

Voith Turbo

VOITH

Troubleshooting DIWA .5

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1 General Information

1.1 Safety Instructions

General

Operation, maintenance and repair of the transmission are always subject to the relevant local safety regulations and accident prevention regulations.

These regulations may concern for instance safe handling of hazardous materials, provision and wearing of personal protection equipment or traffic regulations.

Any persons who operate the transmission or who are involved in installation, repair or maintenance must familiarize themselves with the warning notes and precautions described in this document.

Any person involved in operation, installation, repair or maintenance of the transmission must make sure that his or her own personal safety or the safety of other persons is not in danger.

State of the art

This transmission is designed and constructed according to the state of the art in technology and acknowledged safety regulations. Nevertheless, operation, installation, repair and maintenance of the transmission can lead to injury and death of persons or damages to the transmission and other material assets if:

- the transmission is put to a different use than intended,
- the transmission is operated, serviced or repaired by unqualified staff,
- the transmission is modified or reconstructed improperly and/or
- the safety instructions are not observed.

Intended use

The proper use of the DIWA transmission is its application as an automatic drive for busses.

Any use other than this is considered improper. Voith Turbo GmbH & Co. KG does not assume any liability for improper use. The risk lies solely with the user in that case.

The persons in charge, in particular the staff engaged in operation and maintenance, must by all means heed the guidelines for proper and correct usage of the transmission.

Conditions for use

The transmission may be operated only:

- in technically flawless condition,
- for its intended purpose,
- with respect to the safety instructions and the dangers involved and in compliance with the technical manual and other technical documents.

Faults that impair safety must be eliminated at once.

Qualification of personnel

Work on the transmission may only be carried out by staff that is properly trained, instructed and authorized by the operator. The legal minimum age must be observed.

Maintenance and repair require special knowledge and training (e.g. a Voith repair training) and have to be carried out by trained and qualified personnel only.

Personnel that is being trained, instructed, broken in or is currently undergoing a general education may work on the transmission only under the permanent supervision of a person assigned to this purpose.

Responsibilities

The responsibilities of the personnel working at the transmission must be clearly defined and complied with.

Only such personnel as is explicitly ordered to do so may work on the transmission.

Work on the chassis, brakes or steering systems may only be conducted by accordingly qualified personnel.

Unsafe instructions

The personnel working on the transmission must refuse to carry out unsafe instructions given by third persons.

Lifting devices

Use appropriate and technically flawless lifting devices as well as load carrying devices with sufficient load-carrying capacity only.

When replacing the transmission, assemblies or individual parts, these must be carefully attached to lifting devices and secured in a way that excludes any danger.

Never stay or work under suspended loads.

Risk of burns

The oil can become very hot - in extreme cases up to 130 °C.

Improper handling may cause skin burns.

Therefore, allow the transmission to cool down to approx. 60 °C before changing the oil.

Other accident hazards caused by oil

Oil escaping from pipes, seals or O-rings that were improperly installed or are leaking after prolonged running time may cause accidents.

The hydraulic oil in pipes, channels and in the converter can be under high pressure.

Switch off the driving engine before starting maintenance or repair work.

Spare parts

Use only original spare parts for repairs since they only can guarantee that the transmission will comply with the road safety regulations and the technical state upon delivery.

When replacing parts, it is crucial to observe the notes in the spare parts catalogue.

Original spare parts are specially designed for the Voith transmission. Please bear in mind that any parts other than the original spare parts as delivered by Voith have not been tested and released by us. The installation and use of such non-original spare parts may negatively affect the transmission's properties as given by its construction and therefore impair the safety.

Voith does not assume any liability for damages caused by the use of non-original spare parts.

Working on the transmission

Before starting maintenance or inspection at the installed transmission and during installation and removal of the transmission the engine of the bus must be secured against being started.

Before starting maintenance or inspection at the installed transmission and during installation and removal of the transmission the bus must be secured such that it cannot be put in motion, neither deliberately nor accidentally (slope!).

Carry out the prescribed service tasks in regular intervals, timely and using the appropriate operating materials.

The work must be performed in accordance with Voith provisions, e.g. the customer service information that describes improvements and modifications of the transmission to prevent that parts and tools are damaged.

Performing work on the transmission requires a suitable workshop equipment.

After you have worked on the transmission, check all transmission oil lines for leaks, loose connections, chafing and damage. Remove any defects at once.

After you have worked on the transmission, check all seals for leaks.

Retighten all screwed connections that were loosened during work on the transmission to the tightening torques indicated in the technical documents on the transmission.

Cleaning the transmission

Before cleaning the transmission with water or steam jet (high-pressure cleaner) or other cleaning agents, seal any openings into which no water, steam or cleaning agent must penetrate for reasons of safety and functioning.

After cleaning, remove all covers/adhesives completely.

Reconstruction or modification of the transmission

Modifications, attachments or reconstruction to the transmission may not be implemented without approval from Voith Turbo GmbH & Co. KG.

Disposal

Fluids and auxiliary substances (e.g. used oil) and disassembled parts must be disposed of in a safe and environmentally sound manner.

The local regulations and laws on environmental protection and disposal of hazardous materials must be observed.

Towing

Shift transmission to neutral (button N).

Unplug connecting cable between control unit and transmission at the control unit.

If transmission is damaged: Dismantle cardan shaft or stub shaft of rear axle.

If no transmission damage is detected, the vehicle can also be towed with the cardan shaft:

- Max. permissible distance: 10 km
- Max. permissible speed: 30 km/h.

For transmissions with angle drives it is in any case necessary to remove the cardan shaft or stub shaft of the rear axle.

1.2 Signs

	 DANGER DANGER points out an imminent danger to the life and health of persons. If this note is ignored, serious damage to the health and even life-threatening injuries will be the result.
	 WARNING WARNING points out a possible danger to the life and health of persons. If this note is ignored, serious damage to the health and even life-threatening injuries can be the result.
	 CAUTION CAUTION points out a potentially dangerous situation. If this note is ignored, minor injuries or property damage can be the result.
	NOTE Note points out information on proper handling of the transmission. This symbol does not highlight dangerous situations.

	ENVIRONMENT
	Environment points out a potentially harmful situation for the environment owing to operation, maintenance or repair of the transmission.

➔ Means: An activity to be performed.

↩ Means: The result of an activity.

□ Means: Please observe.

2 Transmission Type and Configuration

DIWA - transmission D 864.5 - C 3V T0 R0 W21

Designation	Alternatives	Meaning
DIWA		Bus transmission type "DIWA"
D 864.5	D 854.5	Transmission generation ".5" The transmissions D 864 are generally designed for higher engine output than the transmissions D 854. The last digit before "." (e.g. D 864.5) indicates the number of gears: "4": 4-speed drive
C	D	Drive cover
3	4	Transmission of the input differential: Diff. 3 yields a transmission of 1.43 in 2nd gear, of 1 in 3rd gear, of 0.7 in 4th gear; Diff. 4 yields a transmission of 1.36 in 2nd gear, of 1 in 3rd gear, of 0.735 in 4th gear
V	H, X	Impeller
T0	T2	Turbine
R0	R2	Reverse gear transmission / transmission ratio between output speed n_2 and turbine speed n_{Turbine} :
W21	W18, W22	Output-end angle drive

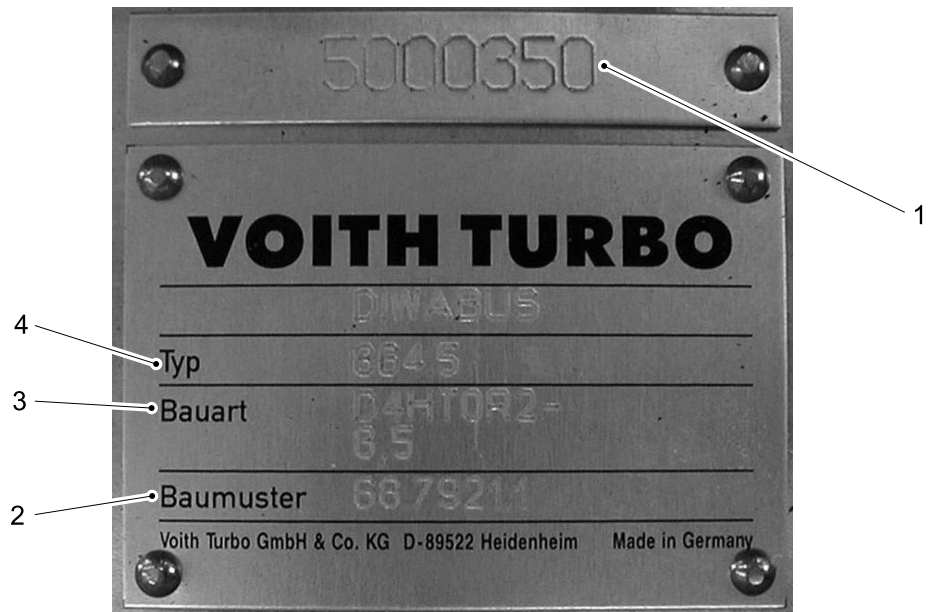
Rating plate

Fig. 1 DIWA .5 rating plate: 1 – Transmission number, 2 – Model, 3 – Configuration, 4 – Transmission type

3 Approach

Faults can occur:

- in the data record of the control unit
- in the electrical part of electro-mechanical components
- in the mechanical part of electro-mechanical components
- in purely mechanical components.

ALADIN (AnaLysis And Diagnostic Network) is the diagnostic software for detecting electrical faults in the transmission. ALADIN displays faults and offers help for troubleshooting.

The chapter "Faults" [⇒ Page 11] contains information on mechanical faults that ALADIN can not detect and information on how to eliminate them.

4 Faults

4.1 During the Start

Description

The vehicle does not set off although:

- a gear is engaged,
- the parking brake was released,
- the accelerator pedal is applied.

The engine revs up to maximum speed while the vehicle is standing still.

Possible cause

EK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipe to EK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

EK disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.2 Starting in Reverse Gear

Description

The vehicle does not reverse although:

- the reverse gear is engaged,
- the parking brake was released,
- the accelerator pedal is applied.

No fault starting forward.

Possible cause

WP solenoid valve

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

Pipe to WP solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Converter inlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Breather valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Converter outlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

RBG solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBG solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RBK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

WR solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to WR solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Converter leaky

- ➔ Dismantle the transmission.
- ➔ Replace all sealings.
- ➔ Reassemble the transmission.

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.3 Shifting Jerk

Description

There is a jerk when a gear is engaged.

Possible cause

EK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipe to EK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

EK disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

4.4 Poor Acceleration in All Gears

Possible cause

Shift program

The shift program is inappropriate for the service conditions.

