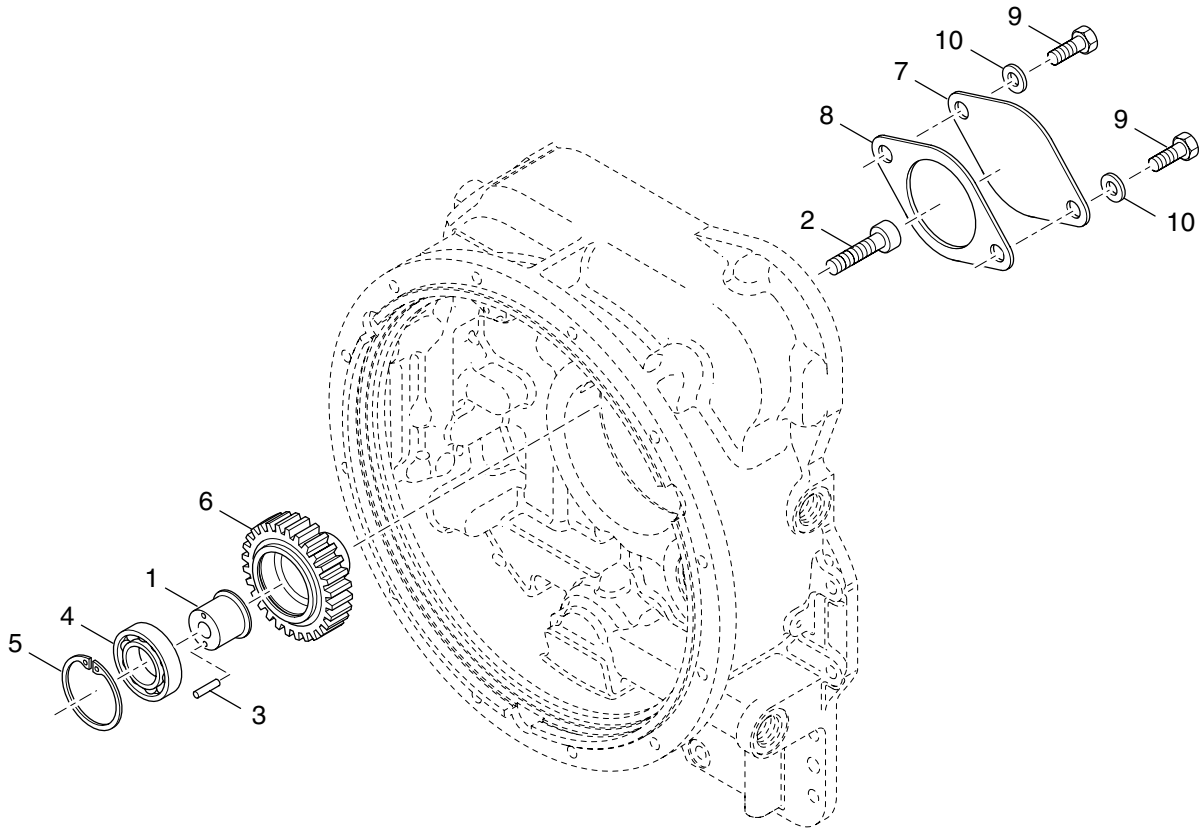


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GROUP - TORQUE CONVERTER

Item	Description	Quantity
1	Assembly - Torque converter	1
2	Bearing - Impeller hub gear	1
3	Ring - External snap	1
4	Plug - Torque converter	1
5	“O”-ring - Torque converter plug	1
6	Ring - Snap	1
7	Ring - Turbine retaining	2

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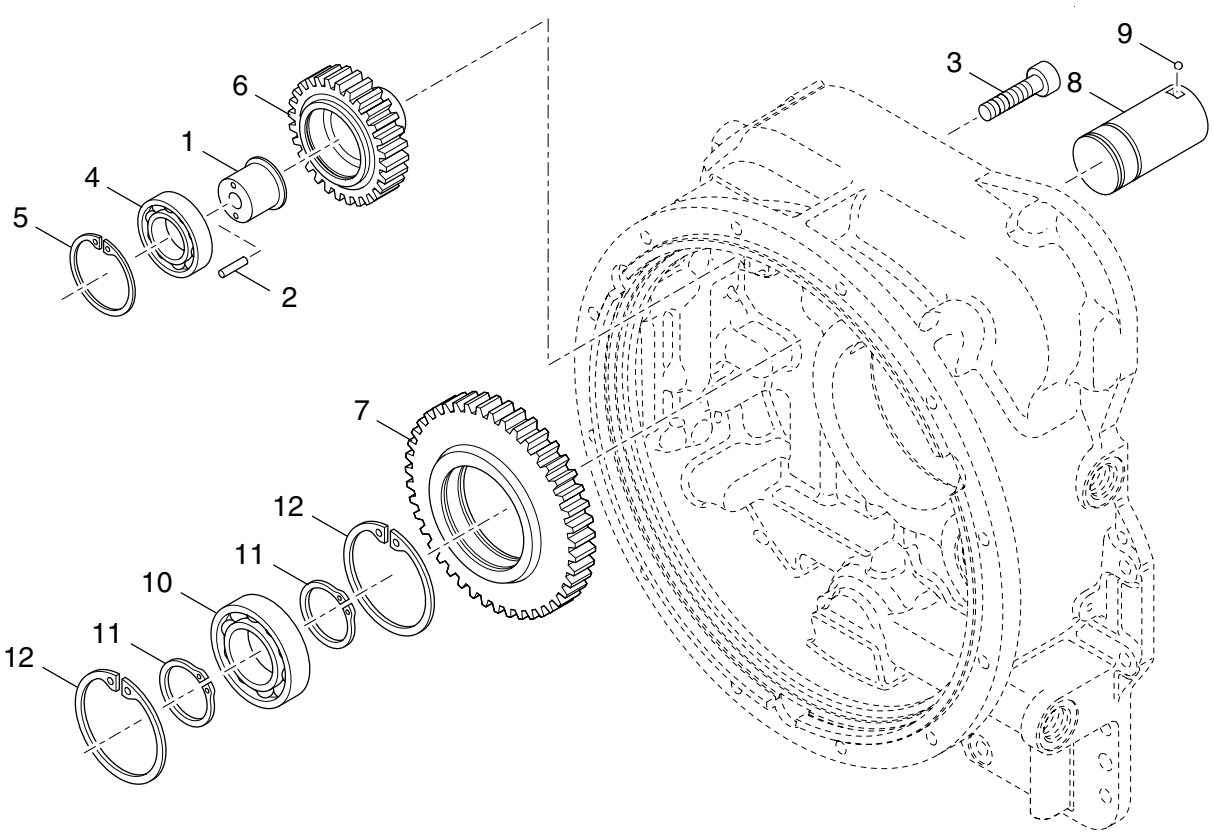


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GROUP - AUXILIARY PUMP DRIVE

Item	Description	Quantity
1	Support - Pump drive bearing	1
2	Screw - Bearing support	1
3	Pin - Bearing support	1
4	Bearing - Ball	1
5	Ring - Drive gear bearing retaining	1
6	Gear - Auxiliary pump drive	1
7	Cover - Pump mounting permanent	1
8	Gasket - Shipping cover	1
9	Screw - Pump mounting permanent cover	2
10	Lockwasher - Pump cover screw	2

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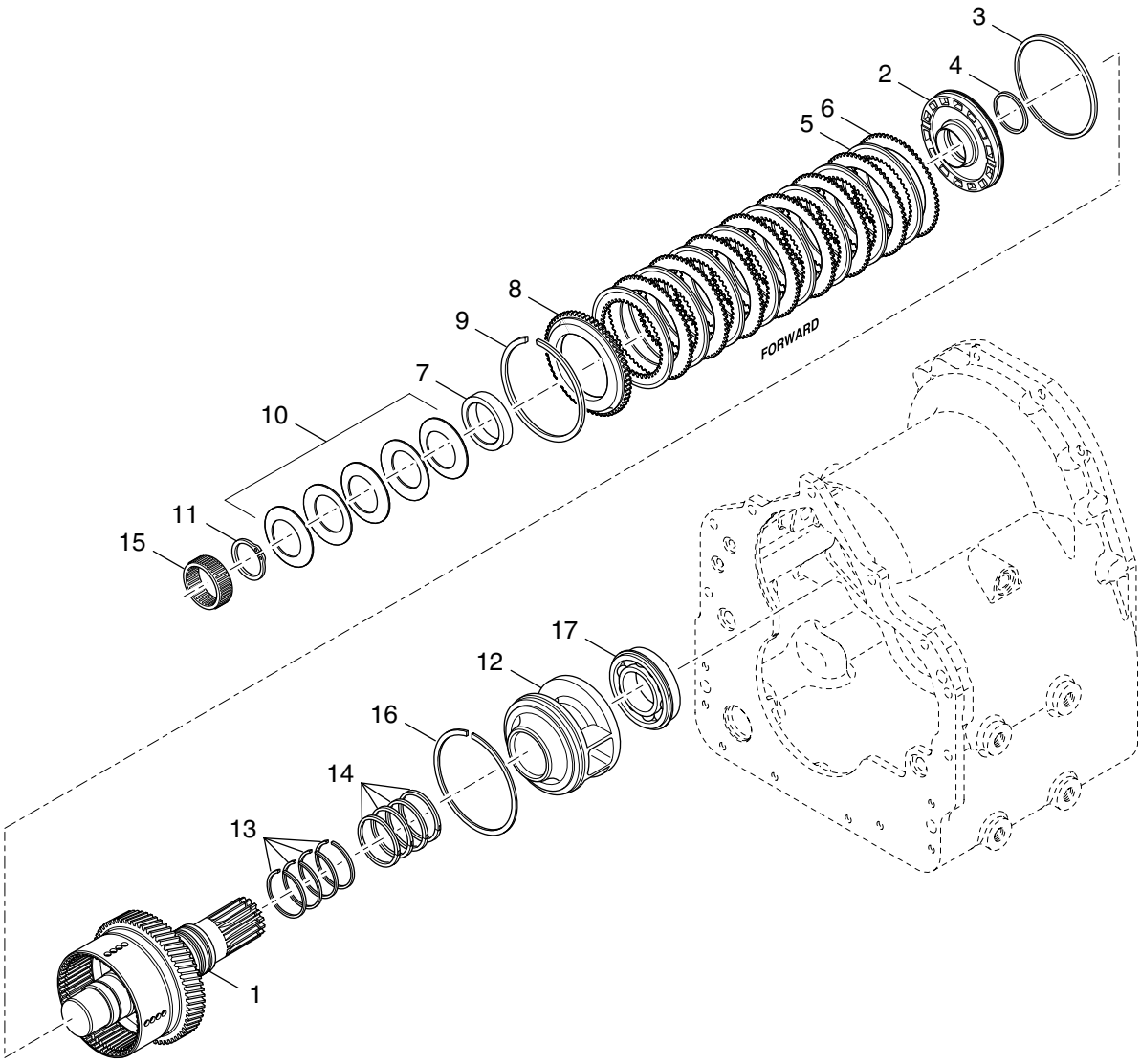


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GROUP - PUMP DRIVE

Item	Description	Quantity
1	Support - Pump drive bearing	1
2	Pin - Bearing support	1
3	Screw - Bearing support	1
4	Bearing - Ball	1
5	Ring - Drive gear bearing retaining	1
6	Gear - Charging pump drive	1
7	Gear - Pump drive idler	1
8	Shaft - Idler gear stub	1
9	Ball - Idler shaft lock	1
10	Bearing - Ball	1
11	Ring - Idler gear bearing location	2
12	Ring - Idler gear bearing retaining	2

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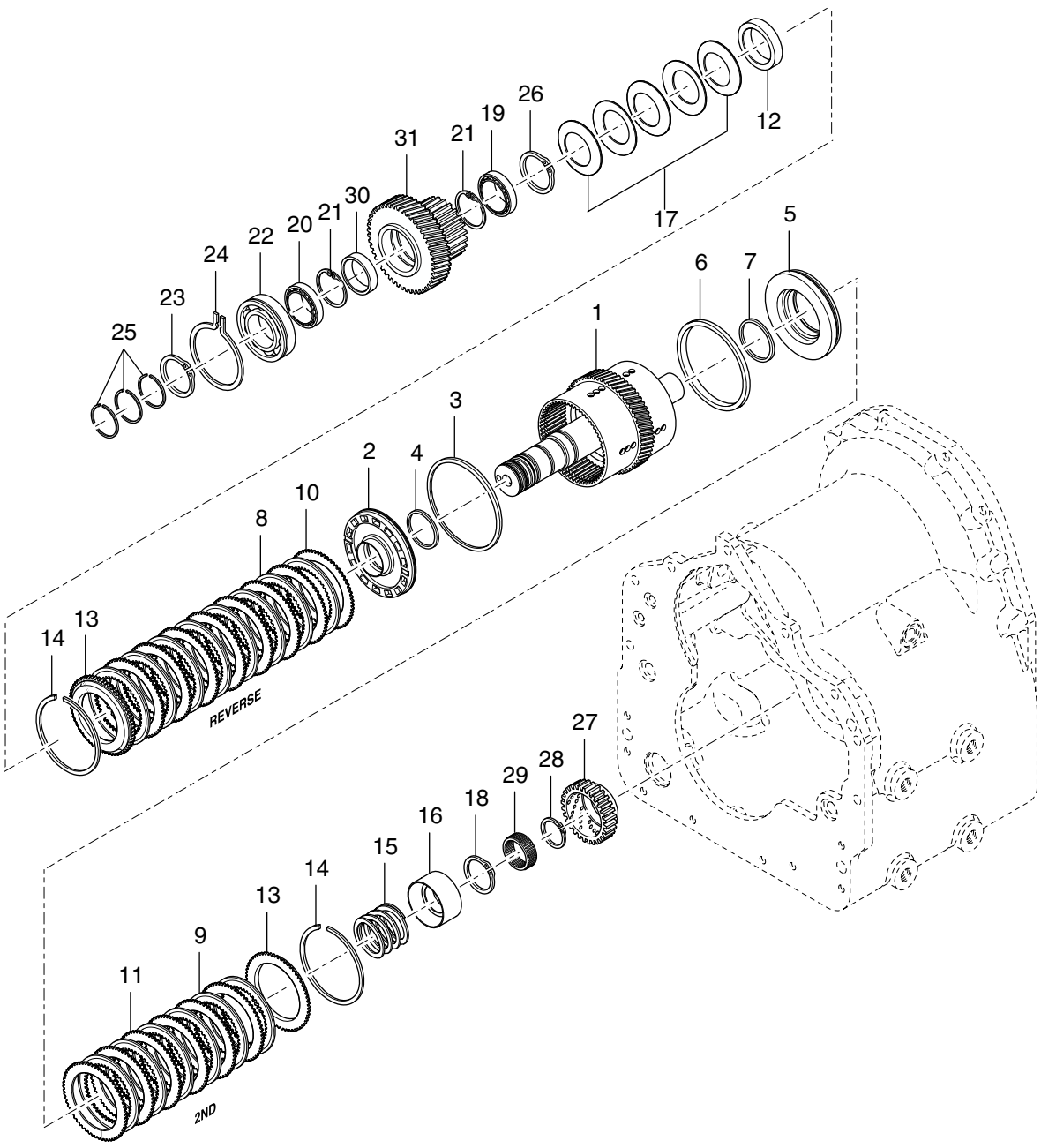


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GROUP - FORWARD SHAFT

Item	Description	Quantity
1	Assembly - Forward shaft, drum and plug	1
2	Piston - Clutch	1
3	Seal - Clutch piston (Outer)	1
4	Seal - Clutch piston (Inner)	1
5	Disc - Clutch (Inner)	8
6	Disc - Clutch (Outer)	8
7	Spacer - Piston return spring	1
8	Plate - Clutch disk backing	1
9	Snap ring - Backing plate	1
10	Assembly - Disc spring	1
11	Snap ring - Spring retaining	1
12	Sleeve - Piston ring	1
13	Spring - Piston ring expander	4
14	Ring - Piston	4
15	Bearing - Forward shaft front	1
16	Snap ring	1
17	Bearing - Forward shaft rear	1

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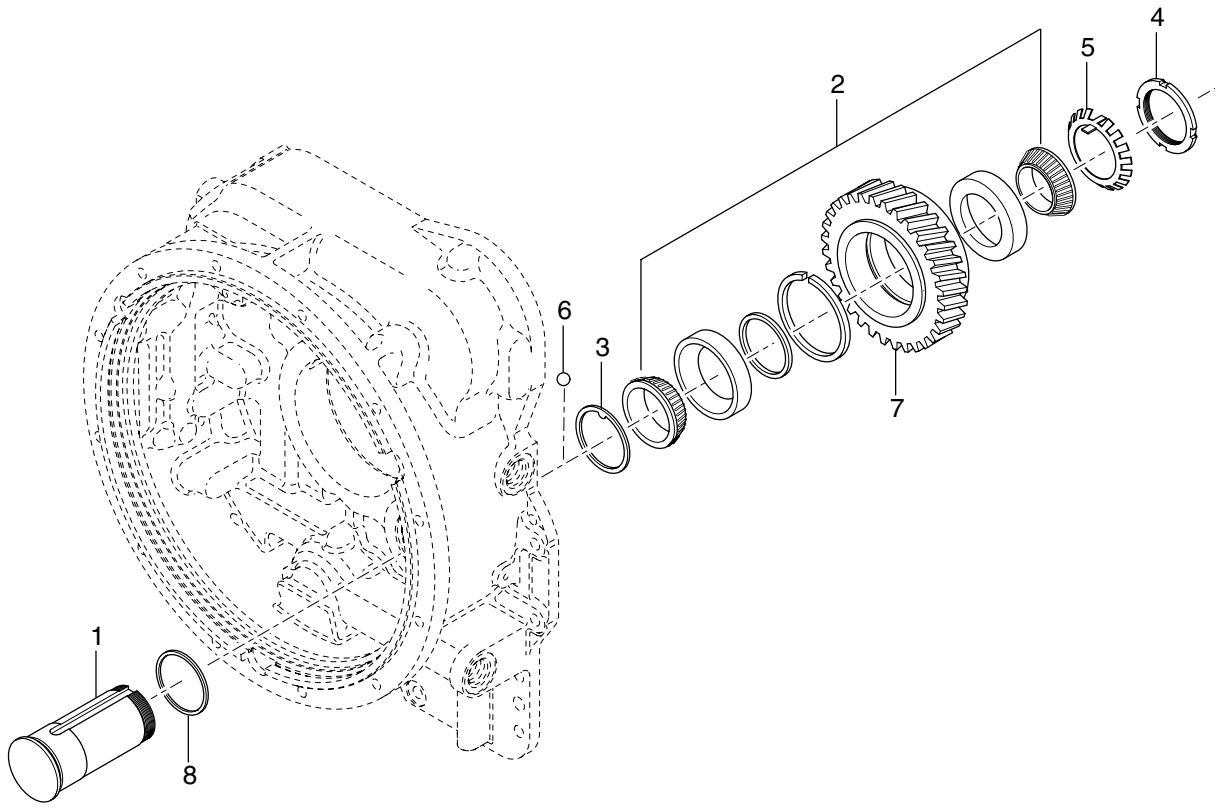


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GROUP - REVERSE AND 2ND SHAFT

Item	Description	Quantity
1	Assembly - Reverse, 2nd shaft & drum	1
2	Piston - Clutch	1
3	Seal - Clutch piston (Outer)	1
4	Seal - Clutch piston (Inner)	1
5	Piston - Clutch	1
6	Seal - Clutch piston (Outer)	1
7	Seal - Clutch piston (Inner)	1
8	Disc - Clutch (Inner)	8
9	Disc - Clutch (Inner)	6
10	Disc - Clutch (Outer)	8
11	Disc - Clutch (Outer)	6
12	Spacer - Piston return spring	1
13	Plate - Clutch disc backing	2
14	Snap ring - Backing plate	2
15	Spring - Piston return	1
16	Retainer - Spring	1
17	Assembly - Disc spring	1
18	Snap ring - Spring retaining	1
19	Bearing - Clutch driven gear	1
20	Bearing - Clutch driven gear	1
21	Ring - Reverse clutch gear bearing	2
22	Bearing - Ball	1
23	Ring - Front bearing retaining	1
24	Snap ring - Front bearing	1
25	Ring - Piston	3
26	Snap ring - Spring retaining	1
27	Hub - 2nd clutch	1
28	Ring - 2nd clutch disc hub retaining	1
29	Bearing - Needle	1
30	Spacer - Reverse clutch gear	1
31	Gear - Reverse clutch	1

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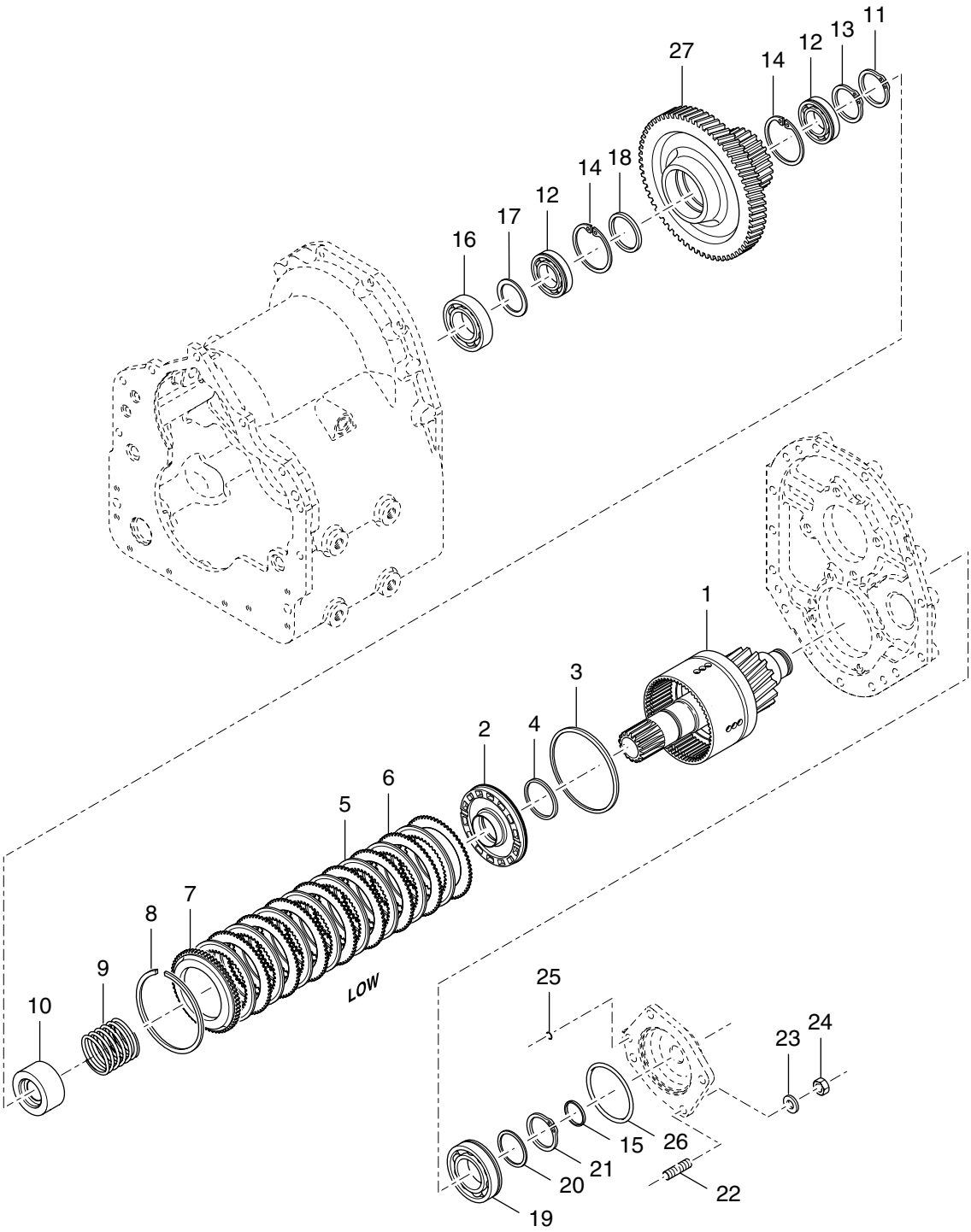


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GROUP - REVERSE IDLER

Item	Description	Quantity
1	Shaft - Reverse idler	1
2	Assembly - Reverse idler bearing	1
3	Washer	1
4	Nut - Bearing retaining	1
5	Washer - Bearing retaining	1
6	Lockball - Idler shaft	1
7	Gear - Reverse idler	1
8	“O”-ring - Idler shaft	1

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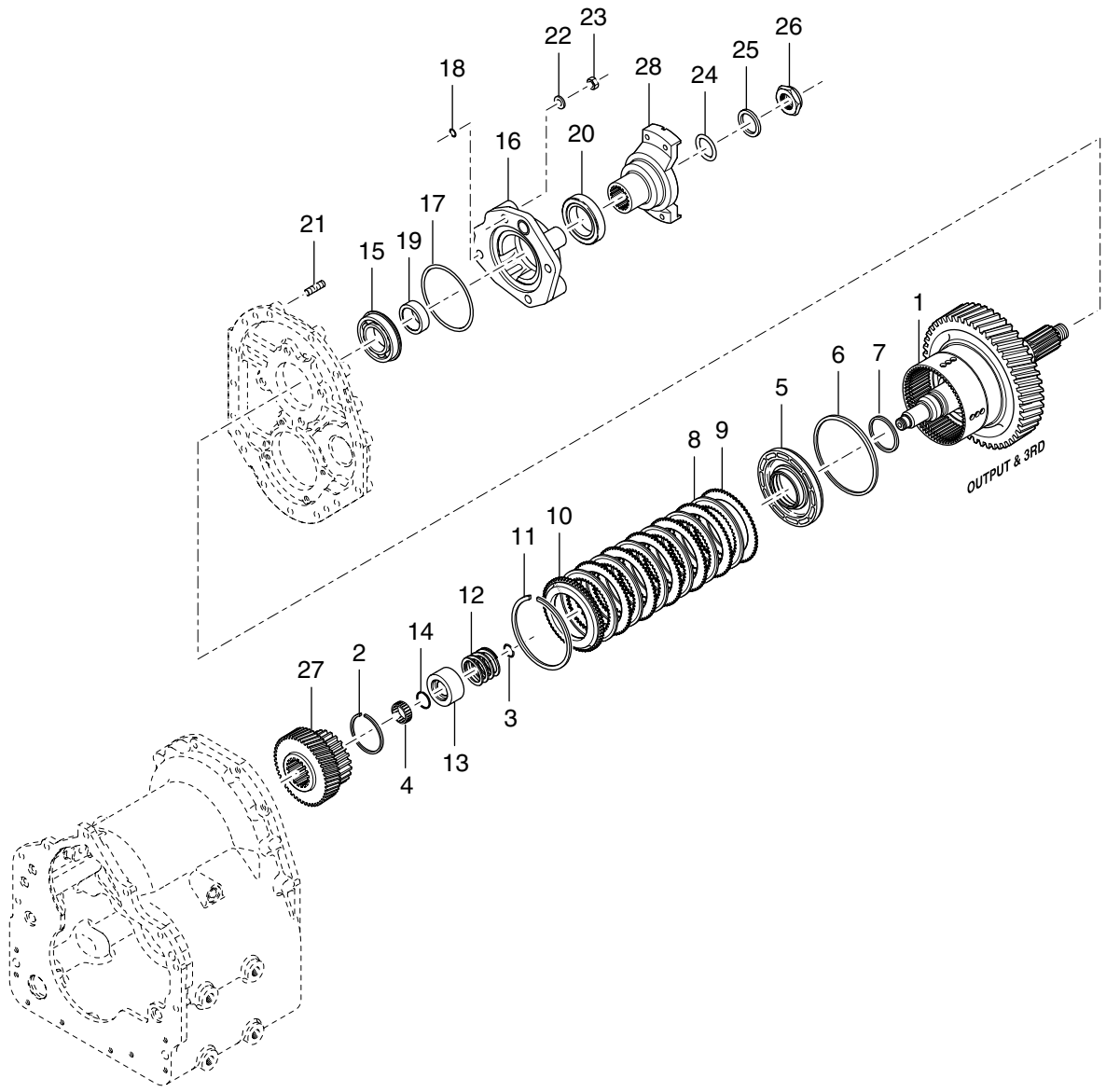


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GROUP - LOW SPEED SHAFT

Item	Description	Quantity
1	Assembly - Low shaft drum	1
2	Piston - Clutch	1
3	Seal - Clutch piston (Outer)	1
4	Seal - Clutch piston (Inner)	1
5	Disc - Clutch (Inner)	8
6	Disc - Clutch (Outer)	8
7	Plate - Clutch disc backing	1
8	Ring - Backing plate retaining	1
9	Spring - Piston return	1
10	Retainer - Spring	1
11	Snap ring - Spring retainer	1
12	Bearing - Low speed gear	2
13	Ring - Low speed gear bearing retainer	1
14	Ring - Low speed gear bearing locating	2
15	Ring - Low shaft piston	1
16	Bearing - Low speed clutch shaft front	1
17	Spacer - Low speed shaft front bearing	1
18	Spacer - Low speed gear	1
19	Bearing - Low speed shaft rear	1
20	Washer - Rear bearing support	1
21	Ring - Rear bearing retainer	1
22	Stud - Bearing cap	4
23	Lockwasher - Bearing cap stud	4
24	Nut - Bearing cap stud	4
25	“O”-ring - Rear bearing cap	1
26	“O”-ring - Rear bearing cap	1

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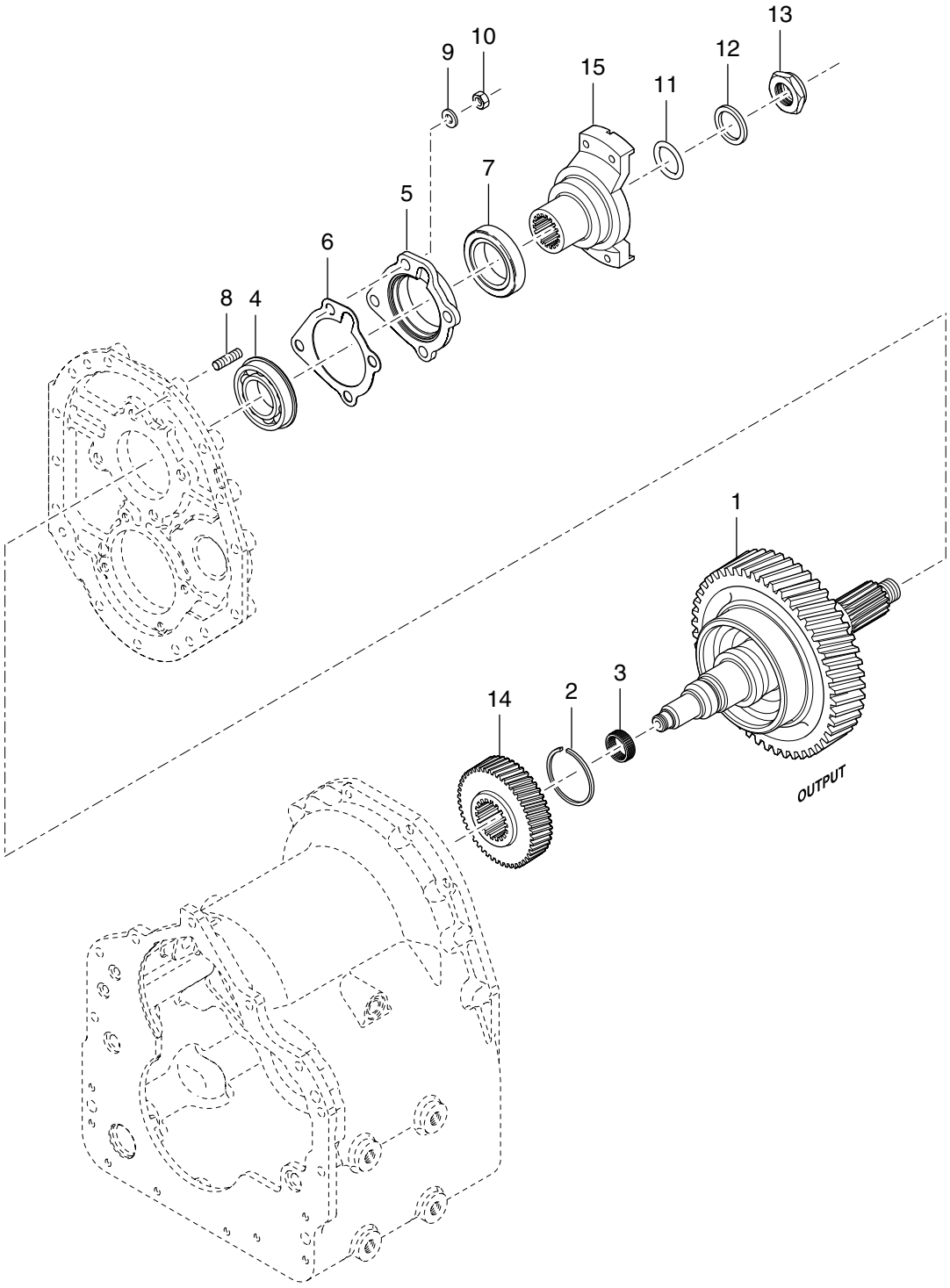


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GROUP - OUTPUT AND 3RD SHAFT (3-SPEED)

Item	Description	Quantity
1	Assembly - Output & 3rd clutch shaft and drum	1
2	Ring - 3rd clutch gear and hub retaining	1
3	Ring - Output shaft piston	1
4	Bearing - Output & 3rd shaft pilot	1
5	Piston - Clutch	1
6	Seal - Clutch piston (Outer)	1
7	Seal - Clutch piston (Inner)	1
8	Disc - Clutch (Inner)	6
9	Disc - Clutch (Outer)	6
10	Plate - Clutch disc backing	1
11	Snap ring - Backing plate	1
12	Spring - Piston return	1
13	Retainer - Spring	1
14	Snap ring - Spring retainer	1
15	Bearing - Outer shaft rear	1
16	Cap - Output shaft rear bearing	1
17	“O”-ring - Output shaft bearing cap	1
18	“O”-ring - Bearing cap	1
19	Spacer - Bearing to flange	1
20	Seal - Rear bearing cap oil	1
21	Stud - Rear bearing stud	1
22	Lockwasher - Rear bearing cap stud	1
23	Nut - Rear bearing cap stud	1
24	“O”-ring - Flange	1
25	Washer - Flange	1
26	Nut - Flange	1
27	Gear - 3rd clutch	1
28	Flange - Output shaft	1

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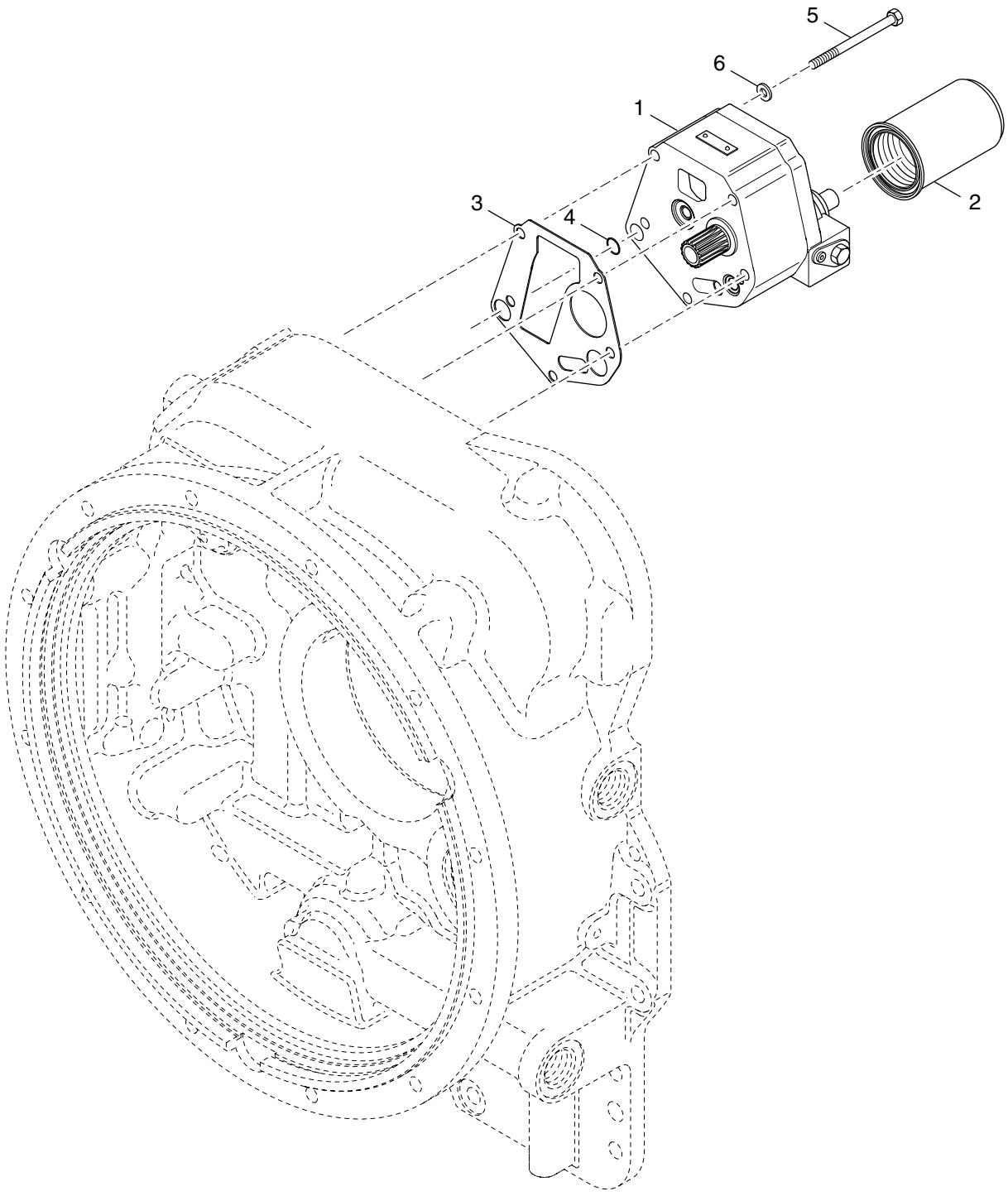


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GROUP - OUTPUT SHAFT (2-SPEED)

Item	Description	Quantity
1	Shaft - Output	1
2	Ring - 3rd gear and hub retainer	1
3	Bearing - Output shaft pilot	1
4	Bearing - Output shaft rear	1
5	Cap - Output shaft rear bearing	1
6	Gasket - Bearing cap	1
7	Seal - Rear bearing cap oil	1
8	Stud - Rear bearing cap	4
9	Lockwasher - Rear bearing cap oil	4
10	Nut - Rear bearing cap stud	4
11	“O”-ring - Flange	1
12	Washer - Flange	1
13	Nut - Flange	1
14	Gear - Forward shaft	1
15	Flange - Output shaft	1

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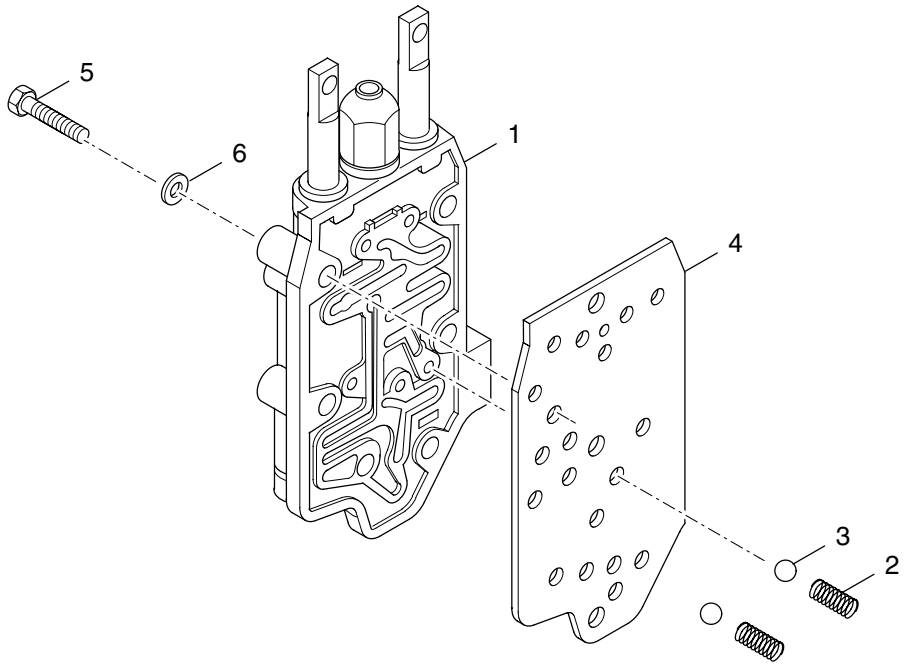


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GROUP - CHARGING PUMP & FILTER

Item	Description	Quantity
1	Pump - Charging	1
2	Assembly - Hydraulic spin on filter	1
3	Gasket - Pump assembly to converter housing	1
4	“O”-ring	1
5	Screw - Pump mounting	5
6	Lockwasher - Pump mounting screw	5

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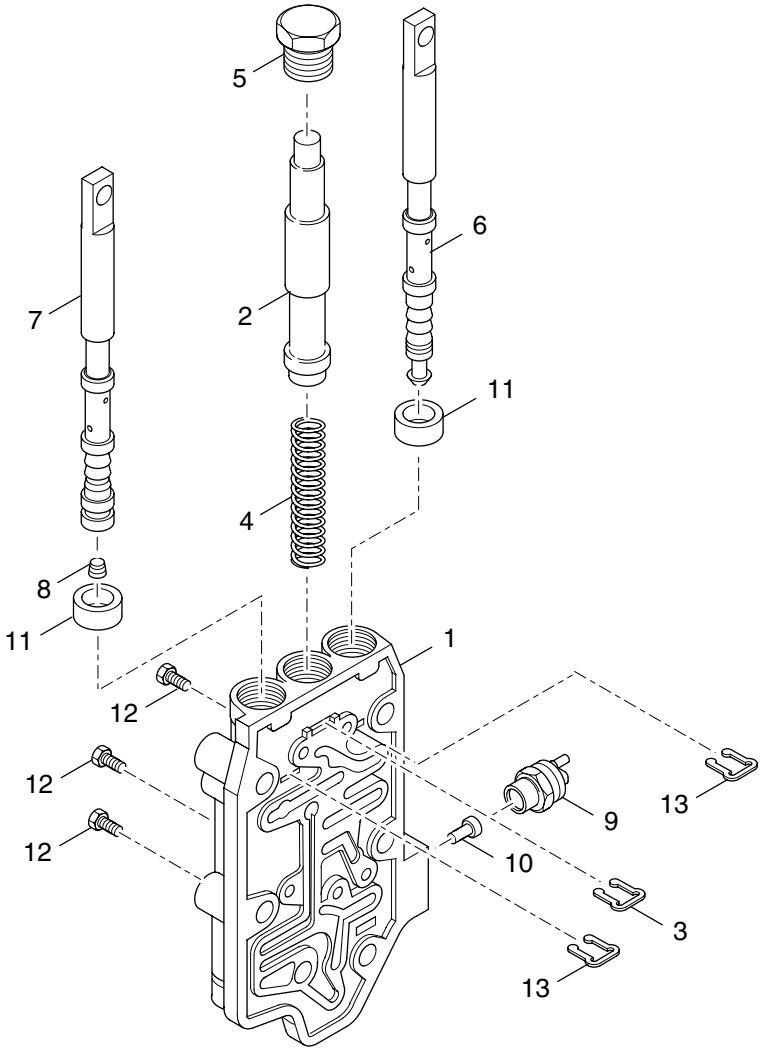


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GROUP - CONTROL VALVE (MECHANICAL)

Item	Description	Quantity
1	Assembly - Control valve	1
2	Spring - Detent	2
3	Ball - Detent	2
4	Gasket - Control valve	1
5	Screw - Control valve mounting	9
6	Lockwasher - Control valve mounting screw	9

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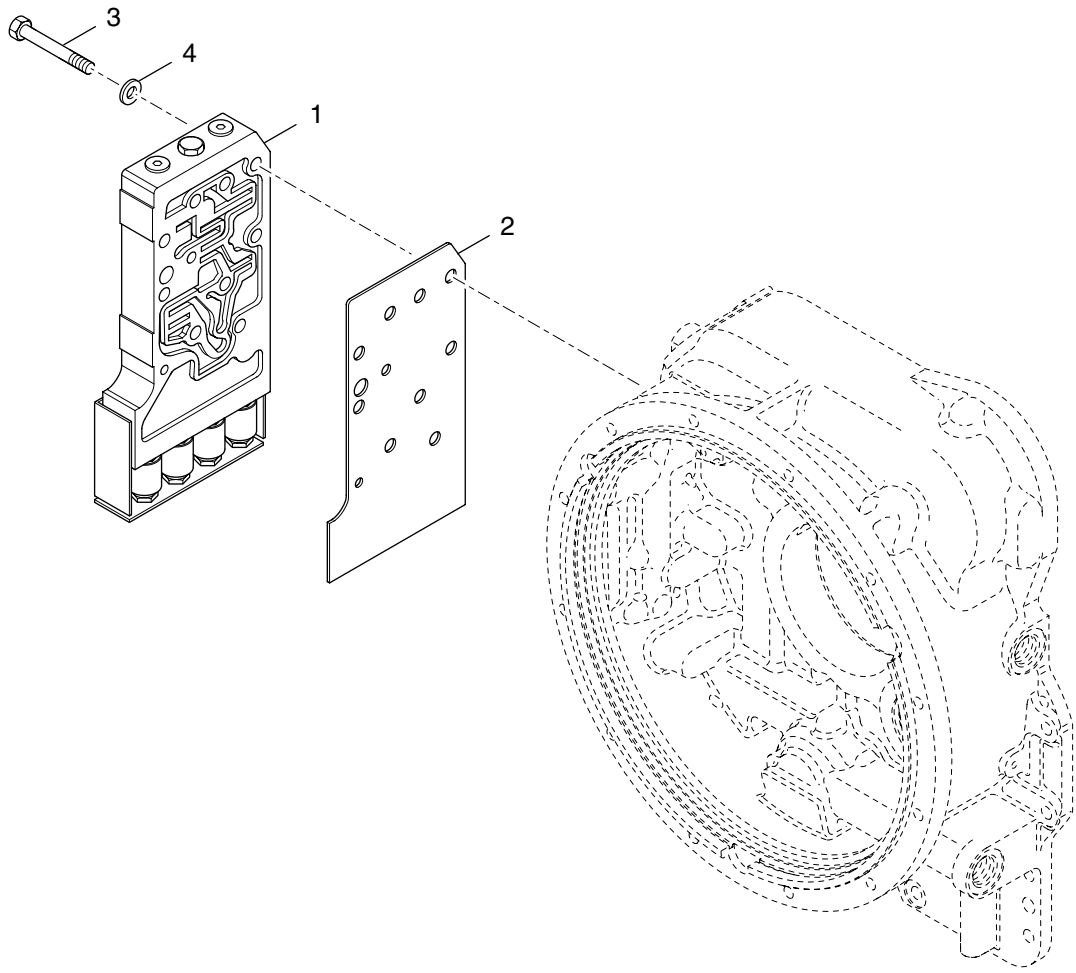


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GROUP - CONTROL VALVE ASSEMBLY (MECHANICAL)

Item	Description	Quantity
1	Housing - Control valve	1
2	Spool - Declutch	1
3	Stop - Spool	1
4	Spring - Spool	1
5	Plug	1
6	Spool - Forward and reverse	1
7	Spool - Speed selector	1
8	Plug	1
9	Switch - Start	1
10	Pin	1
11	Oil - Seal	2
12	Pipe plug	4
13	Stop - Spool	2

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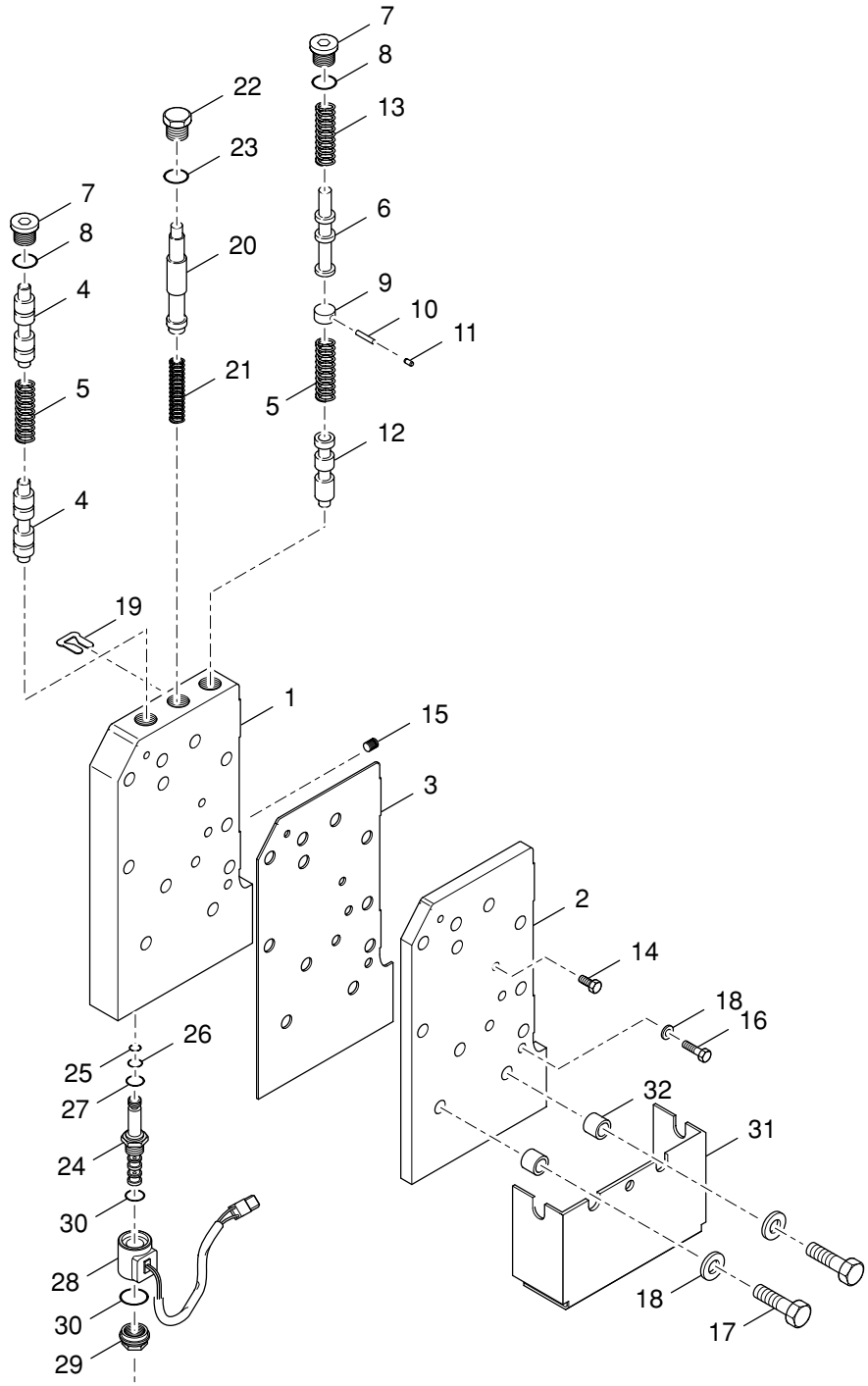


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GROUP - ELECTRIC CONTROL VALVE MOUNTING

Item	Description	Quantity
1	Assembly - Electric control valve	1
2	Gasket - Control valve to front cover	1
3	Screw - Valve to converter housing	9
4	Lockwasher - Valve to converter housing screw	9

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GROUP - ELECTRIC CONTROL VALVE ASSEMBLY

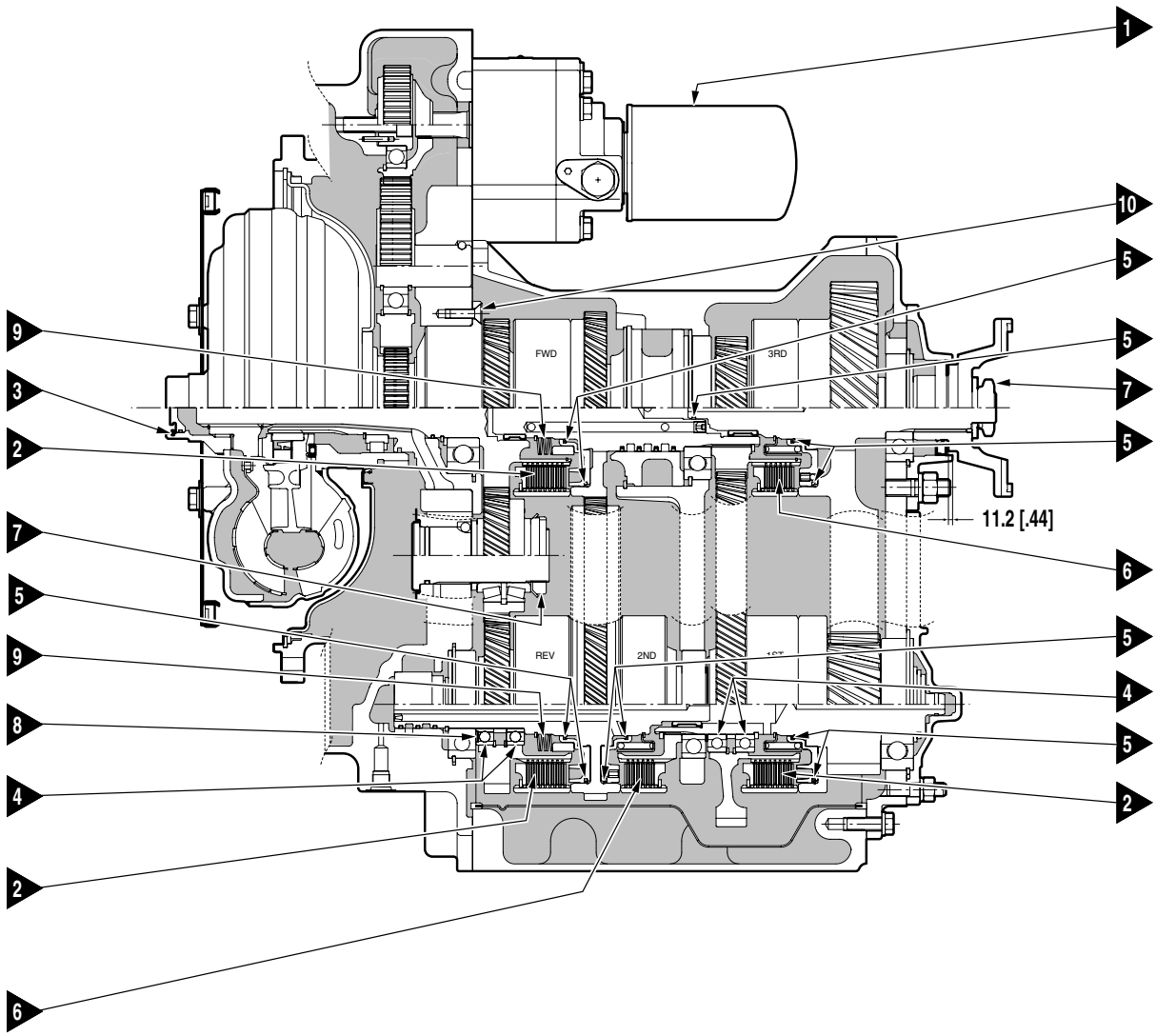
Item	Description	Quantity
1	Housing control valve	1
2	Cover - Control valve	1
3	Gasket - Control valve cover	1
4	Spool - Forward and reverse shift	2
5	Spring	2
6	Spool - Range (3rd)	1
7	Valve housing plug	2
8	Valve housing plug “O”-ring	2
9	Spool stop	1
10	Pin	1
11	Plug stop	1
12	Spool - Range (1st and 2nd)	1
13	Spring	1
14	Pipe plug	8
15	Plug	1
16	Screw	1
17	Screw	2
18	Lockwasher	3
19	Stop - Spool	1
20	Forward and reverse declutching spool	1
21	Spring - Declutch	1
22	Plug	1
23	“O”-ring - Plug	1
24	Cartridge - Ball valve	4
25	“O”-ring - Cartridge	4
26	“O”-ring - Cartridge	4
27	“O”-ring - Cartridge	4
28	Coil 12V	4
29	Nut - Solenoid	4
30	“O”-ring	8
31	Cover - Solenoid	1
32	Spacer - Cover	2

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9. ASSEMBLY INSTRUCTIONS

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9. ASSEMBLY INSTRUCTIONS (CONTINUED)



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9. ASSEMBLY INSTRUCTIONS (CONTINUED)

All lead in chamfers for oil seals, piston rings, and “O”-rings must be smooth and free from burrs. Inspect at assembly.

Lubricate all piston ring grooves and “O”-rings with oil before assembly.

Apply a thin coating of grease between seal lips on lip type seals prior to assembly.

Use only precoated pipe plugs. On uncoated pipe plugs apply a light coat of Loctite no. 592.

After assembly of parts using Loctite, there must not be any free or excess material which might enter the oil circuit.

Apply a light coat of Loctite no. 262 or no. 270 to all thru hole stud holes.

1. Tighten oil filter to 20-25 lbf.ft [27-34 N.m].

2. Fwd. and rev. with standard piston & low clutch. 8 Outer steel discs and 8 inner friction discs. Insert one (1) Steel disc. Insert one (1) friction disc. Alternate steel and friction discs until proper amount of discs are installed. First disc next to the piston is steel, last disc installed is friction.

3. Snap ring is to be assembled with sharp edges to front.

4. Must be loose internal fit bearing with a no. 3 etched on the bearing.

5. Seals must be sized prior to assembly.

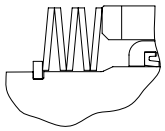
6. Two clutches (2nd & 3rd). 6 Outer steel discs and 6 inner friction discs.

   Start with outer steel disc alternate friction and steel.

7. Tighten to 200 - 250 lbf.ft [271.2 - 339.0 N.m].

8. Shielded bearing, be sure that bearing shield is on the outside.

9. Forward and reverse clutch springs concave side of first belleville spring to be placed against clutch piston. Remaining four springs of each clutch to be stacked alternatly reversed as shown.



10. Stator support screw assembly:

    1. Clean stator support mounting surface and tapped holes with solvent. Dry thoroughly. Being certain tapped holes are clean and dry.
    2. Install 6 special stator support screws. Tighten screws to 12 - 16 lbf.ft [16.3 - 21.7 N.m] torque.

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9. ASSEMBLY INSTRUCTIONS (CONTINUED)



Note

ASSEMBLY OF STATOR SUPPORT TO CONVERTER HOUSING MUST BE COMPLETED WITHIN A 15 MINUTE PERIOD FROM START OF SCREW INSTALLATION. THE SPECIAL SCREW IS TO BE USED FOR ONE INSTALLATION ONLY. IF SCREW IS REMOVED FOR ANY REASON IT MUST BE REPLACED. THE LOCTITE LEFT IN THE HOLES MUST BE REMOVED WITH THE PROPER TAP AND CLEANED WITH SOLVENT. DRY HOLE THOROUGHLY AND USE A NEW SCREW FOR REINSTALLATION.

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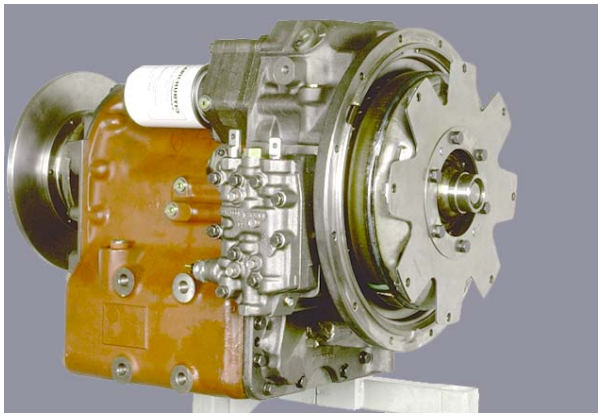


Figure 1

Side view of the T20000 inline 2- or 3-speed transmission. The transmission being disassembled is the 3-speed version.

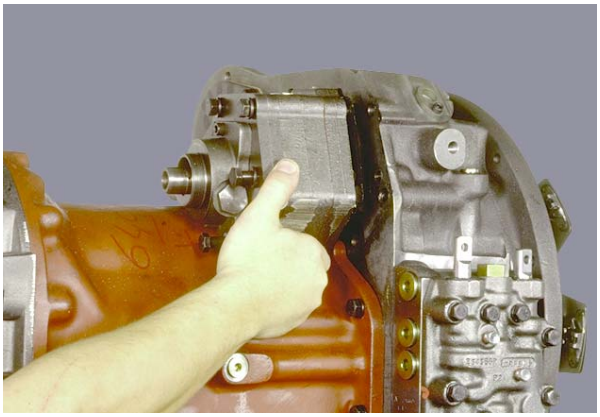


Figure 4

Remove valve and pump assembly.

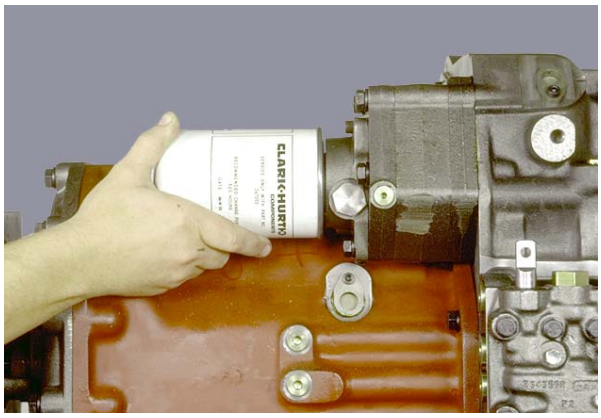


Figure 2

It is recommended a small pan be used to catch the oil left in the filter element. Remove filter element.

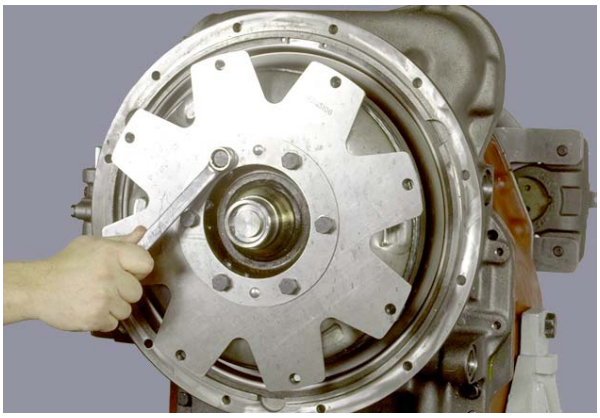


Figure 5

Remove drive plate mounting screws and washers.

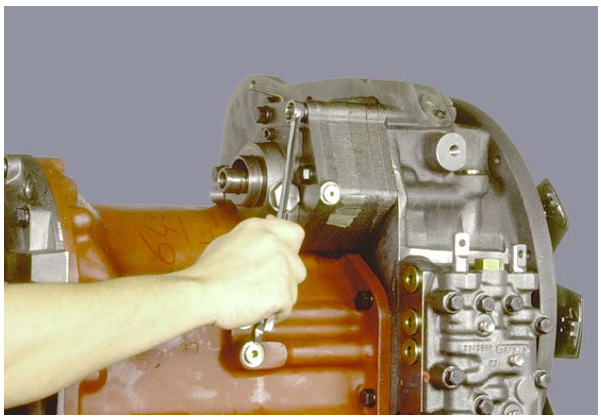


Figure 3

Remove pressure regulating valve and charging pump bolts.

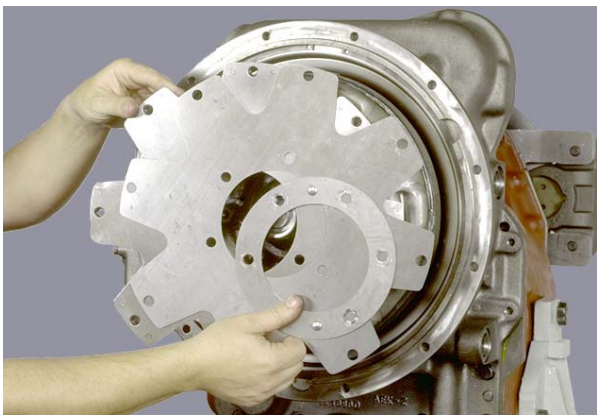


Figure 6

Remove drive plate and backing ring.

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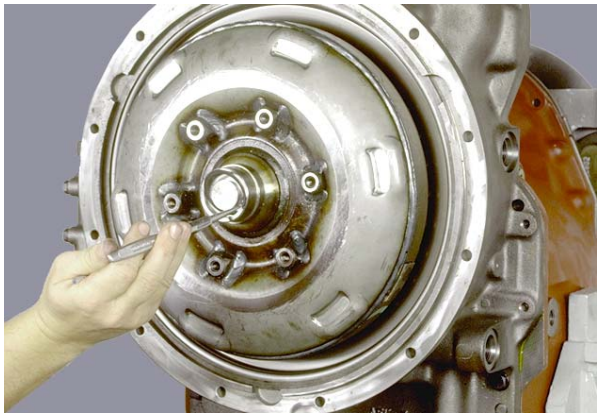


Figure 7
Remove impeller cover bore plug retainer ring.

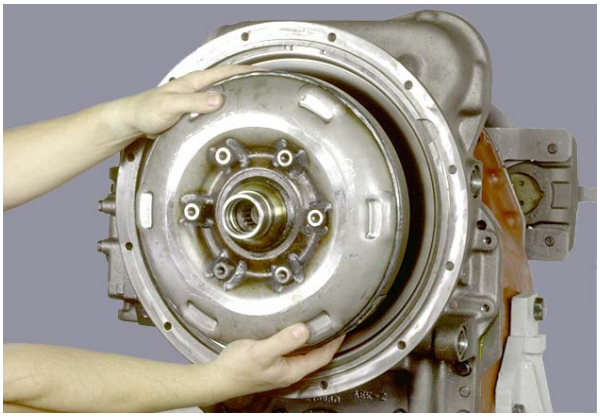


Figure 10
Remove torque converter assembly.

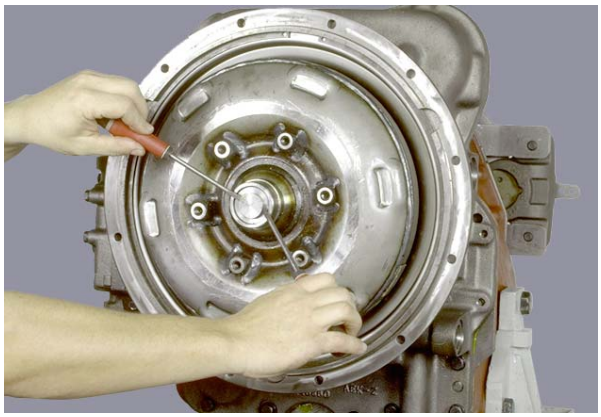


Figure 8
Using two small screw drivers as shown, remove plug.

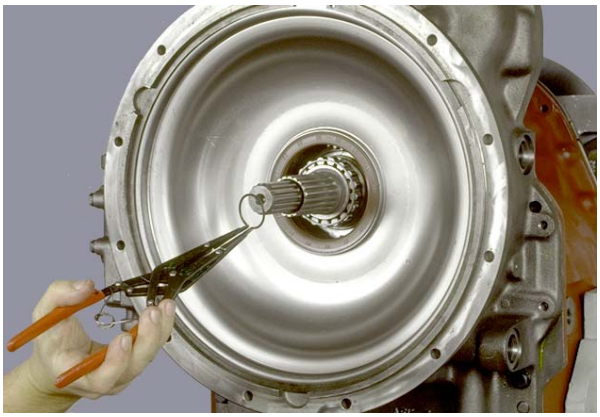


Figure 11
Remove turbine locating ring.

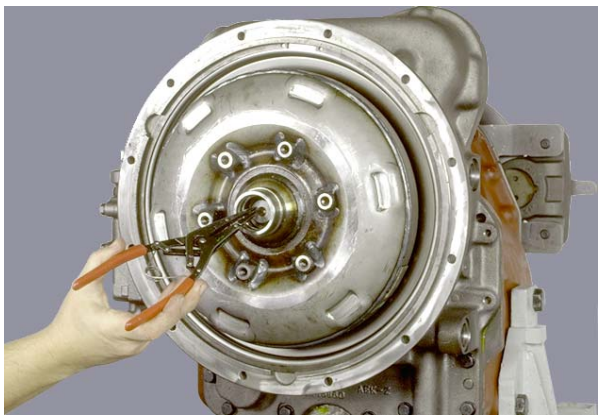


Figure 9
Through bore plug hole, remove turbine retaining ring.

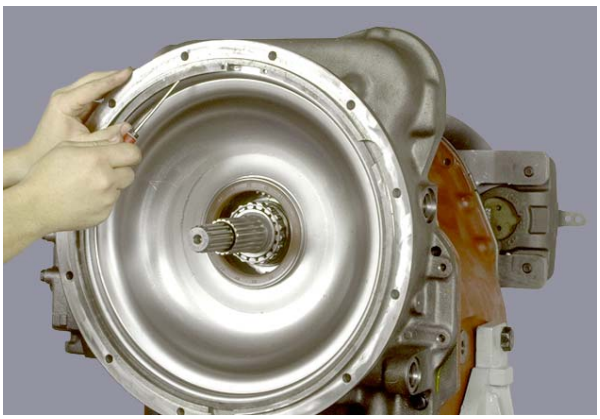


Figure 12
Using slots provided in converter housing. Remove oil baffle retaining ring.

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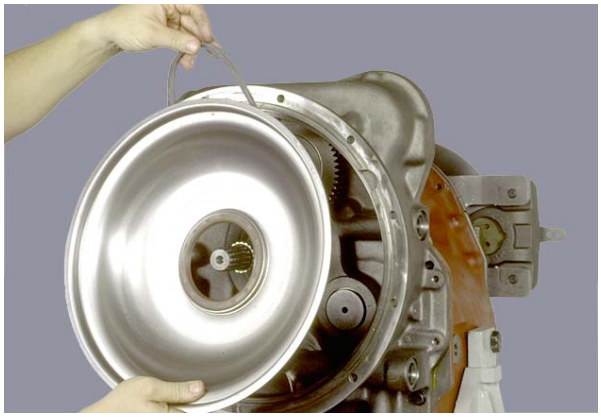


Figure 13
Baffle and sealing ring removed.

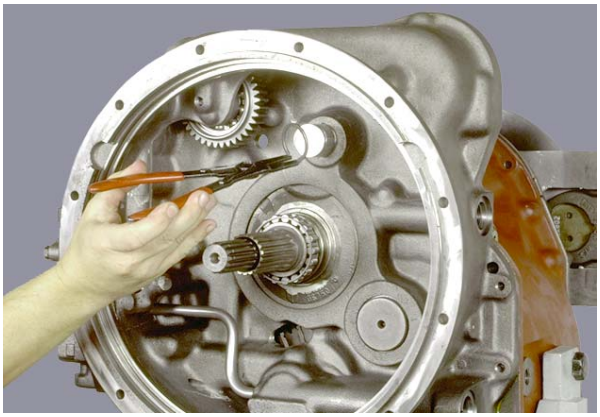


Figure 16
Remove pump drive idler gear locating ring.

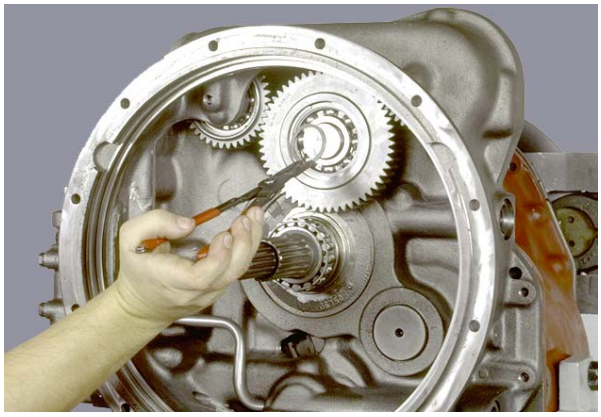


Figure 14
Remove pump drive idler gear retaining ring.

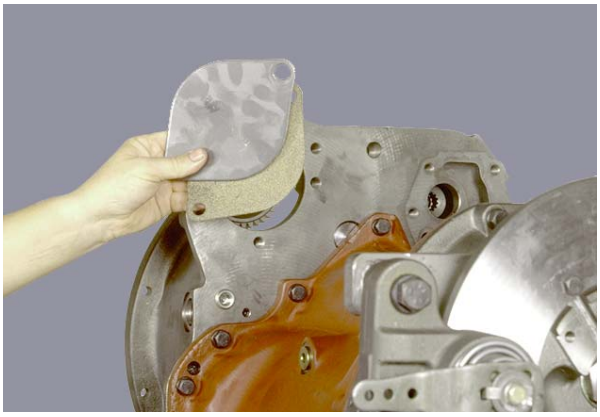


Figure 17
From the rear, remove pump hole cover, screws, lockwashers and gasket.

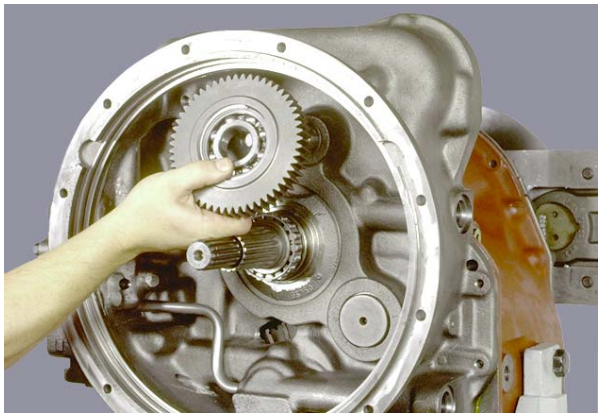


Figure 15
Remove idler gear and bearing assembly.

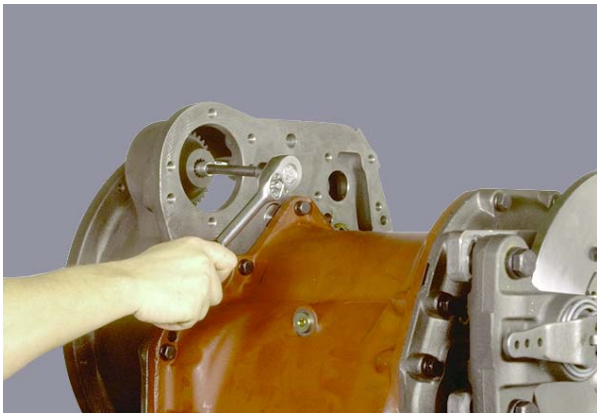


Figure 18
Remove auxiliary pump drive bearing support screws. See figure 256.

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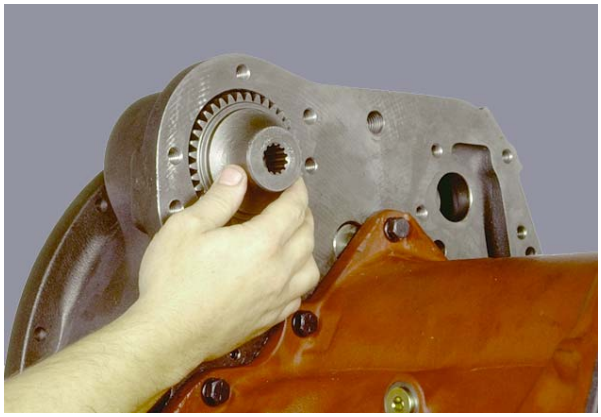


Figure 19
Remove auxiliary pump drive gear.

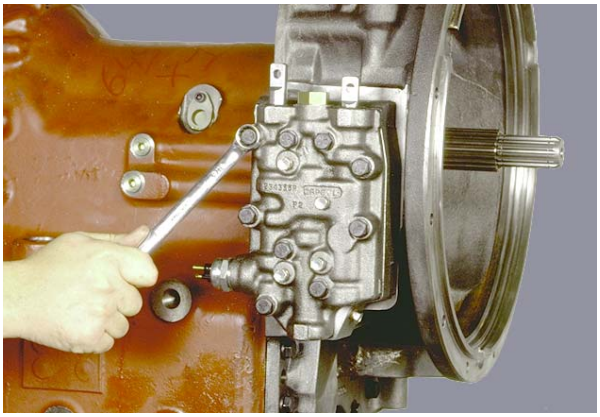


Figure 22
Remove control cover bolts and lockwashers.

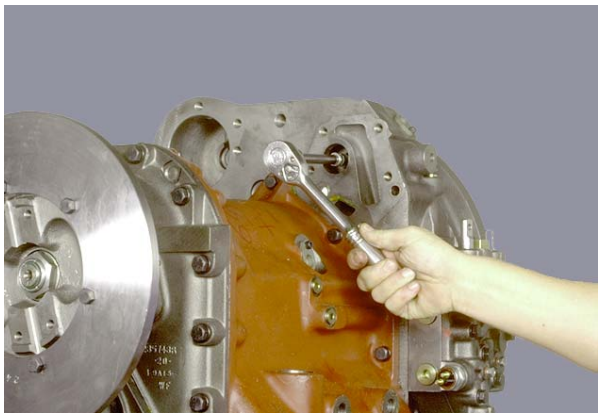


Figure 20
From the rear through the pump drive hole, remove pump drive bearing support screw. See figure 259.

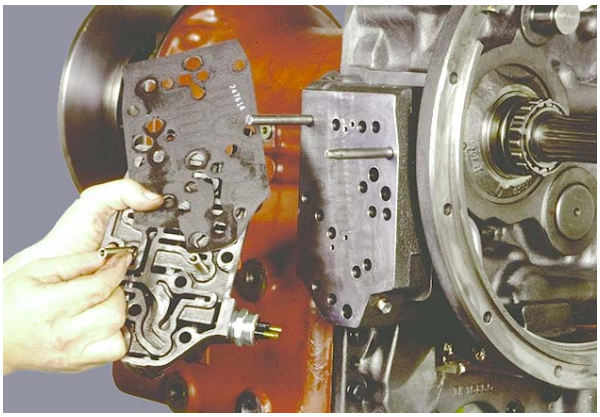


Figure 23
Remove control valve assembly.
Use caution as not to lose detent springs and balls.
Some units will have an electrical control valve.

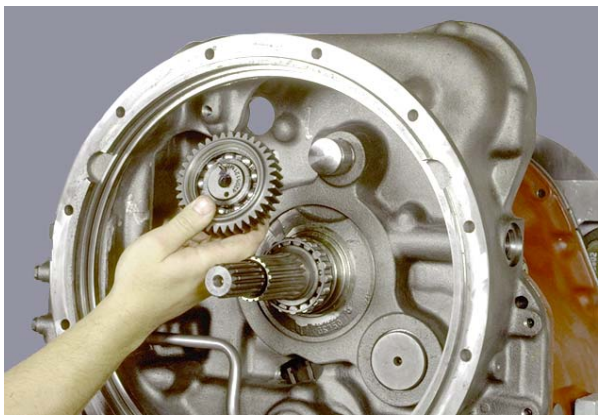


Figure 21
From the front, tap pump drive gear and bearing support from housing.

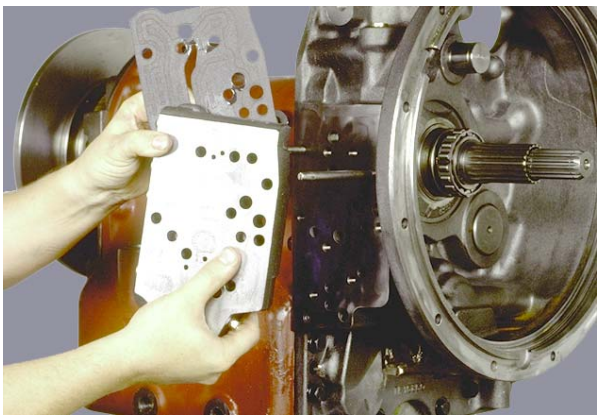


Figure 24
Remove modulator valve and gasket if used.

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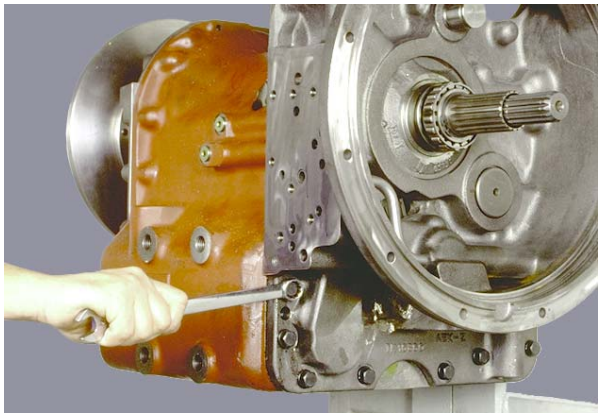


Figure 25
Remove all bolts but one securing transmission to converter housing.

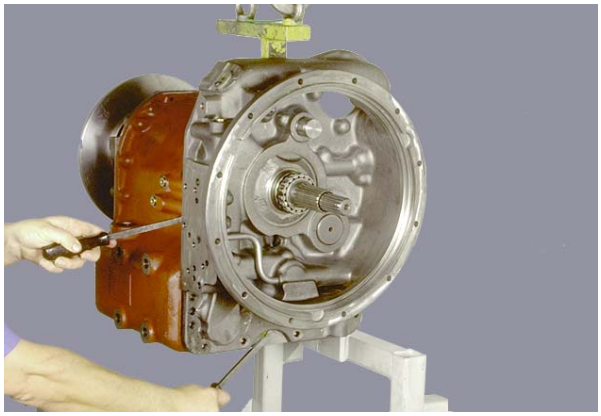


Figure 26
Support converter housing with a chain hoist. Remove remaining bolt.

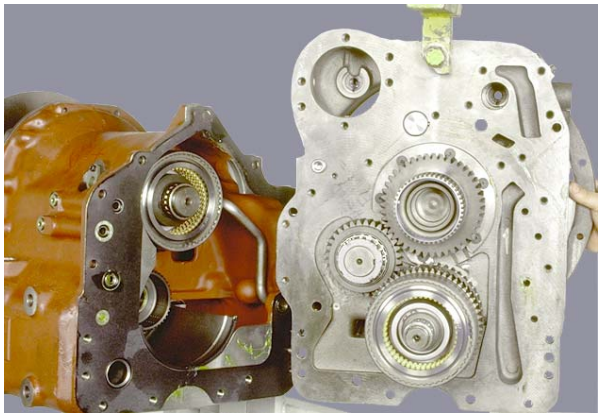


Figure 27
Separate converter housing from transmission case assembly.
NOTE: Reverse and 2nd clutch will remain in converter housing.

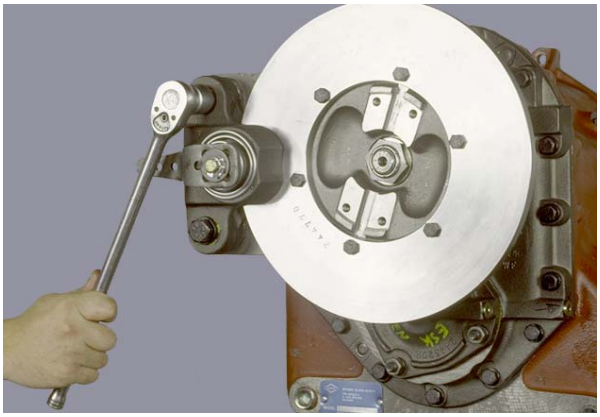


Figure 28
Before removing parking brake (if used), see to the parking brake instructions. See section 11: “Options”.

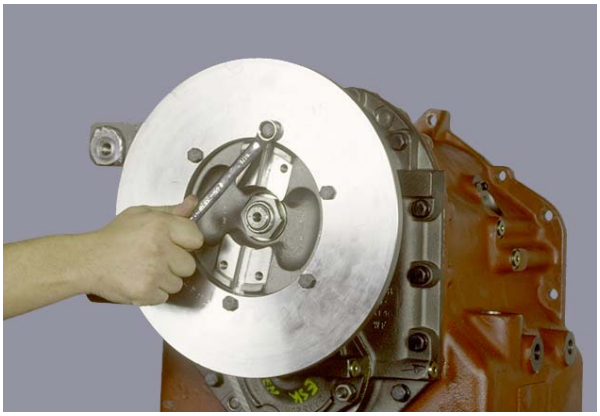


Figure 29
Remove brake disc mounting screws and lockwashers.

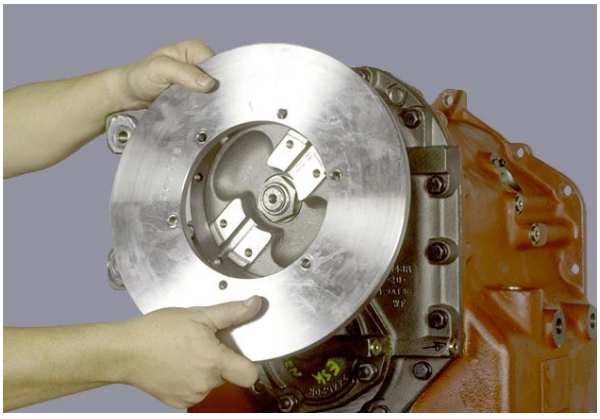


Figure 30
Brake disc removed.

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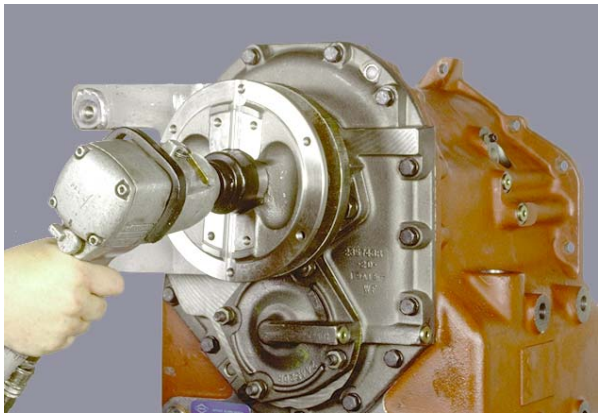


Figure 31
Remove output shaft flange nut, washer, “O”-ring and flange.

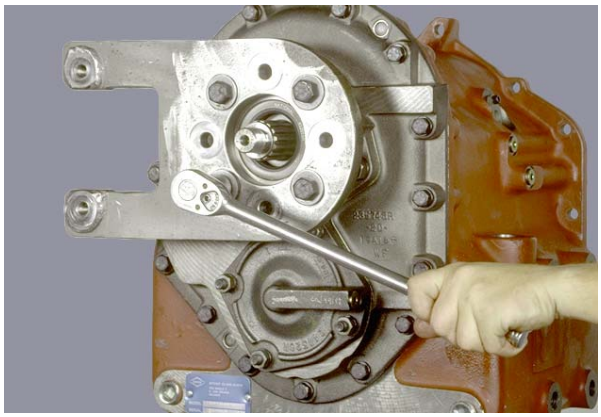


Figure 32
Remove brake adaptor mounting bolts.

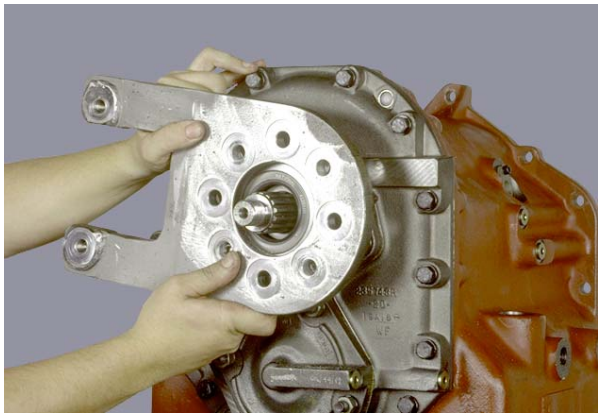


Figure 33
Brake adaptor removed.

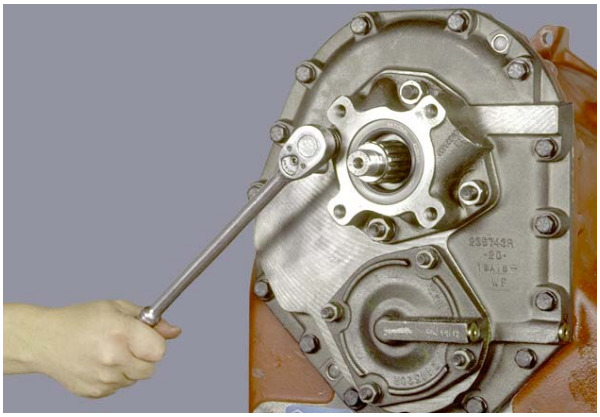


Figure 34
Remove output shaft bearing cap stud nuts and lockwashers.

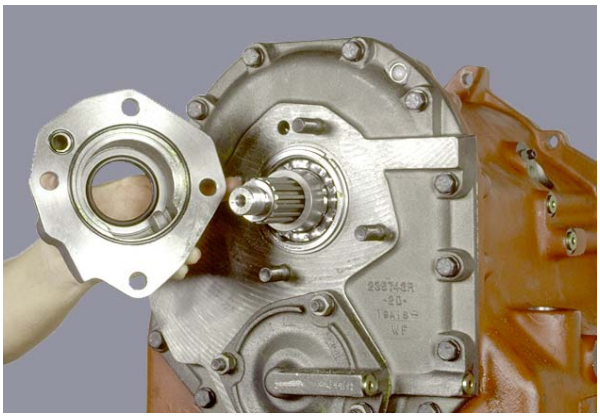


Figure 35
Remove output shaft bearing cap and “O”-rings.

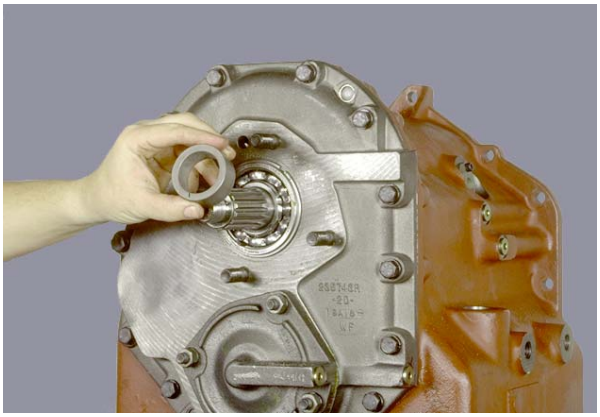


Figure 36
Remove output shaft rear bearing spacer.

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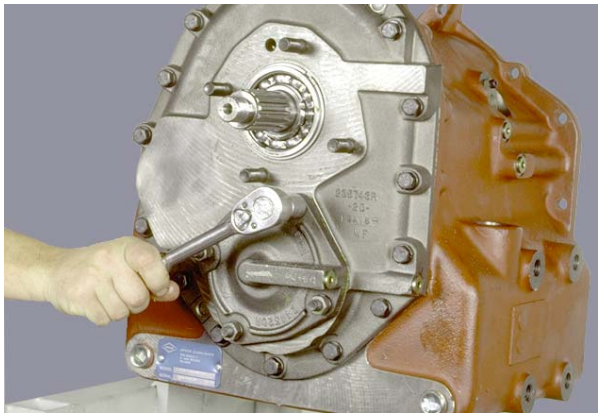


Figure 37
Remove low clutch shaft bearing cap nuts and lockwashers.

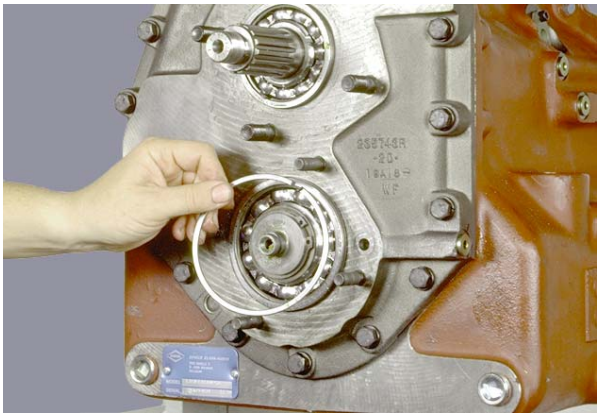


Figure 40
Remove low clutch shaft rear bearing locating ring.

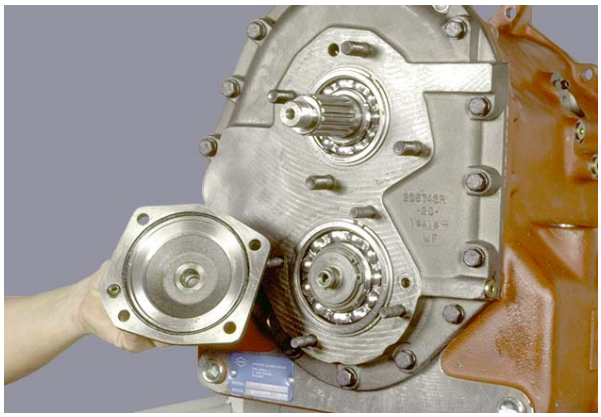


Figure 38
Low clutch shaft bearing cap removed.

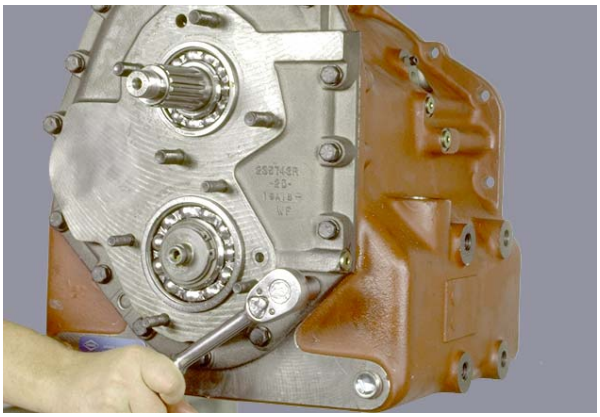


Figure 41
Remove rear cover screws and lockwashers.