- ➔ Contact vehicle manufacturer and/or Voith.

4.5 Poor Acceleration in First Gear

Possible cause

TB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to TB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

TB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

WR solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to WR solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.6 Vehicle Drives in First Gear Only

Possible cause

Gear selector switch

Pushbutton 1 depressed.

- ➔ Press button D.

PB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to PB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

PB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.7 No Traction in Second Gear

Possible cause

PB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to PB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

PB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

TB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to TB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

TB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.8 Vehicle Drives in First and Second Gear Only

Possible cause

Gear selector switch

Pushbutton 2 depressed.

- ➔ Press button D.

DK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to DK solenoid valve

Pipes are dirty or interrupted.

→ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .

□ $p_{ATarget} \geq 3.5 \text{ bar}$

→ Check the pipes.

→ Clean the pipes if necessary.

DK disks

The disks are damaged.

→ Check the disks.

→ Replace the disks if necessary (see Repair Manual).

4.9 No Traction in Third Gear

Possible cause

DK solenoid valve

The solenoid valve is defective.

→ Check the solenoid valve.

→ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

→ Dismantle the solenoid valve.

→ Check the solenoid valve.

→ Clean the solenoid valve if necessary.

Pipes to DK solenoid valve

Pipes are dirty or interrupted.

→ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .

□ $p_{ATarget} \geq 3.5 \text{ bar}$

→ Check the pipes.

→ Clean the pipes if necessary.

DK disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.10 Vehicle Drives in First, Second and Third Gear Only

Possible cause

Gear selector switch

Pushbutton 3 depressed.

- ➔ Press button D.

SK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to SK solenoid valve

Pipes are dirty or interrupted.

→ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .

□ $p_{ATarget} \geq 3.5 \text{ bar}$

→ Check the pipes.

→ Clean the pipes if necessary.

SK disks

The disks are damaged.

→ Check the disks.

→ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

→ Check the working pressure [⇒ Page 39] .

→ Readjust the working pressure if necessary.

4.11 No Traction in Fourth Gear

Possible cause

SK solenoid valve

The solenoid valve is defective.

→ Check the solenoid valve.

→ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

→ Dismantle the solenoid valve.

→ Check the solenoid valve.

→ Clean the solenoid valve if necessary.

Pipes to SK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

SK disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

Working pressure

The working pressure is too low.

- ➔ Check the working pressure [⇒ Page 39] .
- ➔ Readjust the working pressure if necessary.

4.12 Engine Stalls in Reverse Gear

Possible cause

Converter outlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

WP solenoid valve

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

Pipe to WP solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

4.13 No Retarder Operation

Possible cause

PB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to PB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

PB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

WP solenoid valve

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

Pipe to WP solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
 - ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RBG solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBG solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RBK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

TB solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to TB solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

TB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

4.14 Hard Retarder Activation in First, Second and Third Gear

Possible cause

WP solenoid valve

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

Pipe to WP solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Converter inlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Breather valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Converter outlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

RBG solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBG solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Pipes to RBK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ❑ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RBK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

RB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

4.15 Brake Power in Second, Third and Fourth Gear Too High

Possible cause

Converter outlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

4.16 Brake Power Too Low

Possible cause

WR solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to WR solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

Converter inlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Converter outlet valve

The solenoid valve is sluggish or jammed.

- ➔ Check the valve.
- ➔ Repair or replace the solenoid valve if necessary.

Converter leaky

- ➔ Dismantle the transmission.
- ➔ Replace all sealings.
- ➔ Reassemble the transmission.

4.17 Brake Power in First Gear Too Low or Too High

Possible cause

RBG solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBG solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
 - ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RBK solenoid valve

The solenoid valve is defective.

- ➔ Check the solenoid valve.
- ➔ Repair or replace [⇒ Page 47] the solenoid valve if necessary.

The solenoid valve is sluggish or jammed because it is dirty.

- ➔ Dismantle the solenoid valve.
- ➔ Check the solenoid valve.
- ➔ Clean the solenoid valve if necessary.

Pipes to RBK solenoid valve

Pipes are dirty or interrupted.

- ➔ Check the oil pressure at the test port of the measuring cover [⇒ Page 39] .
- ☐ $p_{ATarget} \geq 3.5 \text{ bar}$
- ➔ Check the pipes.
- ➔ Clean the pipes if necessary.

RB disks

The disks are damaged.

- ➔ Check the disks.
- ➔ Replace the disks if necessary (see Repair Manual).

5 Measurement and Test

5.1 Measuring the stall point

- ➔ Apply the parking brake.
- ➔ Start the engine.
- ❑ The engine must have operating temperature.
- ➔ Press one of the buttons "1", "2", "3" or "D".
- ↩ A forward gear is engaged.
- ➔ Depress the accelerator pedal to full load and let the engine run at full speed for max. 15 seconds.



NOTE

Engine run-up time

Good engine run-up times are between 5 and 8 s. A run-up time of more than 10 s is a sign of poor engine run-up.

- ➔ Contact the vehicle or engine manufacturer in such cases.

- ➔ Read off maximum engine speed n_1 (= stall speed) on the vehicle's tachometer.

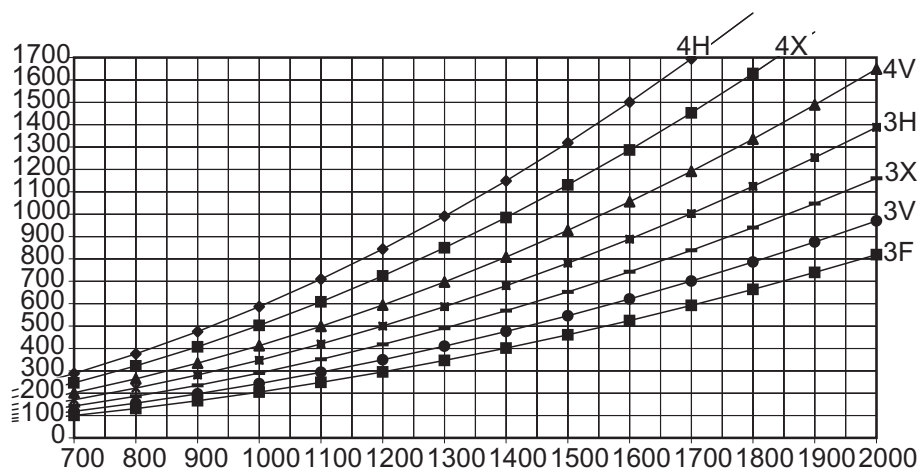


Fig. 2 Pump characteristic diagram (to the right: engine speed n_1 [1/min]; upwards: engine torque M [Nm]).

- ➔ The differential used in the transmission and the pump version are indicated on the type plate [⇒ Page 8] .
- ❑ The possible combinations of input differential and impeller range from "4H" to "3F".
- ➔ Enter the measured maximum engine speed n_1 in the pump characteristic diagram.
- 🔍 Read off the maximum possible engine torque on the pump characteristic diagram while the bus is standing still.
- ➔ Check whether the determined engine torque complies with the specifications made by the vehicle manufacturer.

	NOTE
	Engine torque at vehicle standstill The torque of the stationary vehicle can significantly deviate from the maximum engine torque while driving since the electronic engine control in standstill may limit the engine output to a certain value. ➔ Ask the vehicle manufacturer.

If the determined engine torque is **greater** than the value indicated by the manufacturer:

- ➔ Check whether the correct impeller as specified by the type plate is installed.
- ➔ Check the converter pressure [⇒ Page 39] .

If the determined engine torque is **smaller** than the value indicated by the manufacturer:

- ➔ Check whether the correct impeller as specified by the type plate is installed.
- ➔ Contact the vehicle or engine manufacturer.

5.2 Dismantling the Oil Pan

- ➔ Release the hex.-head nuts.
- ➔ Remove the hex.-head nuts and washers.



Fig. 3 1 - Oil pan 2. - Hex.-head nut

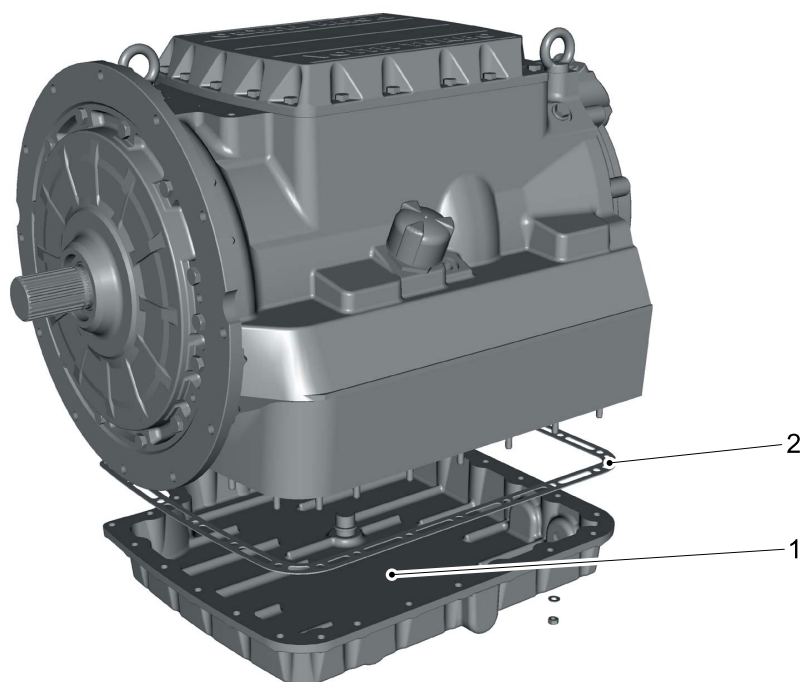


Fig. 4 Transmission with 1 - oil pan, 2 - gasket

	 CAUTION Risk of injury The oil pan can drop and cause injuries. ➔ Secure the oil pan against dropping before releasing the hex.-head nuts.
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- ➔ Remove the oil pain (1) via threaded bolts.
- ➔ Remove gasket (2).
- ❑ Use a new gasket when remounting the oil pan.

5.3 Pressure Measurement

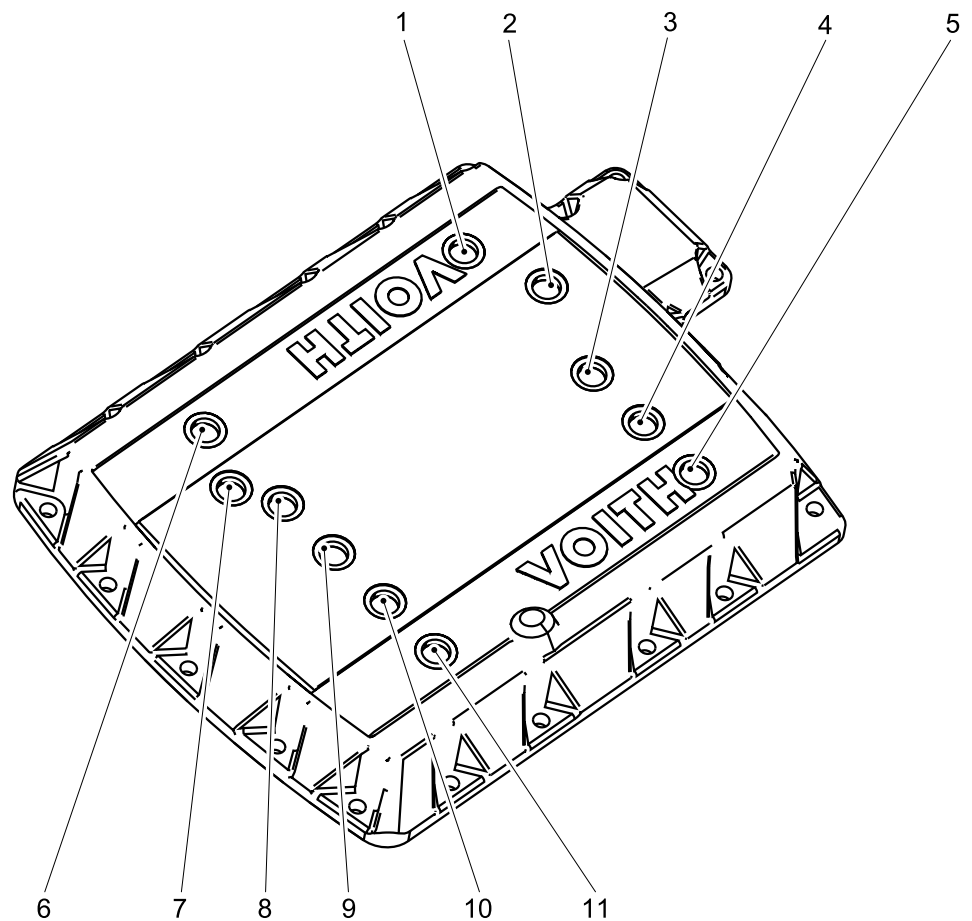


Fig. 5 Measuring cover

1	WR	7	Operating pressure
2	Converter pressure	8	DK
3	TB	9	EK
4	RG	10	PB
5	RK	11	WP
6	SK		

	 DANGER
	Risk of burning through hot oil If handled improperly, the hot oil can cause severe burns or scalding. ➔ Mount measuring cover only when the engine is dead. ➔ Connect pressure gauge only when the engine is dead.

Operating pressure

- ➔ Measure the operating pressure at measuring point 7 (see illustration)
- after shifting into the second gear,
- at an engine speed of approx. 1,500 1/min,
- at an oil temperature of 80-90°C.
- ☐ The setpoint for the operating pressure is $p_A = 8.5 \text{ bar}$. ($\pm 0.2 \text{ bar}$).
- ☐ If the operating pressure deviates from this value, it has to be readjusted. The operating pressure can deviate from the setpoint for instance after dismantling and reassembling the operating pressure valve.
- ☐ The adjustment bore in the housing allows turning the threaded pin at the operating pressure valve. The threaded pin adjusts the pre-tension of the spring in the working pressure valve.

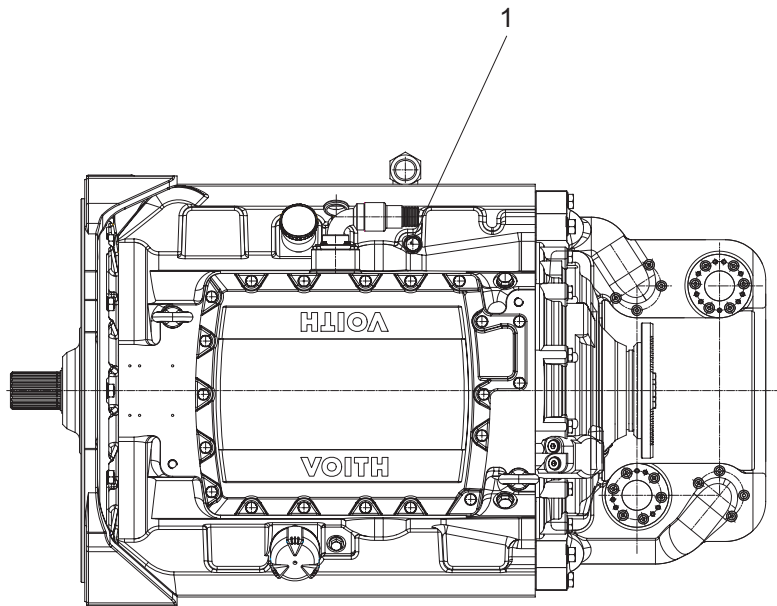


Fig. 6 1 - Adjustment bore

➔ Turn the threaded pin until a operating pressure of 8.5 bar is achieved.

If the operating pressure is below the setpoint and can not be readjusted to 8.5 bar, the gear pump may have shaken down.

➔ Check the gear pump and repair or replace it if necessary (see Repair Manual).

❑ The setpoint at engine idle (500 $\pm$ 50 1/min) is $p_A \geq 3.5$ bar.

➔ See illustration for measuring points.

Pressures at the solenoid valves

At the measuring points DK, EK, PB, WP and SK, the pressures must be identical to the working pressure.

	NOTE
	WR pressure The WR oil pressure is cycled and therefore variable over time. Its height depends on the operating status (braking or reversing). Therefore, a simple pressure measurement using a pressure gauge is not suitable for a more thorough troubleshooting of the WR valve.

	NOTE
	Exception RBK pressure The RBK pressure is 1 bar while braking in first gear. In a few applications the RBK pressure is max. 2 bar while braking in first gear .

Converter pressure

➔ Measure the converter pressure at measuring point 2.

❑ $P_w \geq 2 \text{ bar}$

- oil temperature t_{oil} 80-90 °C
- with forward gear engaged,
- engine at idle speed ($500 \pm 50 \text{ 1/min}$),
- and parking brake applied.

See illustration for measuring points.

If this value is not reached, the converter sealing must be improved.

❑ $P_w = 0 \text{ bar}$ when the converter filling control (CFC) is active.

5.4 Overview of Pipes

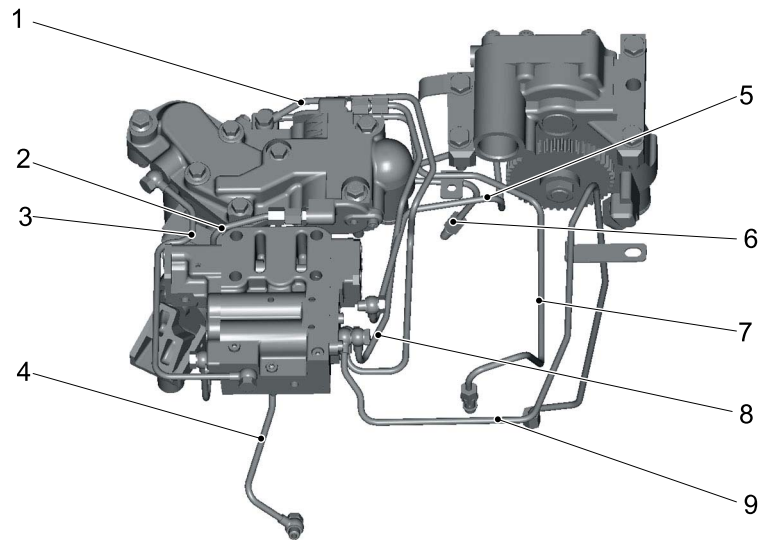


Fig. 7 Pipes

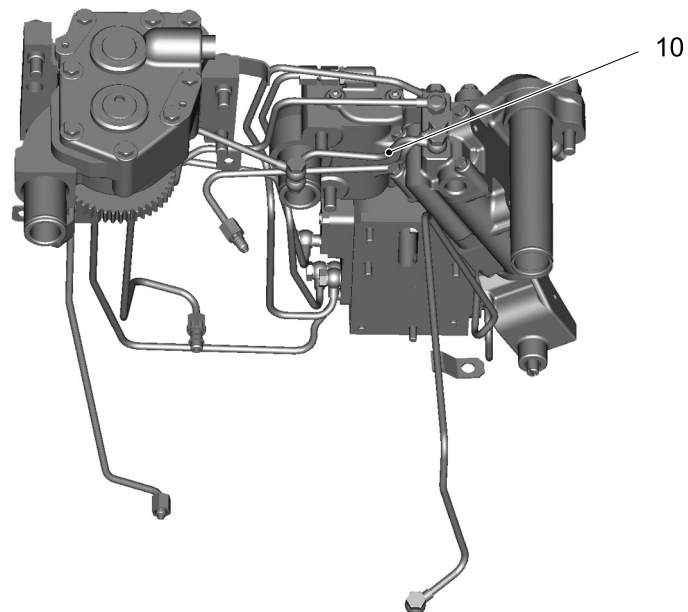


Fig. 8 Pipes

Ref. number	Designation	Item number
1	Pipe	H68.076310
2	Pipe	H68.076510
3	Pipe	H68.315210
4	Pipe	H68.315110
5	Pipe	H68.315810
6	Pipe	H68.076610
7	Pipe	H68.303410
8	Pipe	H68.076110
9	Pipe	H68.090811
10	Pipe	H68.315310

6 Troubleshooting

6.1 Dismounting the Control Cover

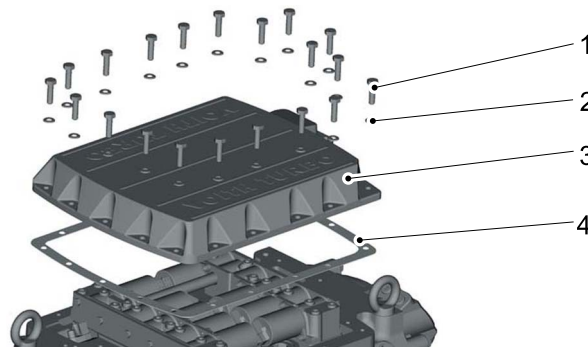


Fig. 9 Control cover

- ➔ Loosen the 20 screws (1) and remove them including washers (2).
- ➔ Remove the cover (3).
- ➔ Remove the gasket (4).