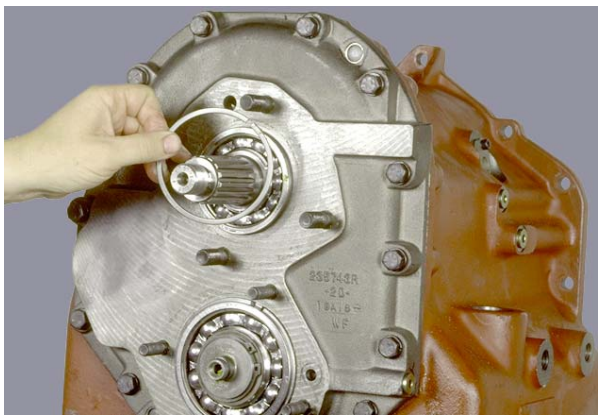


Figure 39
Remove output shaft rear bearing locating ring.

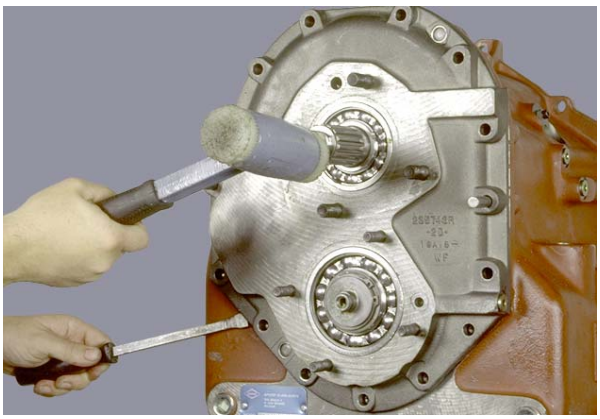


Figure 42
Using pry slots provided, pry cover from transmission housing, tapping on low clutch and output shaft to allow cover to be removed without shaft binding.

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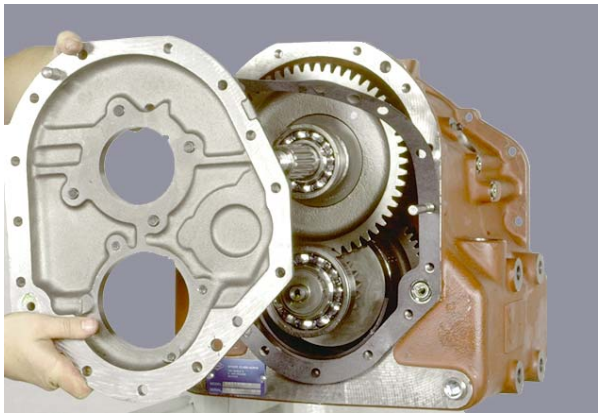


Figure 43
Rear cover removed, showing low clutch (bottom) and output shaft (top).

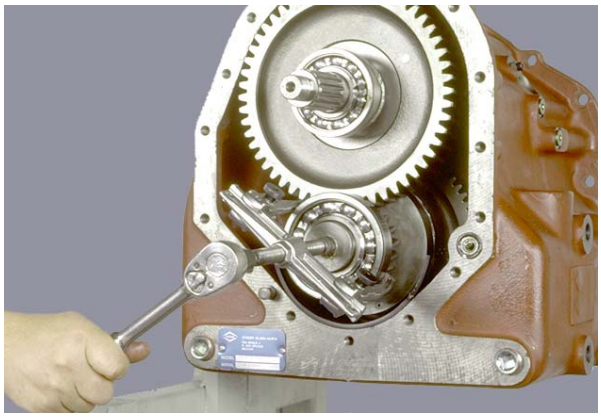


Figure 46
Remove low clutch shaft rear bearing.

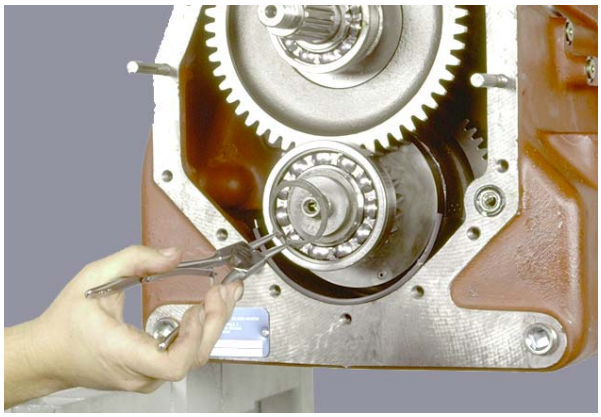


Figure 44
Remove low clutch shaft rear bearing retainer ring.

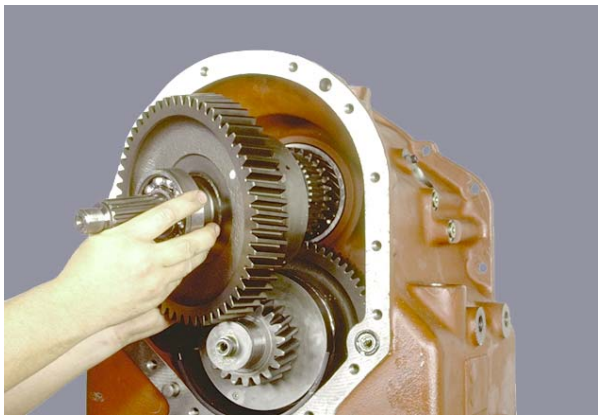


Figure 47
Remove output shaft and 3rd speed clutch assembly from housing.
NOTE: The 2-speed transmission would not have a clutch on the shaft.

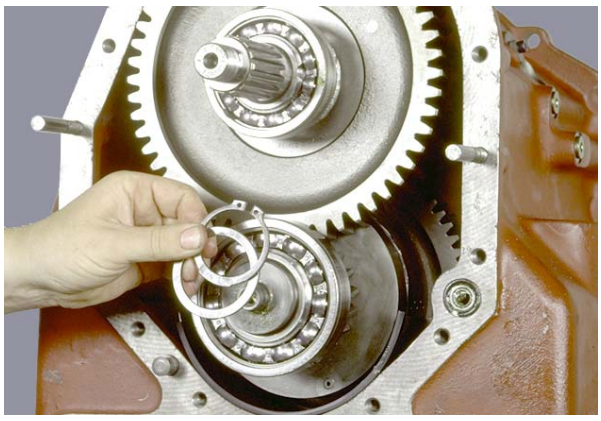


Figure 45
Remove low clutch shaft rear bearing spacer and retainer ring.

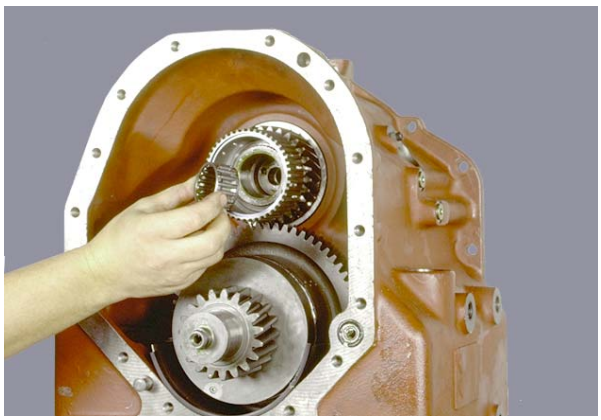


Figure 48
Remove the output shaft pilot bearing.

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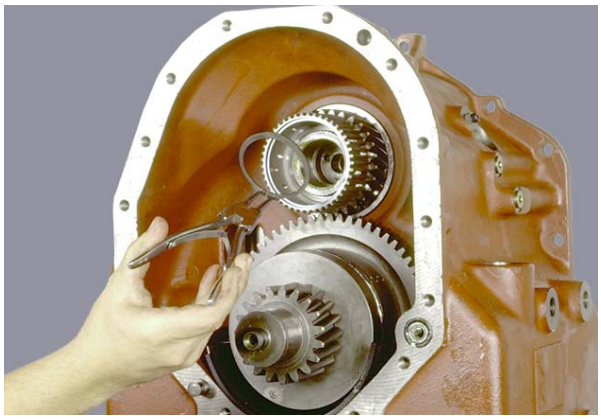


Figure 49
Remove 3rd clutch gear retainer ring.

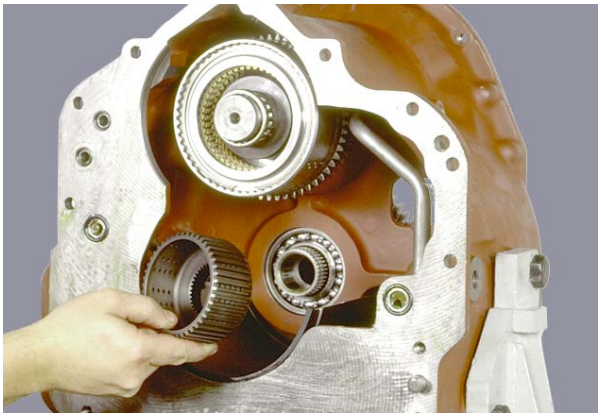


Figure 52
Remove 2nd clutch disc hub.

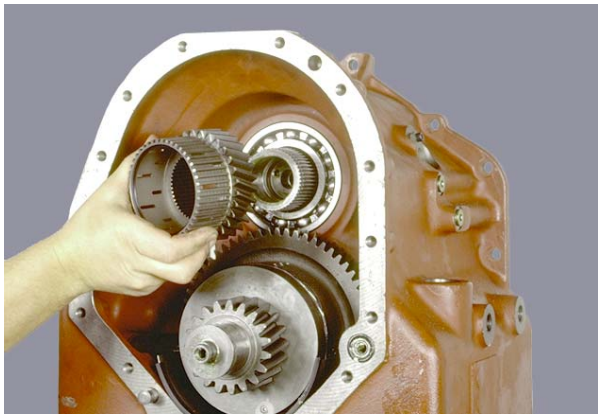


Figure 50
Remove gear and 3rd speed clutch hub.
NOTE: 2-Speed would be gear only.

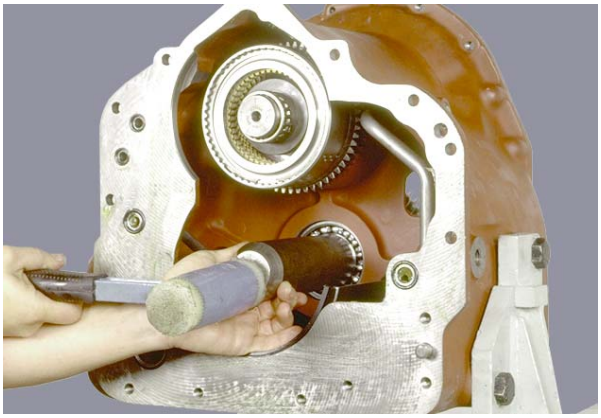


Figure 53
Tap low clutch and gear assembly from housing.

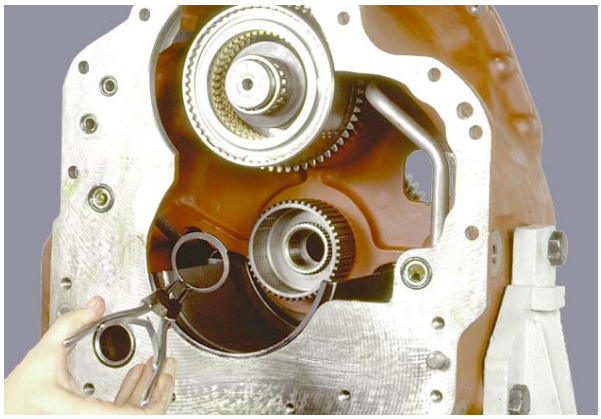


Figure 51
Remove 2nd clutch disc hub retainer ring and pilot bearing.

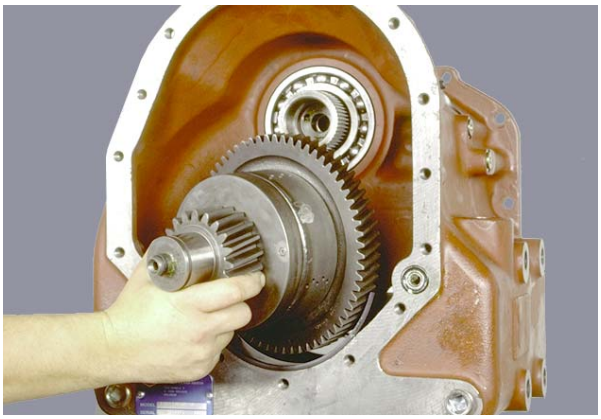


Figure 54
Low clutch assembly removed.

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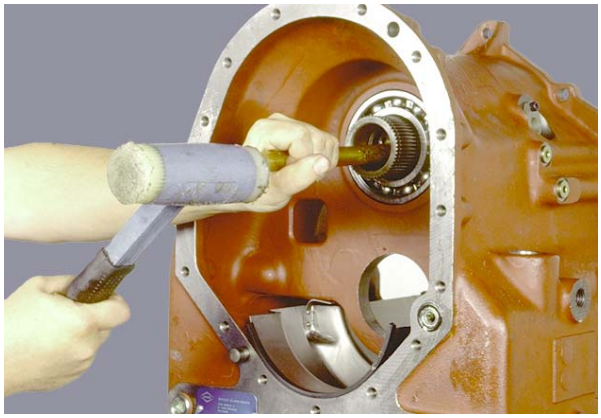


Figure 55
Tap forward clutch from housing.



Figure 58
Remove forward clutch sealing ring sleeve retainer ring.

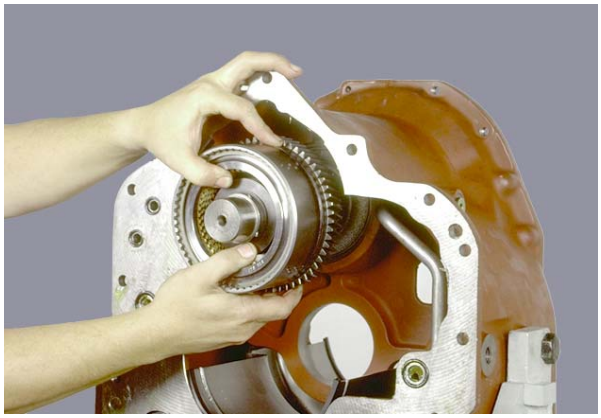


Figure 56
Forward clutch assembly removed.

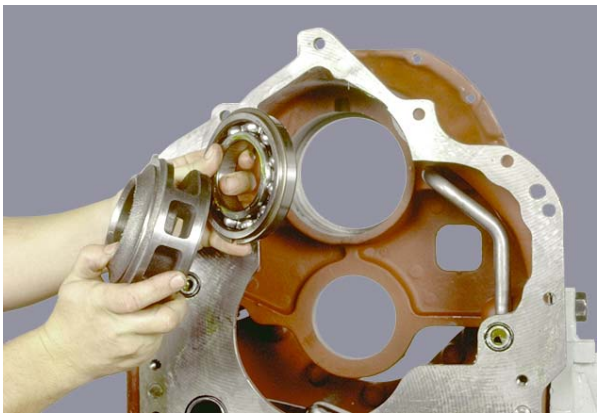


Figure 59
Tap sealing ring sleeve from housing.

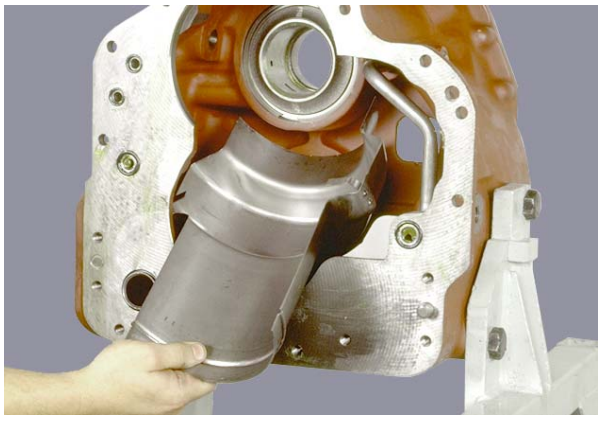


Figure 57
Remove oil baffle and baffle seals.

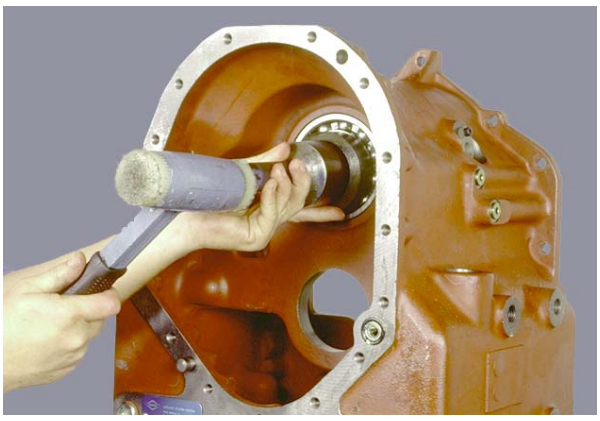


Figure 60
Sleeve removed.

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Figure 61
Remove suction tube and “O”-ring from housing.

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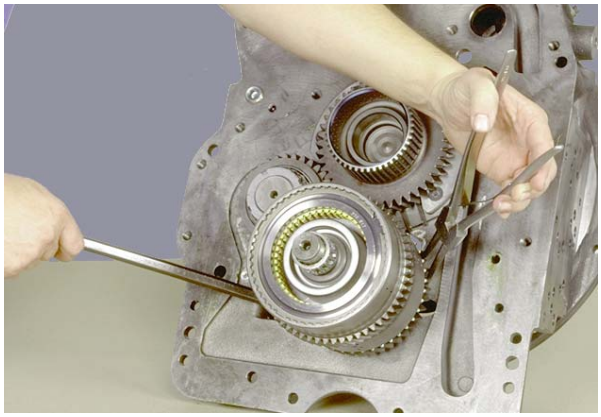


Figure 62

Using spreading type snap ring pliers, spread ears on the reverse front bearing retaining ring.
Holding snap ring open pry reverse and 2nd clutch assembly from converter housing.

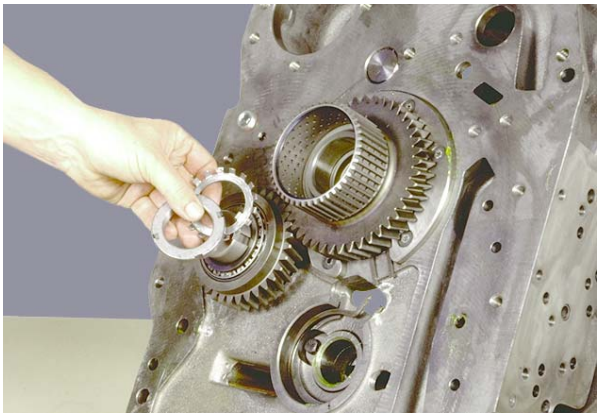


Figure 65

Remove idler shaft bearing retainer nut, lockplate.

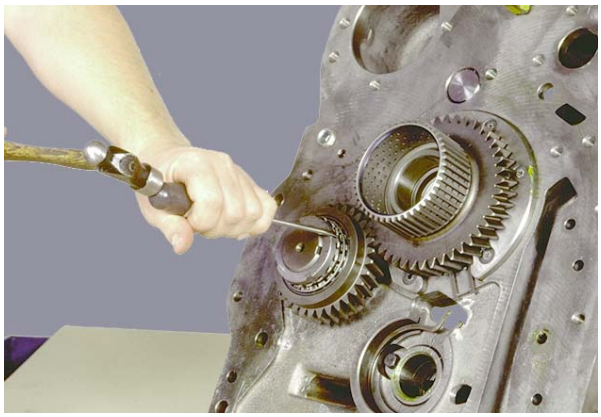


Figure 63

Straighten tang on reverse idler bearing retainer nut lockplate.

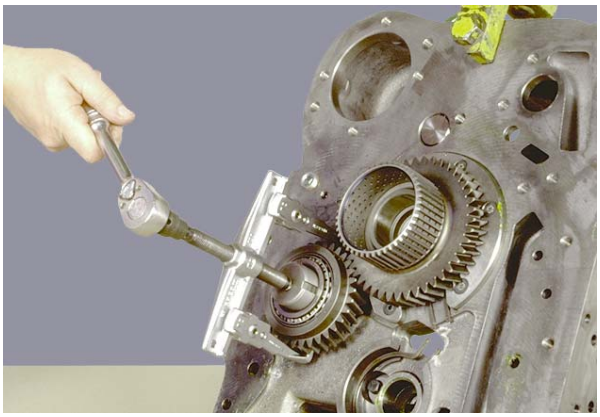


Figure 66

Remove idler gear and outer taper bearing from idler shaft.

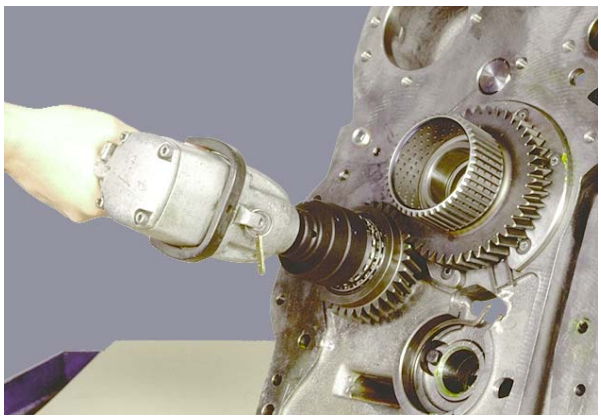


Figure 64

Remove idler shaft bearing retainer nut.
Use TG 1304-54. See section 12: “Service tools” (page 12-1).

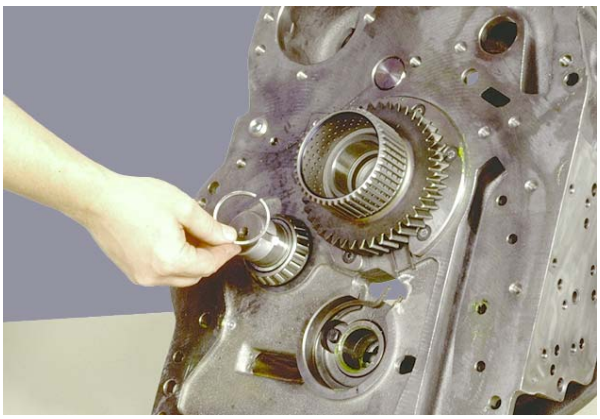


Figure 67

Remove idler gear bearing spacer.

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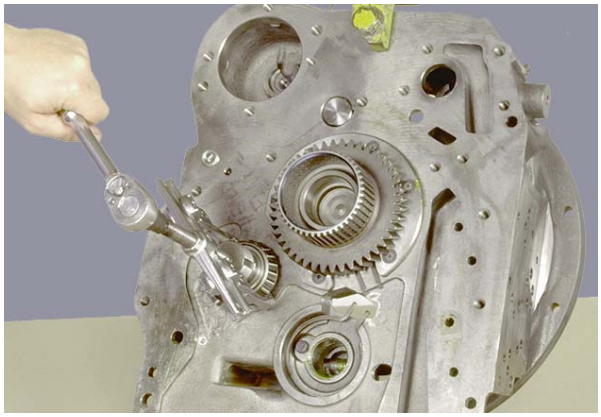


Figure 68
Remove idler gear inner taper bearing.

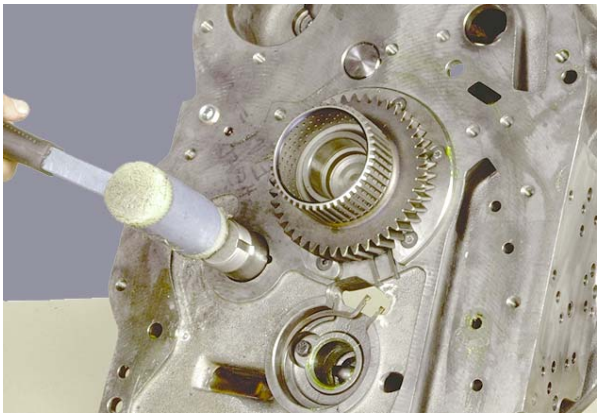


Figure 71
Tap idler shaft from converter housing.



Figure 69
Remove idler gear inner taper bearing spacer.

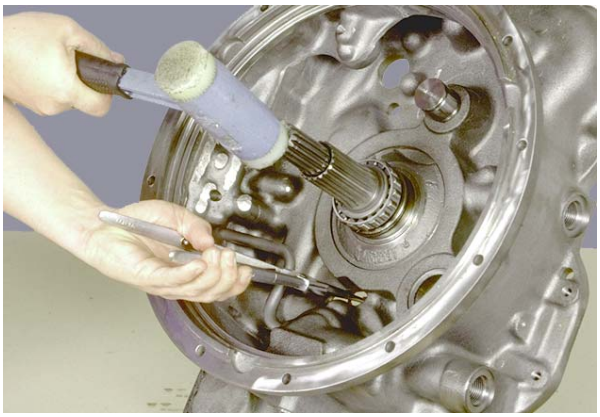


Figure 72
Using spreader type pliers spread ears on the turbine shaft bearing snap ring.
Tap turbine shaft and baring from converter housing.



Figure 70
Remove idler shaft lock ball.

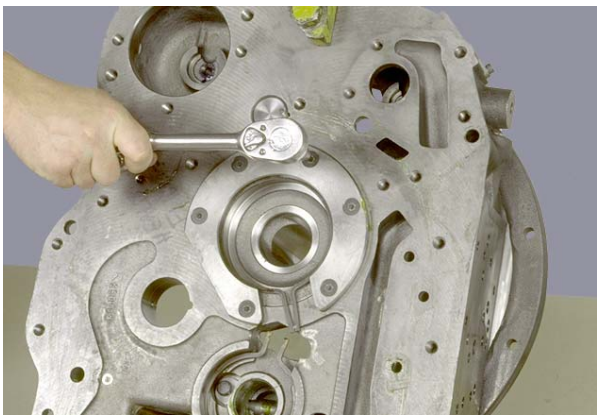


Figure 73
Remove stator support screws.

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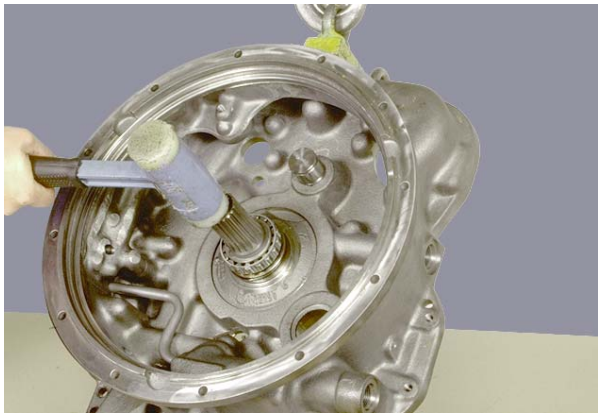


Figure 74
Tap stator support from converter housing.



Figure 77
Remove support bearing retaining ring.

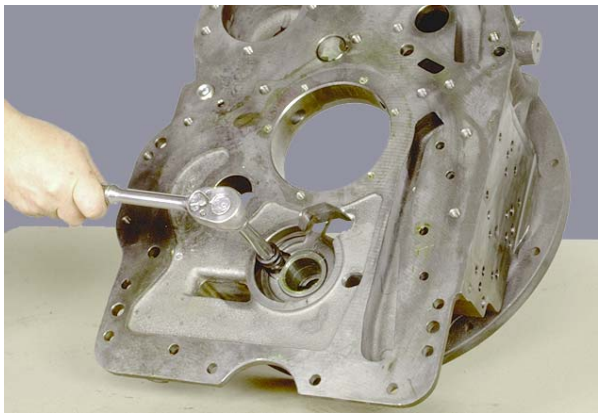


Figure 75
Remove oil sealing ring sleeve retainer and washer.
Remove sleeve lock.

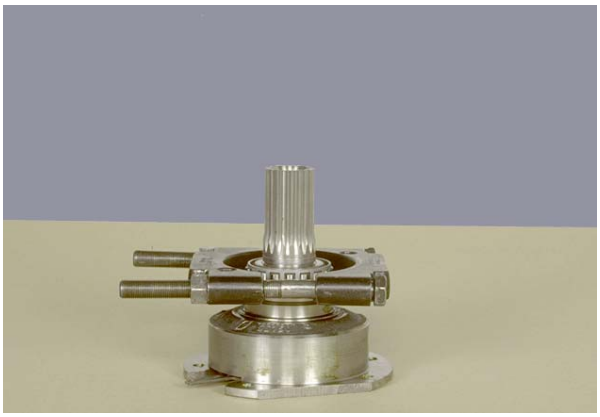


Figure 78
Remove bearing from support.
Remove support oil seal ring.

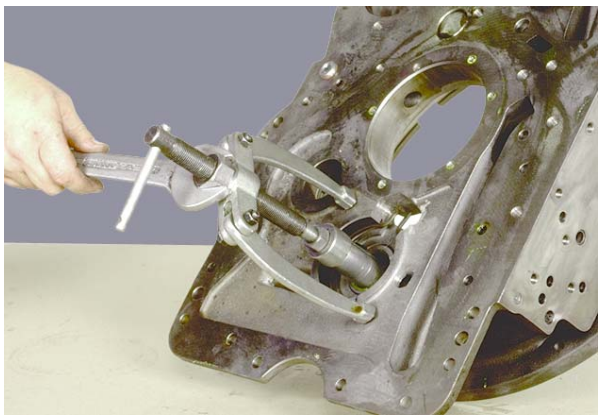


Figure 76
Using a sleeve puller like the one shown, remove sleeve.

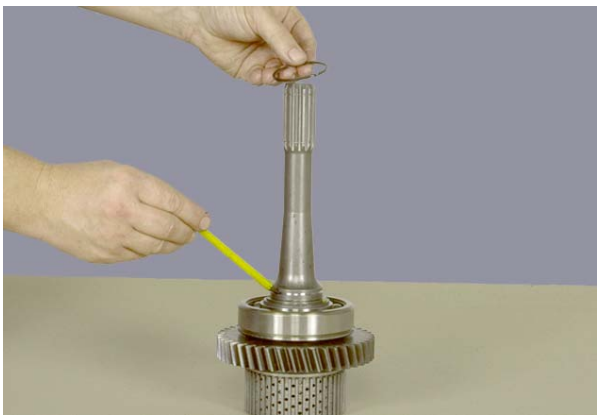


Figure 79
Remove turbine shaft oil sealing ring.

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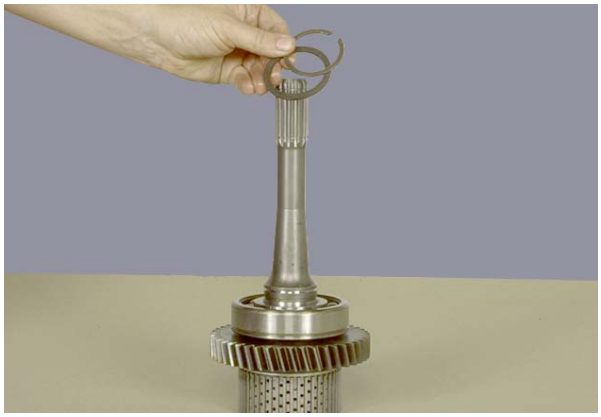


Figure 80
Remove turbine shaft bearing retaining ring and washer.



Figure 81
Remove turbine shaft bearing.

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Disassembly of low (1st) clutch

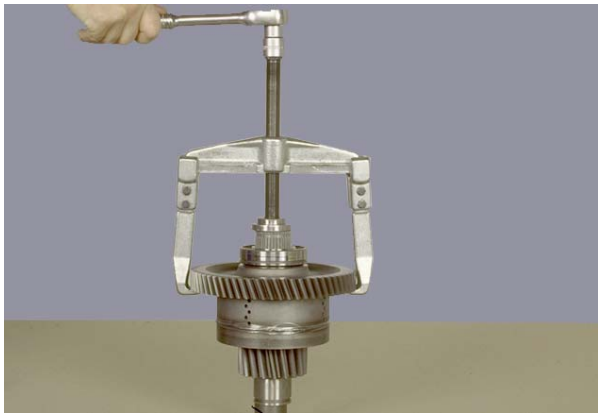


Figure 82
Remove low gear and hub, low shaft front bearing, bearing spacer and clutch gear outer bearing.



Figure 85
Remove end plate.



Figure 83
Remove low speed gear bearing spacer.

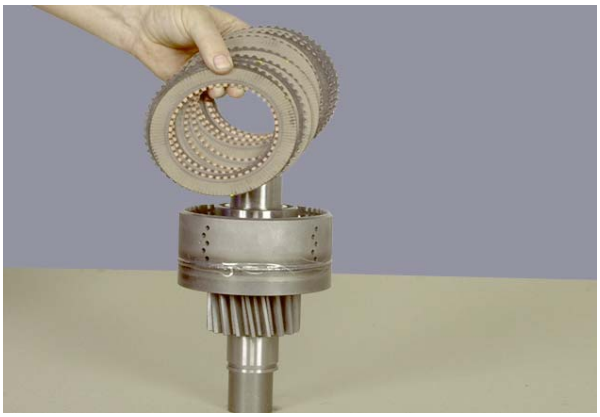


Figure 86
Turn clutch over. Remove inner and outer clutch discs.Do not mix low clutch friction discs with friction discs in other clutches.



Figure 84
Remove end plate retainer ring.



Figure 87
Remove low speed gear inner bearing.

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Disassembly of low (1st) clutch



Figure 88

Remove inner bearing retainer ring.



Figure 91

Turn clutch over and tap clutch shaft on a block of wood to remove clutch piston.



Figure 89

Remove clutch piston return spring. A 1-1/2 x 1 sleeve with a portion removed is recommended for removing the clutch piston spring, washer and retainer ring. Sleeve shown is a common pipe with a 1-1/1 x (39,0 x 26,0 mm) opening. The pipe is 6 x 3-1/4 x 2- 3/4 (155,0 x 85,0 x 78,0 mm). Compress spring retainer washer. Through opening remove spring retainer snap ring. Release tension on spring retainer.



Figure 92

Remove clutch shaft piston ring.

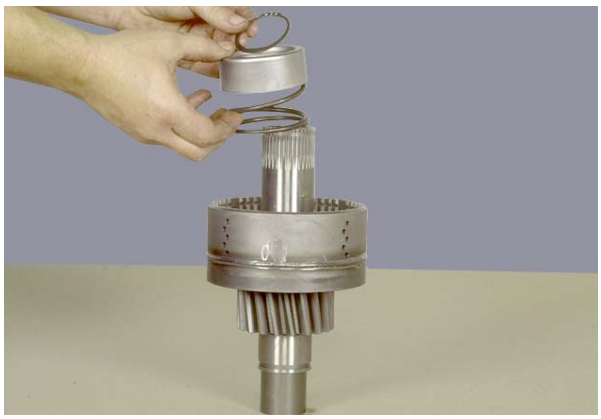


Figure 90

Remove spring retainer ring, spring retainer and spring.

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Reassembly of low (1st) clutch

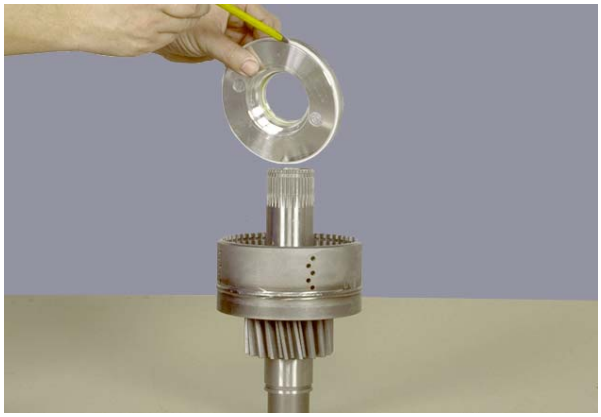


Figure 93

Refer to the “Cleaning and Inspection” pages. The bleed valve in the clutch drum must be clean and free of any foreign material. Install clutch piston outer seal ring. **NOTE**: Ring must be sized before installing in clutch drum. Sizing is best accomplished by rotating clutch while holding a round object against the new seal ring.

Rotate piston until seal ring is flush with outer diameter of piston.

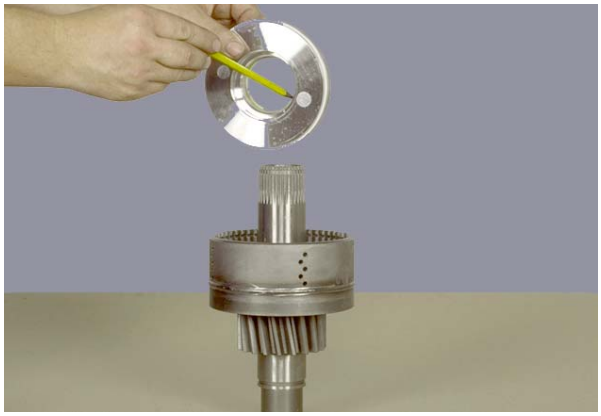


Figure 94

Install clutch piston inner seal ring and size as described in figure 93.



Figure 95

Position piston in low clutch drum as shown. Use caution as not to damage inner and outer piston sealing rings.

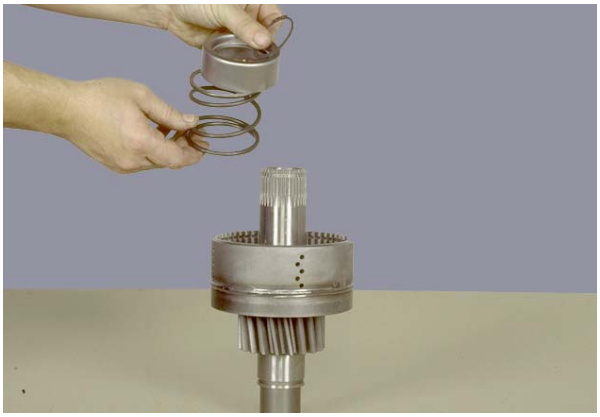


Figure 96

Position piston return spring, spring retainer and snap ring in clutch drum.



Figure 97

Compress spring and retainer. Install retainer snap ring.

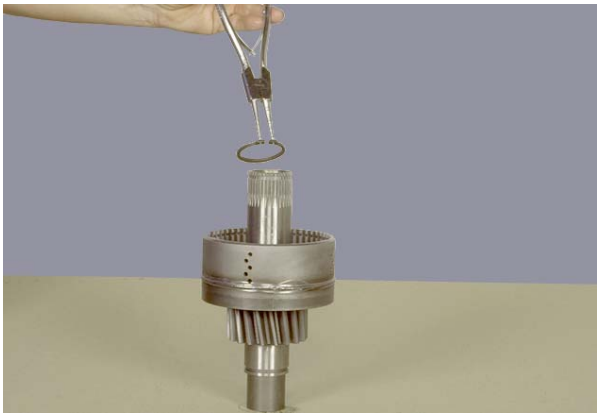


Figure 98

Install clutch inner bearing locating ring.

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Figure 99
Install one steel disc.



Figure 100
Install one friction disc. **NOTE**: the friction discs in the low clutch has a higher co-efficient rating than the friction discs in the other clutches therefore the discs must not be mixed. The low clutch friction disc has a yellow make of non-soluble paint on the outer diameter for permanent identification. Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston in steel last disc installed is friction.



Figure 101
Install clutch disc end plate.



Figure 102
Install end plate retainer ring.



Figure 103
Install low speed gear inner bearing.



Figure 104
Install low speed gear bearing spacer.

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Figure 105

Install clutch driven gear and hub into clutch drum. Align splines on clutch hub with internal teeth of friction discs. Tap gear into position.
Do not force this operation. Gear splines must be in full position with internal teeth of all friction discs.



Figure 106

Install low speed gear outer bearing.



Figure 107

Position low gear front bearing spacer.



Figure 108

Install low shaft front bearing.



Figure 109

Install new oil sealing ring on low clutch shaft.
NOTE: New ring must be sized before installing low shaft bearing cap.
A sizing tool can be made for ease of sizing oil sealing ring. See section 12: “Service tools” (page 12-2).

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Figure 110
Remove clutch shaft piston rings.

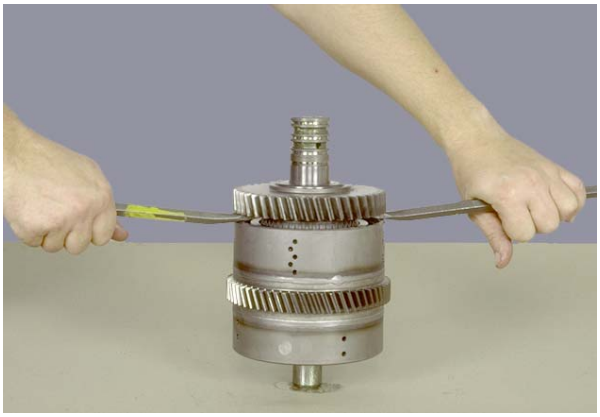


Figure 113
Pry reverse gear from clutch assembly far enough to use a gear puller.



Figure 111
Remove clutch shaft front bearing retainer ring.

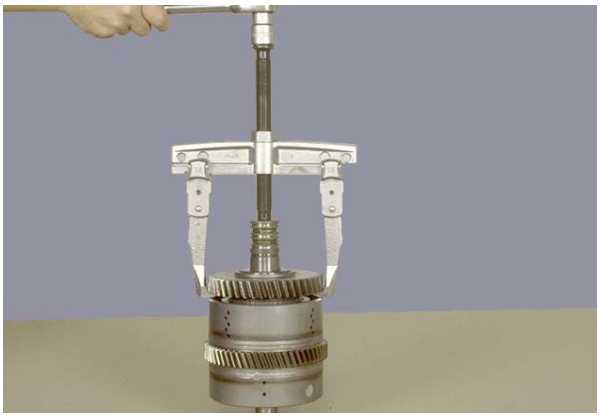


Figure 114
Remove reverse clutch gear and outer bearing.



Figure 112
Remove clutch shaft front bearing.



Figure 115
Remove clutch gear bearing spacer.

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Figure 116
Remove end plate retainer ring.

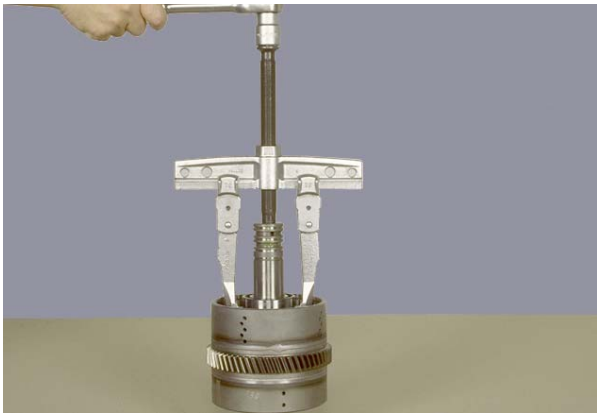


Figure 119
Remove clutch gear inner bearing.



Figure 117
Remove end plate.



Figure 120
Compress piston return disc springs.
Remove return spring retainer ring.

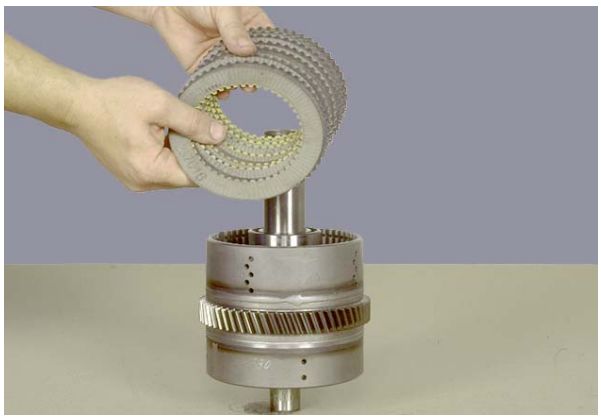


Figure 118
Remove inner and outer discs.



Figure 121
Remove piston return disc springs and piston spacer.
NOTE: Do not mix disc springs with any other disc springs as they are matched spring packs.
See page 10-55.

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Figure 122
Remove clutch piston. 2nd being disassembled.

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Figure 123
Remove end plate retainer ring.



Figure 126
Compress piston return spring.
Remove retainer ring.



Figure 124
Remove end plate.



Figure 127
Remove return spring, spring retainer and retainer ring.



Figure 125
Remove inner and outer clutch discs.



Figure 128
Remove clutch piston.
Reverse and 2nd clutch reassembly, 2nd being assembled.

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Figure 129

Refer to the “Cleaning and Inspection” pages.
The bleed valve in the clutch piston must be clean and free of any foreign material.
Install clutch piston outer seal ring.
Size as explained in figure 93.



Figure 130

Install clutch piston inner seal ring.
Size explained in figure 93.
Install clutch piston in clutch drum.
Use caution as not to damage sealing rings.



Figure 131

Position piston in 2nd clutch drum as shown.
Use caution as not to damage inner and outer piston sealing rings.



Figure 132

Position piston return spring, spring retainer and retainer ring.

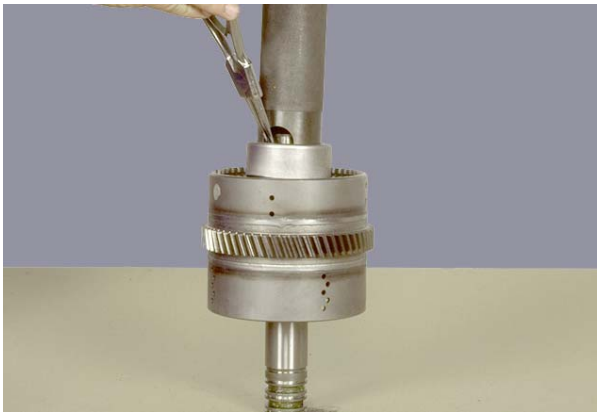


Figure 133

Compress return spring and install retainer ring.



Figure 134

Install one steel disc.

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Figure 135

Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston is steel, last disc installed is a friction disc.



Figure 136

Install end plate.



Figure 137

Install end plate retainer ring.

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Figure 138

Refer to the “Cleaning and Inspection” pages.
Install clutch piston outer seal ring.
Size as explained in figure 93.



Figure 141

Position spring spacer and piston return springs.
First spring with large diameter toward spacer, see figure 143. Alternate five (5) springs.
See note in figure 121.



Figure 139

Install clutch piston inner seal ring.
Size as explained in figure 93.
Install clutch piston in clutch drum.
Use caution as not to damage sealing rings.

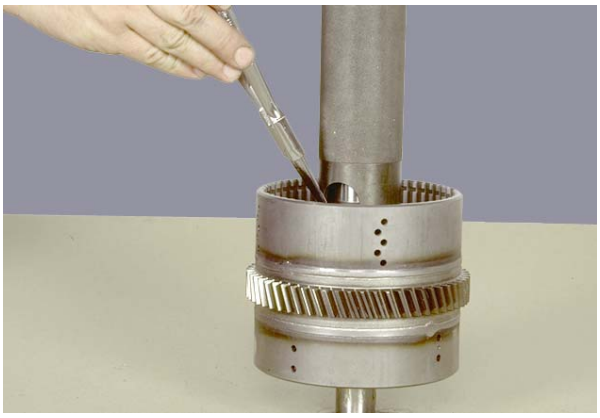


Figure 142

Position spring snap ring.
Compress spring.
Install snap ring.



Figure 140

Position piston in reverse clutch drum as shown.
Use caution as not to damage inner and outer piston rings.

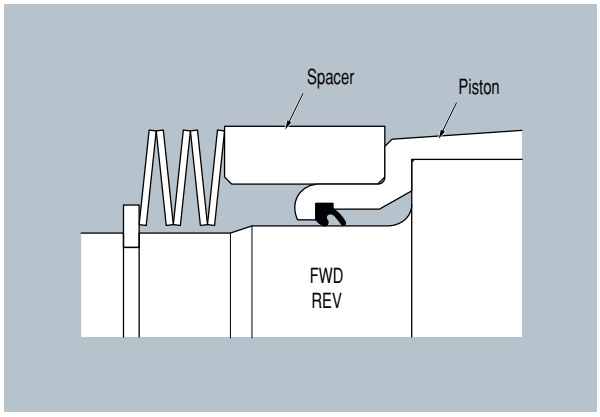


Figure 143

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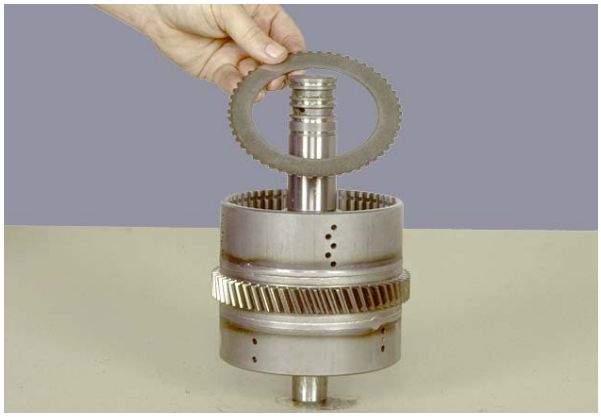


Figure 144
Install one steel disc.



Figure 147
Install end plate retainer ring.

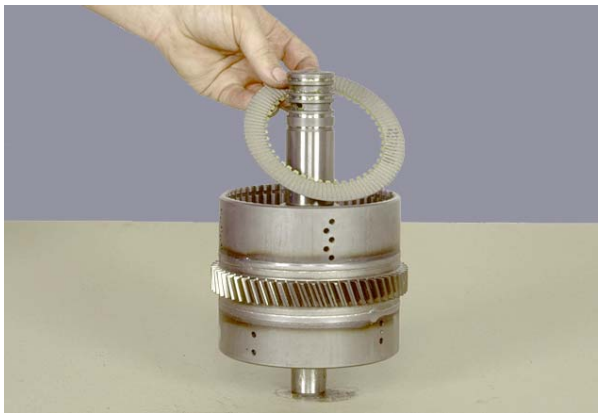


Figure 145
Install one friction disc. Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston is steel, last disc installed is a friction disc.



Figure 148
Install clutch gear inner bearing.
NOTE: this bearing does not have a shield in it.



Figure 146
Install end plate.



Figure 149
Install clutch gear bearing spacer.

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Figure 150

Install reverse gear into clutch drum.
Align splines on reverse gear with internal teeth of friction discs. Do not force this operation. Gear splines must be in full position with internal teeth of all friction discs.



Figure 153

Install bearing retainer ring.



Figure 151

Install clutch gear outer bearing.
NOTE: outer bearing has a shield in it, this shield must be up.



Figure 154

Install clutch shaft piston rings.



Figure 152

Install clutch shaft front bearing.
NOTE: bearing outer diameter locating groove must be up.

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Figure 155
Remove end plate retainer ring.



Figure 158
Compress piston return disc springs.
Return spring retainer ring.



Figure 156
Remove end plate.



Figure 159
Remove piston return disc springs and piston spacer. See note in figure 121.



Figure 157
Remove inner and outer clutch discs.



Figure 160
Remove clutch piston.

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Figure 161
Remove clutch shaft sealing rings.

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Figure 162

Refer to the “Cleaning and Inspection” pages. Install clutch piston outer sealing ring. Size as explained in figure 93.





Figure 165

Position spring spacer and piston return springs. First spring with large diameter toward spacer, see figure 167.
Alternate five (5) springs: see note in figure 121.



Figure 163

Install clutch piston inner sealing ring. Size as explained in figure 93.



Figure 166

Position spring nap ring. Compress spring. Install snap ring.



Figure 164

Install clutch piston in clutch drum, use caution as not to damage sealing rings.



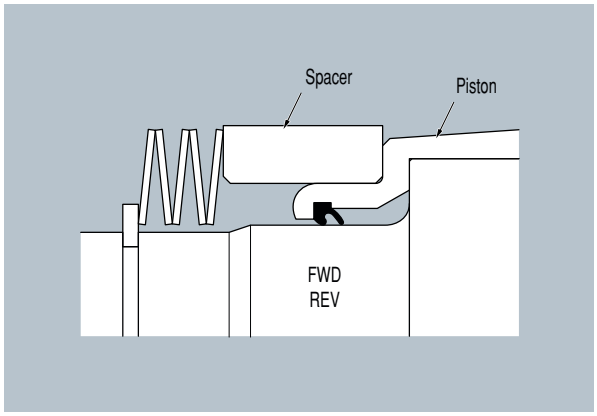


Figure 167

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Figure 168
Install one steel disc.



Figure 171
Install end plate retainer ring.



Figure 169
Install one friction disc. Alternate steel and friction discs, until the proper amount of discs are installed. First disc next to the piston in steel, last disc installed is a friction disc.



Figure 172
Install clutch shaft sealing rings.



Figure 170
Install end plate.

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Figure 173
Remove end plate retaining ring.



Figure 176
Compress piston return spring and spring retainer. Remove retainer ring.



Figure 174
Remove end plate.

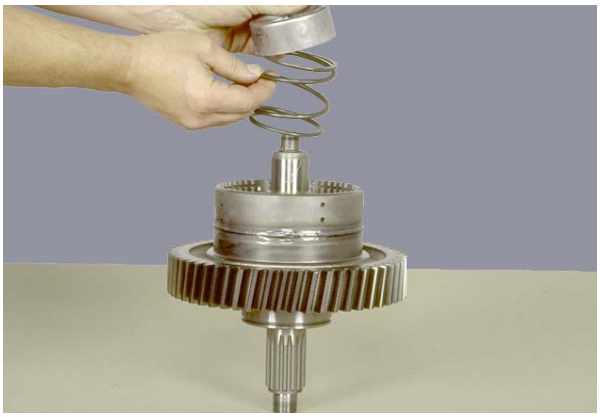


Figure 177
Remove return spring, spring retainer and retainer ring.

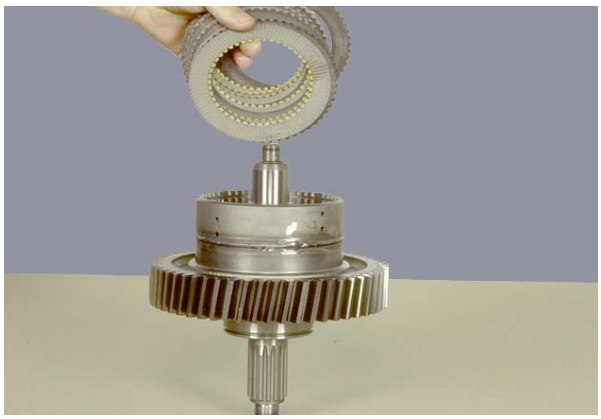


Figure 175
Remove inner and outer discs.



Figure 178
Remove clutch piston.

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Figure 179
Remove sealing ring.

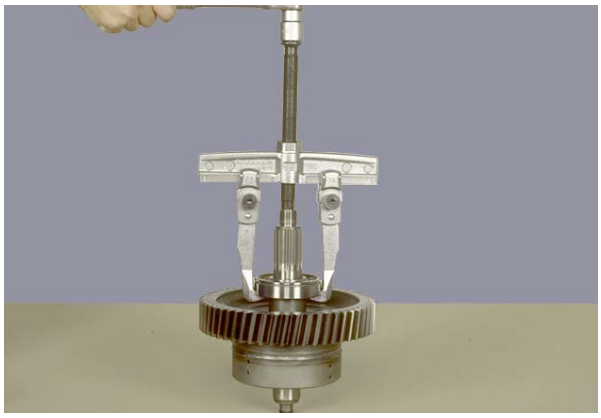


Figure 180
Remove 3rd clutch shaft rear bearing.

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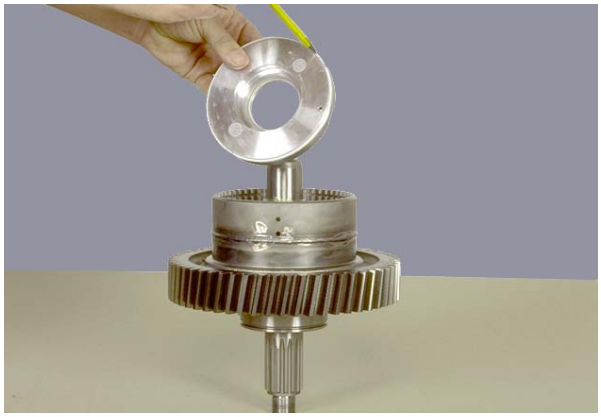


Figure 181

Refer to the “Cleaning and Inspection” pages.
The bleed valve in the clutch piston must be clean and free of any foreign material.
Install clutch piston outer seal ring.
Size as explained in figure 93.





Figure 182

Install clutch piston inner seal ring.
Size as explained in figure 93.



Figure 183

Install clutch piston in clutch drum.
Use caution as not to damage sealing rings.





Figure 184

Install one steel disc.



Figure 185

Install one friction disc. Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston is steel, last disc installed is a friction disc.



Figure 186

Install end plate.

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Figure 187
Install end plate retainer ring.



Figure 188
Position piston return spring, spring retainer and retaining ring.



Figure 189
Compress return spring and install retainer ring.



Figure 190
Install new oil sealing ring on output shaft.
NOTE: New ring must be sized before shaft can be assembled in transmission housing. A sizing tool can be made for ease of sizing oil sealing ring.
See section 12: “Service tools” (page 12-2).



Figure 191
Install 3rd clutch shaft rear bearing.
NOTE: Bearing outer diameter locating ring groove must be up.

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Figure 192

Refer to the “Cleaning and Inspection” pages.
Press turbine shaft bearing into position.
Bearing groove must be down.



Figure 195

Install new stator support oil sealing ring.
Press support bearing into position.
NOTE: bearing part number must be up.

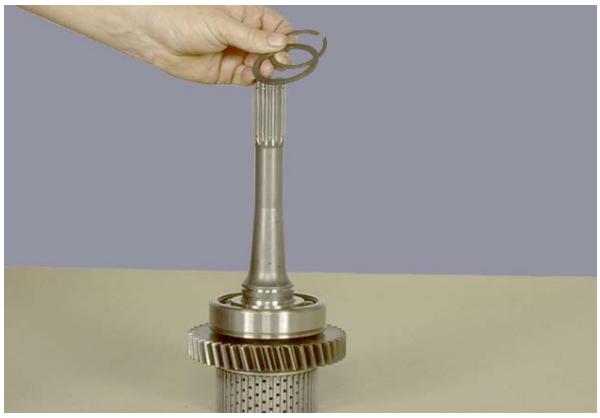


Figure 193

Position bearing spacer and bearing retaining ring.



Figure 196

Install bearing retaining ring.

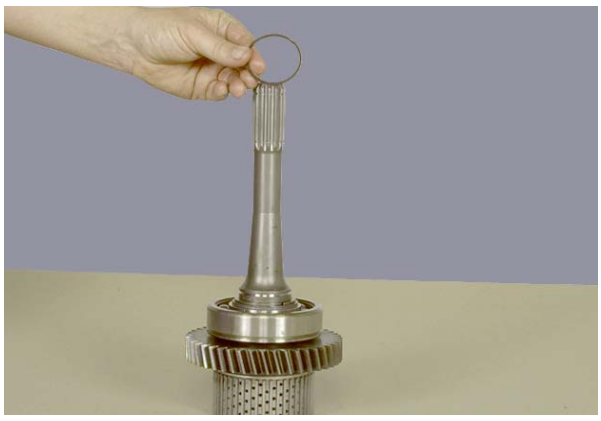


Figure 194

Install new turbine shaft oil sealing ring.

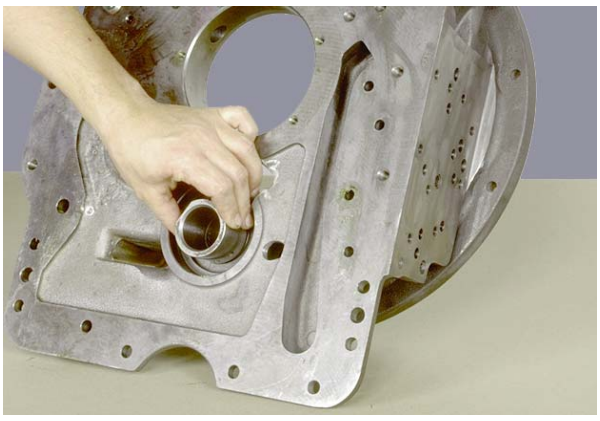


Figure 197

When installing a new sleeve it is recommended a press or a driver be used to prevent damage to the sleeve and be sure the notch in the sleeve is aligned with sleeve lock notch.

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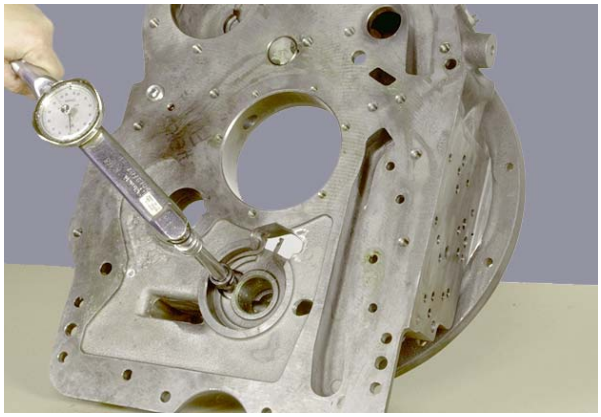


Figure 198

Install sleeve lock and cap screw, tighten screw to specified torque (see torque chart).

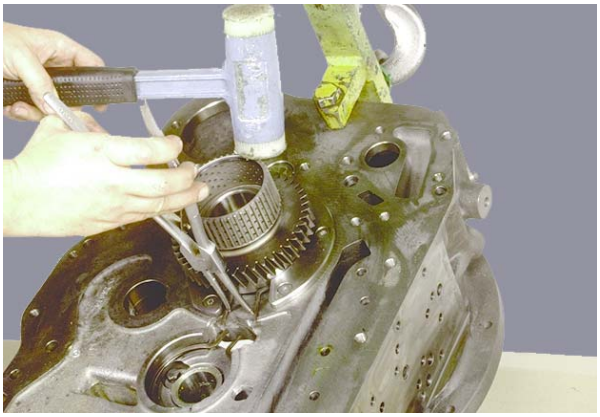


Figure 201

Spread ears on turbine shaft bearing retainer ring located in reaction member support. Tap turbine shaft and bearing into position, being certain bearing snap ring is in full position in snap ring groove.

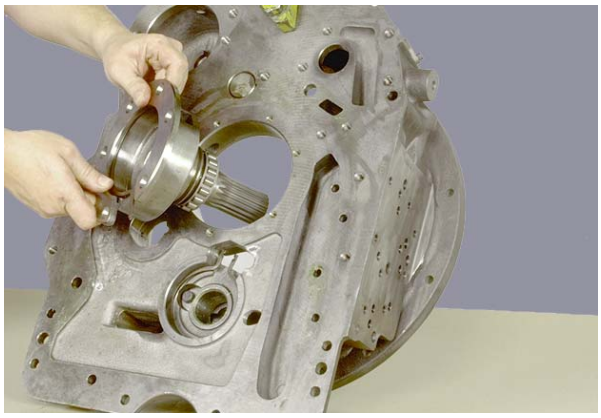


Figure 199

Clean stator support mounting surface and tapped holes with solvent. Dry thoroughly, being certain tapped holes are clean and dry. Position support in converter housing aligning holes in support with holes in housing. Tap support into position.

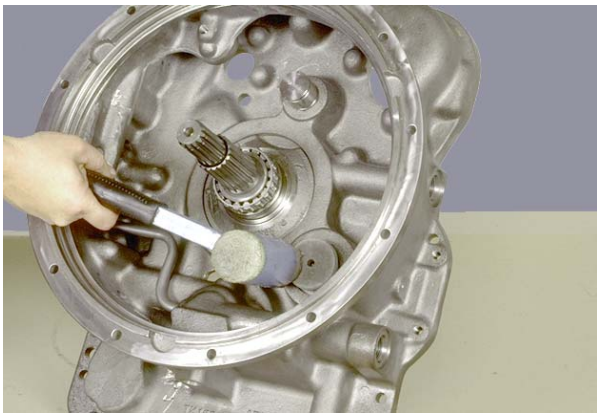


Figure 202

With new “O”-ring on shaft , position idler shaft in converter housing.
Tap shaft into position.

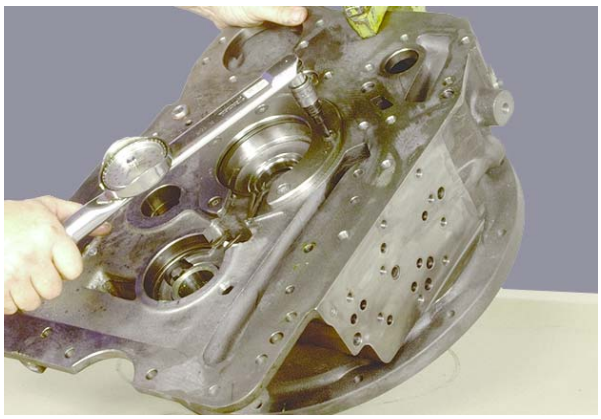


Figure 200

Install 6 special stator support screws. Tighten screws to 12 - 16 lbs. Ft. (16.3 – 21.6 Nm) torque. **NOTE**: assembly of the stator support to converter housing must be completed within a 15 minute period from start of screw installation. The special screw is to be used for one installation only. If the screw is removed for any reason it must be replaced. The Loctite left in the holes must be removed with the proper tap and cleaned with solvent.

Dry hole thoroughly and use a screw for reinstallation.

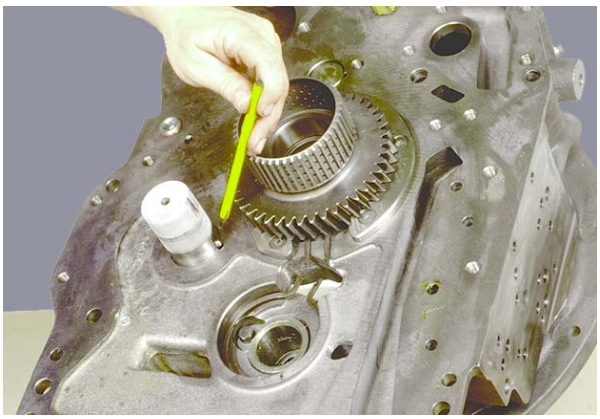


Figure 203

Install idler shaft lock ball.

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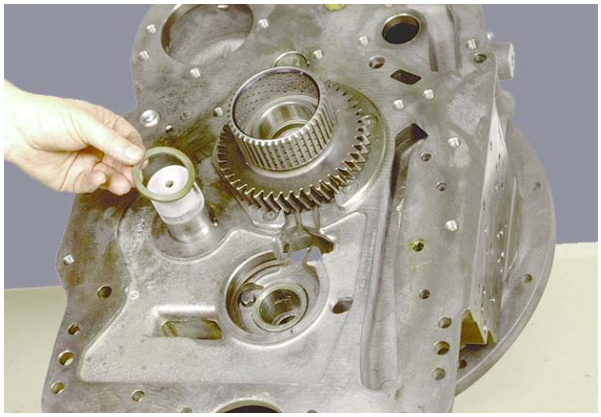


Figure 204
Install idler shaft spacer.

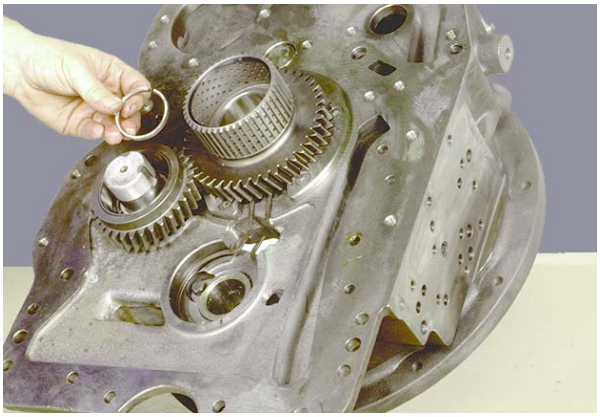


Figure 207
Position bearing spacer on shaft.



Figure 205
Install idler gear inner taper bearing on shaft with large diameter of taper down.

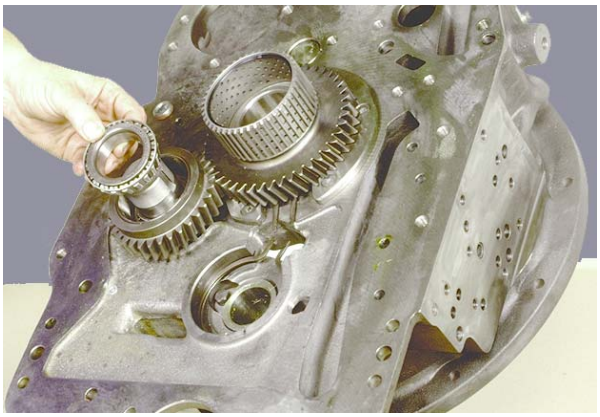


Figure 208
Install taper bearing on shaft with large diameter of taper up.

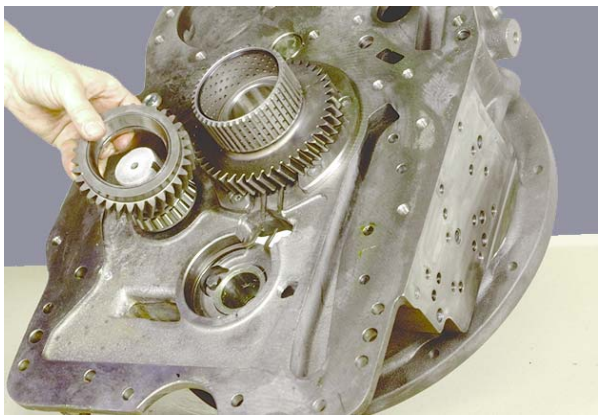


Figure 206
Position idler gear on bearing with hub of gear up.

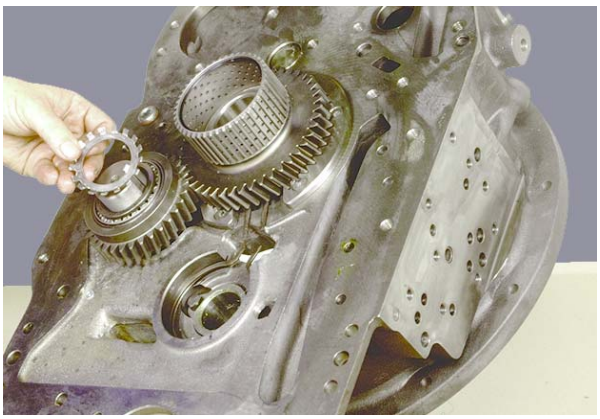


Figure 209
Install reverse idler baring retainer nut lockplate as shown.

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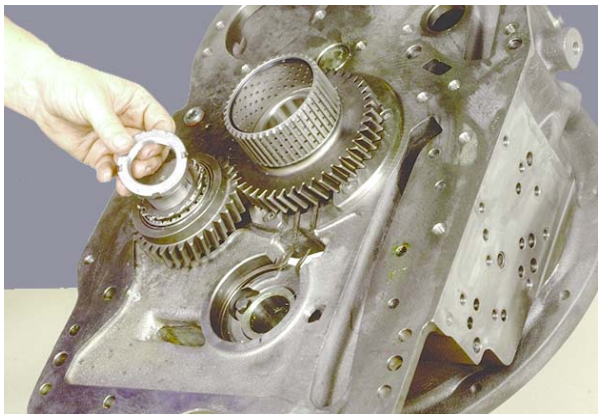


Figure 210

Install reverse idler bearing nut with chamfer down.

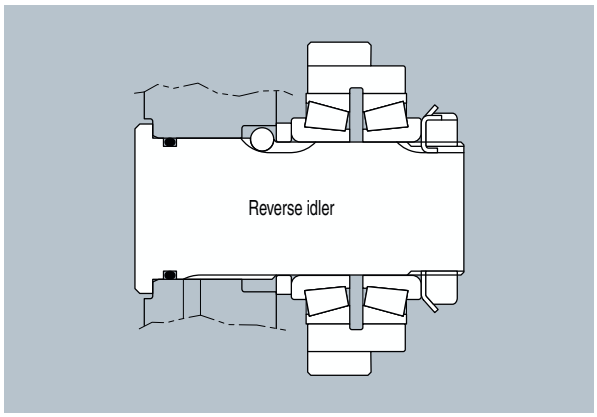


Figure 213

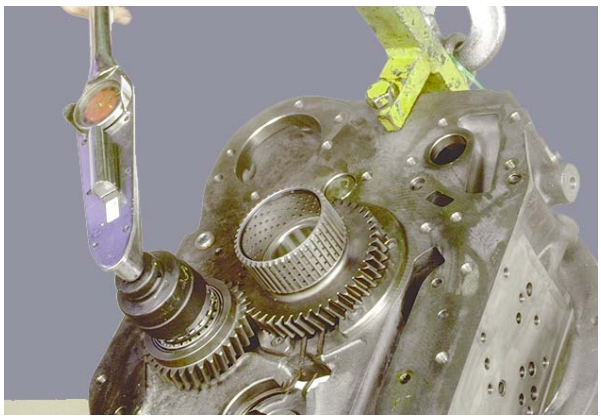


Figure 211

Tighten nut 200 to 250 ft. lbs.
Torque (271.2 – 338.8 Nm). Use TG 1304-54.

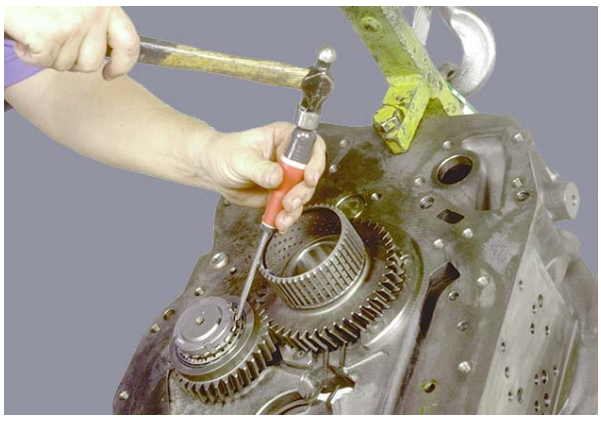


Figure 212

Bend over tag of lock plate that aligns with one of the slots of the lock nut, to secure it (See figure 213).

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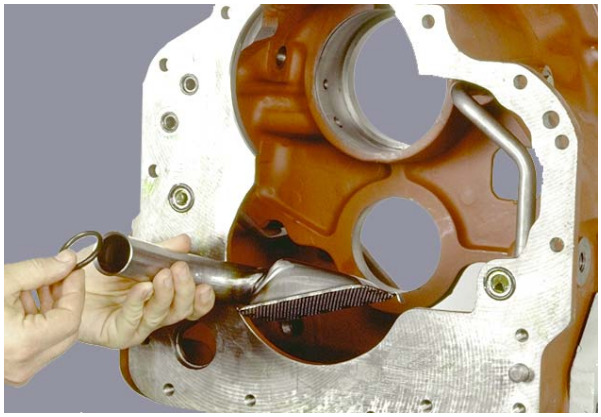


Figure 214
Install suction tube and new “O”-ring.

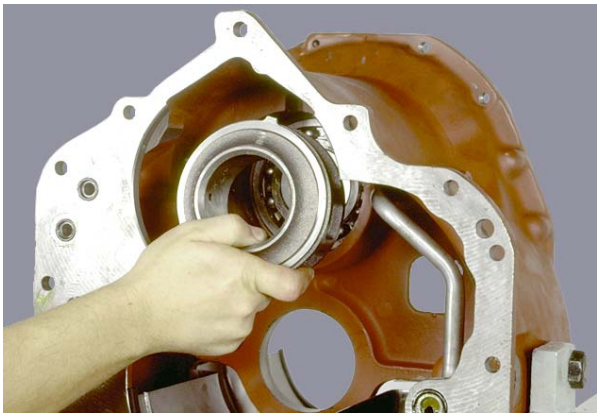


Figure 217
Tap forward shaft piston ring sleeve into position.

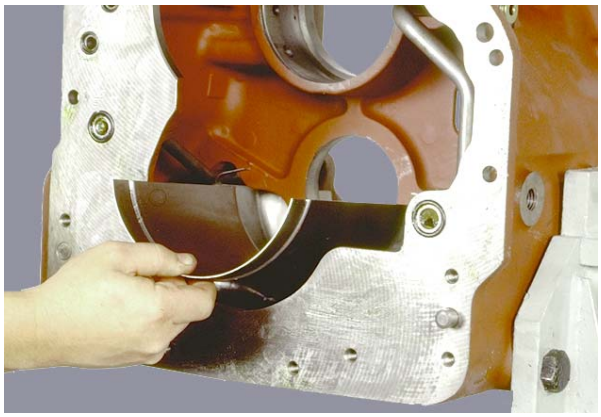


Figure 215
With front and rear baffle seals in position, locate baffle in position.

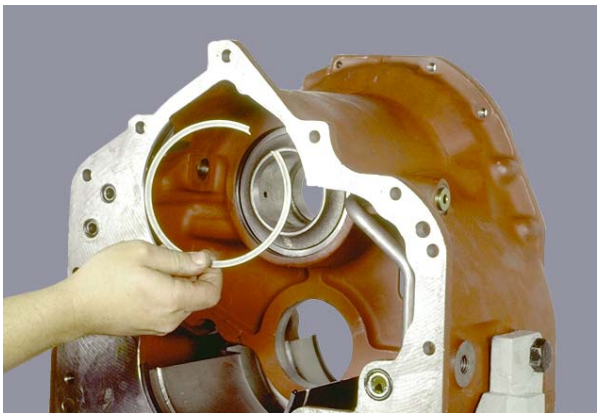


Figure 218
Install piston ring sleeve retainer ring.

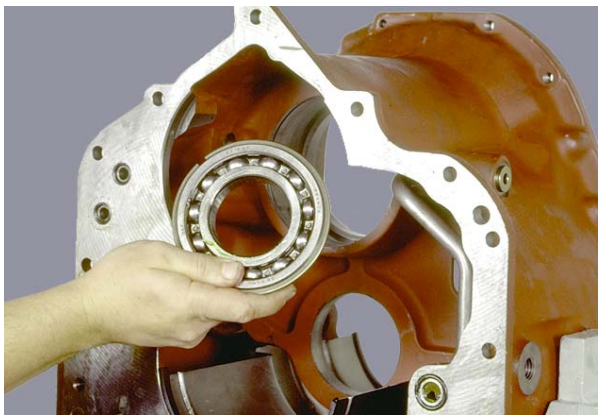


Figure 216
Tap forward shaft rear bearing into position.

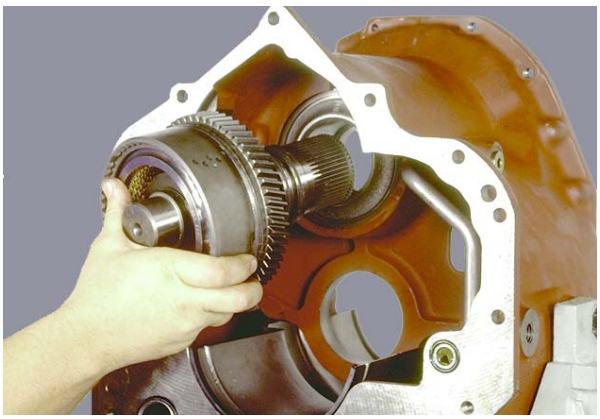


Figure 219
Position forward clutch assembly into transmission housing. Use caution as not to damage forward shaft piston rings.

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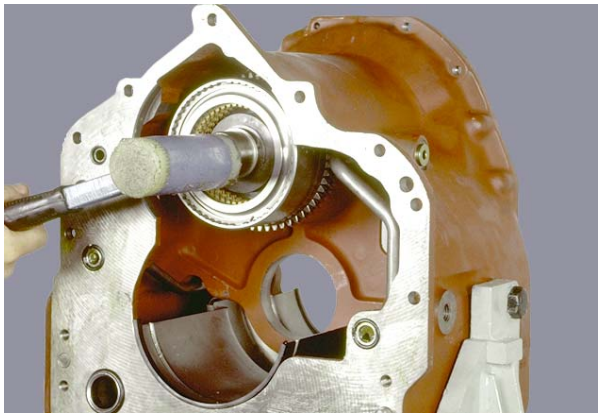


Figure 220
Tap clutch assembly into position.

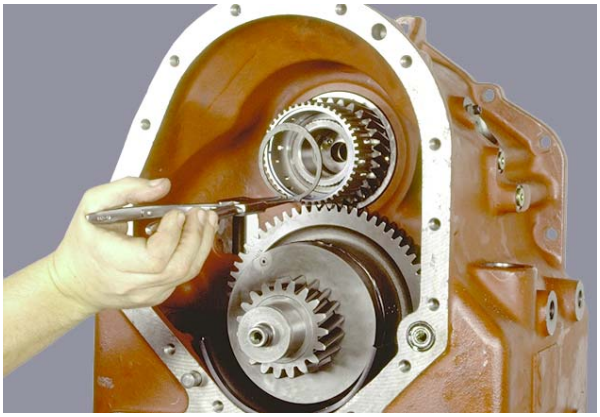


Figure 223
Install gear retainer ring.

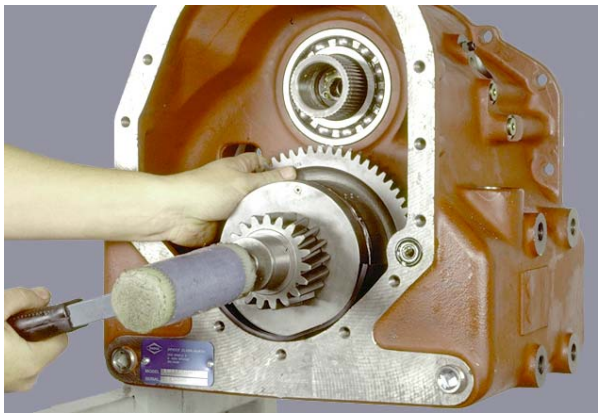


Figure 221
Locate low clutch assembly in housing.
Tap into position.

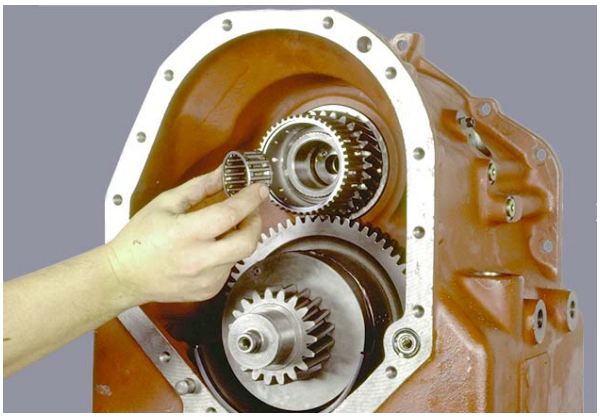


Figure 224
Install output shaft pilot bearing.

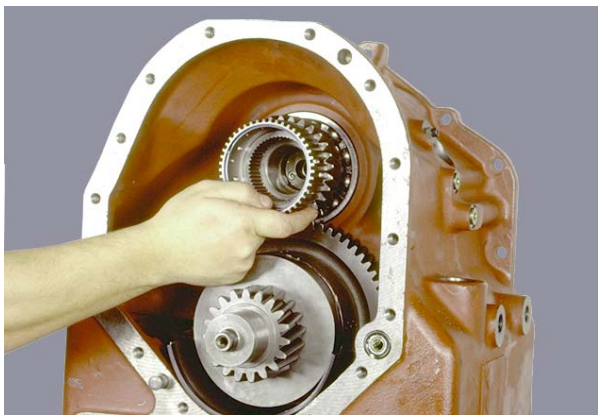


Figure 222
Locate 3rd gear and clutch disc hub on forward clutch shaft.
NOTE: The 2-speed transmission will have only a gear and not a clutch disc hub on it.

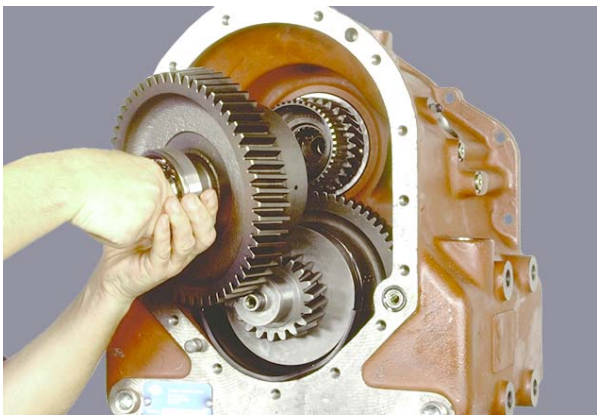


Figure 225
Install output shaft and 3rd clutch.
See note on figure 190.

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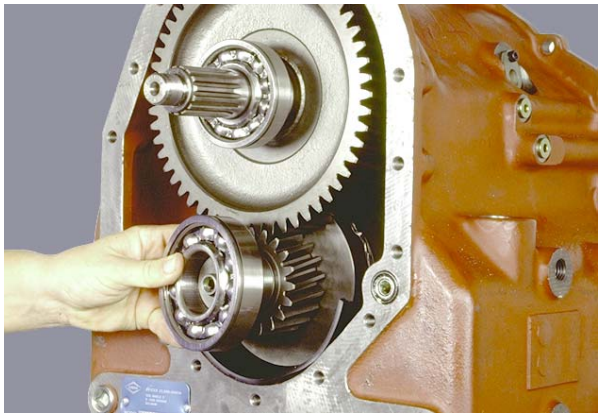


Figure 226
Install low clutch rear bearing with snap ring groove to the rear.

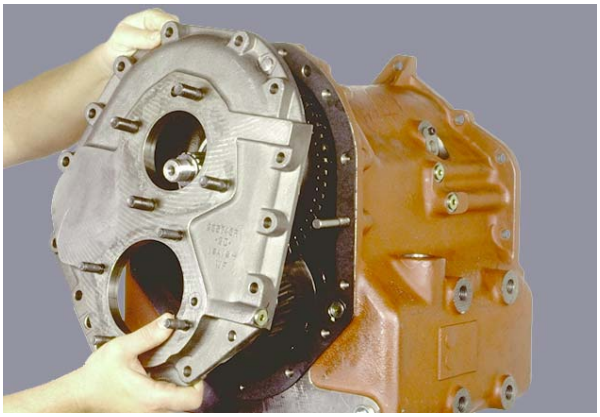


Figure 229
Install rear cover, bolts and lockwashers.

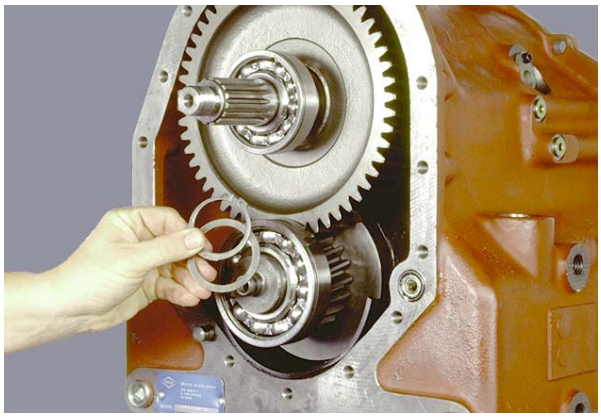


Figure 227
Install low clutch rear bearing washer and retaining ring.

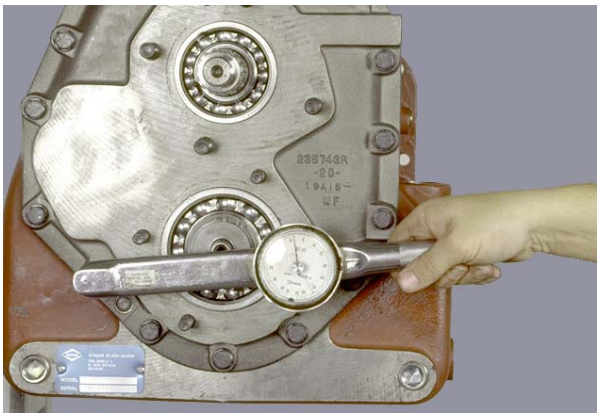


Figure 230
Tighten rear cover screws to specified torque (see torque chart).

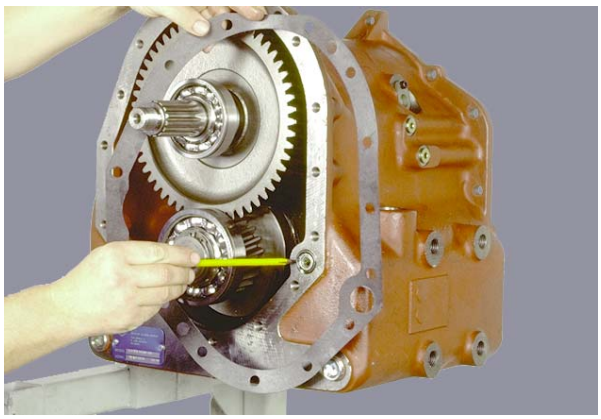


Figure 228
Position new gasket and “O”-ring on rear of transmission housing.
A thin coat of chassis grease will hold the gasket and “O”-ring in place.

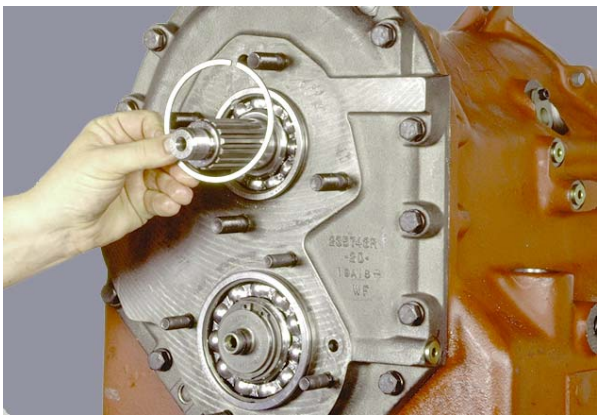


Figure 231
Install output shaft rear bearing locating ring.

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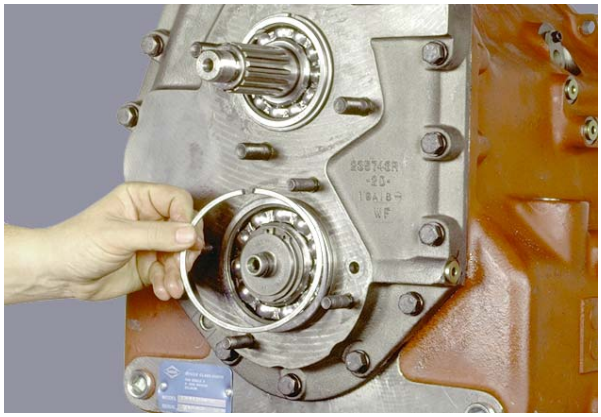


Figure 232
Install low shaft rear bearing locating ring.

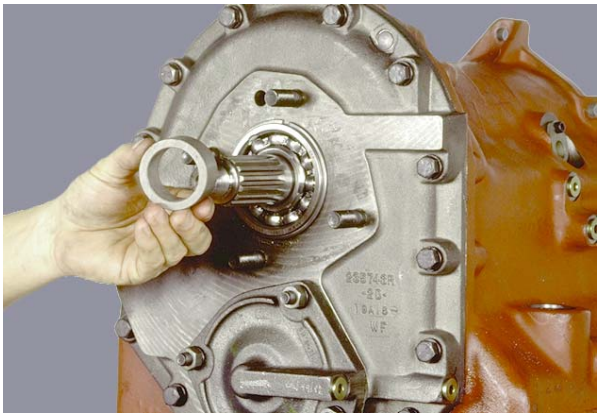


Figure 235
Install output shaft rear bearing spacer.

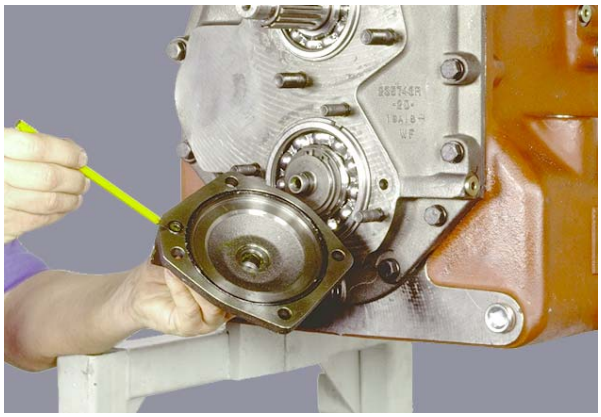


Figure 233
Position new “O”-rings on low shaft rear bearing cap. See note on figure 109. Install bearing cap.

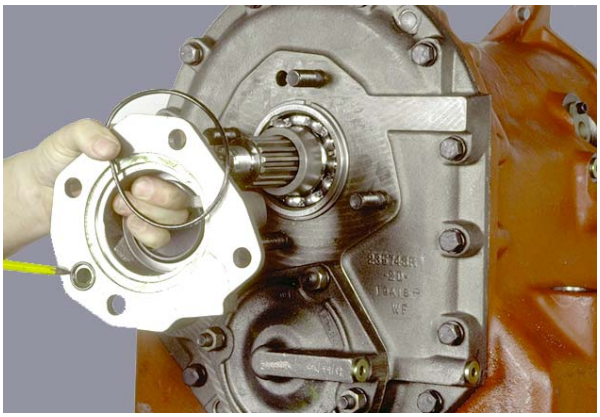


Figure 236
Apply a light coat of loctite 638 to the outer diameter of the output oil seal. Press seal in bearing cap with lip of seal toward bearing side of bearing cap. Position new “O”-rings on bearing cap. **NOTE**: Some units will have a gasket only between the cap and the cover. Install bearing cap on studs.

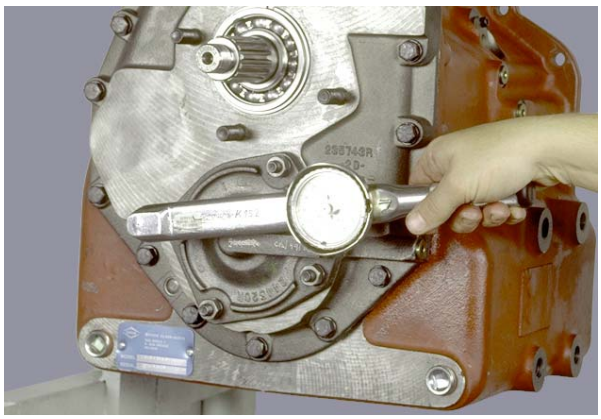


Figure 234
Install lockwashers and stud nuts, tighten nuts to specified torque (see torque chart).