6.2 Removing the Control Blocks

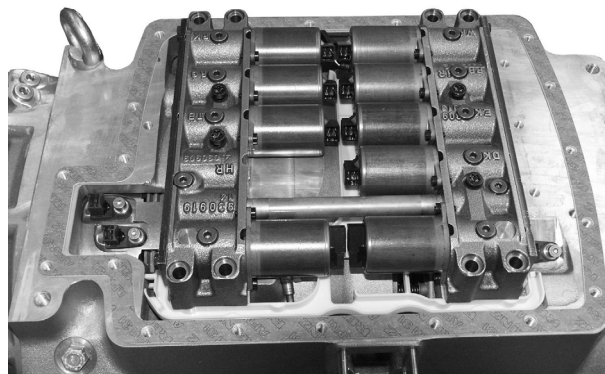


Fig. 10 Solenoid Valves - General View



Fig. 11 1 – Plug; 2 – Cable; 3 – Tool

➔ Unplug cable plug (1) from the solenoid coils.

❑ Special tool [⇒ Page 92]



CAUTION

The connection between plug and cable can be damaged.

When unplugging the cable plug (1), the connection between plug and cable (2) can be damaged.

➔ Use the special tool (3) to unplug the cable plug (1) from the solenoid coils.

➔ Never tug at the cables (2).

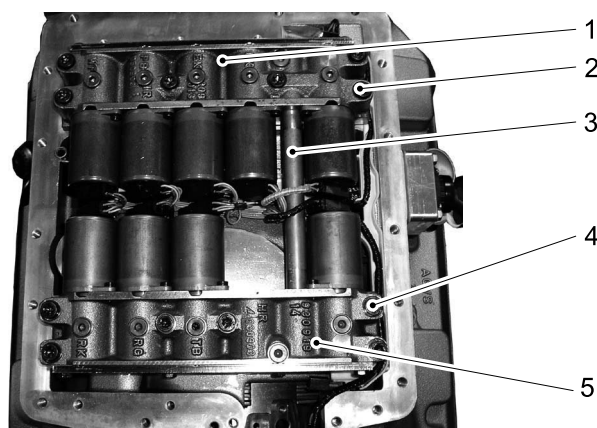


Fig. 12 1 – Control block; 2 – Screws; 3 – Connecting tube; 4 – Control block

➔ Unscrew and remove the 12 cap screws M8 (2).

➔ Detach the control blocks (1 and 4).

➔ Pull out the connecting tube (3).

6.3 Repairing the Control Blocks

Drive-end control block

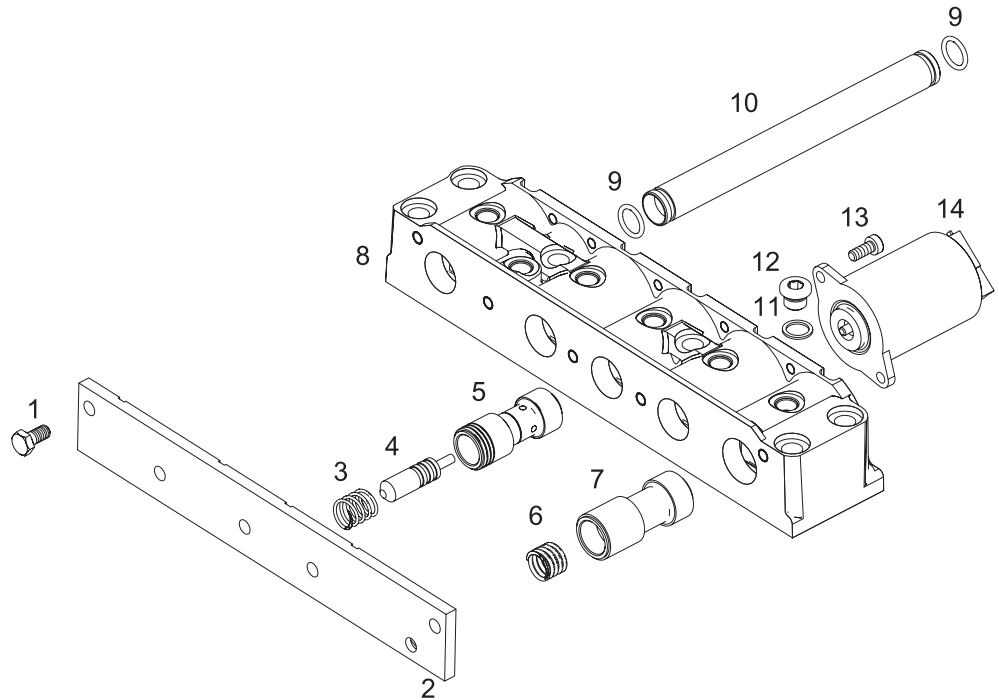


Fig. 13 Drive-end control block

Dismantling the drive-end control block

- ➔ Unscrew the 5 hex.-head screws (1) and remove the cover (2).
- ➔ Dismount 3 spools (5), 3 control pins (4) and 3 compression springs (3) out of housing (8).
- ➔ Unscrew all screw plugs M10 (12) and take them out together with the sealing rings (11).
- ❑ Otherwise the spools can not be dismantled.
- ➔ Remove spool (7) and compression spring (6).
- ➔ Unscrew the 8 hex.-head screws M 5x20-CV84 (13) and remove the solenoid coils (14).

Mounting the drive-end control block

- ➔ Use 8 cap screws M 5x20-CV84 (13) to tighten the 4 solenoid coils (14).
- ❑ Tightening torque 5 Nm
- ❑ The connections must be on top.
- ➔ Install spool (7) with compression spring (6).

- ➔ Install the 3 spools (5), 3 control pins (4) and 3 compression springs (3).
- ➔ Tighten the cover (2) using 5 hex.-head screws (1) M6x12-8.8.
- ❑ Tightening torque 9 Nm
- ➔ Screw in the screw plugs WP M10x1 (12) with new sealing rings (11).
- ❑ Tightening torque 15 Nm



NOTE

Mounting the spools

Improper installation of the spools may cause transmission malfunctions in operation.

- ➔ Make sure that the spools are mounted in the correct position and run smoothly.

Output-end control block

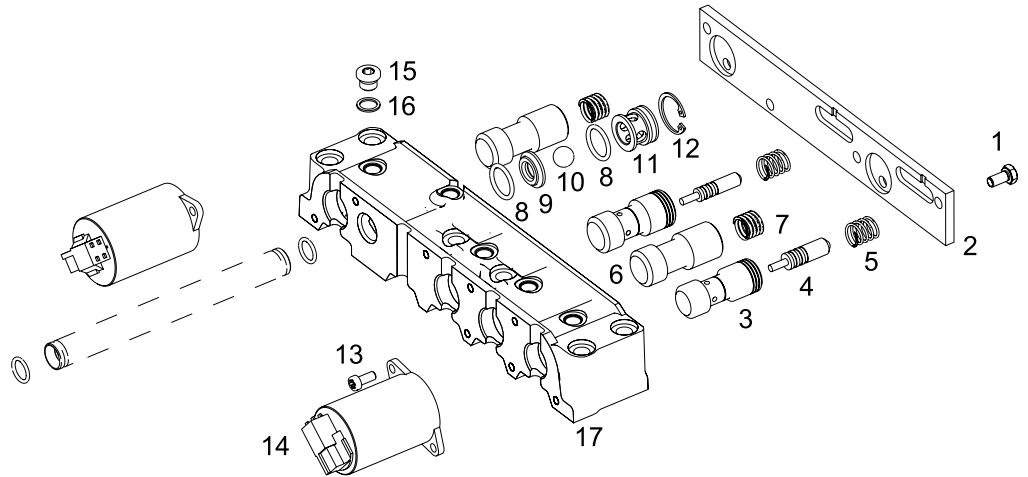


Fig. 14 Output-end control block

Dismantling the output-end control block

- ➔ Unscrew the 5 hex.-head screws (1) and remove the cover (2).
- ➔ Unscrew all screw plugs M10 (15) and take them out together with the sealing rings (16).
- ❑ Otherwise the spools can not be dismounted.
- ➔ Dismount the spools (3), control pins (4) and compression springs (5) out of the housing (17).
- ➔ Dismount the spools (6) and compression springs (7) out of the housing (17).
- ➔ Dismount the insert (8), O-rings (9), ball (10), valve body (11) and circlip (12).
- ➔ Unscrew the 10 hex.-head screws M 5x20 (13) and remove the solenoid coils (14).

Mounting the output-end control block

- ➔ Use 10 cap screws M 5x20-CV84 (13) to tighten the 5 solenoid coils (14).
- ❑ Tightening torque 5 Nm
- ❑ The connections must be on top.
- ➔ Install spool (6) with compression springs (7).
- ➔ Install spools (3), control pins (4) and compression springs (5).
- ➔ Install the insert (8), O-rings (9), ball (10), valve body (11) and circlip (12).
- ➔ Tighten the cover (2) using 5 hex.-head screws M6x12-8.8 (1).
- ❑ Tightening torque 9 Nm
- ➔ Screw in the screw plugs WP M10x1 (15) with new sealing rings (16).
- ❑ Tightening torque 15 Nm



NOTE

Mounting the spools

Improper installation of the spools may cause transmission malfunctions in operation.

➔ Make sure that the spools are mounted in the correct position and run smoothly.

6.4 Replacing the Speed Sensors

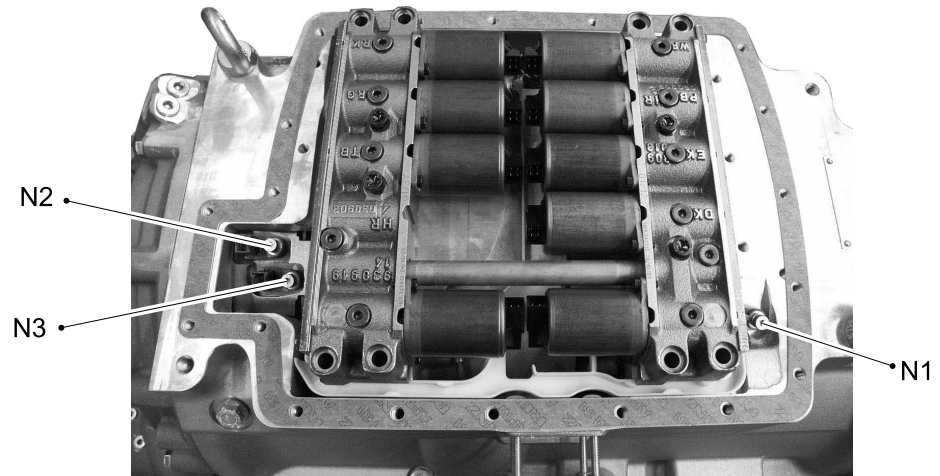


Fig. 15 N1, N2, N3 – speed sensors

Dismounting the speed sensors

- ➔ Detach the plug connection of the speed sensor to the cable harness.
- ➔ Unscrew the speed sensor.