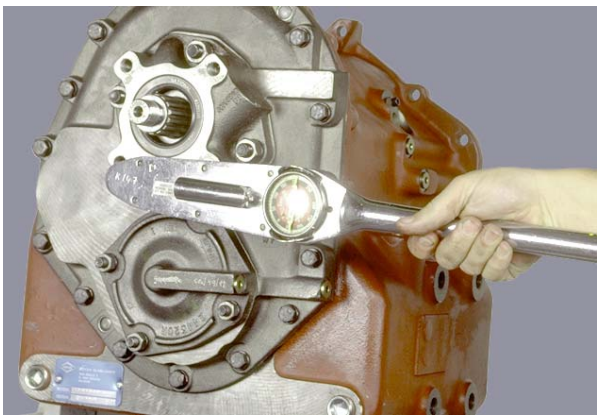


Figure 237
Install lockwashers and steel nuts.
Tighten nuts to specified torque (see torque chart).

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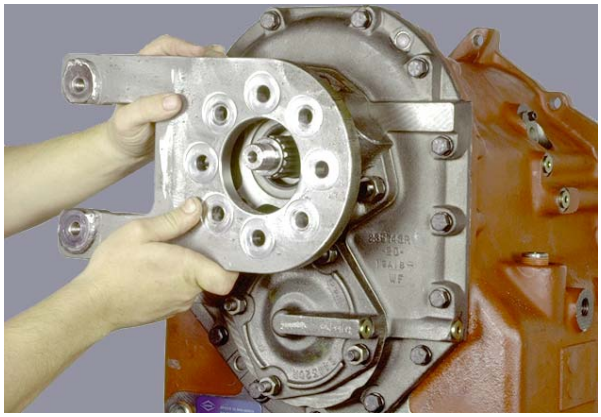


Figure 238

Install brake adaptor, spacers, screws and lockwashers (use loctite 270 on screws).

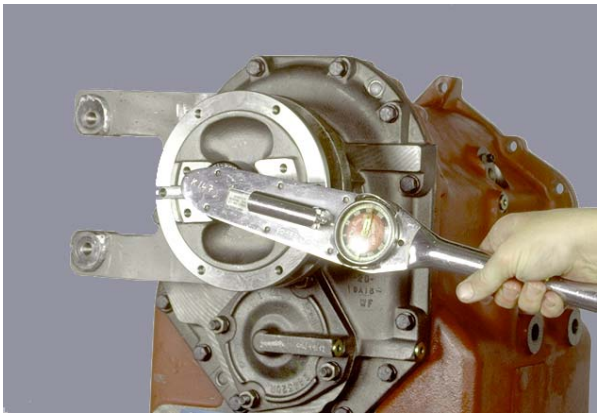


Figure 241

Block flange to prevent turning. Tighten flange nut 200-250 ft. lbs. torque (271.2 - 339.0 Nm.).

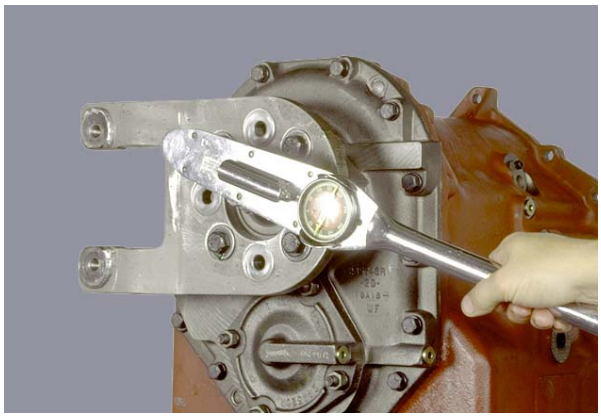


Figure 239

Tighten screws to specified torque (see torque chart).

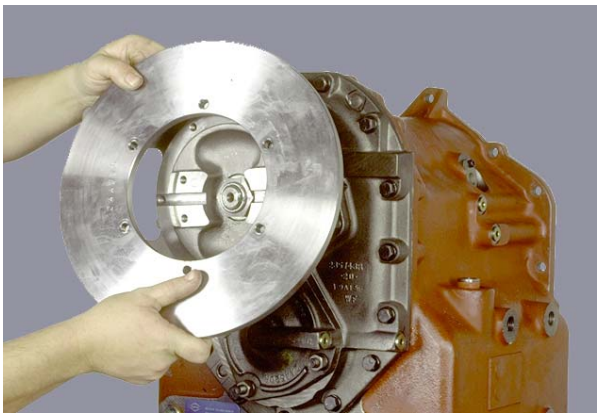


Figure 242

Position brake disc to output flange.

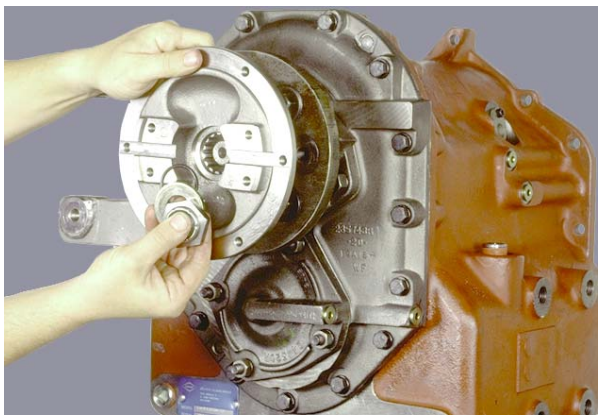


Figure 240

Install output flange, new “O”-ring, washer and nut.

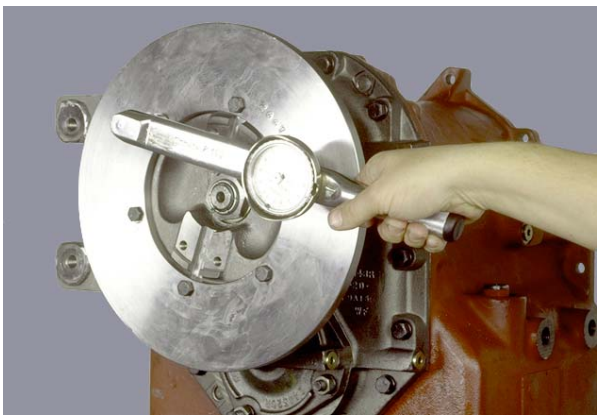


Figure 243

Install mounting screws and lockwashers. Tighten screws to specified torque (see torque chart).

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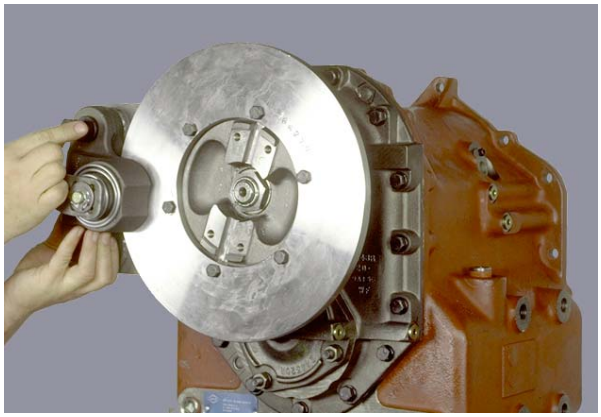


Figure 244

Before installing parking brake (if used), see parking brake instructions in section 11: “Options”.

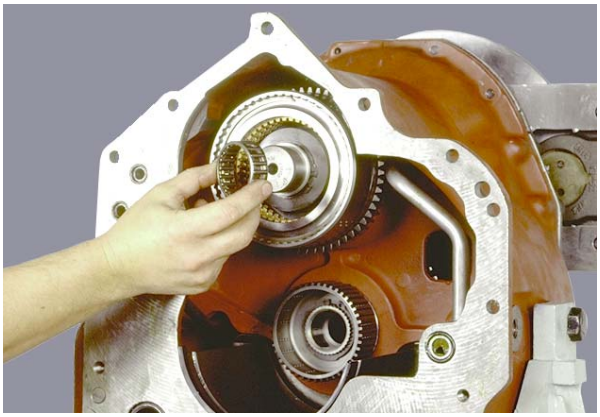


Figure 247

Locate forward shaft pilot bearing.

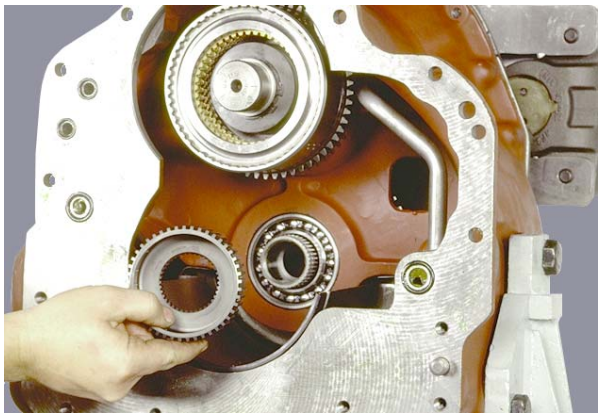


Figure 245

Install 2nd clutch disc hub.

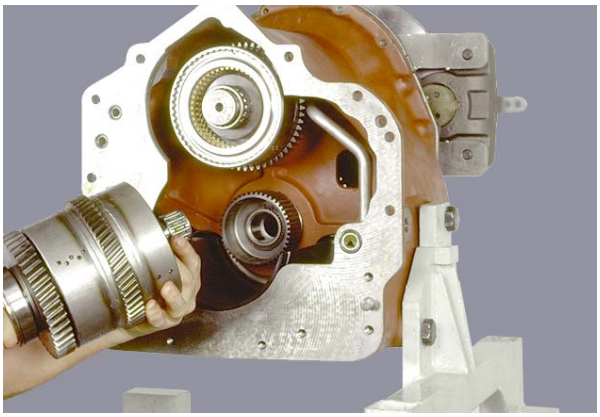


Figure 248

Install 2nd speed clutch shaft rear pilot bearing on shaft.

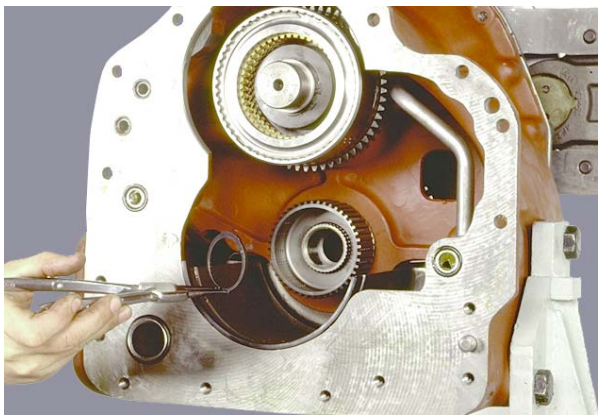


Figure 246

Install 2nd clutch disc hub retaining ring.

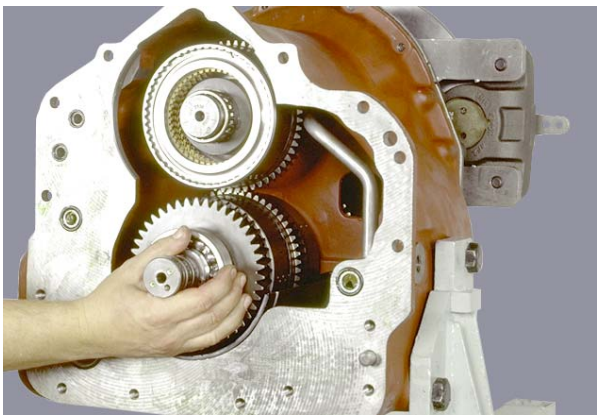


Figure 249

Position reverse and 2nd speed clutch on disc hub, aligning splines of disc hub with internal teeth of 2nd speed clutch friction discs. Disc hub must be in full position with friction discs. Do not force this operation.

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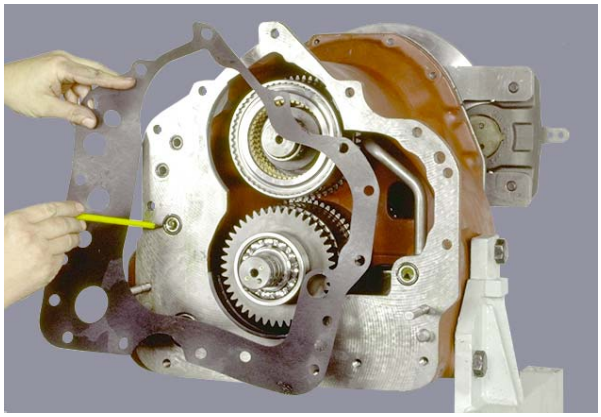


Figure 250

Position a new gasket and “O”-rings on front of transmission housing. A thin coat of chassis grease will hold the gasket and “O”-rings in place.

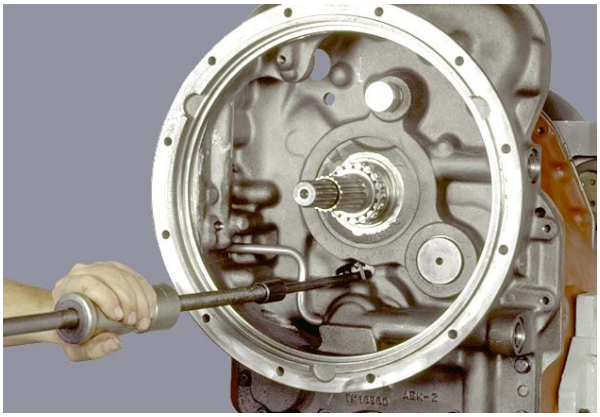


Figure 253

Install a cap screw in the front and one in the rear of the converter housing and snug up but do not tighten. This will hold the converter housing to the transmission housing. Using a hook type hammer puller as shown, pull the reverse clutch gear toward the front of the converter housing. This will move the reverse and 2nd clutch assembly forward to align the snap ring groove in the bearing with the snap ring in the housing. Being certain bearing snap ring is in full position in snap ring groove, remove pliers.

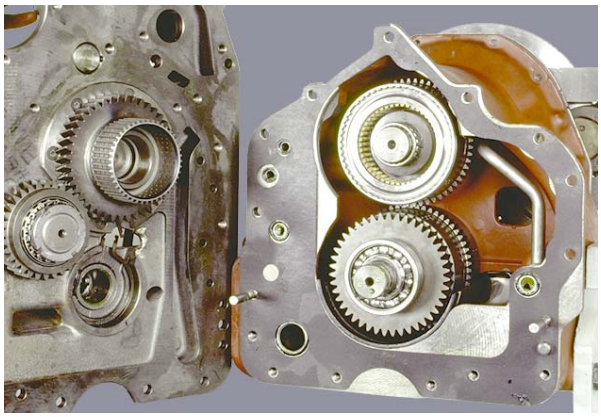


Figure 251

Position converter housing assembly on transmission case. Use caution as not to disturb housing “O”-rings or gasket.

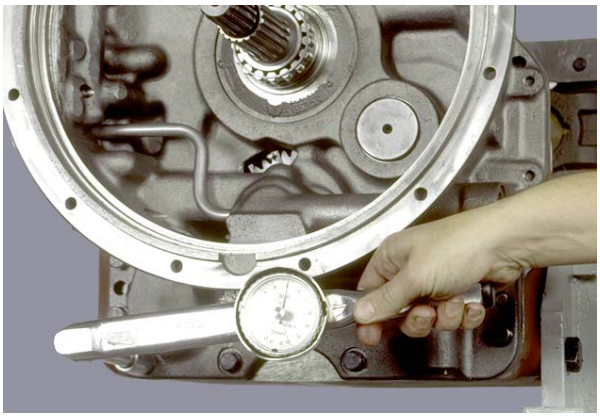


Figure 254

Remove converter housing aligning stud.
Install converter housing and transmission housing capscrews. Tighten screws to specified torque (see torque chart).

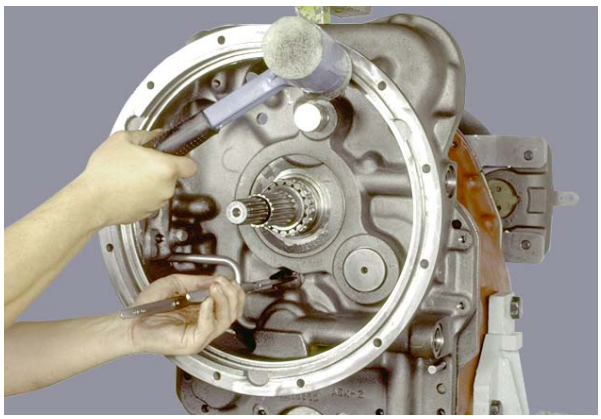


Figure 252

Spread ears on the reverse clutch front bearing snap ring. Lock pliers open to hold snap ring open.
Tap converter housing in place.
Use caution as not to damage reverse clutch front piston rings.

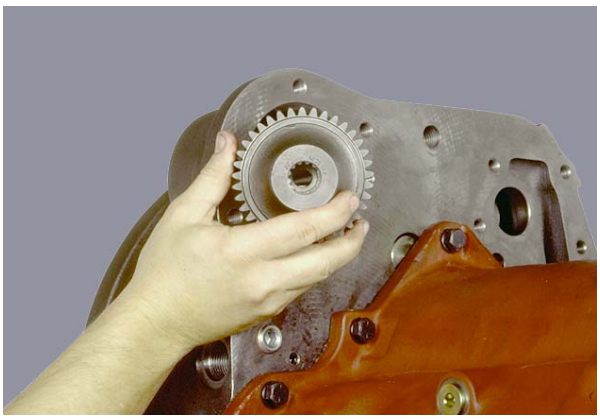


Figure 255

Position auxiliary pump drive gear in converter housing. See figure 256.

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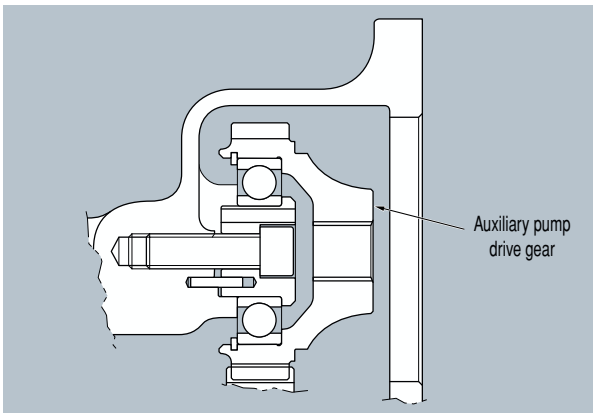


Figure 256

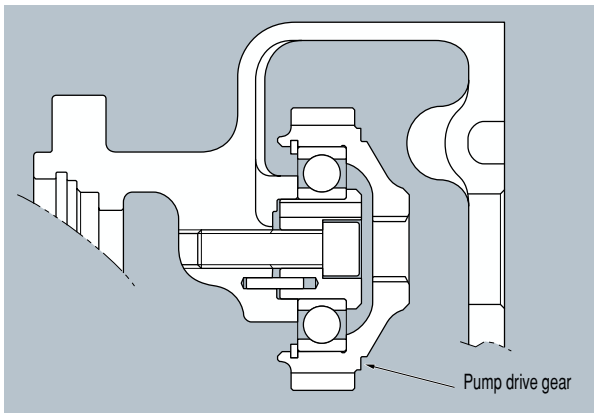


Figure 259

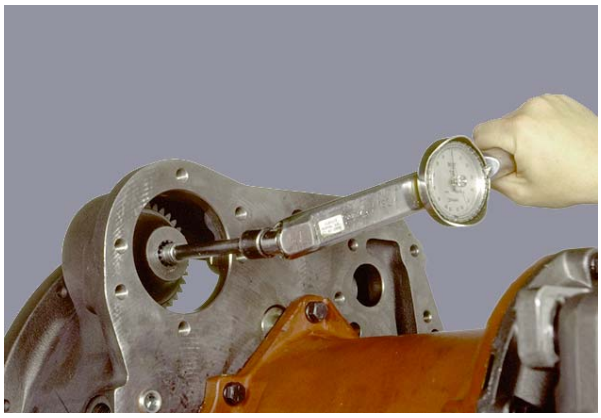


Figure 257

Install cap screw with Loctite No. 243.
Tighten cap screw to specified torque
(see torque chart).

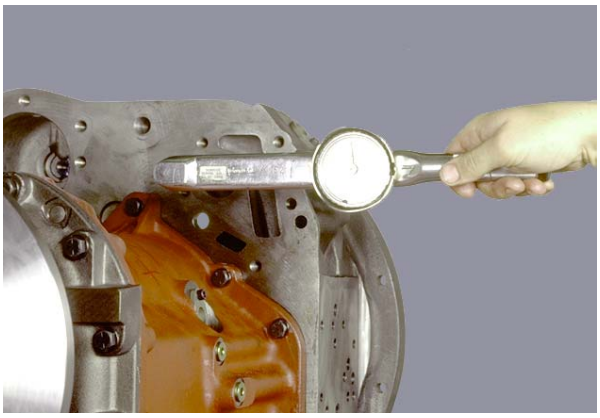


Figure 260

Install cap screw with loctite 243.
Tighten cap screw to specified torque
(see torque chart).

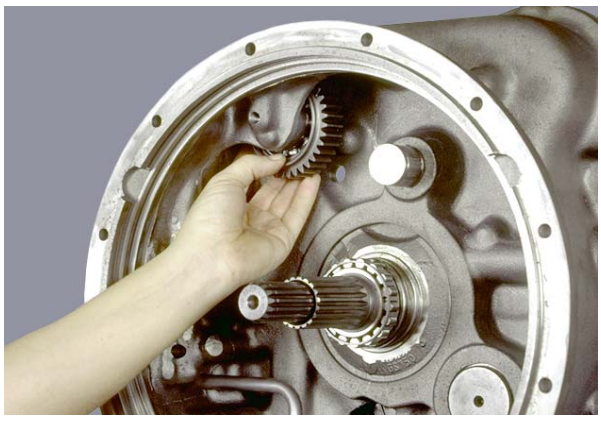


Figure 258

Position charging pump drive gear (see figure 259).

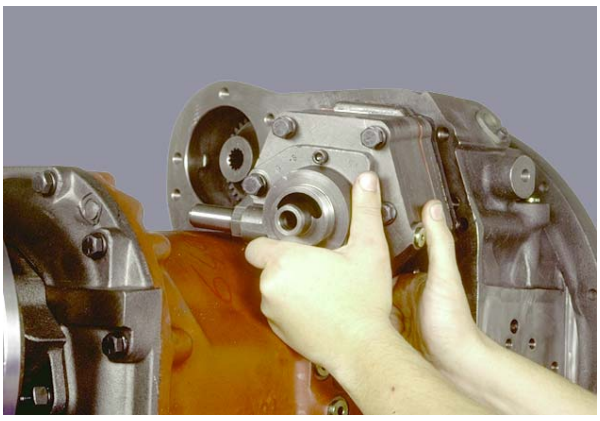


Figure 261

Using a new gasket and “O”-ring, position charging pump assembly.
Install cap screws and lockwashers.

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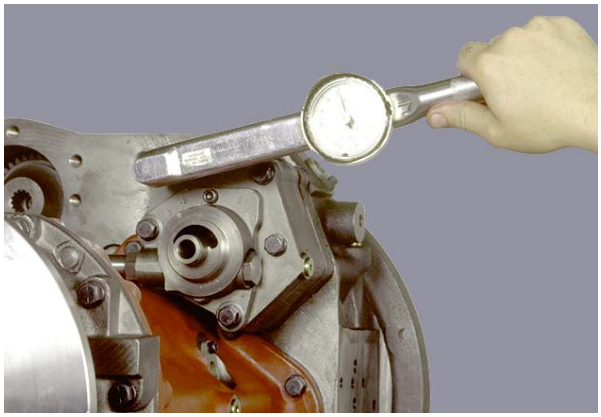


Figure 262
Tighten screws to specified torque (see toque chart).

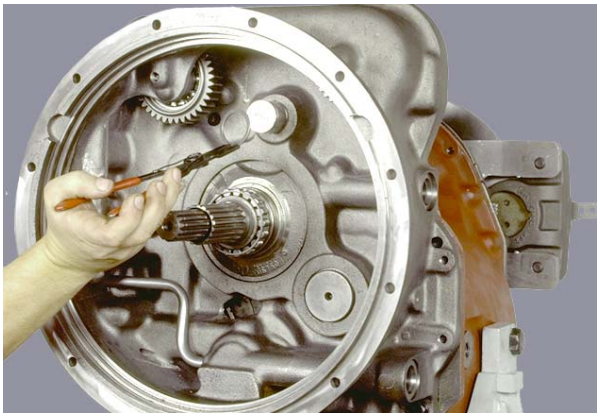


Figure 265
Install idler gear bearing retaining ring.

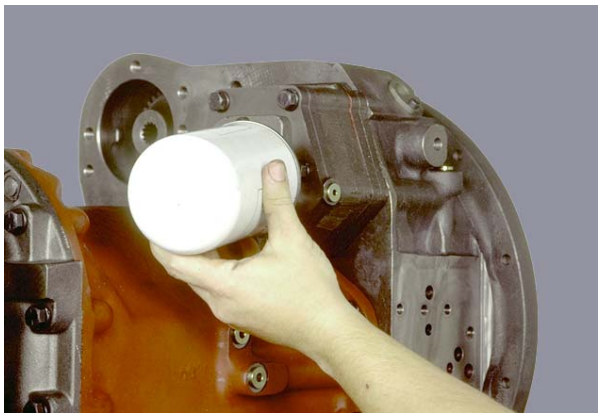


Figure 263
Install new oil filter. Tighten 20 to 25 ft. lbs torque (27.1 - 33.9 N.m.). **NOTE**: it is recommended that the filter cartridge be changed after 100 hours of operation on new and rebuilt or repaired units.

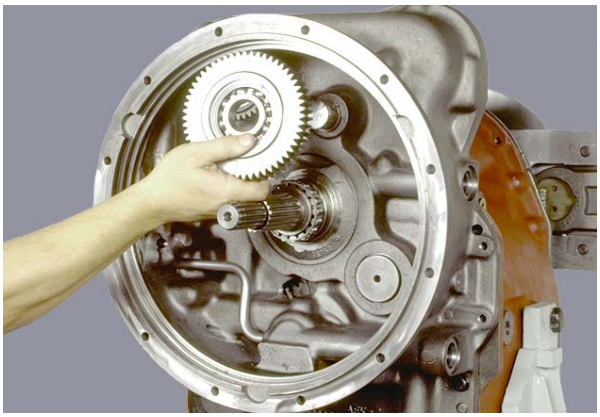


Figure 266
Position pump idler gear and bearing in stab shaft.

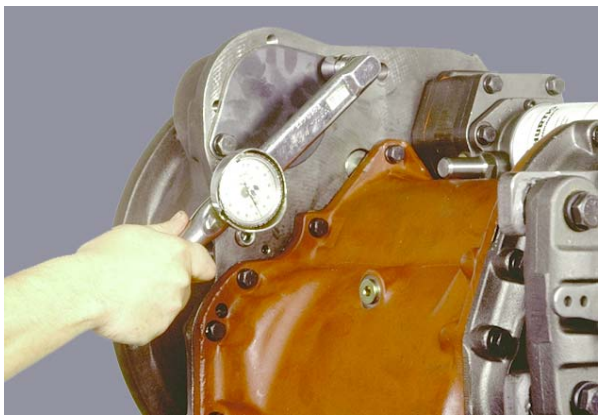


Figure 264
Install pump hole cover, new gasket, screws and lockwashers.
Tighten screws to specified torque (see torque chart).

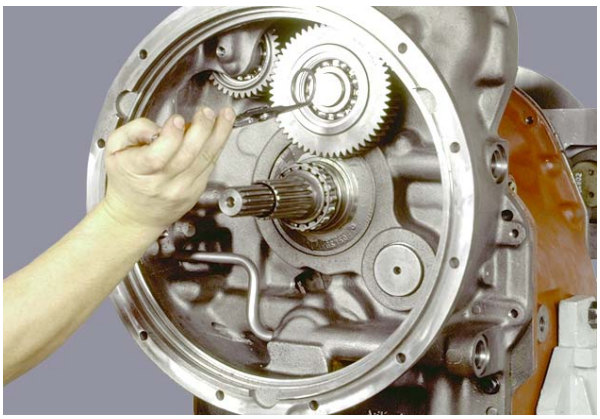


Figure 267
Install idler gear bearing locating ring.

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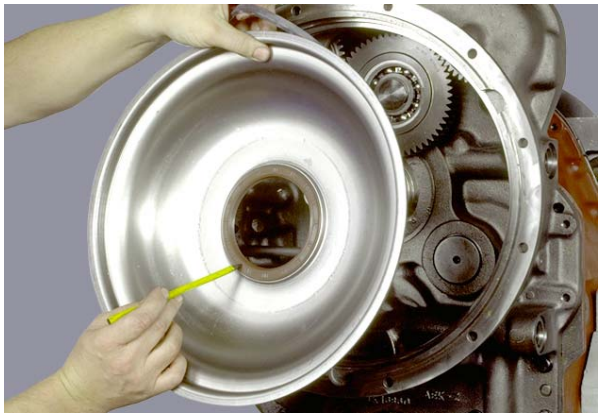


Figure 268

Press new seal in baffle with lip of seal toward impeller hub bearing.
Position new oil baffle sealing ring on oil baffle.

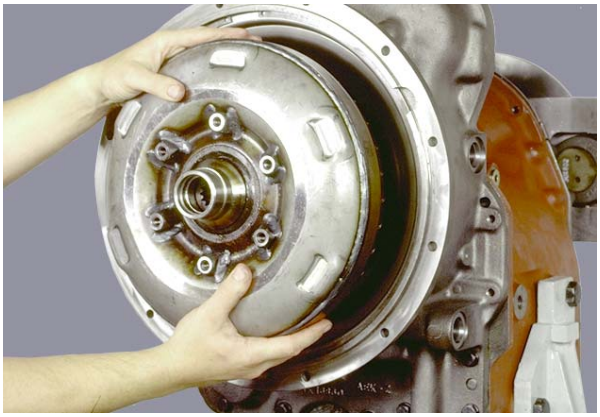


Figure 271

Position converter assembly on stator support and turbine shaft.
NOTE: use extreme caution as not to cut, break or unhook the oil sealing ring in the support.

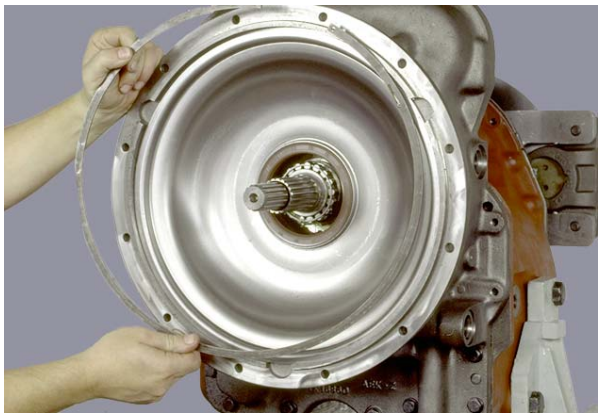


Figure 269

Position oil baffle in housing and install retaining ring. Be sure ring is in full position in ring groove.

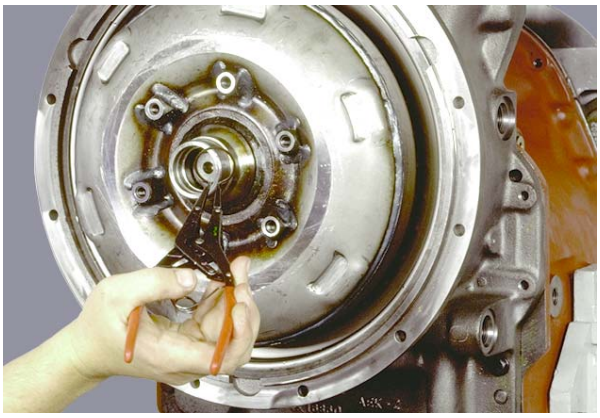


Figure 272

Install converter assembly retaining ring.

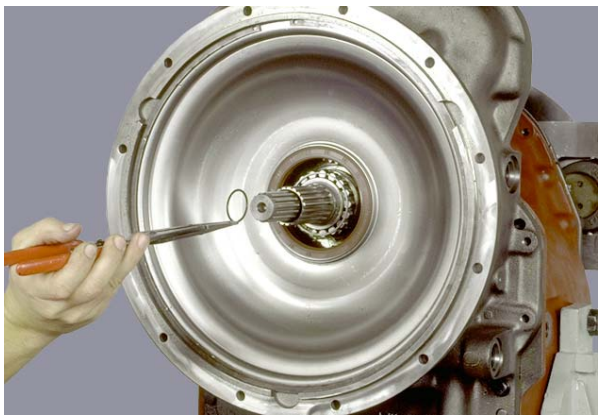


Figure 270

Position inner turbine locating ring on turbine shaft.



Figure 273

With new “O”-ring in place, install bore plug.

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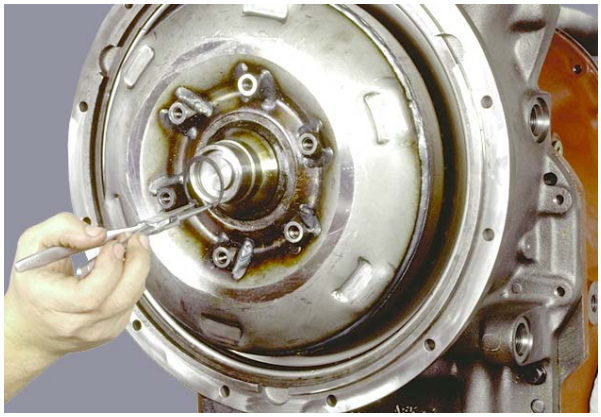


Figure 274

Install bore plug retaining ring.

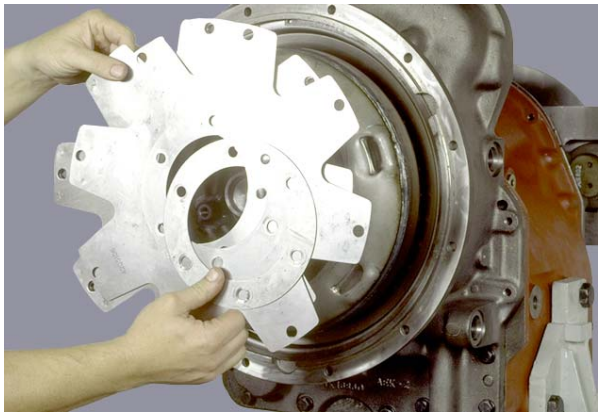


Figure 275

See special section on page 5-1 for drive plate installation.

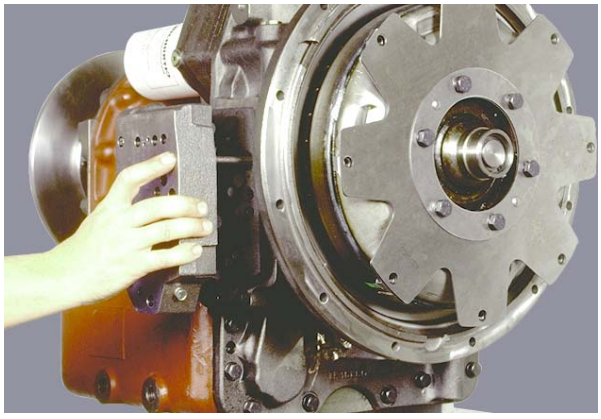


Figure 276

Position new gasket and modulation valve on converter housing (if used).

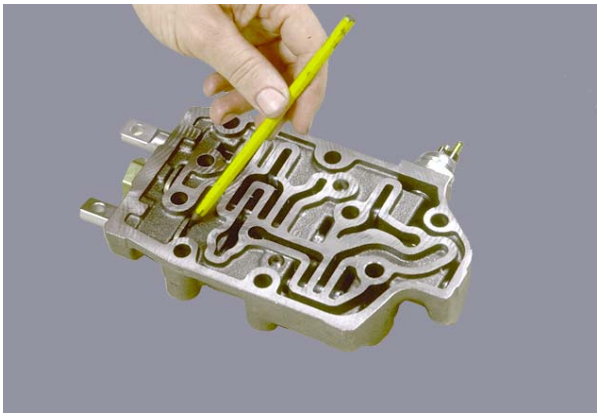


Figure 277

If the control cover valve spools are to be inspected or the spool oil seals changed, remove the valve spool stops as shown and pull spools out of oil seals. Always replace oil seals if valve spools are removed for inspection. Sharp edges on valve spool will cut lip of oil seal. When replacing oil seal, pick old seal out of housing using caution as not to damage oil seal bore. Install new seal in control valve.
NOTE: When installing speed and direction selector spools through oil seal, use extreme caution as not to cut lip of seal.

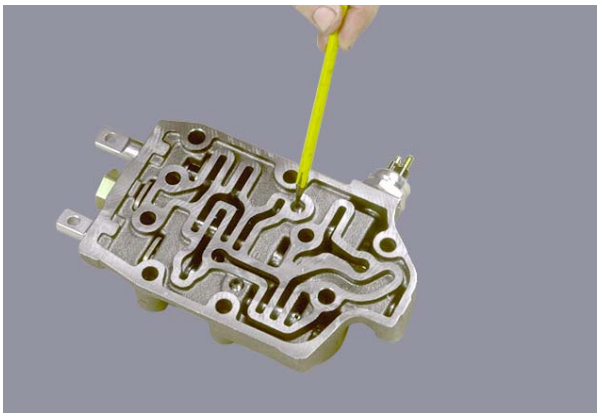


Figure 278

Position detent balls in housing.

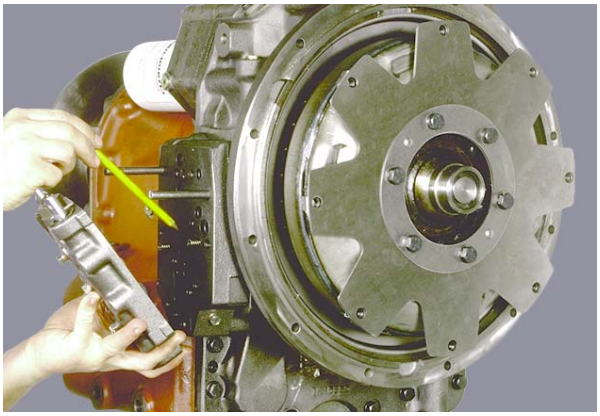


Figure 279

Position new gasket and detent springs on housing. Install control cover and cover to housing capscrews and lockwashers.
Some units will have an electrical control valve.

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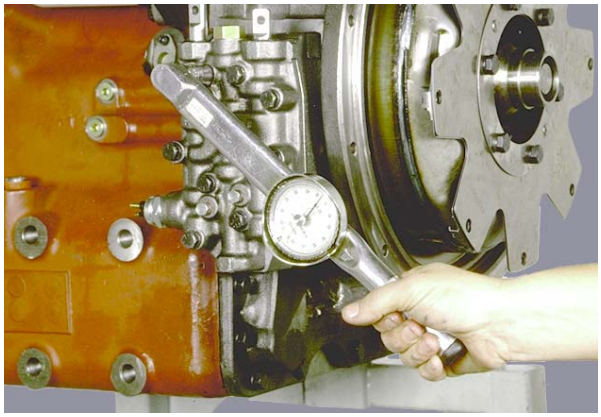


Figure 280

Tighten cap screws to specified torque (see torque chart).

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Note:

CLUTCH RETURN DISC SPRING PACKS ARE CERTIFIED ACCORDING TO COMPRESSION WEIGHT SPECIFICATIONS AND ARE PRE-PACKED IN QUANTITIES TO REPAIR ONE (1) SPECIFIC CLUTCH.

The disc spring packs are to be used as complete assemblies and care should be taken not to intermix the individual disc springs with disc springs in another clutch or disc spring pack.

Each disc spring assembly is made up of selected springs to precisely match each part within this assembly. Failure to replace all piston return springs can result in unequal deflection within the spring pack. The result of this imbalance may adversely affect overall life of springs.

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11. OPTIONS

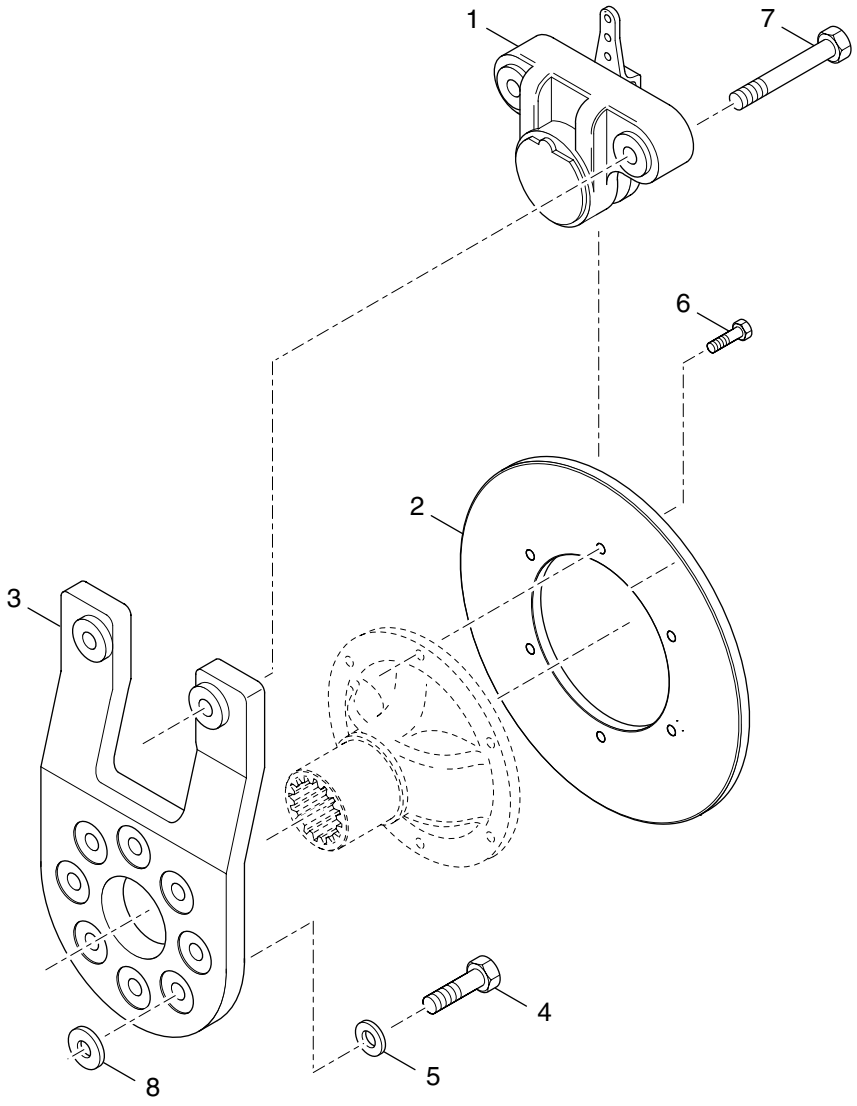
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11.1 PARKING BRAKES

11.1.1 Mechanical Brake

11.1.1.1 Sectional views and parts identification

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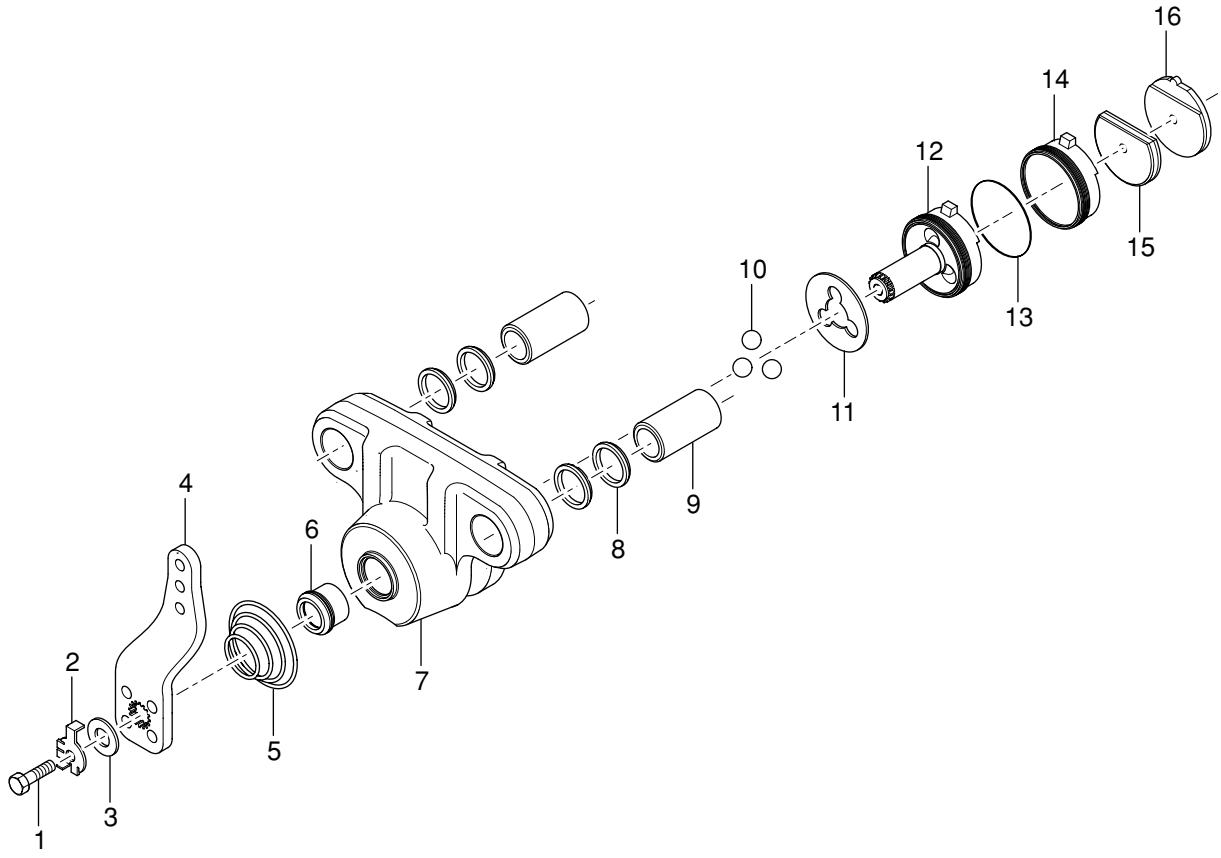


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GROUP - DISC BRAKE (MECHANICAL BRAKE)

Item	Description	Quantity
1	Caliper - Parking brake	1
2	Disc - Brake	1
3	Assembly - Mounting bracket	1
4	Screw - Bracket assembly to bearing cap mounting	4
5	Washer - Bracket assembly to bearing cap mounting flat screw	4
6	Screw - Flange	6
7	Screw - Caliper to mounting bracket	2
8	Spacer	2

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GROUP - MECHANICAL BRAKE

Item	Description	Quantity
1	Screw	1
2	Anti-rotation clip	1
3	Washer	1
4	Lever	1
5	Spring	1
6	Shaft - Seal	1
7	Housing	1
8	“O”-ring	4
9	Bushing	2
10	Ball	3
11	Ball - Spacer	1
12	Rotor	1
13	Plain bearing	1
14	Rotor - Seal	1
15	Lever side pad	1
16	Carrier side path	1

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11.1.1.2 Adjustment and rebuild criteria

1. Check to insure floating parts move freely and that all other parts are mounted securely. Tighten hardware as required.
2. Check actuator linkage to insure that there is adequate freedom of movement for positive brake operation. Adjustment of pad gap is to be accomplished by adjusting the actuating cable or linkage. If adjustment is used up, back off cable or linkage. Unbend tab on anti-rotation clip and loosen screw enough to disengage lever spline. Rotate the lever one tooth, in the direction opposite the actuation direction, and retorque the screw making sure the spline teeth are properly engaged.
   Bend up a tab that aligns with one of the screw head flats, to prevent screw rotation.
   Both lever and linkage must be free to return to home position. An external return spring is required.
3. Check disc surface condition. Replace if it is badly warped, pitted, or below minimum recommended thickness. Check for loose mount bolts. Retighten if necessary.
4. Check to insure friction pads are not worn to less than .039” (1.0mm) thick. Replace worn friction pads. Generally, if the disc is still running true and the pad clearance is still adjustable,
   no other maintenance is required. To check for wear, measure the distance from the carrier side casting face to disc face. If the distance is less than .060” (1.5mm), replace the friction pads.