Inserting the speed sensors

- ➔ Insert the new speed sensor.
- ➔ Tighten the speed sensor.
- Tightening torque 9 Nm
- ➔ Attach the plug connection of the speed sensor to the cable harness.

Layout of the speed sensors

- N1 [⇒ Page 57]
- N2 [⇒ Page 57]
- N3 [⇒ Page 58]

6.5 Replacing the temperature sensors

Removing the temperature sensors

- ➔ Detach the plug connection of the temperature sensor to the cable harness.
- ❑ Special tool [⇒ Page 94]
- ➔ Unscrew the temperature sensor.

Inserting the temperature sensors

- ➔ Insert the new temperature sensor.
- ➔ Tighten the temperature sensor.
- ❑ Tightening torque 20 Nm
- ➔ Attach the plug connection of the temperature sensor to the cable harness.
- ❑ Special tool [⇒ Page 94]

Layout of the temperature sensors

- Converter temperature sensor [⇒ Page 58]
- Oil sump temperature sensor [⇒ Page 59]

6.6 Removing the Wiring Harness



Fig. 16 1 - Tool, 2 - Plug at the solenoid coil

- ➔ Disconnect all connectors from the solenoid coils.
- ❑ Special tool [⇒ Page 92]

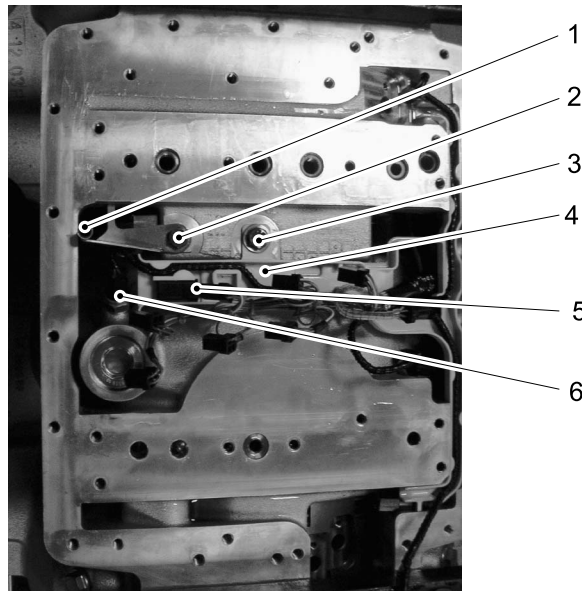


Fig. 17

- ➔ Unplug the connectors from the sensors N1 [⇒ Page 57] (1), N2 [⇒ Page 57] (7) and N3 [⇒ Page 58] (6).
- ➔ Detach the plug connection between the cable harness and the oil sump temperature sensor [⇒ Page 59] (4).
- ❑ Special tool [⇒ Page 94]
- ➔ Detach the plug connection between the cable harness and the converter temperature sensor [⇒ Page 58] (5).
- ➔ Unscrew the hex.-head screw (2).
- ➔ Remove the cable protecting sleeve (3).

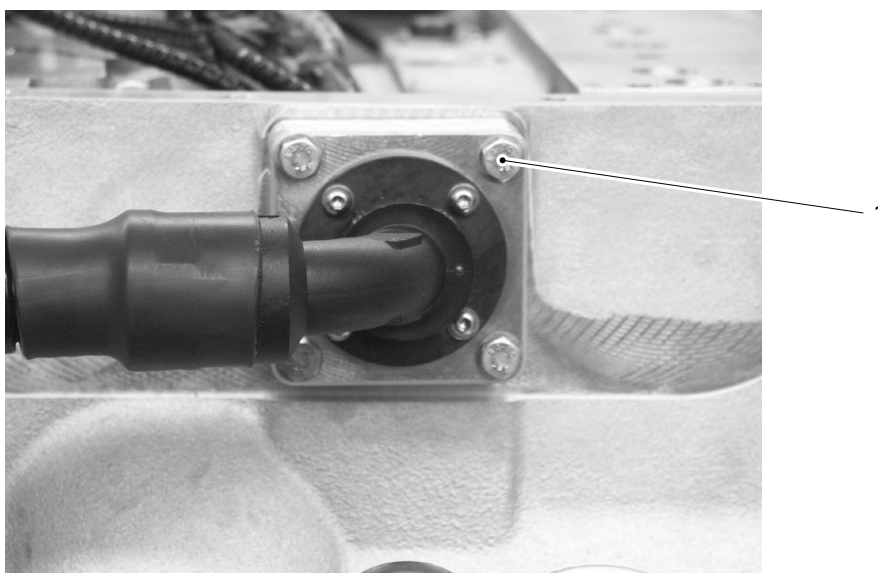


Fig. 18 1 - Cable harness screws

- ➔ Unscrew all 4 screws (1).
- ➔ Pull wiring harness carefully out of the transmission case.

6.7 Installing the Cable Harness

➔ Insert the new cable harness carefully through the bore in the transmission case.

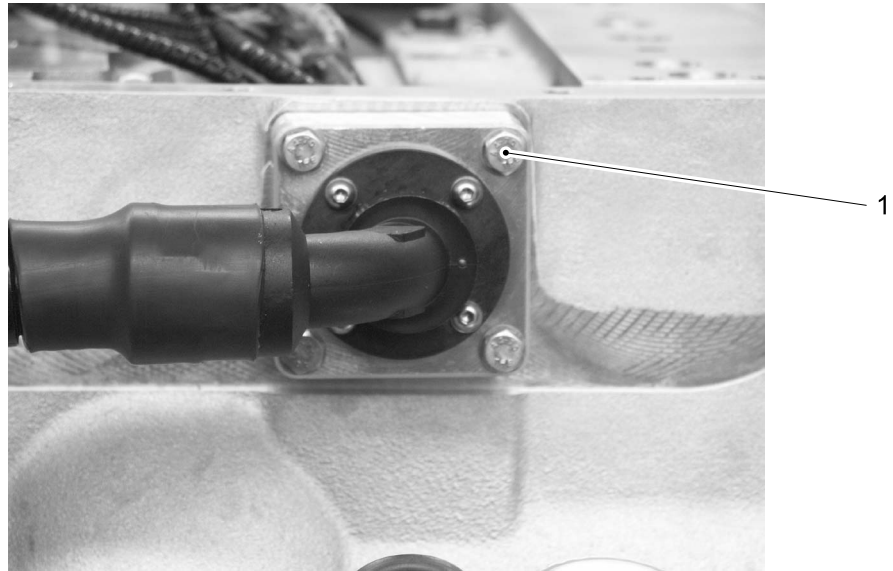


Fig. 19 1 - Cable harness screws

- ➔ Screw down the cable harness to the transmission case using the 4 screws (1).
- ❑ Tightening torque 9 Nm

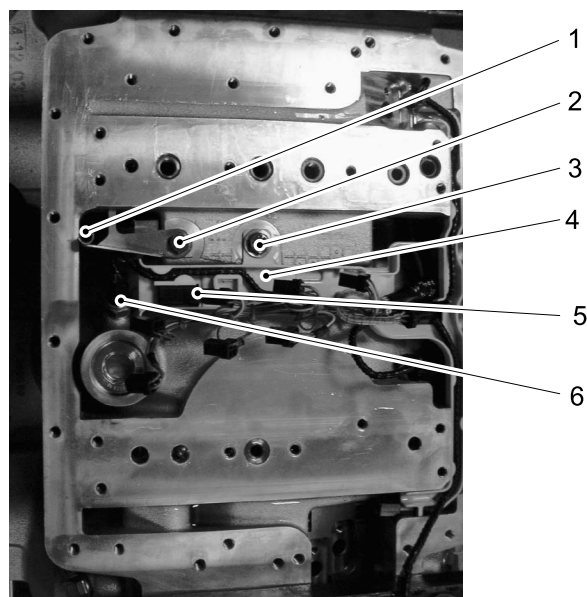


Fig. 20

- ➔ Insert the cable protecting sleeve (3).
- ➔ Insert and tighten the hex.-head screw (2).
- ❑ Tightening torque 23 Nm
- ➔ Fasten the plug connection between the cable harness and the converter temperature sensor [⇒ Page 58] (5).
- ➔ Fasten the plug connection between the cable harness and the oil sump temperature sensor [⇒ Page 59] (4).
- ❑ Special tool [⇒ Page 94]
- ➔ Fasten the connectors of the sensors N1 [⇒ Page 57] (1), N2 [⇒ Page 57] (7) and N3 [⇒ Page 58] (6).
- ➔ Insert all plugs of the solenoid coils.
- ❑ Special tool [⇒ Page 93]

7 Position of the Sensors

7.1 N1

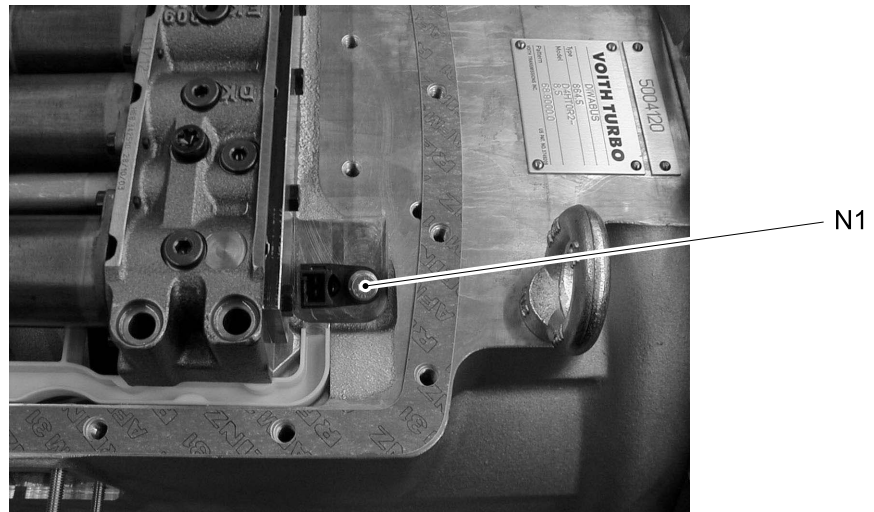


Fig. 21 N1 – speed sensor for N1

7.2 N2

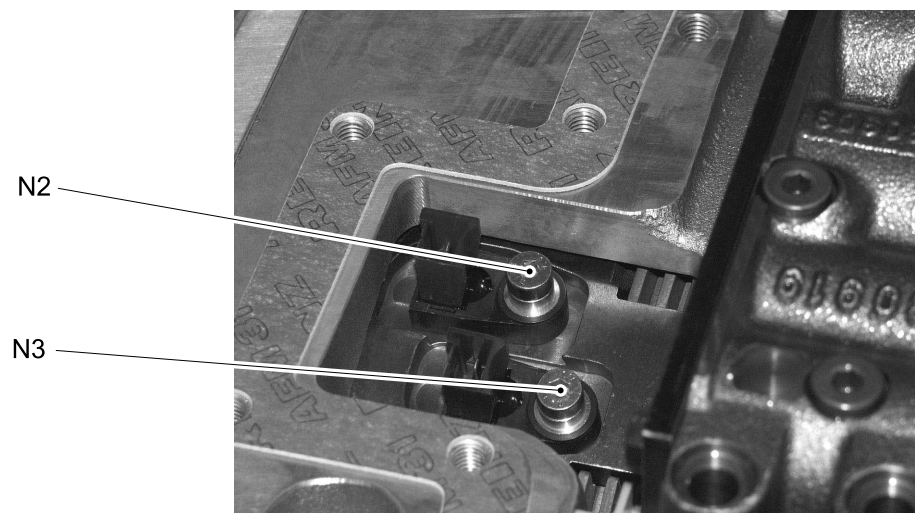


Fig. 22 N2 – speed sensor for N2

7.3 N3

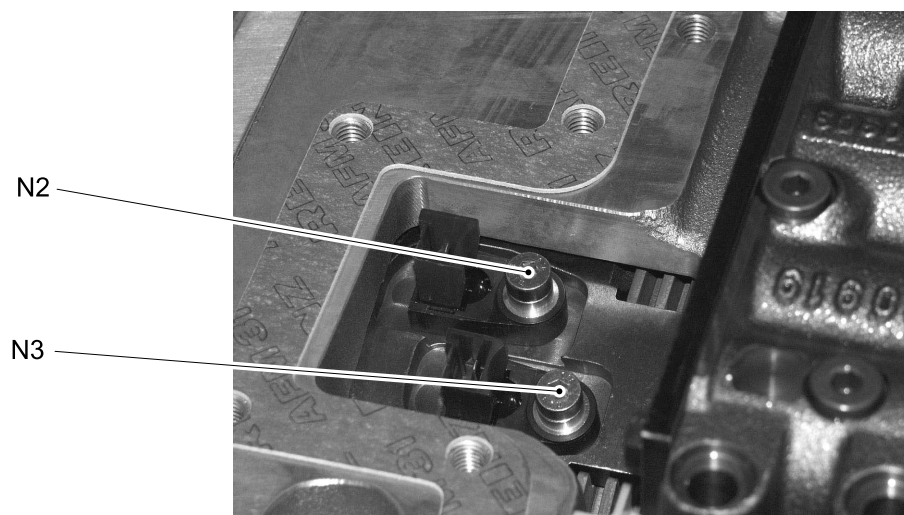


Fig. 23 N3 – speed sensor for N3

7.4 Converter Temperature Sensor

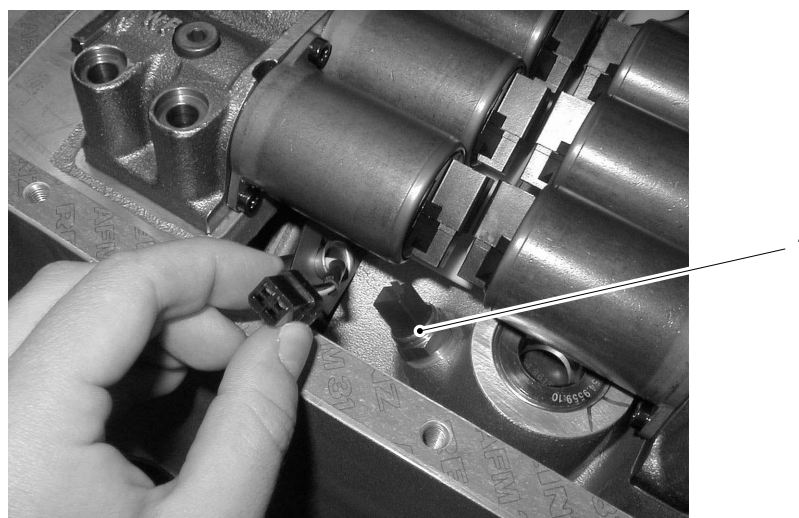


Fig. 24 1 - Converter temperature sensor

7.5 Oil Sump Temperature Sensor

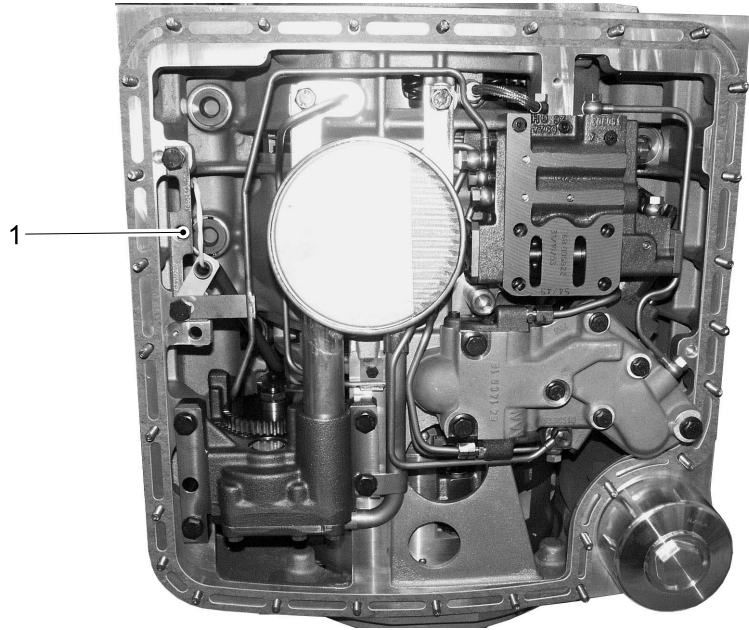


Fig. 25 Oil Sump Temperature Sensor

8 Hydraulic Control Scheme

Components

- Gear pump
- Working pressure valve
- Solenoid valves
 - Pressure-control solenoid valves (EK, DK, SK, PB, TB, RBK)
 - On/Off solenoid valves (WP, WR, RBG)
- Shuttle valve
- Converter outlet valve
- Converter inlet valve
- Breather valve

Gear pump

The gear pump transports the oil

- from the oil sump
- through the suction screen,
- the heat exchanger,
- the oil filter and
- the working pressure valve.

The oil is distributed from the working pressure valve

- to the lubricating system,
- to the control blocks with the electro-hydraulic control system,
- to the converter inlet valve.

The oil flows from the converter inlet valve

- to the transmission with converter,
- and from there to the converter outlet valve.

Working pressure valve

The working pressure valve keeps the oil pressure more or less constant for supplying the multi-disc brakes and clutches, irrespective of the gear pump speed. The working pressure is set by the pretension of the spool spring.

Solenoid valves

The solenoid valves in the control block are pressurized with working pressure.

The solenoid valves direct the oil from the working pressure valve (working pressure) or from the converter (converter pressure) to the pistons of the multi-disc brakes and clutches and to the converter outlet valve.

Converter and working pressure are present at the **shuttle valve**. The function of this valve is to release the higher of the two pressures to flow to the solenoid valves

- TB
- RGB
- RBK.

Converter outlet valve

The converter outlet valve provides for open-loop and closed-loop control of the converter pressure.

Converter inlet valve

The converter inlet valve reduces the converter pressure under certain operating conditions.

The **Converter Filling Control** closes the converter inlet valve thereby reducing the oil supply to the converter. In this condition, only a very small amount of oil is transported via a throttle port into the converter. Furthermore, air is induced to the oil fill of the converter via the opened breather valve.

The converter filling control's purpose is to enable and to improve activation of the converter brake even at high vehicle speeds in 3rd and 4th gear.

Overview

Figure	Shifting Function	EK	DK	SK	PB	TB	WP	WR	RBK	RBG
1	ANS activation					x		x	x ¹	
2	ANS activation via parking brake					x		x		
3	1st gear (DIWA drive range)	x				x		x		
4	Upshift 1st - 2nd gear	x			x					
5	2nd gear	x			x		x			
6	3rd gear		x		x		x			
7	4th gear			x	x		x			
8	Converter filling control CFC (3rd gear)		x		x					
9	Converter filling control CFC (4th gear)			x	x					
10	Activating converter brake via converter filling control CFC (4th gear)			x	x				x	
11	Activating converter brake via converter filling control CFC (3rd gear)		x		x				x	
12	1st braking stage (4th gear)			x	x		x		x	x
13	2nd and 3rd braking stage (4th gear)			x	x		x	x ²	x	x
14	2nd and 3rd braking stage (3rd gear)		x		x		x	x ²	x	x
15	2nd and 3rd braking stage (2nd gear)	x			x		x	x ²	x	x
16	Braking in 1st gear	x				x	x	x	x ¹	
17	Reverse gear up to 1 km/h	x						x	x	x
18	Reverse gear above 1 km/h	x					x	x ²	x	x

Figure	Shifting Function	EK	DK	SK	PB	TB	WP	WR	RBK	RBG
		1 = regulated valve, 2 = oscillated valve								

Activation of solenoid valves at different shifting states

Legend

Abbreviation	Meaning
A	Converter outlet valve COV
B	Converter inlet valve CIV
C	Working pressure valve WV
D	Control blocks with solenoid valves
E	DIWA transmission
F	Gear pump
G	Heat exchanger
H	Oil filter
1-6	Plunger of converter outlet valve
7	Plunger of converter inlet valve
8,9	Plunger of working pressure valve
10	Shuttle valve
11	Reverse gear brake RB
12	Turbine brake TB
13	Breather valve BV
14	Pump brake PB
15	Overdrive clutch SK
16	Lock-up clutch DK
17	Input clutch EK
EK	Control solenoid valve of input clutch
DK	Control solenoid valve of lock-up clutch
SK	Control solenoid valve of overdrive clutch
TB	Control solenoid valve of turbine brake

Abbreviation	Meaning
PB	Control solenoid valve of pump brake
WP	ON solenoid valve for the converter pressure via the COV
WR	Control solenoid valve for the converter pressure via the COV
RBK	Control solenoid valve of the reverse gear brake RB (small piston surface)
RBG	ON solenoid valve of the reverse gear brake RB (large piston surface)