11.1.1.3 Replacing friction pads

Note

STAMPED ON THE BACK OF EACH FRICTION PAD IS A CODE. THE FIRST 1 OR 2 CHARACTERS IS A NUMBER THAT SPECIFIES THE FRICTION MATERIAL TYPE. CHECK TO INSURE NEW PADS ARE THE SAME AS THE WORN PADS REMOVED. REPLACE FRICTION PADS ONLY IN PAIRS.

To replace the friction pads it is necessary to release the brake and disconnect the actuator from the brake lever.

1. Remove one brake mounting bolt. Swing the brake up over the disc to expose the brake pads. In close clearance applications the brake may be removed from the vehicle.
   Using a flat bladed screw driver, pry out the used brake pads from their respective positions.
   The lever side friction pad is snapped onto the plastic actuator cover. Care should be used in removing the friction pad from the plastic actuator cover so as not to break off the center snap tabs.
2. Place the new friction pads in their respective positions.
   The lever side friction pad has a center hole which snaps over the plastic snap tabs of the actuator cover. The flat on the lever side pad must align with the flat on the plastic rotor cover, allowing the pad to sit flat.
   If the snap tabs are gone dab some silicone gasket adhesive around the back edge of the friction pad and press firmly into place aligned as described above. Before placing the carrier pad in postition, clean out excisting pad glue from the pad compartment.
   Place a layer of silicone gasket adhesive all along the back edge of the carrier friction pad and press firmly in place. Push the lever side pad into the brake as far as possible.
3. Swing the brake over the disc and install the mounting bolt and tighten all mounting bolts.
4. After friction pad replacement, the brake actuating lever is no longer in the correct position for the actuating linkage.
   Unbend tab on anti-rotation clip and loosen screw enough to disengage the lever spline.
   Rotate the lever to the OEM and torque screw to 110 - 140 in.lbs.(12.4 -15.8 Nm). Bend up a tab on the antirotation clip that aligns with one of the screw head flats, to prevent screw rotation.
   Attach actuating cable or linkage to the lever. Adjustment of pad gap is accomplished by adjusting the actuating cable or linkage.

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11.1.1.4 Disassembly

Perform disassembly on a clean work bench.

1. Disconnect the actuator cable or linkage and remove brake from its mounting.
2. Remove friction pads. (see “Replacing Friction Pads”)
3. Unbend anti-rotation clip tab away from lever holding screw. Remove screw, anti-rotation clip, washers, lever, and spring.
4. Push out rotor assembly from the casting.



Caution

BALL SPACER AND 3 BALL BEARINGS MAY COME OUT WITH THE ROTOR ASSEMBLY.
(FOR ROTOR DISASSEMBLY SEE “SERVICING ROTOR ASSEMBLY”).

5. Remove 3 ball bearings and ball spacer.
6. Shaft seal need only be replaced if excessively wom or cracked. If replacement is necessary, press out the plastic shaft seal from inside the casting, using a steel spacer block 1.078"(27.38mm) diameter by 2.5” (63.5mm) long and an arbor press.



Note

POPULAR BRAND NAME 3/8" DRIVE 13/16" HEX DEEP SOCKET WORKS WELL AS A SPACER BLOCK.

7. After the shaft seal is pressed out, remove the sliver of plastic that may be left in the groove in the casting.

This completes disassembly of the brake.

11.1.1.5 Cleaning and inspection

1. Clean all parts with denatured alcohol and either wipe dry with a clean lint free cloth or blow dry with an air hose.
2. Examine all parts carefully for signs of excessive wear, damage, or corrosion. Replace any parts found to be damaged.
3. Check rotor assembly for cracks. Replace if necessary.
4. Inspect the casting ball pockets for scoring, pitting, cracks or corrosion. A corroded or deeply scored casting should be replaced. Light scoring and stains may be removed.
5. Check to see that the disc is not bent or misshaped.
6. Check lever spring for breakage.

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11.1.1.6 Assembly

Prior to assembly make sure all parts are clean and serviceable.

1. Install a new shaft seal by inserting the seal from the outside of the casting with the extended smooth surface inserted first. Using an arbor press, with a protective spacer block between the arbor press and the seal, gently press the seal in until it snaps into the groove in the casting.
2. Coat with grease, the ball pockets in the casting, the shaft and ball pockets of the rotor assembly.
3. Insert 3 ball bearings and ball spacer into the pockets in the casting.
4. From the inside of the casting slide the shaft of the rotor assembly thru the shaft seal and seat the ball pockets against the ball beanrings.
5. Place the spring over the large diameter pilot on the outside of the castıng.
6. Install the lever, making sure the small diameter of the spring is piloted on the outside of the 4 pins in the lever. Set the lever in the OEM position.
7. Install the washers and anti-rotation clip with its tab inserted into the lower hole in the lever.
8. Insert screw into rotor assembly shaft and tighten to 110 - 140 in.lbs.(12.4 - 15.8Nm), while guiding lever over rotor assembly spline.
9. After the proper torque is achieved and the lever is in the OEM position, bend up a tab on the anti-rotation clip that aligns with one of the screw head flats, to prevent screw rotation.
10. Install the friction pads onto the rotor assembly and carrier. (see ‘’Replacing Friction Pads”).
11. Stroke lever in its proper direction. The lever must rotate thru 60 degrees of rotation. Return lever to the OEM position and make sure the lever side friction pad is fully rerurned.

11.1.1.7 Replacing mount bushings

1. Push mount bushings completely out of the brake casting.
2. Remove the four (4) “O”-rings from the grooves in the casting, being carefull not to damage the grooves. Clean the grooves and the bore with denatured alcohol or cleaning solvent. Let dry. Lubricate the grooves and “O”-rings with the grease furnished with the service kit. Install the “O”-rings into the grooves.
3. Coat the bushings with kit grease. Insert bushing through the “O”-ring. Wipe off any excess grease.

11.1.1.8 Servicing rotor assembly

Disassemble brake as previously described.

1. Using a sharp knife, make several cuts through the outside diameler of the rigid plastic rotor cover. Break apart the plastic, remove and discard.
2. Discard the plain bearing from under the plasic cover
3. Thoroughly clean all dirt and grease residue from the rotor.
4. Amply grease one face of the new plain bearing and place it into the new rotor cover, grease to plastic. Amply grease the other face of the insert.
5. To assemble the new plastic rotor cover a bench vise is necessary. Snap a friction pad onto the plastic cover. Place the plastic cover over rte rotor, place in a vice, and slowly squeeze the cover and rotor until the cover snaps in place. Remove the friction pad and reassemble the brake as previously described.

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11.1.2 Spring applied hydraulic released brake (high pressure)

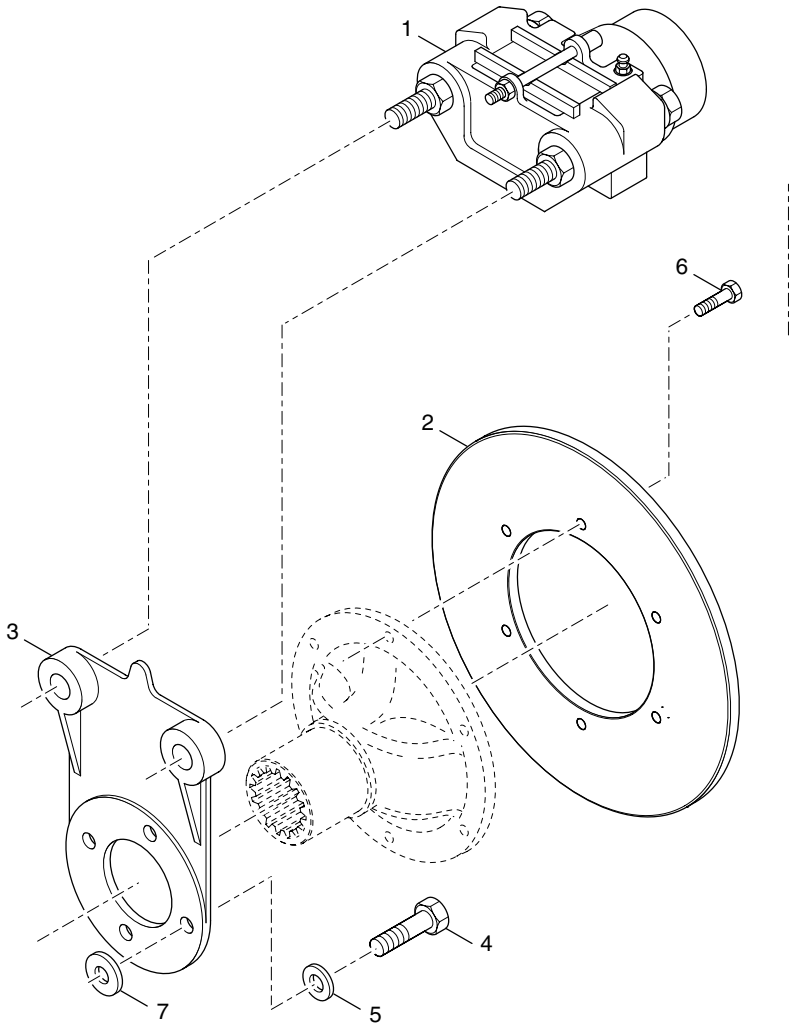


Note

PLEASE READ INSTRUCTIONS BELOW BEFORE ATTEMPTING ANY WORK ON THE BRAKE.

11.1.2.1 Sectional views and parts identification

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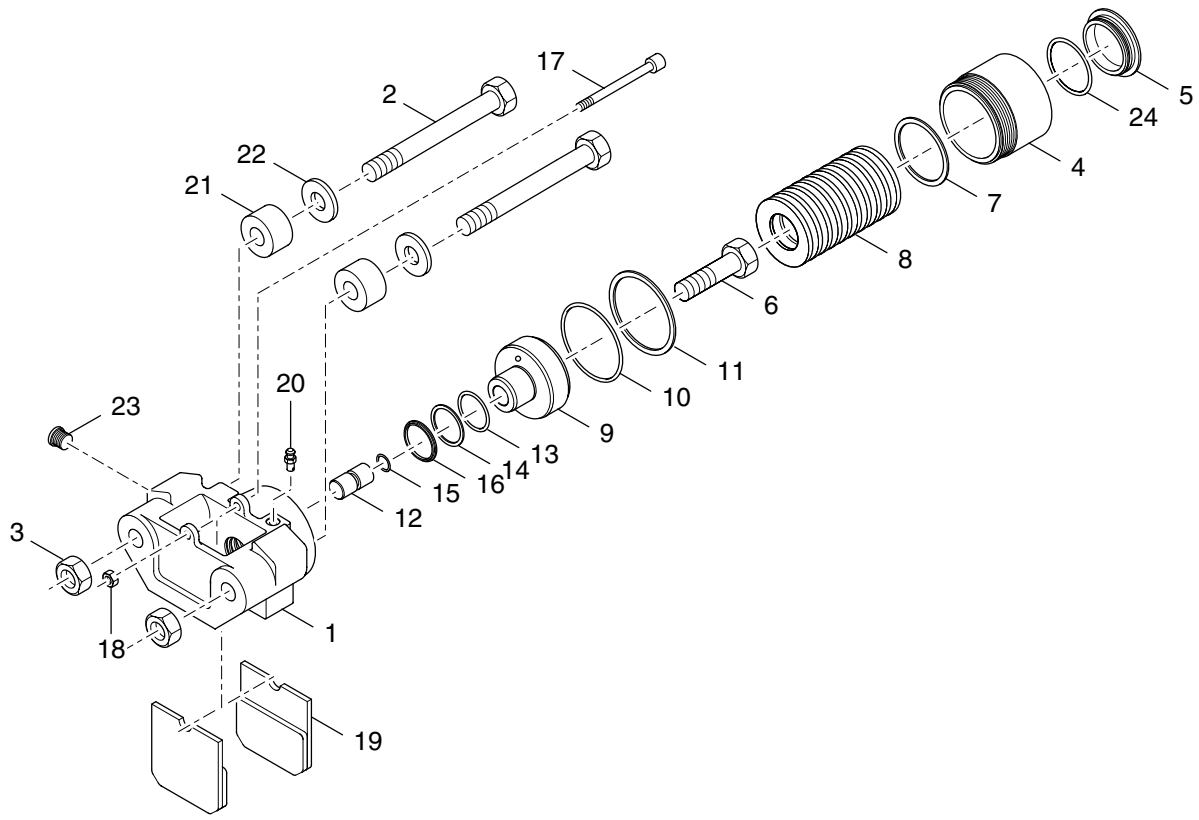


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GROUP - DISC BRAKE (SPRING APPLIED HYDRAULIC RELEASED BRAKE (HIGH PRESSURE))

Item	Description	Quantity
1	Caliper - Parking brake	1
2	Disc - Brake	1
3	Assembly - Mounting bracket	1
4	Screw - Bracket assembly to bearing cap mounting	4
5	Washer - Bracket assembly to bearing cap mounting flat screw	4
6	Screw - Flange	6
7	Spacer	4

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SPRING APPLIED HYDRAULIC RELEASED BRAKE (HIGH PRESSURE)

Item	Description	Quantity
1	Torque plate	1
2	Bolt - Hex	2
3	Jamnut	2
4	Housing - Spring	1
5	Plug	1
6	Bolt - Adjustment	1
7	Shim	AR*
8	Spring disc	10
9	Piston	1
10	Seal - “O”-ring	1
11	Back-up ring	1
12	Piston	1
13	Seal - “O”-ring	1
14	Back-up ring	1
15	Seal - “O”-ring	1
16	Wiper	1
17	Bolt	1
18	Nut	1
19	Lining	2
20	Bleeder	1
21	Spring - Urethane	2
22	Washer - Flat	2
23	Cap - Plug	1
24	Seal - “O”-ring	1

AR*: As Required

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11.1.2.2 Operation

Ten disc springs (8) are used to hold the park brake in the actuated state.
The springs (8) push the pistons (9,12) into the lining and carrier assembly (19) which squeezes a driveline mounted disc. The brake is released by fluid entering a SAE 7/16-20 threaded inlet in the side of the torque plate (1) which pushes the pistons back and compresses the springs (8).

11.1.2.3 Adjustment and rebuild criteria

1. Apply hydraulic pressure to the brake.
2. Remove plug (5) and set running clearance (.020” - .030”) using the adjustment bolt (6).
3. Replace plug (5).
4. Even up running clearance on each side of the disc by adjusting the carrier retaining bolt (17).

The brake should be rebuilt when one or more of the following criteria are met:

1. Any signs of fluid leakage.
2. Lining thickness less than .031".
3. Cracked or chipped linings.

11.1.2.4 Replacing friction pads

1. Apply hydraulic pressure to the brake and remove plug (5) and carrier bolt (17).
2. With pressure applied, back-off adjustment bolt (6) until piston (12) is flush with piston (9).
3. Release hydraulic pressure from the brake and remove lining and carrier assemblies (19).

11.1.2.5 Disassembly

Caution

IF THE PARK BRAKE IS BEING DISASSEMBLED WHILE ON THE VEHICLE, IT IS IMPORTANT TO FOLLOW THE DIRECTIONS REGARDING THE REMOVAL OF THE SPRING HOUSING (4) AND THE LINING AND CARRIERS (19) VERY CLOSELY.

1. Apply hydraulic pressure to the brake and remove plug (5) and carrier bolt (17).
2. With pressure applied, back-off adjustment bolt (6) until piston (12) is flush with piston (9).
3. Release hydraulic pressure from the brake and remove lining and carrier assemblies (19).
4. Using a press, compress springs (8) to reduce the force on the spring housing (4).
5. Use a spanner wrench to remove the spring housing (4) (counter-clockwise direction).
6. The springs (8) will be accessible when the spring housing is removed.

Note

THE SPRING HOUSING (4) MAY BE REMOVED WITHOUT COMPRESSING THE SPRINGS (8), HOWEVER IT IS NOT RECOMMENDED DUE TO THE HIGH TORQUE REQUIRED.

7. The adjustment bolt (6) threaded part of the way into the hydraulic piston (9) may be used to remove the pistons (9 and12) if brake is mounted on the vehicle.
8. If brake is not mounted to the vehicle it is easier to press the pistons out from the lining and carrier (19) side of the torque Plate (1).

Caution

DO NOT DAMAGE SEALS (10,13,15) OR BACK-UP RINGS (11,14) OR THE WIPER (16) WHEN REMOVING THE PISTONS (9 AND12).

9. Piston (12) may be removed from piston (9) by pushing on piston (12) through adjustment bolt hole with a small nut-river or similar device.

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11.1.2.6 Cleaning and inspection

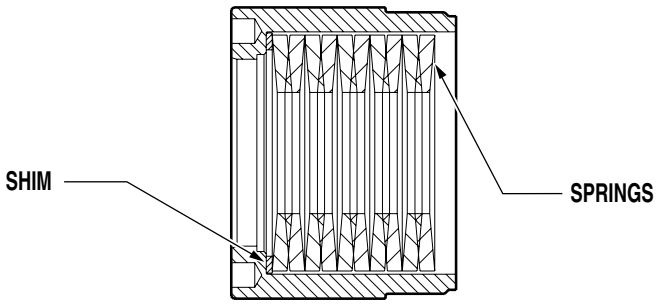
1. Clean all metal parts prior to assembly.
2. Blow excess cleaning solution off of all parts and out of all fluid passages.

11.1.2.7 Assembly

1. Apply a thin coat off fluid (compatible with mineral oil based hydraulic fluid) to seals (10,13,15), Back-up rings (11,14) and the wiper (16).
2. Install seal (15) in seal groove on piston (12).
3. Slide the adjustment piston (12) into the bore located in the hydraulic piston (9) until it hits the bottom of the bore.
4. Install wiper (16), back-up ring (14), and seal (13) in the grooves located in the small hole in the torque plate (1).
5. Install seal (10) and back-up ring (11) in larger grooves in torque plate (1).
6. Install piston assembly into torque plate. (1).
7. Thread adjustment bolt (6) into the hydraulic piston (9) until the bolt contacts the adjustment piston (12).
8. Place springs (8) in the torque plate (1).
   Springs should be placed in an alternating cupped face to cupped face orientation.
   The springs on the outside ends of the stack should be oriented cupped face out.
9. If the brake contained a shim (7) when it was disassembled, place the shim (7) so it will be in the bottom of the spring housing (4) when it is installed.
   See illustration below for a graphical representation.

Note

SPRINGS ARE MATCHED AND PRETESTED. IF NEW SPRINGS ARE BEING INSTALLED ADD A SHIM ONLY IF THE NEW SPRINGS ARE SHIPPED WITH ONE.



10. Thread spring housing (4) into torque plate (1) about 3 turns or until it makes contact, with the springs (8).
11. Using a press, compress springs (8) to reduce the force on the spring housing (4).
12. Use a spanner wrench to tighten spring-housing until the face bottoms out on the counterbore face in the torque plate (1). Tighten to 500 - 600 lb.-in torque.
13. Assemble washer (22) and the urethane spring (21) on the mounting bolt (2) then slide mounting bolts through bolt holes in the torque Plate (1).
14. Thread jam nut/sleeve (3) onto mounting bolt.
    The cylindrical part of the jam nut/sleeve should extend into the torque plate.

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15. Install lining and carrier assemblies (19).
    Thread lining and carrier adjustment bolt into hex nut (8) located in the slot in the back side of the torque plate (1).
16. Install the bleeder (20) in the port located on the top side of the torque plate (1).
17. After brake is mounted and adjusted, snap plug (5) onto spring housing (4).

11.1.2.8 Installation

1. Slide brake over disc and into the mounting position.
2. Start mounting bolts (2) into mounting surface far enough to just support the brake.
3. Remove plug (5) and tighten adjustment bolt (6) until linings (19) are clamped to the disc.
4. Tighten mounting bolts (2) until they make contact with the urethane springs (21), then tighten 1 to 2 flats more.
5. Tighten jam nut/sleeve (3) against mounting surface to torque shown in section 11.1.2.9.

Caution

BRAKE LININGS ARE SUSCEPTIBLE TO CONTAMINATION.
WHEN INSTALLING OR SERVICING BRAKES KEEP ALL OIL AND FLUIDS AWAY FROM THE LININGS.
POOR BRAKE PERFORMANCE MAY RESULT.

6. Attach brake line to inlet port located on the side of the torque plate (1).
7. Bleed brake system to remove trapped air as follows.

Note

USE BLEEDER HOSE ON BLEEDER SCREWS (PREFERABLY CLEAR TUBING) TO ROUTE FLUID AWAY FROM THE BRAKE AND LININGS.

Caution

BRAKE USES HIGH PRESSURE, OPEN BLEEDER SCREW (20) VERY SLOWLY WHEN PERFORMING BLEEDING PROCEDURE.

8. Apply pressure to brake and slowly open the bleeder screw (20) observe any air bubbles that flow from the brake.
9. Repeat above paragraph until no air is observed in the fluid from the bleeder screw (20).

11.1.2.9 Torque specs

PART (ITEM NO.)	THREAD SIZE	DRY TORQUE
BLEEDER SCREW (20)	7/16 - 20	200 - 250 (LB-IN)
JAMNUT/SLEEVE (3)	3/4 - 10	200 (LB-IN)

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11.1.3 Spring applied hydraulic released brake (low pressure)

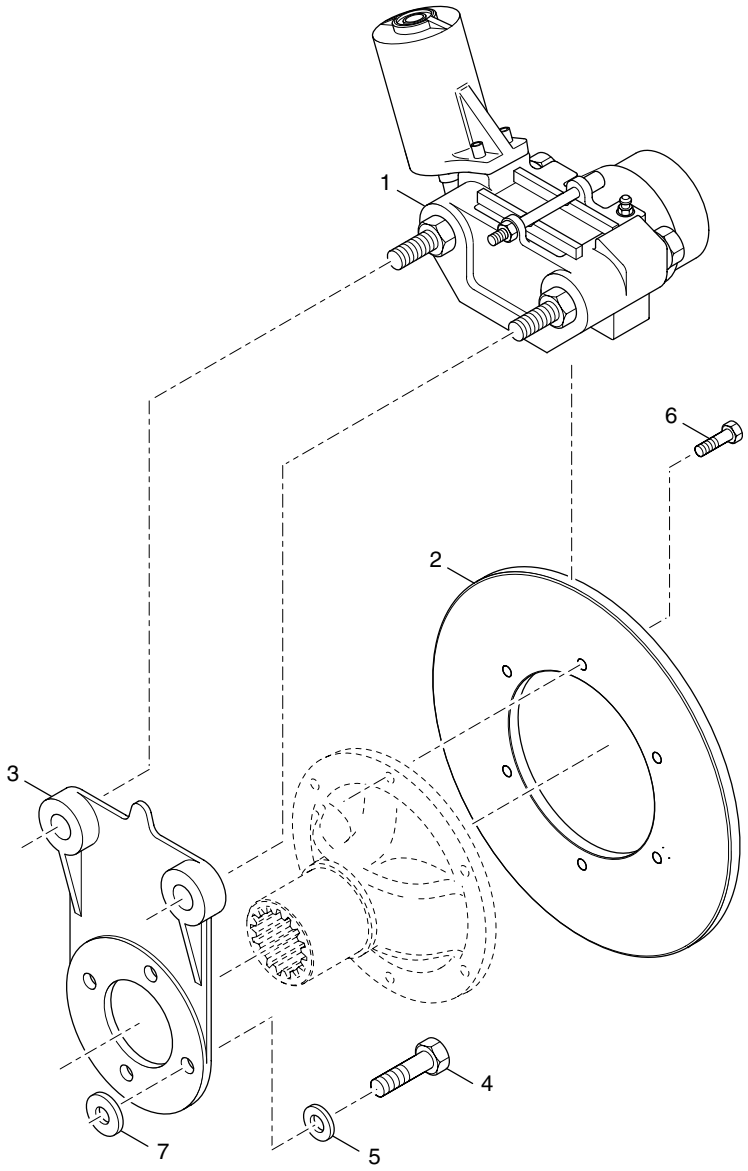


Note

PLEASE READ INSTRUCTIONS BELOW BEFORE ATTEMPTING ANY WORK ON THE BRAKE.

11.1.3.1 Sectional views and parts identification

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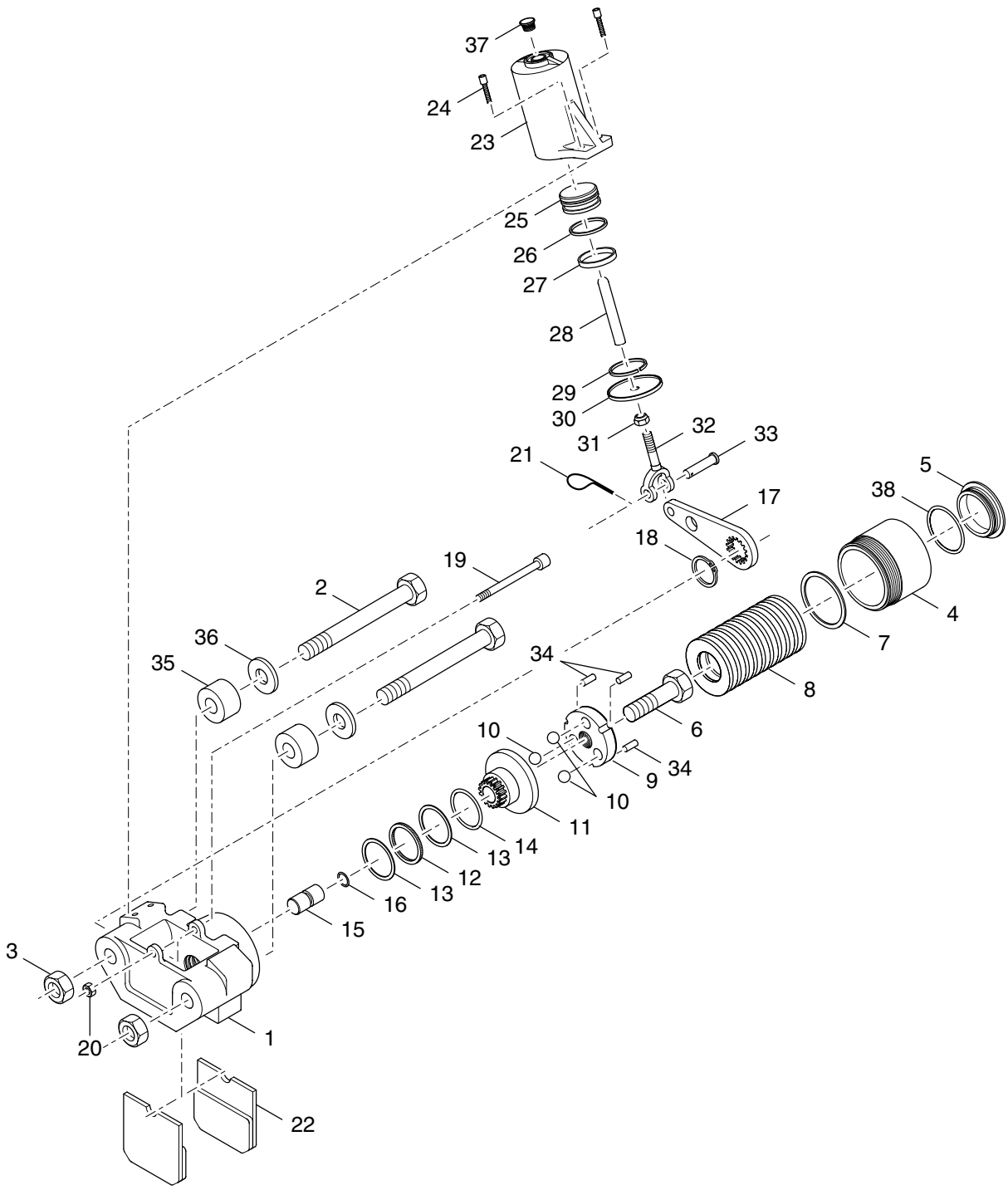


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GROUP - DISC BRAKE (SPRING APPLIED HYDRAULIC RELEASED BRAKE (LOW PRESSURE))

Item	Description	Quantity
1	Caliper - Parking brake	1
2	Disc - Brake	1
3	Assembly - Mounting bracket	1
4	Screw - Bracket assembly to bearing cap mounting	4
5	Washer - Bracket assembly to bearing cap mounting flat screw	4
6	Screw - Flange	6
7	Spacer	4

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SPRING APPLIED HYDRAULIC RELEASED BRAKE (LOW PRESSURE)

Item	Description	Quantity
1	Torque plate	1
2	Bolt - Hex	2
3	Jamnut	2
4	Housing - Spring	1
5	Plug	1
6	Bolt - Adjustment	1
7	Shim	AR*
8	Spring disc	10
9	Cam	1
10	Ball - Bearing	3
11	Cam	1
12	Bearing - Needle	1
13	Washer - Hardened	2
14	Seal - “O”-ring	1
15	Piston	1
16	Seal - “O”-ring	1
17	Lever	1
18	Ring - Retainer	1
19	Bolt	1
20	Nut	1
21	Pin - Cotters	1
22	Lining and carrier assembly	2
23	Cylinder - Hydraulic	1
24	Screw	2
25	Piston	1
26	Seal - STD poly pack	1
27	Sliding ring	1
28	Rod	1
29	Ring - Retaining	1
30	Rod excluder	1
31	Jamnut	1
32	Clevis	1
33	Clevis pin	1
34	Pin - Dowel	3
35	Spring - Urethane	2
36	Washer - Flat	2
37	Cap - Plug	1
38	Seal - “O”-ring	1

AR*: As Required

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11.1.3.2 Operation

Ten disc springs (8) are used to hold the park brake in the actuated state.
The springs push the cams (9,11) and piston (15) into the lining and carrier assembly (22) which squeezes a driveline mounted disc.
The brake is released by fluid entering a SAE 7/16-20 threaded inlet in the top of the hydraulic cylinder (23) which pushes the piston (25) down, thereby rotating the lever (17) and cam (11), compressing the springs (8).

11.1.3.3 Adjustment and rebuild criteria

1. Apply hydraulic pressure to the brake.
2. Remove plug (5) and set running clearance (.020” - .030”) using the adjustment bolt (6).
3. Replace plug (5).
4. Even up running clearance on each side of the disc by adjusting the carrier retaining bolt (19).

The brake should be rebuilt when one or more of the following criteria are met:

1. Any signs of fluid leakage.
2. Lining thickness less than .031”.
3. Cracked or chipped linings.

11.1.3.4 Replacing friction pads

1. Apply hydraulic pressure to the brake and remove plug (5) and carrier retaining bolt (19).
2. With pressure applied remove adjustment bolt (6).
3. Release hydraulic pressure from the brake and remove lining and carrier assemblies (22).

11.1.3.5 Disassembly

Caution

IF THE PARK BRAKE IS BEING DISASSEMBLED WHILE ON THE VEHICLE, IT IS IMPORTANT TO FOLLOW THE FOLLOWING DIRECTIONS REGARDING THE REMOVAL OF THE SPRING HOUSING (4) AND THE LINING & CARRIERS (22) VERY CLOSELY.

1. Apply hydraulic pressure to the brake and remove plug (5) and carrier retaining bolt (19).
2. With pressure applied remove adjustment bolt (6).
3. Release hydraulic pressure from the brake and remove lining and carrier assemblies (22).
4. Use a spanner wrench to remove the spring housing (4) (counter-clockwise direction).
5. The springs (8) will be accessible when the spring housing is removed.
6. Remove hair pin (21) and pin (33) from the clevis (32).
7. Remove hydraulic cylinder (23) from torque plate (1) by removing cylinder mounting bolts (24).
8. Remove retaining ring (18) and lever (17) from the spline on the cam (11).
9. The opposing cams (9, 11), adjustment piston (15) and dowel pins (34) can be removed by pressing them out of the torque plate (1) from the lining and carrier (22) side.
10. Remove balls (10) and adjustment piston (15) from cams (9, 11).
11. The “O”-ring seal (16) can be removed from the adjustment piston (15) if necessary.
12. Remove needle bearing (12), hardened washers (13), and “O”-ring seal (14) from the torque plate (1) once the cams (9, 11) are removed.
13. Slide the rod (28) and clevis (32) out of the hydraulic cylinder (23).
14. Remove the rod excluder (30) from the hydraulic cylinder (23) by prying with a small screwdriver.
15. The retaining ring (29) may be removed once the rod excluder (30) has been removed.
16. Press piston (25) out of the hydraulic cylinder (23) by pushing on the top of the piston with a long slender rod.

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Note

DO NOT SCAR CYLINDER WALLS OR NICK THE PISTON DURING REMOVAL.

11.1.3.6 Cleaning and inspection

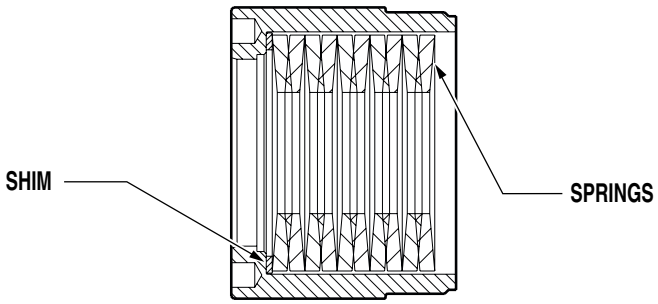
1. Clean all metal parts prior to assembly.
2. Blow excess cleaning solution off of all parts and out of all fluid passages.

11.1.3.7 Assembly

1. Apply a thin coat of fluid to seals (14,16).
2. Install seal (16) in seal groove on adjustment piston (15).
3. Slide the adjustment piston (12) into the bore located in the cam (11) until the seal (16) is inside the bore.
4. Install seal (14) in the grooves located in the small hole in the torque plate (1).
5. Install needle bearing (12) between the two hardened washers (13).
6. With bearing and washers (12,13) in place, install cam (11) and balls (10) into torque plate (1).
7. Install cam (9) and dowel pins (34) into torque plate (1).
8. Thread adjustment bolt (6) into the cam (9) until the bolt contacts the adjustment piston (15).
9. Place springs (8) in the torque plate (1).
   Springs should be placed in an alternating cupped face to cupped face orientation.
   The springs on the outside ends of the stack should be oriented cupped face out.
10. Replace the shim (7) in the bottom of the spring housing (4) before adding the springs if the brake contained a shim when it was disassembled. See illustration below for a graphical representation.

Note

SPRINGS ARE MATCHED AND PRETESTED.
IF NEW SPRINGS ARE BEING INSTALLED ADD A SHIM ONLY IF THE NEW SPRINGS ARE SHIPPED WITH ONE.



11. Apply a thin coat of Never-Seez to the spring housing (4) threads.
12. Screw spring housing (4) onto torque plate (1). Tighten with a spanner wrench until the spring housing face bottoms out on the counterbore face in the torque plate (1).
13. Assemble washer (36) and the urethane spring (35) on the mounting bolt (2) then slide mounting bolts through bolt holes in the torque plate (1).
14. Thread jam nut/sleeve (3) onto mounting bolt.
    The cylindrical part of the jam nut/sleeve should extend into the torque plate.
15. Apply a thin coat of fluid to seal (25) and sliding ring (27).
16. Install seal (25) and the sliding Ring (27) on the Piston (25).

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17. Install piston (25) into the hydraulic cylinder (23) with the flat side facing the top of the cylinder.
18. Push the piston (25) to the top of the hydraulic cylinder (23) and install the retaining ring (29) in the groove at the bottom of the cylinder.

Note

MAKE SURE INLET PORT IS UNCAPPED WHEN INSTALLING PISTON (25).

19. Press rod excluder (30) with the rubber side facing out of the hydraulic cylinder (23).
20. Thread clevis (32) with the 3/8-16 jam nut installed into the rod (28).
21. Insert the rod (28) and clevis (32) through the rod excluder (30) into the hydraulic cylinder (23).
22. Position assembled hydraulic cylinder (23) onto torque plate (1) and install the cylinder mounting bolts (24) into their respective holes.
23. Pin clevis (32) to the lever (17) with clevis pin (33) and hair pin (21).
24. Adjust rod (28) until it contacts the rod retaining hole in piston (25) and tighten the jam nut.
25. Install lever (17) on the spline of cam (11).
    The centerline of the lever should be oriented parallel to the top of the torque plate (1).
26. Install retaining ring (18) in groove on the cam (11).
27. Install lining and carrier assemblies (22).
28. Thread carrier adjustment bolt (19) into hex nut (18) located in the slot in the back side of the torque plate (1).
29. After brake is mounted and adjusted, snap plug (5) onto spring housing (4).

11.1.3.8 Installation

1. Slide brake over disc and into the mounting position (per vehicle specification).
2. Start mounting bolts (2) into mounting surface far enough to just support the brake.
3. Remove plug (5) and tighten adjustment bolt (6) until linings (22) are clamped to the disc.
4. Tighten mounting bolts (2) until they make contact with the urethane springs (35), then tighten 1 to 2 flats more.
5. Tighten jam nut / sleeve (3) against mounting surface to torque shown in section 11.1.3.9.

Caution

BRAKE LININGS ARE SUSCEPTIBLE TO CONTAMINATION.
WHEN INSTALLING OR SERVICING BRAKES KEEP ALL OIL AND FLUIDS AWAY FROM THE LININGS.
POOR BRAKE PERFORMANCE MAY RESULT.

6. Attach brake line to inlet port located on the top of the hydraulic cylinder (23).

11.1.3.9 Torque specs

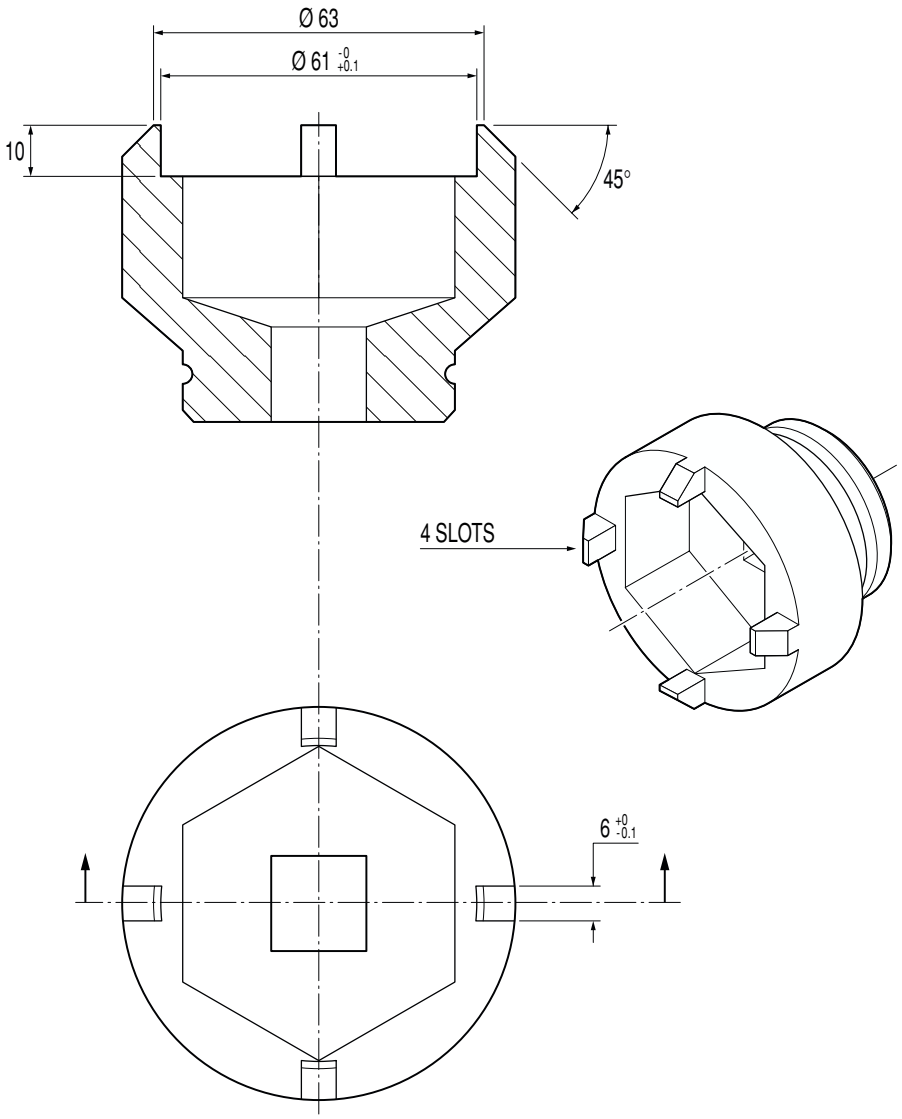
PART (ITEM NO.)	THREAD SIZE	DRY TORQUE
PLUG-INLET (37)	7/16 - 20	12/17 (LB-IN)
JAM NUT/SLEEVE (3)	3/4 - 10	200 (LB-IN)

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12. SERVICE TOOLS

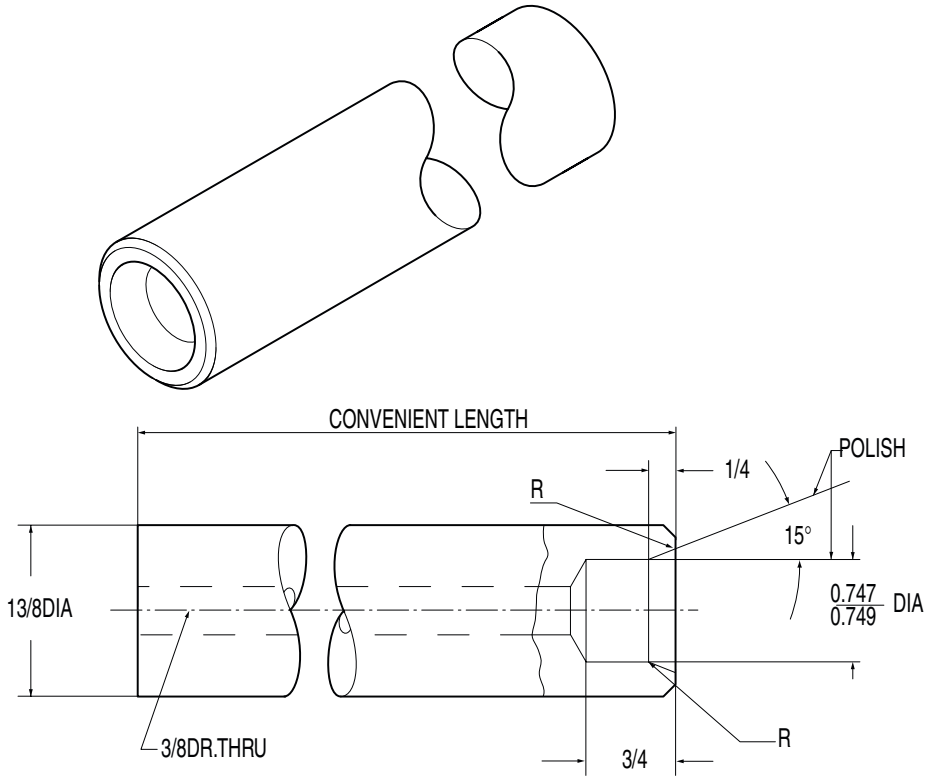
12.1 REVERSE IDLER SHAFT NUT SOCKET (TG 1304 - 54)

Made from Snap-on IM662A Socket 2 1/16” drive 3/4”.



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12.2 OIL SEALING RING SIZING TOOL



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Brugge, Belgium

Printed in Belgium

Prepared and printed for SPICER OFF-HIGHWAY PRODUCTS by Brouwer Technisch Bureau

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6.2 Differential gear

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NAF

Service and Repair Manual

Type :	STA 04 / STA 05 Differential in VP 2400 L (Stavostroj)
Drawing no.:	DG 0600.108 / DG 0600.109
Valid as of Serial no.	01
Preparation of data :	28.05 2004
Author:	Rauh

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Type :	STA 04 / STA 05 Differential in VP 2400 L (Stavostroj)
Drawing no.:	DG 0600.108 / DG 0600.109
Valid as of Serial no.	01
Preparation of data :	28.05 2004
Author:	Rauh

1 General and Service Work

1.1 Introduction

The series production of STA 05 was start in November 2002. This model contains a hydraulic differential lock. The four outer planetary drives are driven by spur gears. Both axle housings are mounted with slewing rings. The axle is not a steering axle and is constructed for direct frame mounting with mounting surfaces for a lift cylinder. The main drive is achieved over a DIN 150 cardan flange. Two hydraulically operated multi-disk brakes used as operating brake and as parking brake are sufficient for the installation.

1.2 Ordering Spare Parts

Spare parts for these NAF Axles should best be bought direct from an official STAVOSTROJ supplier whereby many of the important parts are conveniently stored and available. Even when parts are not immediately available, it is recommended to order from the supplier and not from the factory. The supplier can usually describe the necessary part more accurately and give the part number more precisely and therefore avoid errors and mistaken shipments.

For every spare part delivery, it is important to give the full exact type name with factory number and year of fabrication. The type sign is located on the diff. Housing near the oil fill plug (refer to Fig. 1).

Use only original NAF spare parts. Use of parts from other manufacturers voids every warranty and may lead to impaired function such as service life.