8.1 Neutral Position

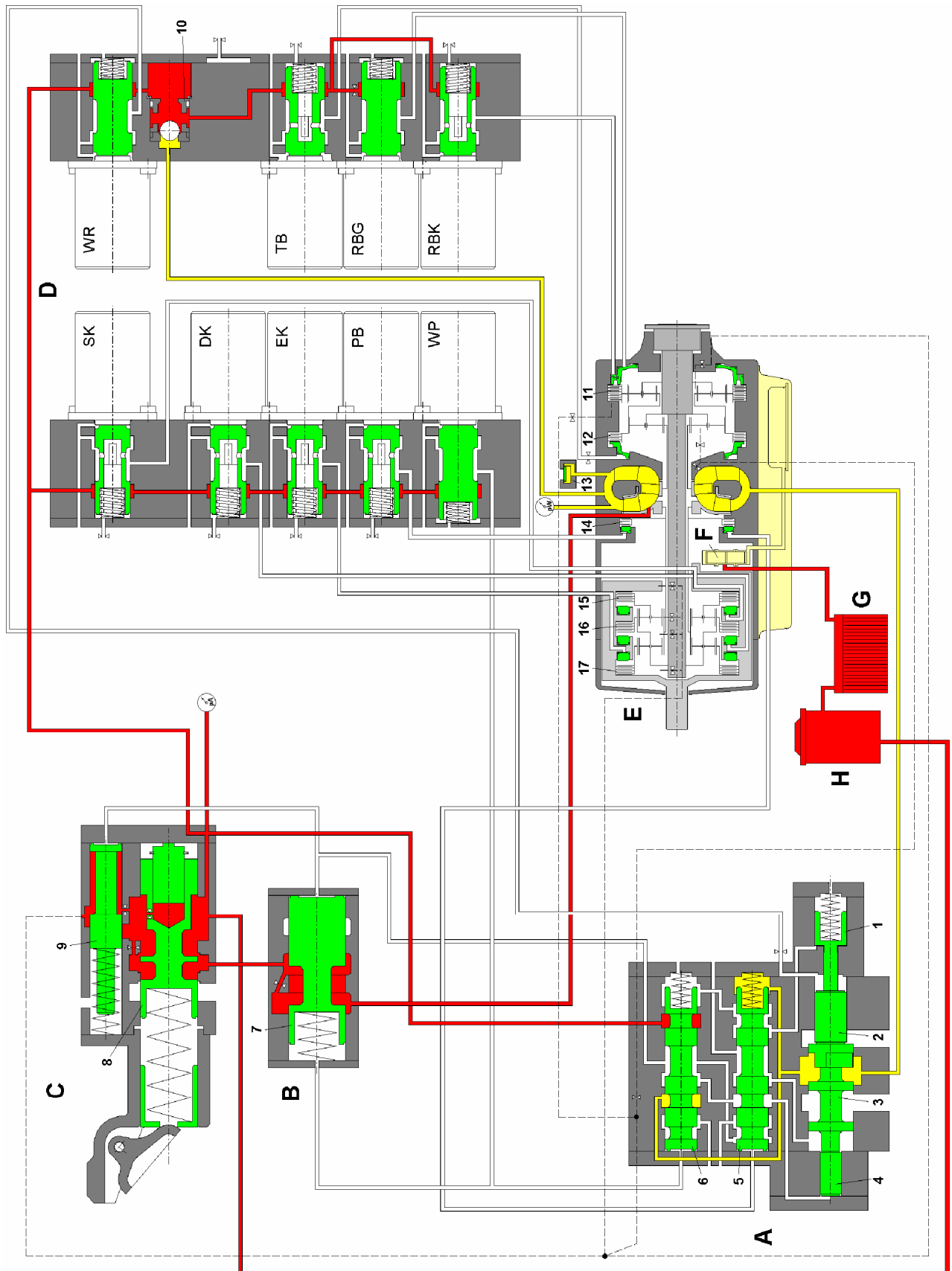
The oil pressure in the **working pressure valve** pushes the spool (8) against the force of the corresponding spring thereby opening the oil flow to the converter.

The transmission is supplied with lubricating oil via the spool (9) and a throttle port in the housing of the working pressure valve.

In neutral position, the working pressure is higher than the converter pressure, so that all **solenoid valves** of the control block are pressurized with working pressure.

The solenoid valves are closed and therefore all multi-disc brakes are released and clutches disengaged.

The spools (1-4) of the **converter outlet valve** are moved to their initial position by the corresponding spring. The converter is thus closed via the converter outlet valve. The converter pressure increases accordingly. The breather valve is equally closed.

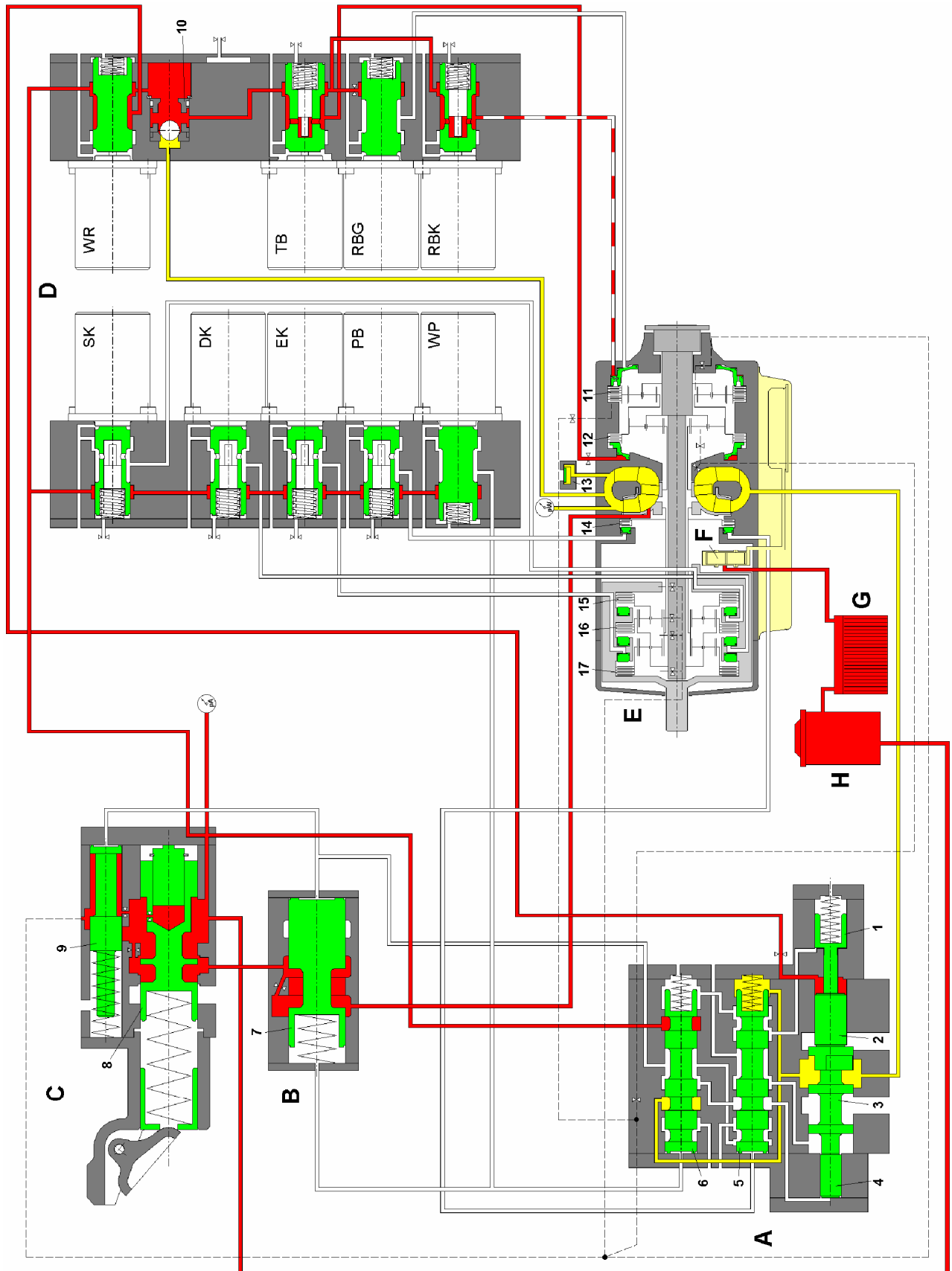


8.2 ANS Activation

The input clutch (17) is disengaged via the **EK solenoid valve**. The turbine brake (12) closes via the **TB solenoid valve**.

The **RBK solenoid valve** establishes and maintains a certain pressure on the small piston surface of the reverse gear brake RB (11). The transmission is mechanically locked up because the two **brakes TB and RB** are closed, i.e. the vehicle is stalled.

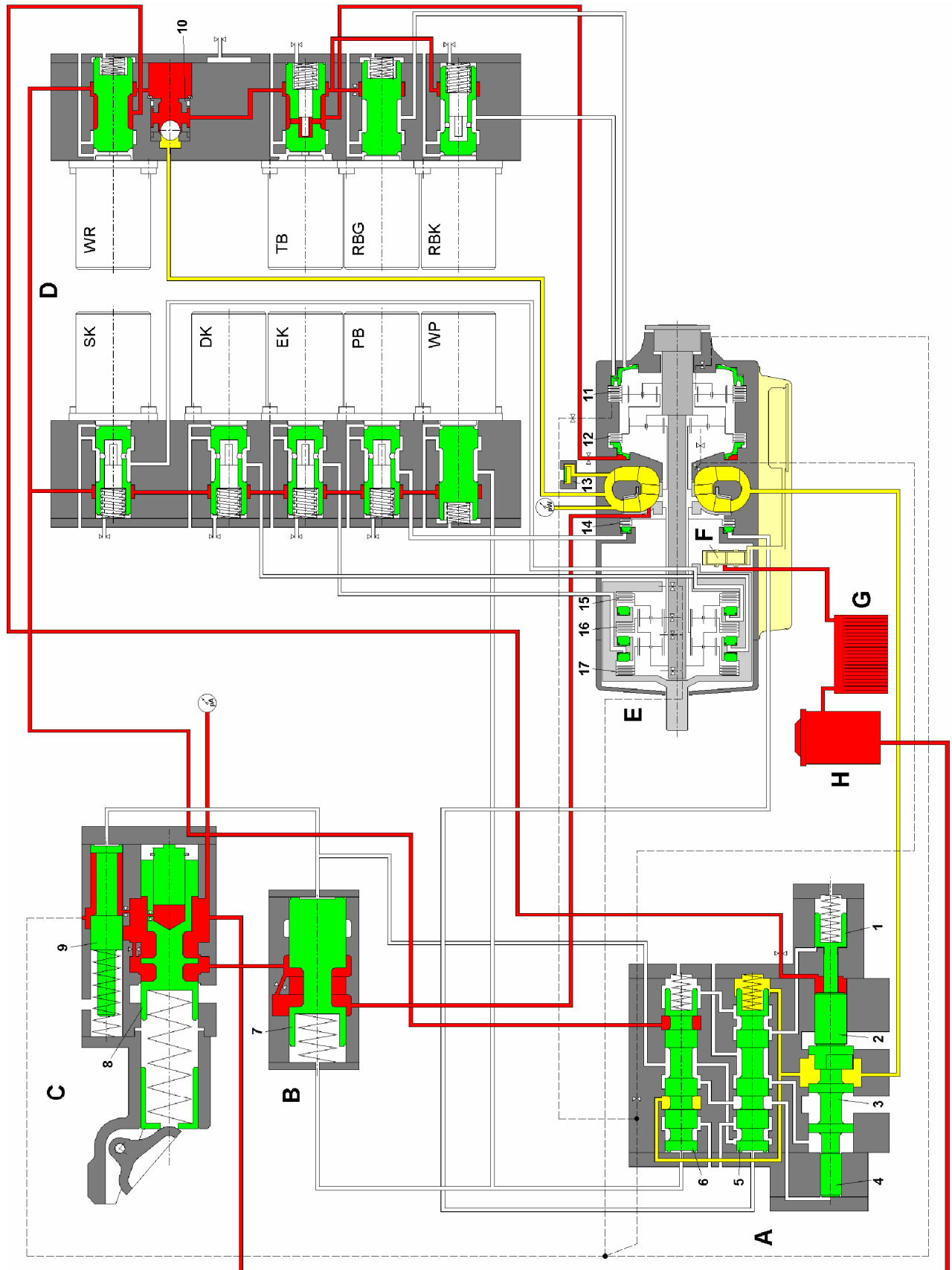
The spool (2) in the **converter outlet valve** is pressurized with working pressure via the fully opened WR solenoid valve. This reinforces the spring force applied to the spool (1), and the spools (1-4) assume their initial position. The converter outlet valve closes and the converter pressure rises to values corresponding to the engine speed.