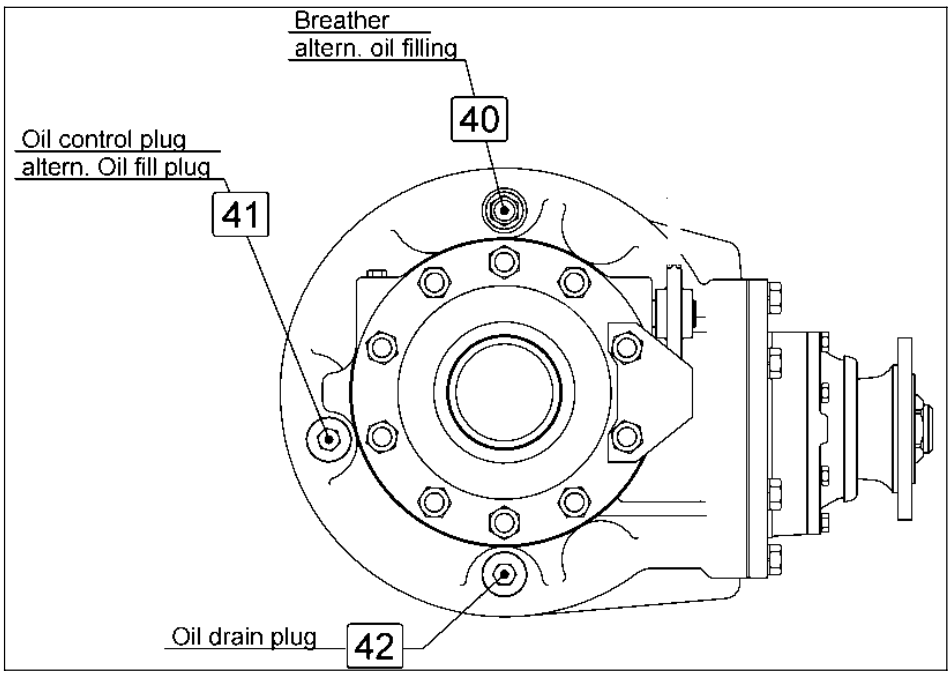


Figure. 1

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1.3 Parts Liability and Guarantees for safety related components

We strongly recommend changing complete components in the case of safety related components such as (control cylinders, steering cylinders, brake cylinders, spring housing cylinders, etc.).
Once a safety related component has been disassembled or opened, all guarantees and liabilities will be void and therefore NAF will not assume product liability for the drive unit. This also applies, even if the complete drive unit is still under guarantee.

1.4 Working Conditions and Tools

A clean and well-lit work environment is necessary for an orderly proper repair. There should also be enough room available to lay out the various parts and sub-assemblies and to put them in order.
Furthermore, a complete as possible quality tool set of all important tools and basic hardware is needed. Additionally, certain special tools are also necessary, which usually prove to be of invaluable help, especially, when one must perform certain repairs frequently. One spares oneself a lot of time and frustration. The speciality tools will be described in the subsequent sections, i.e. marked (e.g. with WZ. No.).
Furthermore, a certain expertise, and for some repairs, even specific training is necessary.

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1.5 Service Work

1.5.1 Lubrication Table

Lubrication Table for STA 04 / 05			
Lubricating Location	No.	Fill Quantity	Lubricant
Differential	40/41/42	6.5 Litre	SAE 90 (Hypoidoil) / GL 5

Description of the Lubricating Location Numbers:

No.: 40 ⇒ Breather alternatively oil fill plug for Differential
No.: 41 ⇒ Oil control plug Differential
No.: 42 ⇒ Oil drain plug for Differential
(refer to Fig. 1/3)

Examples for Brand-EP-Transmission oil SAE 90 specification: API-GL 5 or MIL-L-2105 B/C / LS

Fuchs	(Renogear 90)
DEA	(Deagear SAE 85 W-90), (Dearon BHS SAE 90)
Aral	(Degol 3216)
Mobil	(Mobilube SHC)
Esso	(Gear oil LSA 85 W-90)
Shell	(Gear oil 90)
BP	(Energear 90)
ELF	(Tranself BM 90)

Please refer to the legend of the Lubrication Plan concerning the fill quantity.

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1.5.2 Service Interval

NAF axles are designed and built from long term experience and knowledge of work machines. Proper functioning and constant work readiness is only achieved if the axle is well cared for, properly handled and regularly serviced. This includes compliance to the service interval, the use of appropriate lubricants corresponding to the Lubrication Table and checking various service points. Special tools for maintenance work are not necessary.

Service Interval Table for STA 04 / 05

Operating Hours / Service Location (No.)	0 / Initiation	After 1 day	-250	250 (every)	500 (every)	2000 (every) or 1x year
Differential (40/41/42)	1		2		3	2
Various visible nuts and bolts			4			

1 = First filling (see section 1.5.2.1)
2 = Oil change (see section 1.5.2.2)
3 = Checking oil level (see section 1.5.2.3)

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1.5.2.1 First Filling

Caution! The differential is delivered from NAF without oil.

Explanation: The differential housing and axle housing have a common oil chamber.

- Differential
  Remove breather (No.40) or alternatively oil control plug (No.41) and fill oil corresponding to the Lubrication Table until the oil reaches the lower edge of the oil control opening (No.41). Check after approx. 5 minutes and if need be, refill. Tightening moment for the oil control plug (No.41) 80^{+10} Nm and for the breather (No.40) is 70^{+10} Nm. (Fig. 1)

1.5.2.2 Oil Change

Note: Clean the area around the screw plugs (No.41/42) and the breather (No.40) beforehand.

- Differential
  Perform oil change when oil is warm. Remove breather (No.40) then open oil drain plug (No.42) and drain oil. Clean the oil drain plug (No.42) of any grime and of any existing filings, before threading in. Fill new oil corresponding to the Lubrication Table, until the oil level reaches the lower edge of the oil control opening (No.41). Tightening moment for the oil drain plug (No.42) and oil control plug (No.41) is 80^{+10} Nm and for the breather (No.40) is 70^{+10} Nm. (Fig. 1).

1.5.2.3 Checking Oil Level

Note: Clean the area around the screw plugs of dirt beforehand.

- Differential
  Open the oil control plug (No.41) and check the oil level. The oil level must reach the lower edge of the oil control opening (No.41), if necessary add oil. (Fig. 1). Tightening moment for the oil control plug (No.41) is 80^{+10} Nm

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2 Repair Manual

2.1 General

- When servicing the differential, the axle must be removed from the vehicle. If the damage is serious enough it may be more advantages to exchange the complete differential, rather than repair it.
- As a prerequisite for a proper repair, cleanliness and certain technical knowledge are required.
- Prior to any repair the oil must be drained.

2.2 Disassembly

2.2.1 Removal of Pinion

- Remove hex bolt M14x35 from the bearing retainer. With a rubber hammer, tap the bearing retainer on the side to loosen it and by inserting two pry-bars at the bearing retainer, pull the bearing retainer and pinion out.
- Clamp the pinion in a large vice (if required use soft jaws) and. heat the pinion nut M40x1.5 to approx. 150°C and loosen. Remove hex bolts from the bearing cover situated behind the pinion flange and pull the bearing cover off. Clamp bearing retainer and push out pinion through the bearing inner rings.
- Remove the bearing inner ring from the pinion with the use of a extractor.

2.2.2 Removal of the Crown Wheel

- Loosen hex bolt M14 at the housing split, and with the use of a rubber hammer tap the cover to loosen and remove.
- Remove the differential cage complete with mounted crown wheel.
- Loosen wheel mounting hex bolts M14x40 and remove the crown wheel.

2.3 Installation of new Crown Wheel and Pinion

2.3.1

- The crown wheel and pinion can only be exchanged as a matched set since they have been mated to one another! Matched components are identified by numbers. (the pinion is marked on the face and the crown wheel is marked on the outside circumface)

2.3.2

- Prior to installing the new parts, the compensating gears in the differential cage are to be inspected. For this the one cage half can be removed after loosening the hex bolts M12x100. Defective parts (gears, crossbolt, worn out sleeves and thrust washers) are to be replaced. The thickness of the thrust washers of the axle shaft gears is to be chosen such that the gears can compensate smoothly. When reassembling the two halves, the proper orientation must be maintained. (mark on both halves at the circumference). The hex bolts M12x100 are secured with coating of micro capsules of adhesive. They can only be turned in and out before having to be replaced.

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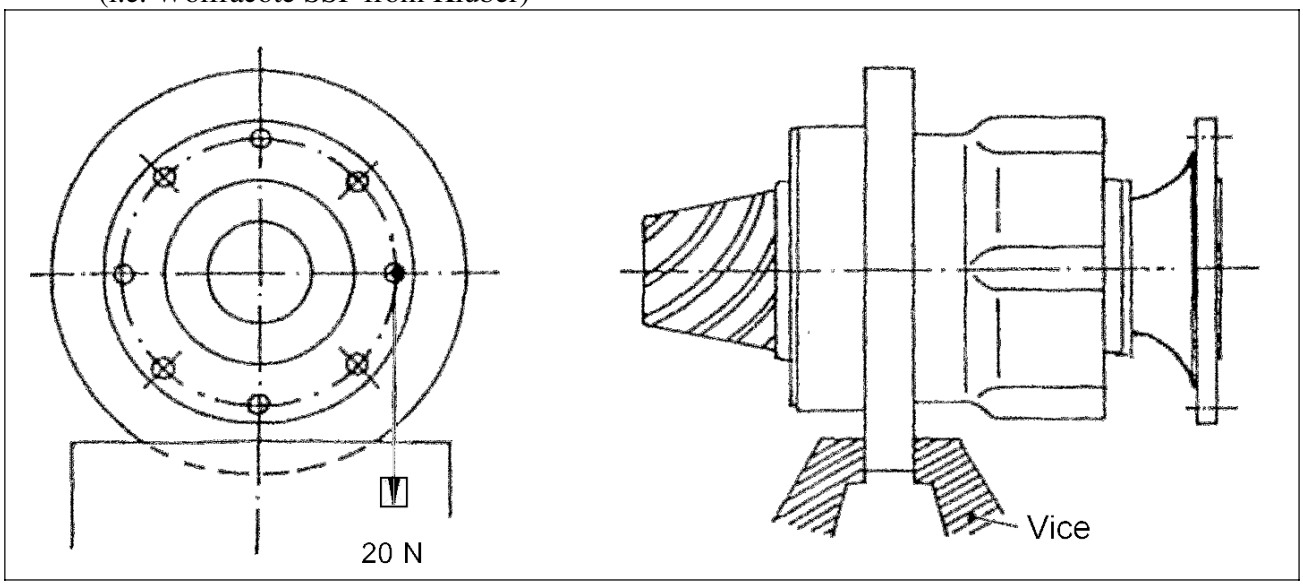
Tighten bolts immediately with 115 Nm and not retighten.
Attention: The differential cage halves cannot be exchanged separately but rather as a left and right half together.

2.3.3

- Clean the contact surface of the crown wheel and differential cage of any chemicals and particles and also remove any oil. Insert the crown wheel and tighten hex bolts M14x40 in a crosswise manner with a torque wrench to 220 Nm. These bolts are also secured with a coating of adhesive in micro caplets. If new bolts are used then initial torque can only 185 Nm

2.3.4 Pinion installation

- Installing pinion into the differential housing, fitting pinion head bearing.
  Press pinion head bearing onto pinion shaft then mount pinion into differential housing. Where new bearings are used, press new bearing outer races into housing first. Slide on spacer sleeve and mount the pinion flange with counter washer. Whilst continuously spinning the pinion, tighten the nut M40x1.5. The thickness of spacer may need to be adjusted several times until the pinion is able to be rotated with between 1 – 2 Nm at its full torque 100^{+5} Nm. This can be checked by placing a 10 mm bolt into the pinion flange and whilst keeping the bolt horizontal place a weight of approx. 20N on it. The pinion should then start to evenly rotate.
  When this setting is reached remove the pinion nut, mount the bearing cover including the oil seal paying particular attention to the correct locating of the oil return opening.
- Re-tighten the pinion nut
  Clean pinion thread M40 and pinion nut from dirt, oil and inhibitors. Coat entire diameter and length of thread of pinion and pinion nut, with Loctite 262. Apply wear and seizing inhibiting paste to the contact surface of the nut (No.50).
  (i.e. Wolfracote SSP from Klüber)



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2.3.5 Adjustment of the Backlash and Contact Pattern

- First the housing must be carefully cleaned and both small side covers of the housing halves are to be removed (each 8 bolts M10). If both tapered roller bearing inner rings of the differential cage were renewed, then the outer rings must also be renewed.
- Now both adjusting rings Sk. 3.70-047 of the assembly jig are to be mounted, each with 4 bolts M10x40 and the threaded ring Sk. 3.70-048 is to be turned in. (lubricate the thread or coat it with Molykote). The differential cage, complete with mounted crown wheel, is to inserted and the housing cover is to be mounted and tightened. Turn in and tighten the threaded ring until 10 N of force is required to turn the crown wheel at its circumference through the bearing retainer opening (now the preload is properly adjusted). Since the bearing outer rings of the differential cage must be moved when doing this, a high torque is required which can be achieved with the use of a lever Sk 3.70-049 and hitting of a hammer on this lever.
- Mount adjusting washers 712-509 in the bearing retainer, paint the teeth of the pinion with a thin oil paint or ink and insert the bearing retainer. Insert bolts M14 and tighten bearing retainer in a crosswise manner.
- Now simultaneously turn the threaded rings Sk. 3.70-048 in the same direction and same angle until a backlash of approximately 0.15 to 0.25 mm (equals approximately 0.4 to 0.6 mm on the circumference of the drive shaft flange) at the tightest point is reached. Turn the pinion by hand half a direction numerous times. Loosen bearing retainer and pull it out. Inspect the contact pattern on the crown wheel and pinion. If the contact pattern is per Figure 2, then the adjustment is correct.

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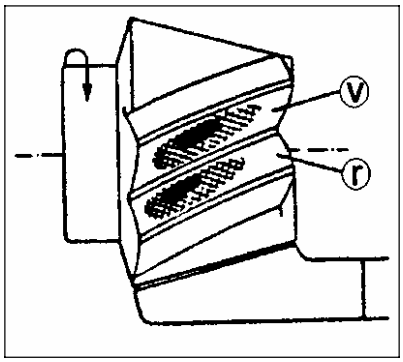


Figure 2

If the contact pattern as per Fig. 3 or 4, then by moving the pinion with use of varying thickness of adjusting washer between the bearing retainer housing and differential housing figure 2 can be obtained. By turning the threaded rings and the crown wheel as indicated by Figure 3 or 4 can also be adjusted.

Attention: Note proper bearing preload and backlash when turning the thread rings. Remove any old paint from the previous adjustment fore attempting to readjust.

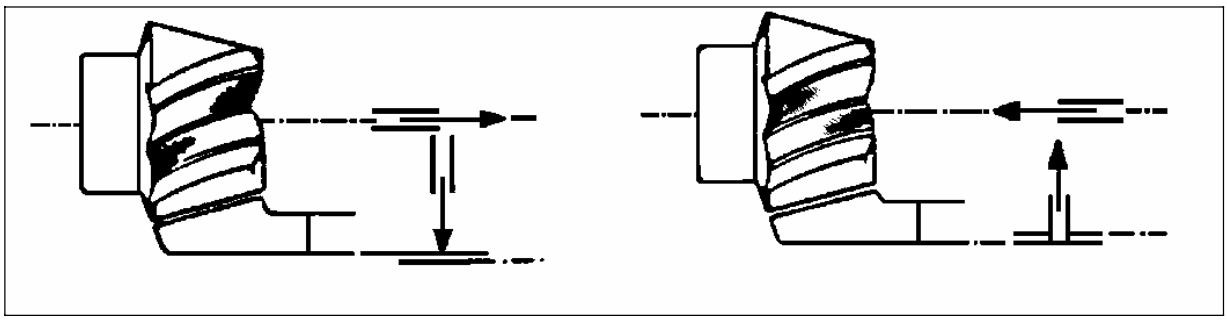
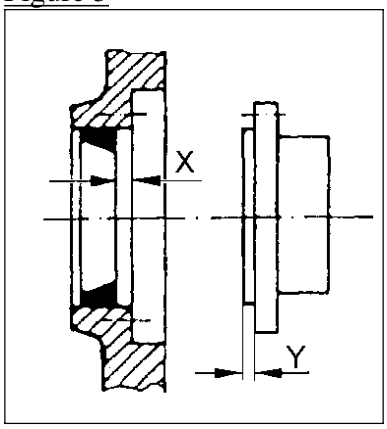


Figure 3 Figure 4



Once the proper contact pattern has been adjusted, usually after numerous attempts, the bearing retainer must be tightly mounted. Now the adjusting rings must be removed and with depth gauge dimension “X” which is the bearing outer ring to the bearing cover plate surface must be measured. The adjusting washers 7512.011 are to be determined when added together such that this dimension touches the bearing cover plate.
Calculation: Sum of all adjusting washers thicknesses of one side:
$Z = Y - X$

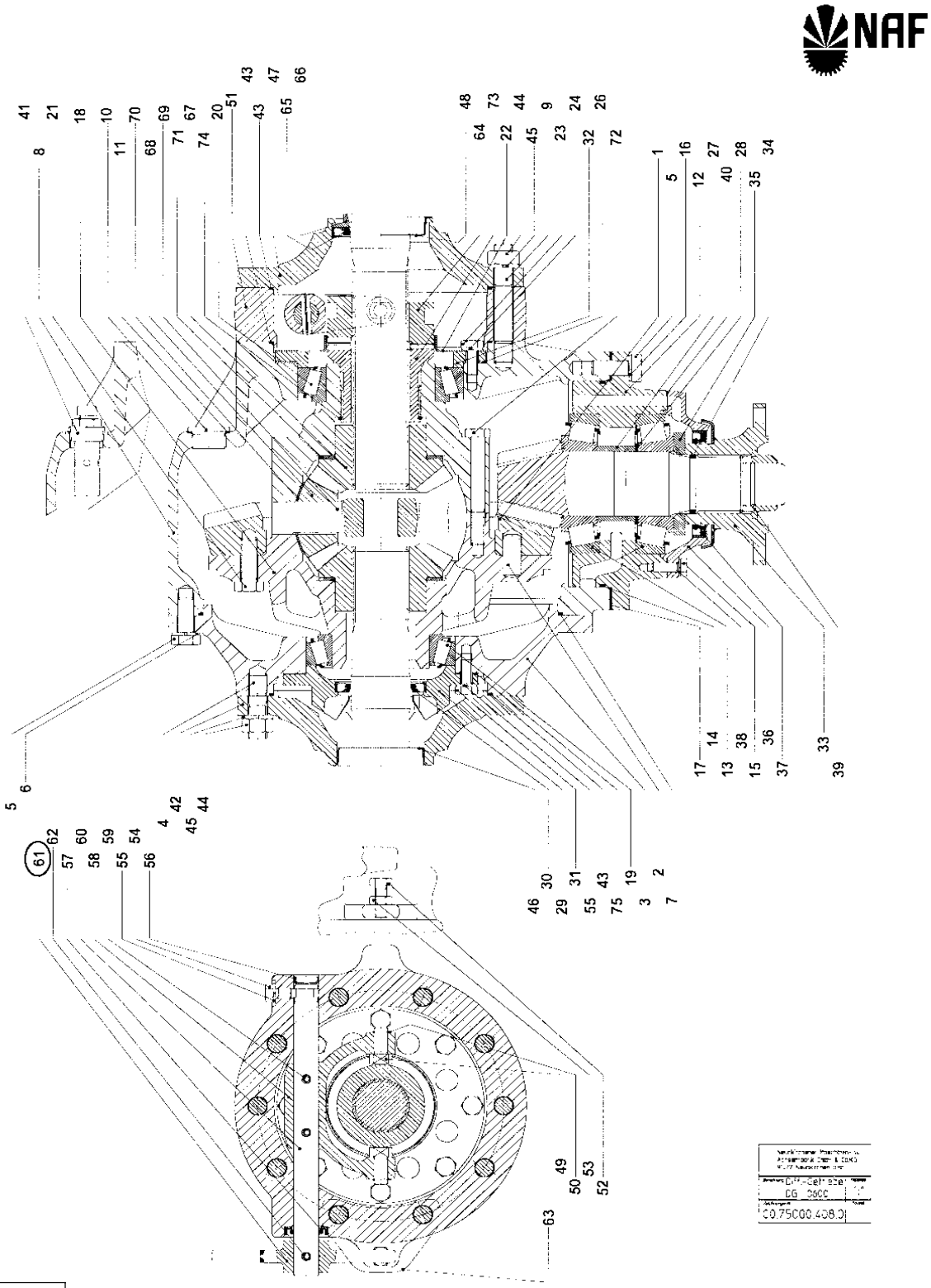
Figure 4

Prior to starting repairs, adjusting washers of various thicknesses should be obtained:

Adjusting Washer	7509.012	0.4 / 0.5 / 0.6 / 0.7 / 1.0 / 2.0	Bearing Retainer
Adjusting Washer	7512.011	0.4 / 0.5 / 0.6 / 0.7 / 1.0 / 2.0	Bearing Ret., side
Adjusting Washer	7317.038	various lengths	Pinion Bearing

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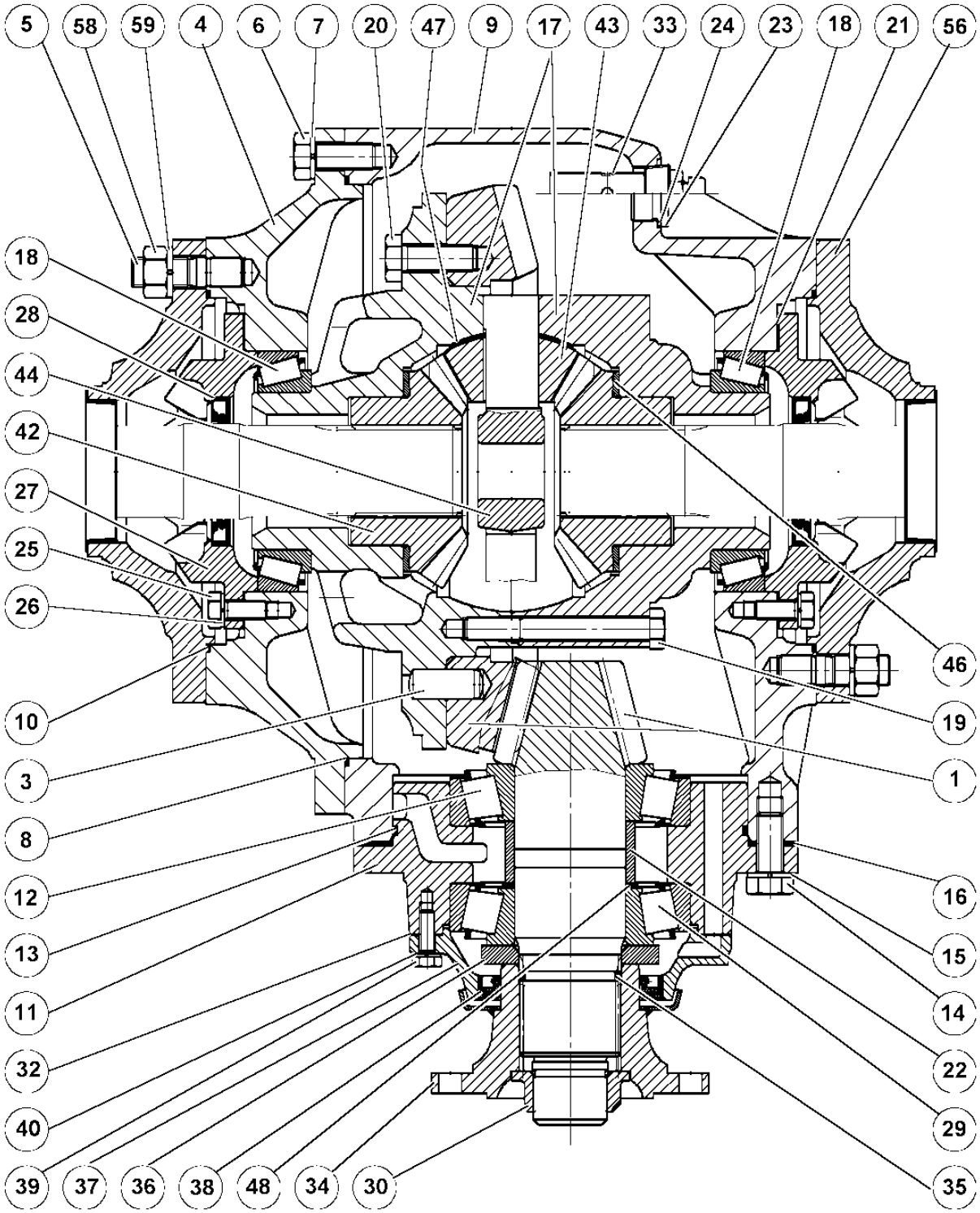
Type :	STA 04 / STA 05 Differential in VP 2400 L (Stavostroj)
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STA 05

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STA 04

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NAF Tool table for STA 04/05 differential

Description:	WZ number:
Adjusting ring to adjust the bearing pre-load on the differential casing	**WZ 652/01** (Sk 3.70-047)
Threaded washer Second part to the adjusting ring	**WZ 652/02** (Sk 3.70-048)
Lever For turn the threaded washer	**WZ 652/03** (Sk 3.70-049)

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Neunkirchen on the May 28,2004

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7 Circuit diagrams

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Circuit diagrams

- The circuit diagrams valid at the date of printing are part of these repair instructions.
- The circuit diagrams valid for the machine serial number can be found in the spare parts catalogue for the machine.

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7.1 Wiring diagram

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Standardverkabelung: dicke Linien standard wireing: thick lines	Platinenverdrahtung: dünne Linien connection on printed circuit board: thin lines

Inhaltsverzeichnis: BW 24 R, mit 24V Fremdstartsteckdose
table of contents: BW 24 R, with 24V jump start socket

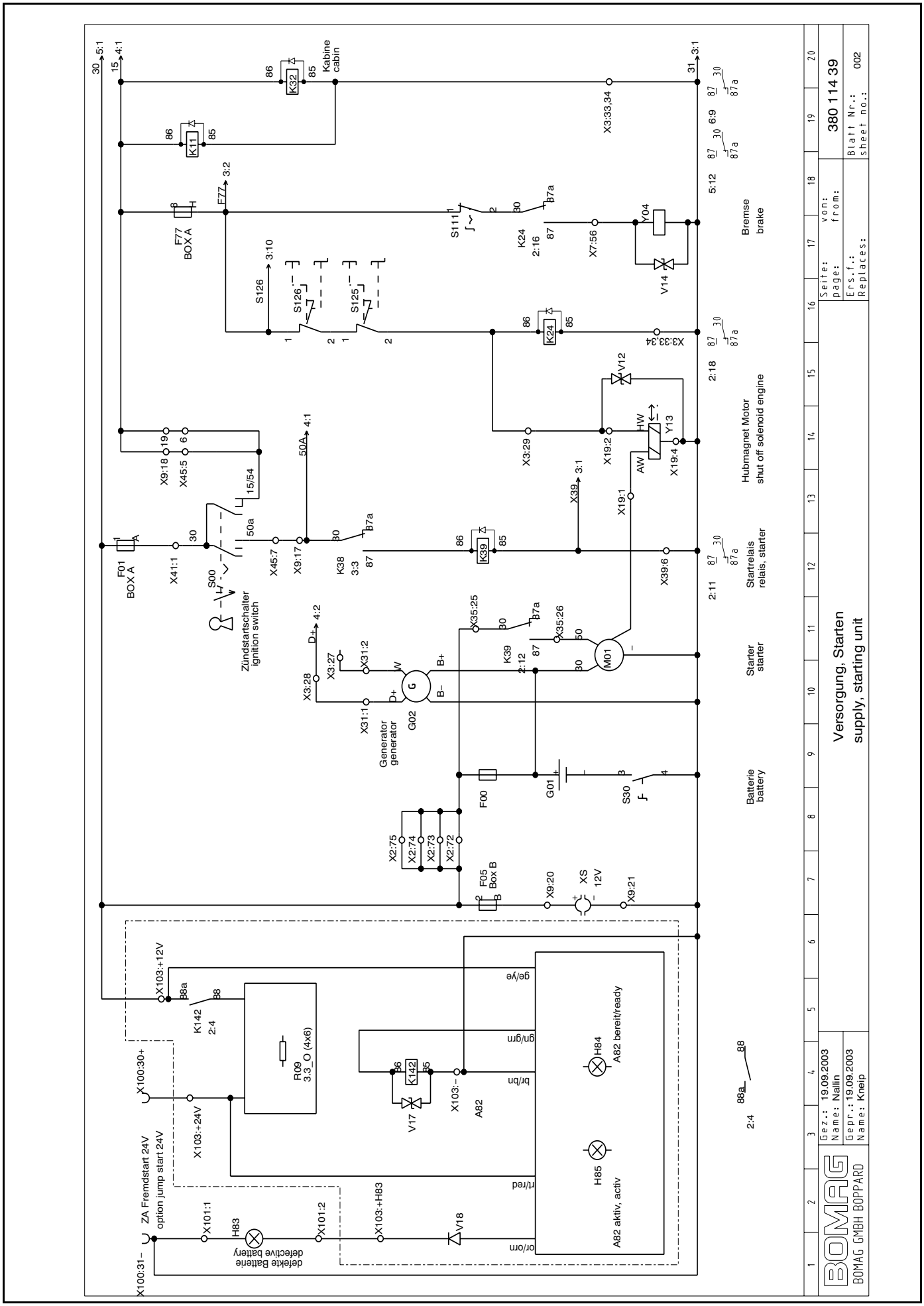
Blatt Nr.: sheet no.:	Zeichnungsnummer drawing – no.	Funktionsgruppe	function unit
001	380 114 39	Stromlaufplan	Circuit Diagram
002	380 114 39	Versorgung, Starten	supply, starting unit
003	380 114 39	Fahren	travel system
004	380 114 39	Überwachung	monitoring unit
005	380 114 39	Blinker, Arbeitsbel., Rundumkennl., Bremsl., Signalhorn	illumination, working, warning–, brake lights, warning horn
006	380 114 39	Scheibenw., Berieselung, Klimaanl., Geschw.anzeige	windsreen wiper, sprinkler system, air condit., speedometer
101	380 114 39	Bauteilliste	component listing
201	380 114 39	Zentralelektrik	cross bonding box

1	2	3	4	5	6	7	8	9	10

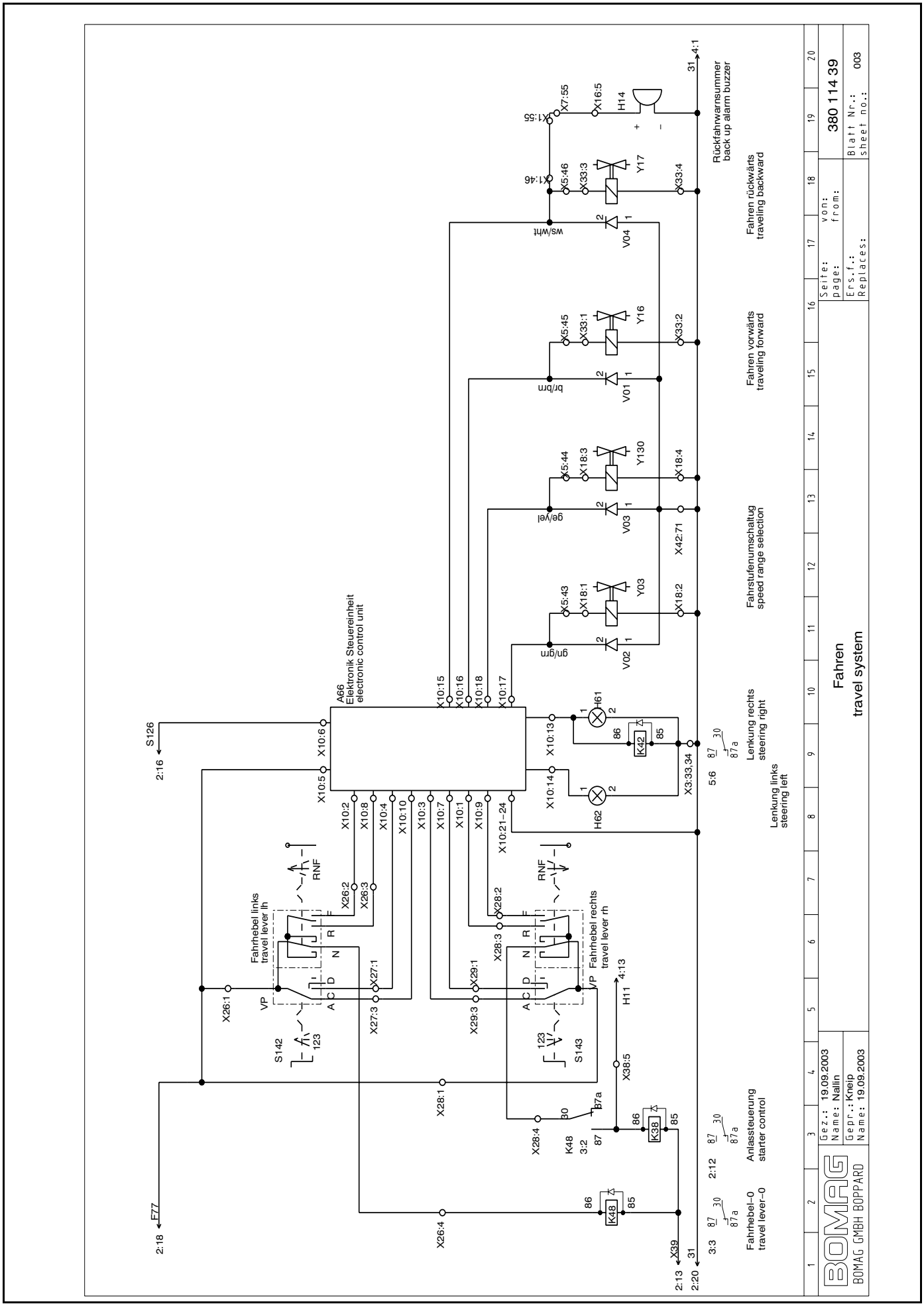
BOMAG BOMAG GMBH BOPPARD	Gez.: 19.09.2003 Name: Nallin Gepr.: 19.09.2003 Name: Kneip	Stromlaufplan circuit diagram	Seite: von: page: from: Ers.f.: Replaces:	380 114 39 Blatt Nr.: sheet no.: 001

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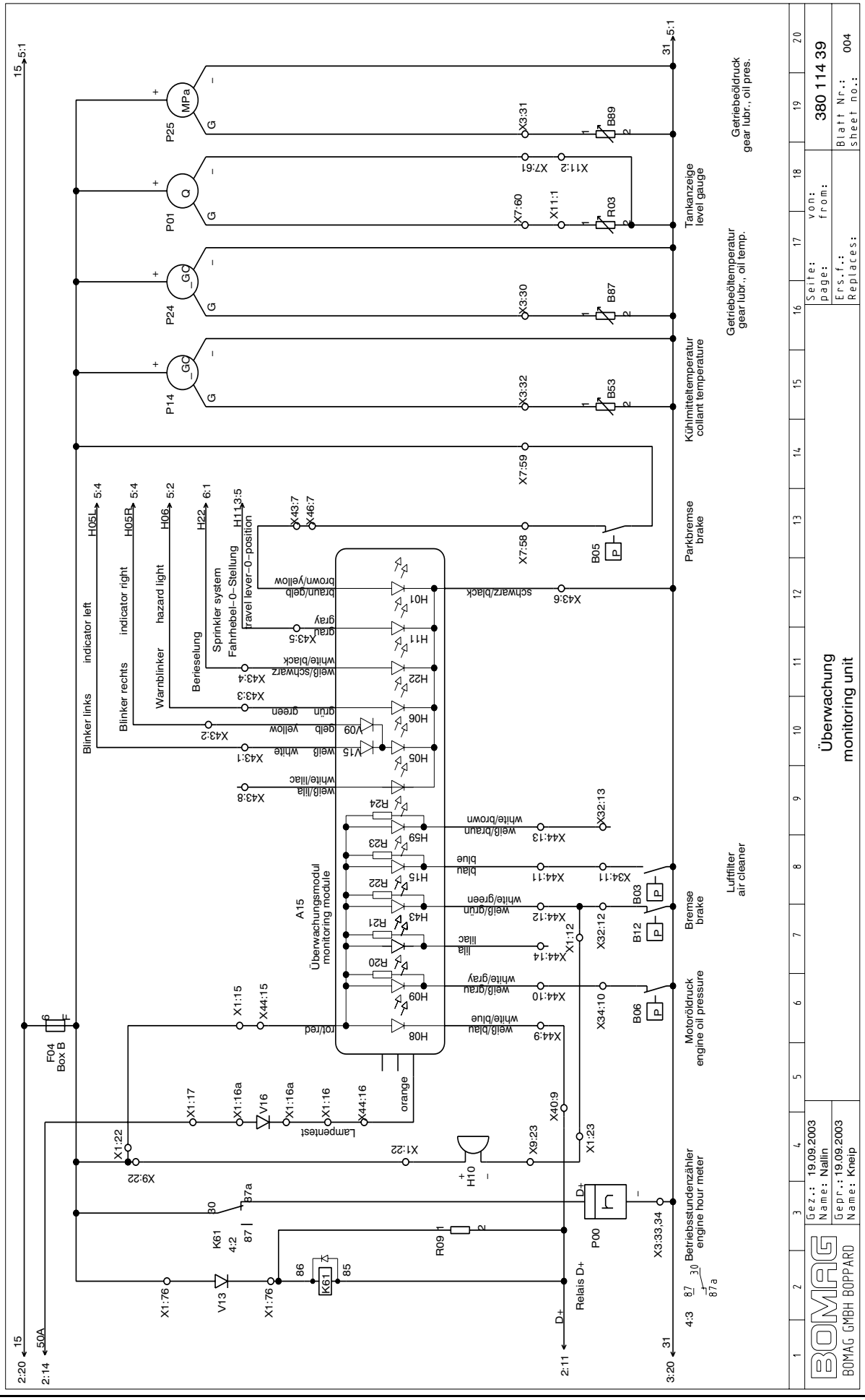
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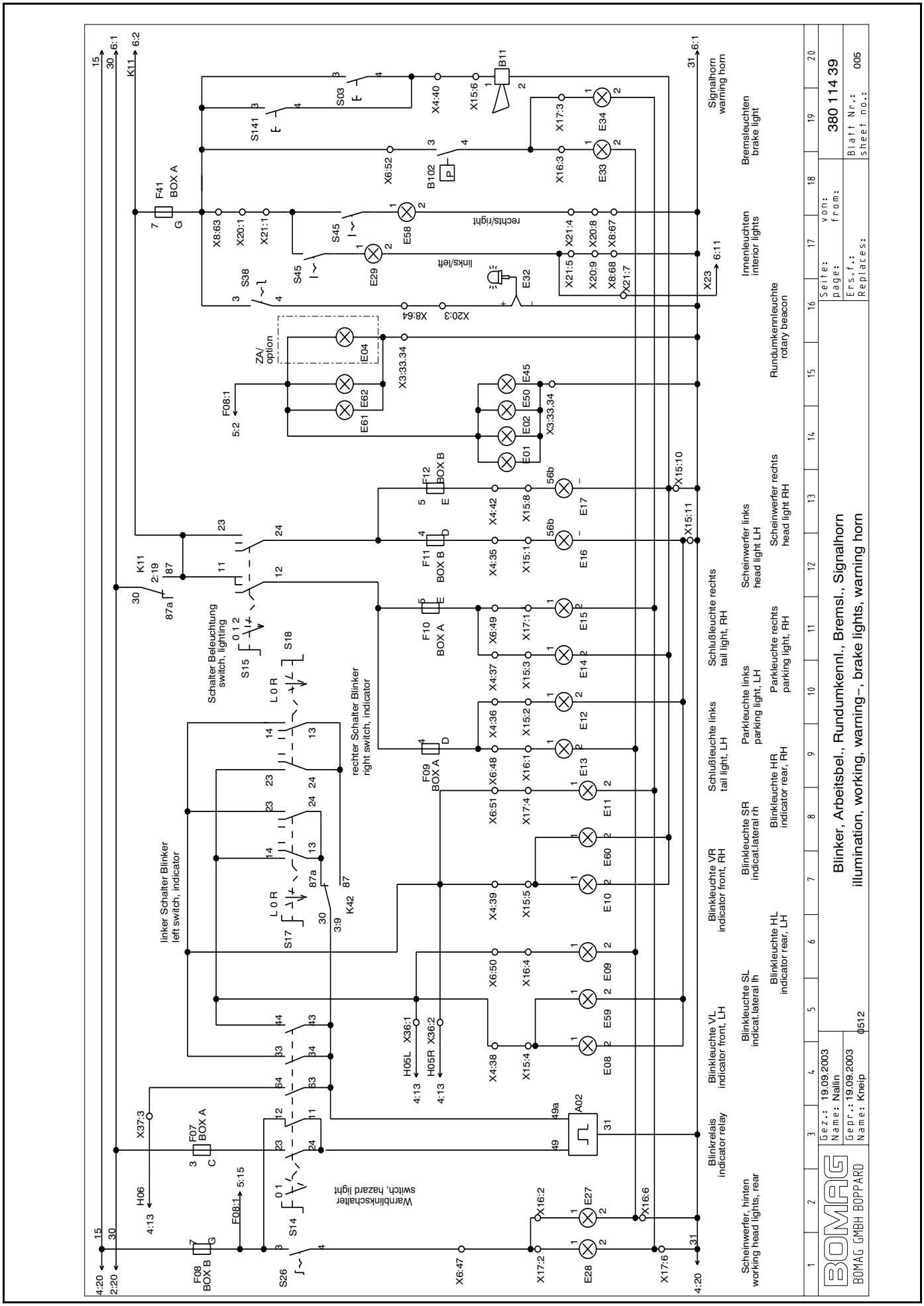
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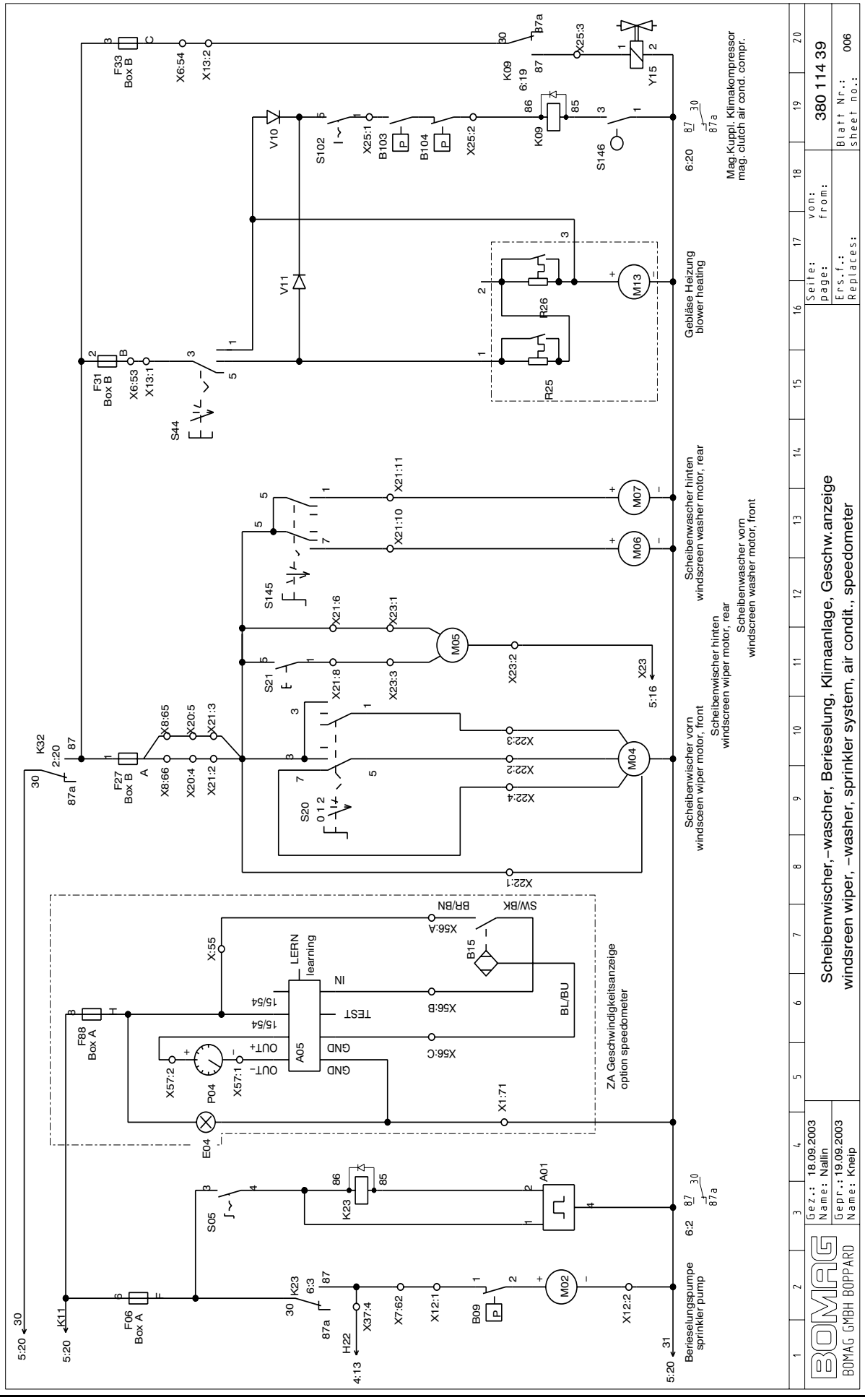
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BOMAG GMBH BOPPARD

Gez.: 23.9.3
Name: Nallin
Gepr.: 23.9.03
Name: Kneip

Bauteilliste
component listing

Seite: 1 von: 4
page: 1 from: 4
Ers.f.:
Replaces:

Blatt Nr.: 380 114 39
sheet no.: 101

Name	Bl.	Pf.	Benennung	title	TYP
A01	006	3	Intervallschalter Berieselungssystem	intervall switch, sprinkler system	0.17W
A02	005	3	Blinkrelais	indicator relay	0.06W
A05	006	5	Elektronik Geschwindigkeitsanzeige	Electronic system, speedometer	
A66	003	9	Elektronik Steuereinheit	Electronic control unit	
A82	002	3	Starthilfeschaltung 12/24V	jump start circuit 12/24V	
B03	004	8	Unterdruckschalter Luftfilter	Vacuum switch, air cleaner	
B05	004	13	Druckschalter Bremse	Pressure switch, brake	
B06	004	6	Druckschalter Motoroel	Pressure switch, engine oil	
B09	006	2	Druckschalter Berieselungssystem	Pressure switch, sprinkler system	
B11	005	20	Signalhorn	Warning horn	96W
B12	004	7	Druckschalter Bremse	Pressure switch, brake	
B15	006	7	Aufnehmer Geschwindigkeit	Transducer, speed	Schließer 4mm
B53	004	15	Temperaturgeber Kuehlmittel	Temperature switch, collant	
B87	004	16	Temperaturgeber Getriebeoel	Sender, gear lubr. oil temperature	
B89	004	19	Druckgeber Getriebeoel	Sender, gear lubr. oil pressure	
B102	005	19	Druckschalter Bremsleuchten	Pressure switch, brake lights	
B103	006	19	Temperaturschalter Klimaanlage	Temperature switch, air conditioning	
B104	006	19	Druckschalter Klimaanlage	Pressure switch, air conditioning	
E01	005	14	Beleuchtung Tankanzeige	Illumination, level gauge	2W
E02	005	14	Beleuchtung Temperaturanzeige	Illumination, temperature gauge	2W
E04	005	16	Beleuchtung Geschwindigkeitsanzeige	Illumination, speedometer	2W
E04	006	4	Beleuchtung Geschwindigkeitsanzeige	Illumination, speedometer	2W
E08	005	4	Blinkleuchte vorne links	Indicator, front, lh.	21W
E09	005	6	Blinkleuchte hinten links	Indicator, rear, lh.	21W
E10	005	7	Blinkleuchte vorne rechts	Indicator, front, rh.	21W
E11	005	8	Blinkleuchte hinten rechts	Indicator, rear, rh.	21W
E12	005	10	Parkleuchte links	Parking light, lh.	5W
E13	005	9	Schlussleuchte links	Tail light, lh.	5W
E14	005	11	Parkleuchte rechts	Parking light, rh.	5W
E15	005	11	Schlussleuchte rechts	Tail light, rh.	5W
E16	005	12	Scheinwerfer links	Head light, lh.	55W
E17	005	13	Scheinwerfer rechts	Head light, rh.	55W
E27	005	2	Arbeitsscheinwerfer hinten links	Working head light, rear, lh.	55W
E28	005	1	Arbeitsscheinwerfer hinten rechts	Working head light, rear, rh.	55W
E29	005	17	Innenleuchte Kabine	Inside light, cabin	2x10W
E32	005	16	Kennleuchte	Warning light	55W
E33	005	19	Bremsleuchte links	Brake light, lh.	21W
E34	005	19	Bremsleuche rechts	Brake light, rh.	21W
E45	005	15	Beleuchtung Oeldruckanzeige	Illumination oil pressure indicator	2W
E50	005	14	Beleuchtung Wasseranzeige	Illumination water indicator	2W
E58	005	18	Innenleuchte Kabine	Inside light, cabin	2x10W
E59	005	5	Blinkleuchte links seitlich	Indicator, lateral lh	21W
E60	005	8	Blinkleuchte rechts seitlich	Indicator, lateral rh	21W
E61	005	14	Beleuchtung Reifendruckanzeige	Illumination	2W
E62	005	15	Beleuchtung Bremsdruckanzeige	Illumination	2W
F00	002	9	Hauptsicherung Batterie	Fuse, main, battery	80A
F01	002	12	Hauptsicherung	Fuse, main	35A
F04	004	6	Sicherung Instrumente	Fuse, gauges	10A
F05	002	7	Sicherung Steckdose	Fuse, socket	10A
F06	006	2	Sicherung Berieselung	Fuse, sprinkler system	10A
F07	005	3	Sicherung Warnblinker	Fuse, hazard light	15A
F08	005	1	Sicherung Blinker u. Arbeitsscheinw.	Fuse, indicators a. work. head light	15A
F09	005	9	Sicherung Park- u. Schlussl. links	Fuse, parking and tail light, lh.	5A
F10	005	11	Sicherung Park- u. Schlussl. rechts	Fuse, parking and tail light, rh.	5A
F11	005	12	Sicherung Scheinwerfer links	Fuse, head light, lh.	7.5A
F12	005	13	Sicherung Scheinwerfer rechts	Fuse, head light, rh.	7.5A
F27	006	10	Sicherung Wischer u. Wascher vorne	Fuse, windscr. wiper and washer, fr.	10A
F31	006	15	Sicherung Kabinenluefter	Fuse, cabin ventilator	20A
F33	006	20	Sicherung Klimageraet	Fuse, air conditioning	10A
F41	005	18	Sicherung Rundumkennleuchte	Fuse, rotary beacon	20A
F77	002	18	Sicherung Fahren	Fuse, traveling	10A
F88	006	6	Sicherung, Frequenz-/Geschwindigkeitsanz.	Fuse, frequenzy-and speedometer	10A
G01	002	9	Batterie	Battery	100Ah
G02	002	10	Generator	Generator	
H01	004	12	Meldeleuchte Bremse	Indicator light, brake	
H05	004	10	Meldeleuchte Blinker	Indicator light, indicators	
H06	004	10	Meldeleuchte Warnblinker	Indicator light, hazard light	
H08	004	6	Meldeleuchte Ladekontrolle	Indicator light, charge control	
H09	004	6	Meldeleuchte Oeldruck Motor	Indicator light, engine oil pressure	
H10	004	4	Warnsummer Bremse	Warning buzzer, brake system	
H11	004	11	Meldeleuchte Fahrhebel '0'-Stellung	Indicator light, travel lever '0' pos.	
H14	003	19	Warnsummer Rueckwaertsfahrt	Back-up alarm buzzer	
H15	004	8	Meldeleuchte Motorluftfilter	Indicator light, engine air filter	
H22	004	11	Meldeleuchte Berieselung	Indicator light, sprinkler system	
H43	004	7	Meldeleuchte Bremsdruck	Indicator light, brake pressure	
H59	004	9	Meldeleuchte Differentialsperre	Indicator light, differential lock	
H61	003	10	Meldeleuchte Lenkung rechts	Indicator light, steering rh	
H62	003	8	Meldeleuchte Lenkung links	Indicator light, steering lh	
H83	002	1	Warnleuchte Batterie	Warning light, battery	LED Rot
H84	002	4	Meldeleuchte Fremdstartmodul bereit	indicator light, jump start modul ready	LED
H85	002	3	Meldeleuchte Fremdstartmodul aktiv	indicator light, jump start modul activ	LED
K09	006	19	Relais Klimageraet	Relay, air conditioning	BOSCHW
K11	002	19	Relais Klemme 30 auf 15	Relay, terminal 30 to 15	BOSCHW
K23	006	3	Relais Berieselungssystem	Relay, sprinkler system	BOSCHW
K24	002	16	Relais Bremssperre	Relay, brake lock	BOSCHW
K32	002	20	Relais Kabine	Relay, cabin	BOSCHW
K38	003	3	Relais Anlassteuerung	Relay, starter control	BOSCHW
K39	002	12	Relais Anlasser	Relay, starter	BOSCHW
K42	003	9	Umschaltrelais	Relay, switch over	BOSCHW
K48	003	2	Relais Fahrhebel 0-Stellung	Relay, travel lever 0-position	BOSCHW
K61	004	2	Relais Ladekontrolle	Relay, charge control	BOSCHW
K142	002	4	Relais Fremdstart	Relay, jump start	BOSCHS

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BOMAG GMBH BOPPARD

Gez.: 23.9.3
Name: Nallin
Gepr.: 23.9.03
Name: Kneip

Bauteilliste
component listing

Seite: 2 von: 4
page: 2 from: 4

Ers.f.:
Replaces:

Blatt Nr.: 102
sheet no.: 102

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Name	Bl.	Pf.	Benennung	title	TYP
M01	002	10	Starter	Starter	60A/10A
M02	006	2	Berieselungspumpe	Sprinkler pump	76.8W
M04	006	9	Scheibenwischermotor vorne	Windscreen wiper motor, front	60W
M05	006	11	Scheibenwischermotor hinten	Windscreen wiper motor, rear	21.6W
M06	006	13	Scheibenwaschermotor vorne	Windscreen washer motor, front	12W
M07	006	13	Scheibenwaschermotor hinten	Windscreen washer motor, rear	12W
M13	006	16	Geblaese Heizung	Blower heating	
P00	004	3	Betriebsstundenzaehler	Operating hour meter	0.05W
P01	004	18	Tankanzeige	Level gauge	0.8W
P04	006	5	Geschwindigkeitsanzeige	Speedometer	
P14	004	15	Anzeige Kuehlmitteltemperatur	Temperature gauge, coolant	0.8W
P24	004	16	Anzeige Getriebeoeltemperatur	Temperature gauge, gear lubr. oil	0.8W
P25	004	19	Anzeige Getriebeoeldruck	Pressure gauge, gear lubr. oil	0.8W
R03	004	17	Geber Tankanzeige	Sender, level gauge	
R09	002	4	Vorwiderstand	Dropping resistor	3.3_O (4x6)
R09	004	3	Vorwiderstand	Dropping resistor	82_O 10W
R20	004	6	Widerstand	Resistor	100 OHM
R20	004	6	Widerstand	Resistor	
R21	004	7	Widerstand	Resistor	100 OHM
R21	004	7	Widerstand	Resistor	
R22	004	8	Widerstand	Resistor	100 OHM
R22	004	8	Widerstand	Resistor	
R23	004	8	Widerstand	Resistor	100 OHM
R23	004	8	Widerstand	Resistor	
R24	004	9	Widerstand	Resistor	100 OHM
R24	004	9	Widerstand	Resistor	
R25	006	15	Widerstand	Resistor	
R26	006	16	Widerstand	Resistor	
S00	002	12	Startschalter	Starter switch	
S03	005	20	Taster Signalhorn	Push button, warning horn	
S05	006	3	Berieselungsschalter	Switch, sprinkler system	
S14	005	3	Warnblinkschalter	Switch, hazard light	
S15	005	12	Beleuchtungsschalter StVZO	Switch, lighting StVZO	
S17	005	7	Schalter Blinker links	Switch, indicator, lh.	
S18	005	10	Schalter Blinker rechts	Switch, indicator, rh.	
S20	006	10	Schalter Scheibenwischer vorne	Switch, windscreen wiper, front	
S21	006	11	Schalter Scheibenwischer hinten	Switch, windscreen wiper, rear	
S26	005	1	Schalter Arbeitsbeleuchtung hinten	Switch, working head lights, rear	
S30	002	9	Batterietrennschalter	Switch, battery disconnect	
S38	005	16	Schalter Kennleuchte	Switch, warning light	
S44	006	15	Schalter Kabinenluefter	Switch, cabin ventilator	
S45	005	17	Schalter Kabineninnenleuchte	Switch, cabin inside light	
S45	005	18	Schalter Kabineninnenleuchte	Switch, cabin inside light	
S102	006	19	Schalter Klimaanlage	Switch air conditioning	
S111	002	18	Schalter Feststellbremse	Switch, parking brake	
S125	002	16	Schalter NOT AUS, links	Switch, emergency off,lh.	
S126	002	16	Schalter NOT AUS, rechts	Switch, emergency off,rh.	
S141	005	19	Taster Signalhorn	Push button, warning horn	
S142	003	5	Fahrhebel links	Travel lever, lh	
S143	003	5	Fahrhebel rechts	Travel lever, rh	
S145	006	13	Taster Scheibenwascher	Push button,windscreen washer	
S146	006	19	Endschalter Heizung	Limit switch, heater	
V01	003	15	Diode	Diode	Diodenmodul
V02	003	11	Diode	Diode	Diodenmodul
V03	003	13	Diode	Diode	Diodenmodul
V04	003	17	Diode	Diode	Diodenmodul
V09	004	10	Diode	Diode	in A15
V10	006	19	Diode	Diode	
V11	006	16	Diode	Diode	
V12	002	15	Diode	Diode	1.5KE36CA
V13	004	2	Diode	Diode	Wago UF4004
V13	201	17	Diode	Diode	WAGO UF4004
V14	002	17	Diode	Diode	1.5KE36CA
V15	004	10	Diode	Diode	in A15
V16	004	4	Diode	Diode	WAGO UF4004
V16	201	7	Diode	Diode	WAGO UF4004
V17	002	4	Diode	Diode	
V18	002	1	Diode	Diode	Kabeldiode
X1:12	004	7	Elektrokasten	Cross-bonding box	
X1:15	004	6	Elektrokasten	Cross-bonding box	
X1:16	004	4	Elektrokasten	Cross-bonding box	
X1:17	004	4	Elektrokasten	Cross-bonding box	
X1:22	004	4	Elektrokasten	Cross-bonding box	
X1:22	004	4	Elektrokasten	Cross-bonding box	
X1:23	004	4	Elektrokasten	Cross-bonding box	
X1:46	003	18	Elektrokasten	Cross-bonding box	
X1:55	003	19	Elektrokasten	Cross-bonding box	
X1:71	006	4	Elektrokasten	Cross-bonding box	
X1:76	004	2	Elektrokasten	Cross-bonding box	
X1:76	004	2	Elektrokasten	Cross-bonding box	
X1:16a	004	4	Elektrokasten	Cross-bonding box	
X1:16a	004	4	Elektrokasten	Cross-bonding box	
X2:72	002	8	Elektrokasten	Cross-bonding box	
X2:73	002	8	Elektrokasten	Cross-bonding box	
X2:74	002	8	Elektrokasten	Cross-bonding box	
X2:75	002	8	Elektrokasten	Cross-bonding box	
X3:27	002	11	Elektrokasten	Cross-bonding box	
X3:28	002	10	Elektrokasten	Cross-bonding box	
X3:29	002	14	Elektrokasten	Cross-bonding box	
X3:30	004	16	Elektrokasten	Cross-bonding box	
X3:31	004	19	Elektrokasten	Cross-bonding box	
X3:32	004	15	Elektrokasten	Cross-bonding box	
X3:33,34	002	16	Elektrokasten	Cross-bonding box	
X3:33,34	002	20	Elektrokasten	Cross-bonding box	

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BOMAG GMBH BOPPARD

Gez.: 23.9.3
Name: Nallin
Gepr.: 23.9.03
Name: Kneip

Bauteilliste
component listing

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Ers.f.:
Replaces:

Blatt Nr.: 380 114 39
sheet no.: 103

Name	Bl.	Pf.	Benennung	title	TYP
X3:33,34	003	9	Elektrokasten	Cross-bonding box	
X3:33,34	004	3	Elektrokasten	Cross-bonding box	
X3:33,34	005	15	Elektrokasten	Cross-bonding box	
X3:33.34	005	16	Elektrokasten	Cross-bonding box	
X4:35	005	12	Elektrokasten	Cross-bonding box	
X4:36	005	10	Elektrokasten	Cross-bonding box	
X4:37	005	11	Elektrokasten	Cross-bonding box	
X4:38	005	4	Elektrokasten	Cross-bonding box	
X4:39	005	7	Elektrokasten	Cross-bonding box	
X4:40	005	20	Elektrokasten	Cross-bonding box	
X4:42	005	13	Elektrokasten	Cross-bonding box	
X5:43	003	11	Elektrokasten	Cross-bonding box	
X5:44	003	13	Elektrokasten	Cross-bonding box	
X5:45	003	16	Elektrokasten	Cross-bonding box	
X5:46	003	18	Elektrokasten	Cross-bonding box	
X6:47	005	1	Elektrokasten	Cross-bonding box	
X6:48	005	9	Elektrokasten	Cross-bonding box	
X6:49	005	11	Elektrokasten	Cross-bonding box	
X6:50	005	6	Elektrokasten	Cross-bonding box	
X6:51	005	8	Elektrokasten	Cross-bonding box	
X6:52	005	19	Elektrokasten	Cross-bonding box	
X6:53	006	15	Elektrokasten	Cross-bonding box	
X6:54	006	20	Elektrokasten	Cross-bonding box	
X7:55	003	19	Elektrokasten	Cross-bonding box	
X7:56	002	17	Elektrokasten	Cross-bonding box	
X7:58	004	13	Elektrokasten	Cross-bonding box	
X7:59	004	14	Elektrokasten	Cross-bonding box	
X7:60	004	17	Elektrokasten	Cross-bonding box	
X7:61	004	18	Elektrokasten	Cross-bonding box	
X7:62	006	2	Elektrokasten	Cross-bonding box	
X8:63	005	18	Elektrokasten	Cross-bonding box	
X8:64	005	16	Elektrokasten	Cross-bonding box	
X8:65	006	10	Elektrokasten	Cross-bonding box	
X8:66	006	10	Elektrokasten	Cross-bonding box	
X8:67	005	18	Elektrokasten	Cross-bonding box	
X8:68	005	17	Elektrokasten	Cross-bonding box	
X9:17	002	12	Elektrokasten	Cross-bonding box	
X9:18	002	14	Elektrokasten	Cross-bonding box	
X9:19	002	14	Elektrokasten	Cross-bonding box	
X9:20	002	7	Elektrokasten	Cross-bonding box	
X9:21	002	7	Elektrokasten	Cross-bonding box	
X9:22	004	4	Elektrokasten	Cross-bonding box	
X9:23	004	4	Elektrokasten	Cross-bonding box	
XS	002	7	Steckdose	Socket	
X10:1	003	8	An A66	to A66	
X10:2	003	8	An A66	to A66	
X10:3	003	8	An A66	to A66	
X10:4	003	8	An A66	to A66	
X10:5	003	9	An A66	to A66	
X10:6	003	10	An A66	to A66	
X10:7	003	8	An A66	to A66	
X10:8	003	8	An A66	to A66	
X10:9	003	8	An A66	to A66	
X10:10	003	8	An A66	to A66	
X10:13	003	10	An A66	to A66	
X10:14	003	9	An A66	to A66	
X10:15	003	10	An A66	to A66	
X10:16	003	10	An A66	to A66	
X10:17	003	10	An A66	to A66	
X10:18	003	10	An A66	to A66	
X10:21-24	003	8	An A66	to A66	
X11:1	004	17	Geber Tankanzeige	sender level gauge	
X11:2	004	18	Geber Tankanzeige	sender level gauge	
X12:1	006	2	Berieselungspumpe	sprinkler pump	
X12:2	006	2	Berieselungspumpe	sprinkler pump	
X13:1	006	15	Heizung/Klima	heating/air conditioning	
X13:2	006	20	Heizung/Klima	heating/air conditioning	
X15:1	005	12	Beleuchtung vorn	Illumination front	
X15:2	005	10	Beleuchtung vorn	Illumination front	
X15:3	005	11	Beleuchtung vorn	Illumination front	
X15:4	005	4	Beleuchtung vorn	Illumination front	
X15:5	005	7	Beleuchtung vorn	Illumination front	
X15:6	005	20	Beleuchtung vorn	Illumination front	
X15:8	005	13	Beleuchtung vorn	Illumination front	
X15:10	005	13	Beleuchtung vorn	Illumination front	
X15:11	005	12	Beleuchtung vorn	Illumination front	
X16:1	005	9	Bel. hinten links	illumination back lh	
X16:2	005	2	Bel. hinten links	illumination back lh	
X16:3	005	19	Bel. hinten links	illumination back lh	
X16:4	005	6	Bel. hinten links	illumination back lh	
X16:5	003	19	Bel. hinten links	illumination back lh	
X16:6	005	2	Bel. hinten links	illumination back lh	
X17:1	005	11	Bel. hinten rechts	illumination, back rh	
X17:2	005	1	Bel. hinten rechts	illumination, back rh	
X17:3	005	19	Bel. hinten rechts	illumination, back rh	
X17:4	005	8	Bel. hinten rechts	illumination, back rh	
X17:6	005	1	Bel. hinten rechts	illumination, back rh	
X18:1	003	11	an Y03/Y130	to Y03/Y130	
X18:2	003	11	an Y03/Y130	to Y03/Y130	
X18:3	003	13	an Y03/Y130	to Y03/Y130	
X18:4	003	13	an Y03/Y130	to Y03/Y130	
X19:1	002	13	an Y13	to Y13	
X19:2	002	14	an Y13	to Y13	
X19:4	002	14	an Y13	to Y13	
X20:1	005	18	Kabine	cabin	
X20:3	005	16	Kabine	cabin	
X20:4	006	10	Kabine	cabin	
X20:5	006	10	Kabine	cabin	
X20:8	005	18	Kabine	cabin	

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BOMAG GMBH BOPPARD

Gez.: 23.9.3
Name: Nallin
Gepr.: 23.9.03
Name: Kneip

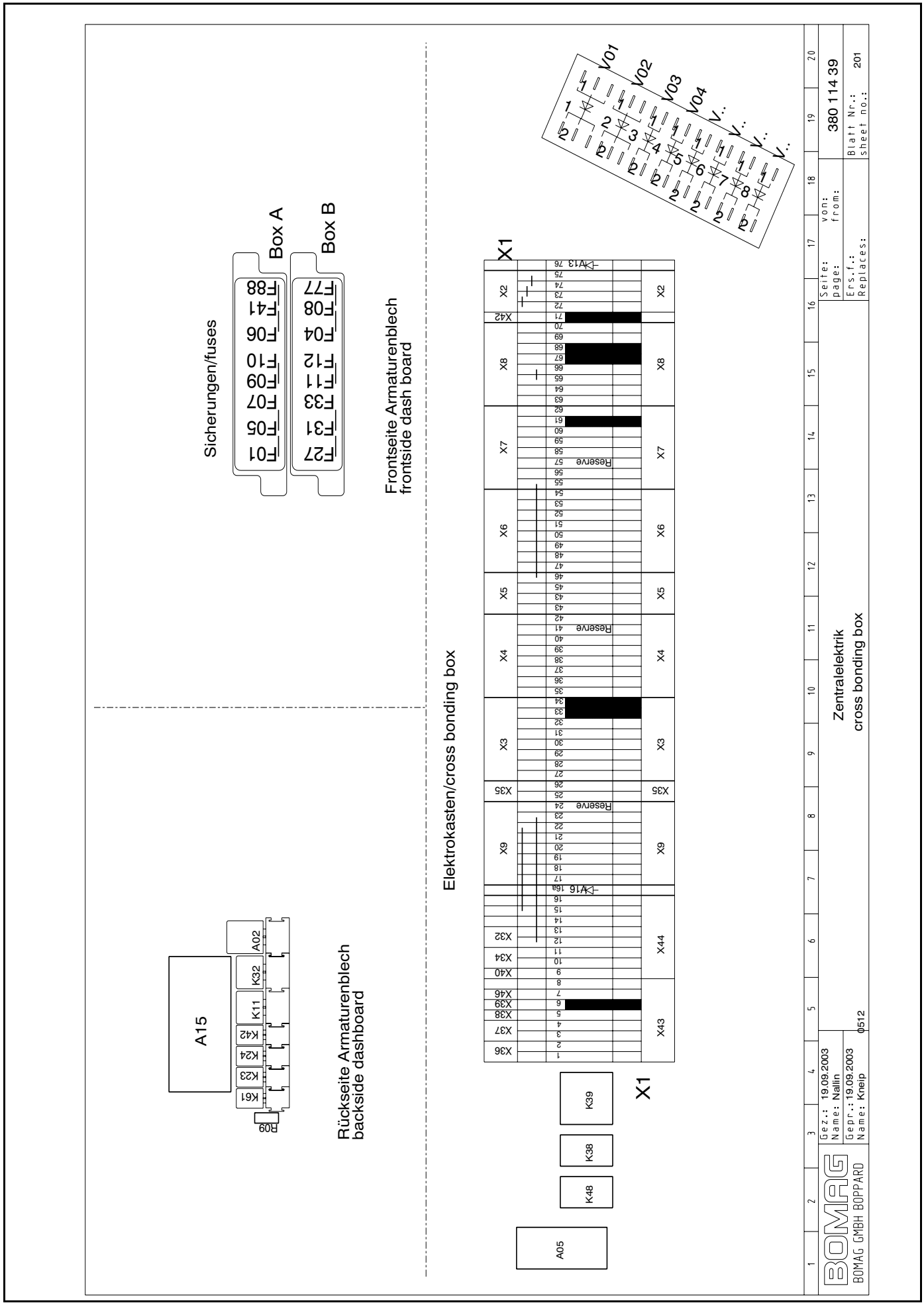
Bauteilliste
component listing

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Replaces:

Blatt Nr.: 380 114 39
sheet no.: 104

Name	Bl.	Pf.	Benennung	title	TYP
X20:9	005	17	Kabine	cabin	
X21:1	005	18	Kabine	cabin	
X21:2	006	10	Kabine	cabin	
X21:3	006	10	Kabine	cabin	
X21:4	005	18	Kabine	cabin	
X21:5	005	17	Kabine	cabin	
X21:6	006	11	Kabine	cabin	
X21:7	005	16	Kabine	cabin	
X21:8	006	11	Kabine	cabin	
X21:10	006	13	Kabine	cabin	
X21:11	006	13	Kabine	cabin	
X22:1	006	8	Kabine, Bel. vorn	cabin, illum. front	
X22:2	006	10	Kabine, Bel. vorn	cabin, illum. front	
X22:3	006	10	Kabine, Bel. vorn	cabin, illum. front	
X22:4	006	9	Kabine, Bel. vorn	cabin, illum. front	
X23:1	006	11	Kabine, Bel. hinten	cabin, illum. back	
X23:2	006	11	Kabine, Bel. hinten	cabin, illum. back	
X23:3	006	11	Kabine, Bel. hinten	cabin, illum. back	
X25:1	006	19	Klimaanlage	air conditioning	
X25:2	006	19	Klimaanlage	air conditioning	
X25:3	006	20	Klimaanlage	air conditioning	
X26:1	003	5	Linker Fahrhebel	left travel lever	
X26:2	003	7	Linker Fahrhebel	left travel lever	
X26:3	003	7	Linker Fahrhebel	left travel lever	
X26:4	003	2	Linker Fahrhebel	left travel lever	
X27:1	003	5	Linker Fahrhebel	left travel lever	
X27:3	003	5	Linker Fahrhebel	left travel lever	
X28:1	003	4	Rechter Fahrhebel	right travel lever	
X28:2	003	6	Rechter Fahrhebel	right travel lever	
X28:3	003	6	Rechter Fahrhebel	right travel lever	
X28:4	003	3	Rechter Fahrhebel	right travel lever	
X29:1	003	5	Rechter Fahrhebel	right travel lever	
X29:3	003	5	Rechter Fahrhebel	right travel lever	
X31:1	002	10	Generator	generator	
X31:2	002	10	Generator	generator	
X32:12	004	7	Elektrokasten	Cross-bonding box	
X32:13	004	9	Elektrokasten	Cross-bonding box	
X33:1	003	16	an Y16/Y17	to Y16/Y17	
X33:2	003	16	an Y16/Y17	to Y16/Y17	
X33:3	003	18	an Y16/Y17	to Y16/Y17	
X33:4	003	18	an Y16/Y17	to Y16/Y17	
X34:10	004	6	Elektrokasten	Cross-bonding box	
X34:11	004	8	Elektrokasten	Cross-bonding box	
X35:25	002	11	Elektrokasten	Cross-bonding box	
X35:26	002	11	Elektrokasten	Cross-bonding box	
X36:1	005	5	Elektrokasten	Cross-bonding box	
X36:2	005	5	Elektrokasten	Cross-bonding box	
X37:3	005	3	Elektrokasten	Cross-bonding box	
X37:4	006	2	Elektrokasten	Cross-bonding box	
X38:5	003	4	Elektrokasten	Cross-bonding box	
X39:6	002	12	Elektrokasten	Cross-bonding box	
X40:9	004	4	Elektrokasten	Cross-bonding box	
X41:1	002	12	Zündstartschalter	ignition switch	
X42:71	003	13	Elektrokasten	Cross-bonding box	
X43:1	004	10	Elektrokasten	Cross-bonding box	
X43:2	004	10	Elektrokasten	Cross-bonding box	
X43:3	004	10	Elektrokasten	Cross-bonding box	
X43:4	004	11	Elektrokasten	Cross-bonding box	
X43:5	004	11	Elektrokasten	Cross-bonding box	
X43:6	004	12	Elektrokasten	Cross-bonding box	
X43:7	004	13	Elektrokasten	Cross-bonding box	
X43:8	004	9	Elektrokasten	Cross-bonding box	
X44:9	004	6	Elektrokasten	Cross-bonding box	
X44:10	004	6	Elektrokasten	Cross-bonding box	
X44:11	004	8	Elektrokasten	Cross-bonding box	
X44:12	004	7	Elektrokasten	Cross-bonding box	
X44:13	004	9	Elektrokasten	Cross-bonding box	
X44:14	004	7	Elektrokasten	Cross-bonding box	
X44:15	004	6	Elektrokasten	Cross-bonding box	
X44:16	004	4	Elektrokasten	Cross-bonding box	
X45:5	002	14	Zündstartschalter	ignition switch	
X45:6	002	14	Zündstartschalter	ignition switch	
X45:7	002	12	Zündstartschalter	ignition switch	
X46:7	004	13	Elektrokasten	Cross-bonding box	
X56:A	006	7	3pol Deutsch	3pol Deutsch	
X56:B	006	6	3pol Deutsch	3pol Deutsch	
X56:C	006	6	3pol Deutsch	3pol Deutsch	
X57:1	006	5	Elektrokasten	Cross-bonding box	
X57:2	006	5	Elektrokasten	Cross-bonding box	
X100:31-	002	1	NATO Steckdose	NATO socket	
X100:30+	002	4	NATO Steckdose	NATO socket	
X101:1	002	1	Deutsch 2pol	Deutsch 2pol	
X101:2	002	1	Deutsch 2pol	Deutsch 2pol	
X103:+12V	002	5	Modul A82	Modul A82	
X103:+24V	002	4	Modul A82	Modul A82	
X103:+H83	002	1	Modul A82	Modul A82	
X103:-	002	4	Modul A82	Modul A82	
X:55	006	7	Elektrokasten	Cross-bonding box	
Y03	003	11	Magnetventil Fahrstufenumschaltung	Solenoid valve, speed range selector	
Y04	002	17	Magnetventil Bremse	Solenoid valve, brake	30W
Y13	002	14	Hubmagnet Motor	Shut off solenoid, engine	12W
Y15	006	20	Magnetkupplung Klimakompressor	Magnetic clutch, air conditioning compr.	45W
Y16	003	16	Magnetventil Fahrtrichtung vorwaerts	Solenoid valve, travel direction forw.	
Y17	003	18	Magnetventil Fahrtrichtung rueckwaerts	Solenoid valve, travel direction backw.	
Y130	003	13	Magnetventil Fahrstufenumschaltung	Solenoid valve, speed range selector	

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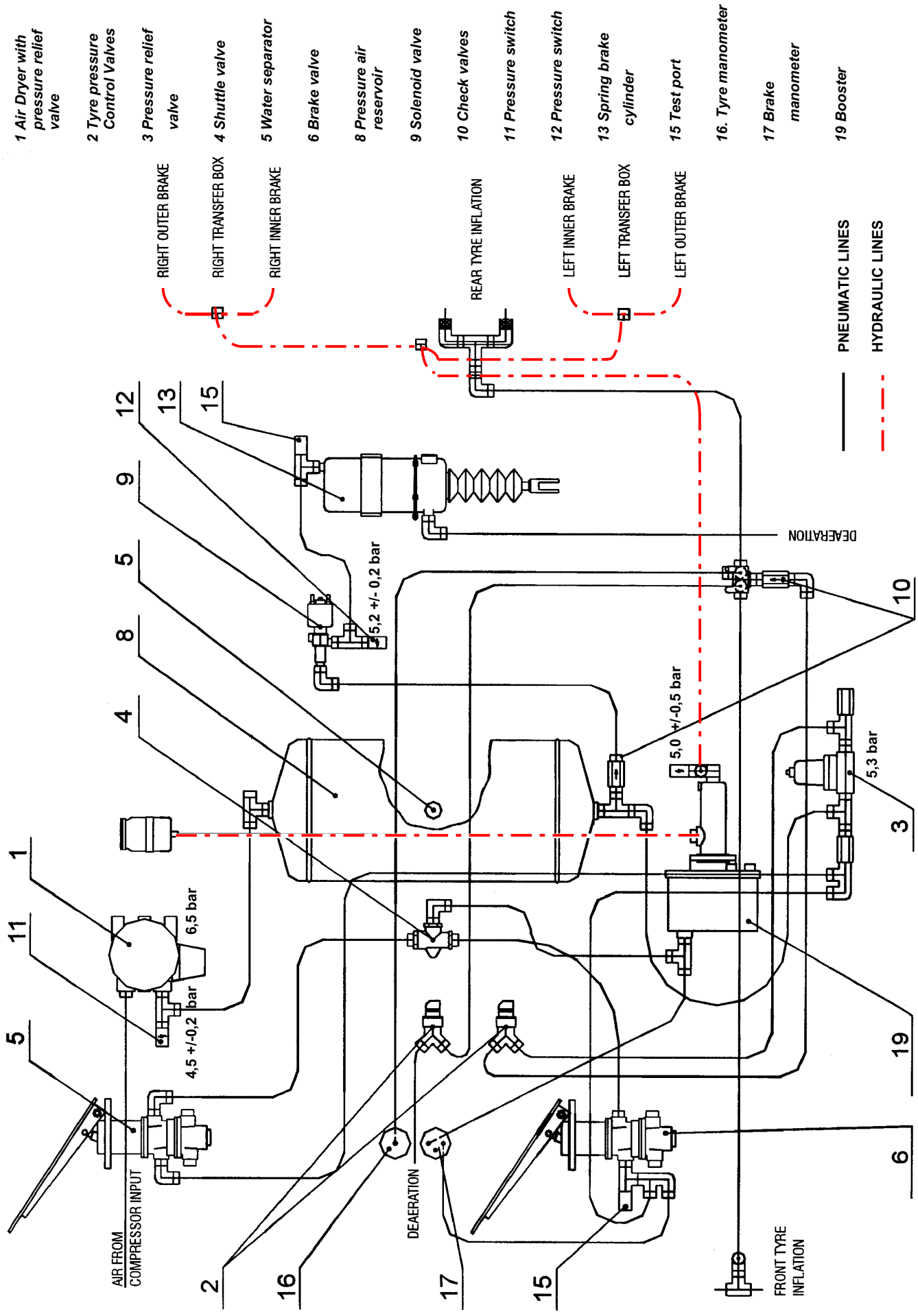
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7.2 Pneumatic diagram

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8 Supplement to circuit diagram

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8.1 Control elements in circuit diagram

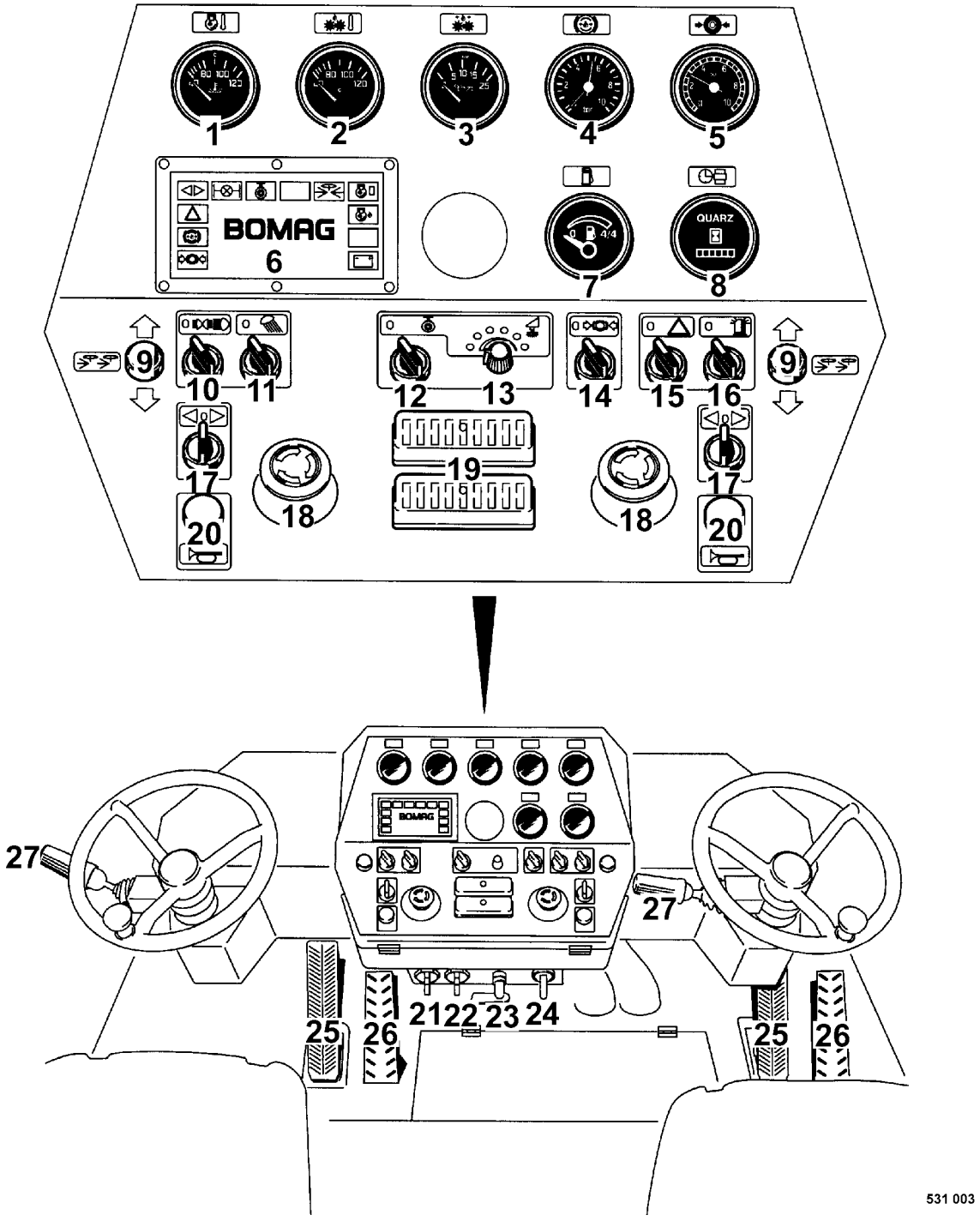


Fig. 28

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Pos.	Designation in circuit diagram	Designation in circuit diagram
1	P14 / E02	Gauge, coolant temperature / illumination
2	P24	Gauge, transmission oil temperature
3	P25 / E45	Gauge, transmission oil pressure / illumination
4	E62	Illumination, brake pressure gauge
5	E61	Illumination, tire pressure gauge
6	A15	Monitoring board
7	P01 / E01	Tank gauge / illumination
8	P00	Operating hour meter
9	H61 / H62	Control light steering, right / left
10	S15	Light switch
11	S26	Switch for working lights, rear
12	S05	Switch for sprinkling system
13	A01	Sprinkling system interval switch
14	S111	Parking brake switch
15	A14	Hazard light switch
16	S38	Switch for flashing beacon
17	S17 / S18	Switch, indicators left / right
18	S125 / S126	Emergency stop switch, left / right
19	F01.... F41	Fuses
20	S141 / S03	Button for warning horn
23	S30	Battery disconnecting switch
24	S00	Start switch
27	S142 / S143	Travel lever, left / right

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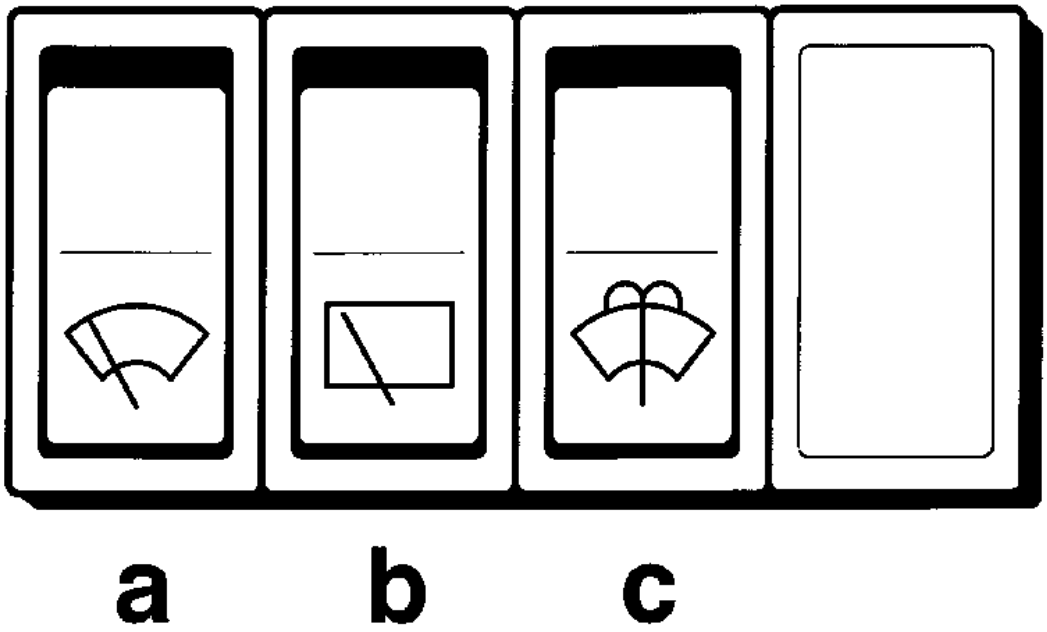


Fig. 29

Pos.	Designation in circuit diagram	Designation in circuit diagram
a	S20	Switch front windscreen wiper
b		Switch rear windscreen wiper
c	S145	Push button, windscreen wiper

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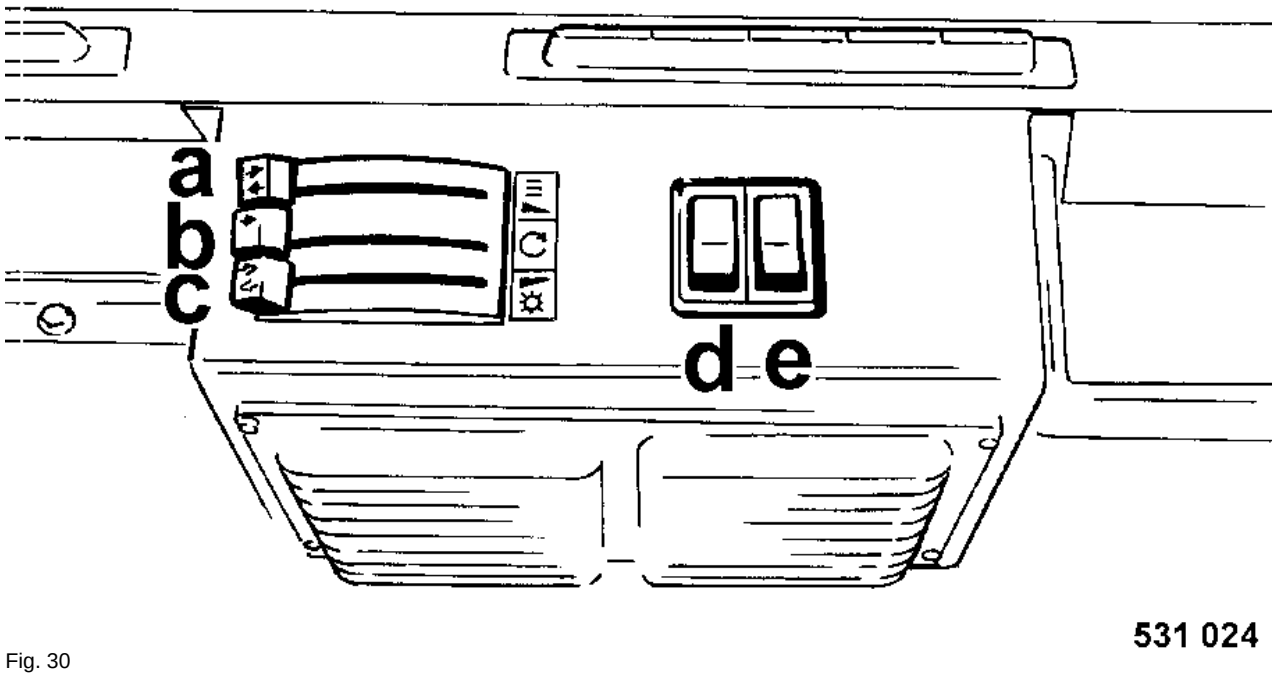


Fig. 30

Pos.	Designation in circuit diagram	Designation in circuit diagram
d	S44	Switch cabin fan
e	S102	Switch for air conditioning

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8.2 Monitoring module A15 in circuit diagram

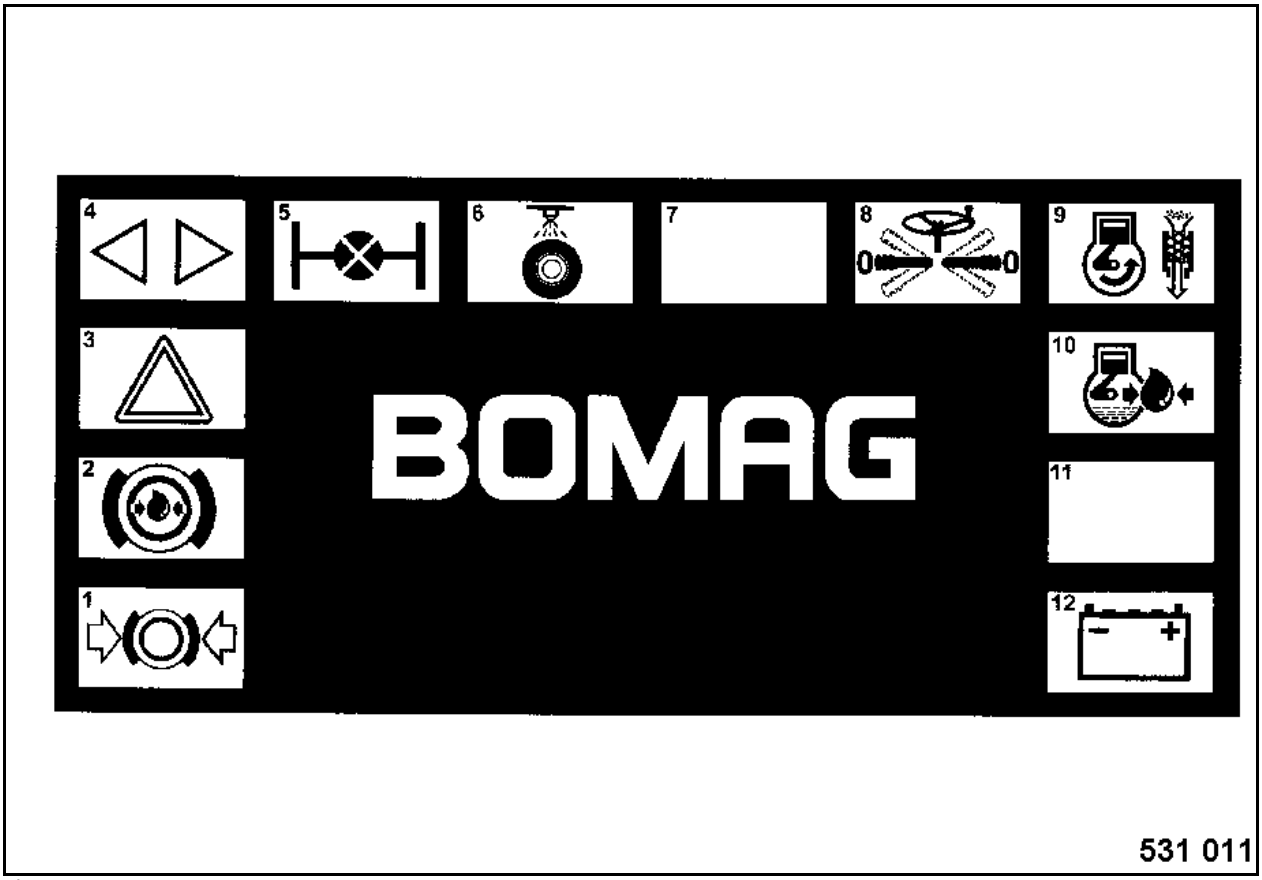


Fig. 31

Pos.	Designation in circuit diagram	Designation in circuit diagram
1	H01	Brake control light
2	H43	Brake pressure control light
3	H06	Hazard light control light
4	H05	Indicator control light
5	H59, not connected	Differential lock control light
6	H22	Sprinkler system control light
7		
8	H11	Control light, travel lever "0"-position
9	H15	Control light for engine air filter
10	H09	Engine oil pressure control light
11	not used	
12	H08	Charge control light

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