8.3 **ANS Activation via Parking Brake**

This shifting function differs from the ANS activation in that the **reverse gear brake (11)** is released and the vehicle is stalled by the **parking brake**.

The parking brake is activated by the transmission control unit.

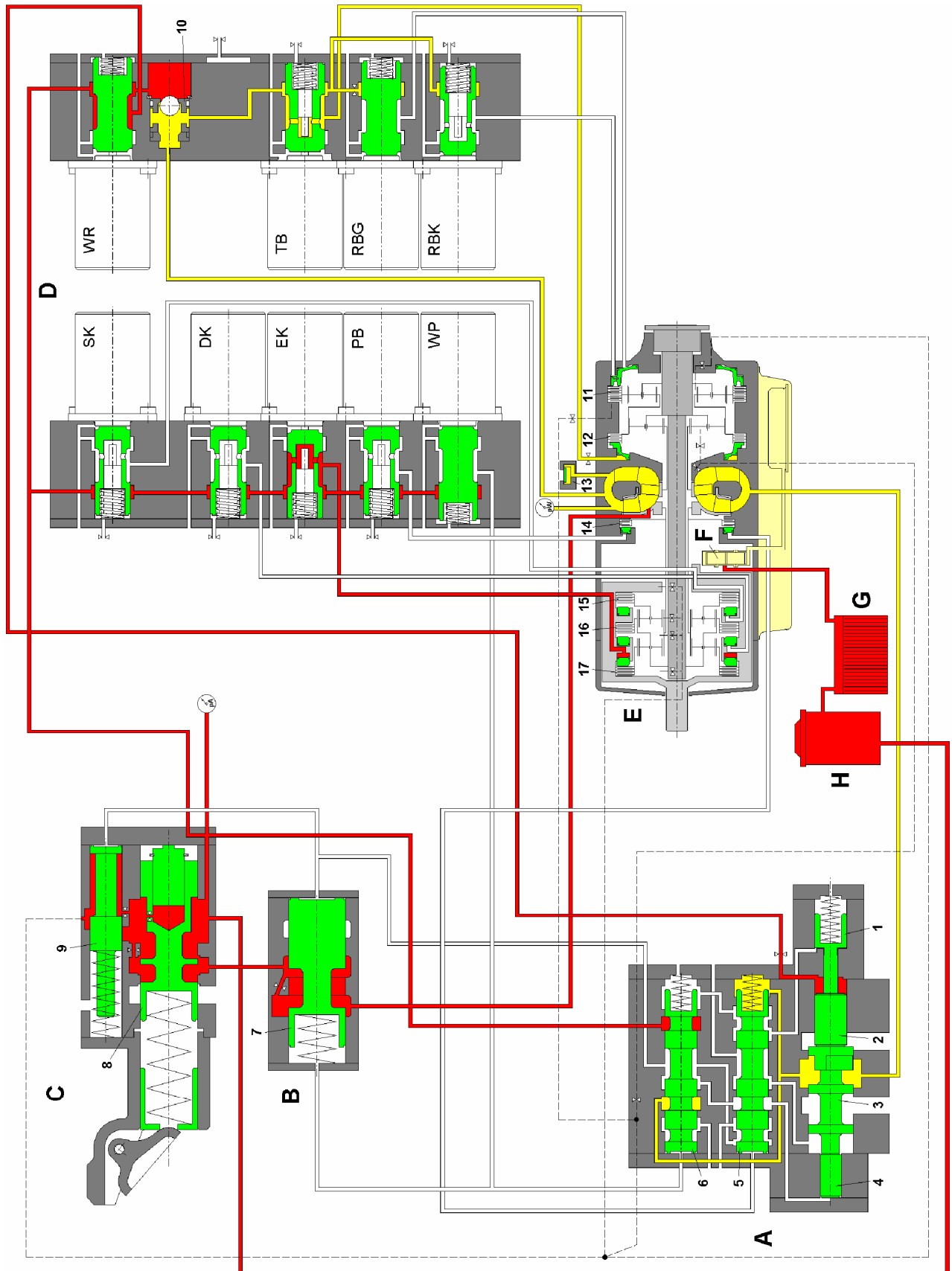


8.4 1st Gear (DIWA drive range)

The input clutch (17) closes via the EK solenoid valve. The turbine brake (12) closes via the TB solenoid valve.

The spool (2) in the **converter outlet valve** is pressurized with working pressure via the fully opened WR solenoid valve. This reinforces the spring force applied to the spool (1), and the spools (1-4) assume their initial position. The converter outlet valve closes and the converter pressure rises to values corresponding to the engine speed.

Because the converter plays an active role in power transmission, the working pressure in this service condition is lower than the converter pressure. Therefore, the shuttle valve (10) releases the higher converter pressure to the solenoid valves TB, RBG and RBK.



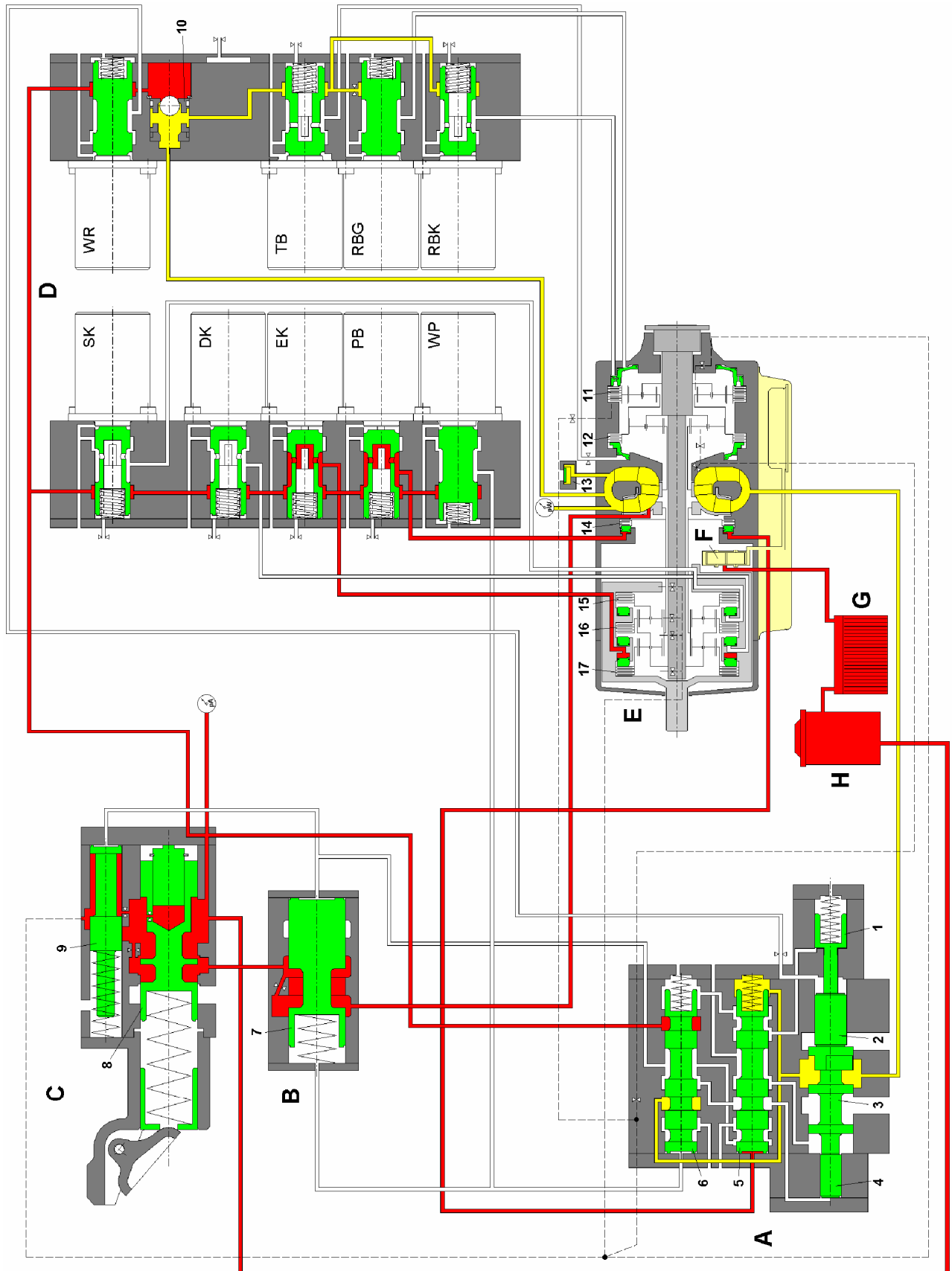
8.5 Upshift 1st - 2nd Gear

This status is only briefly active.

The WR solenoid valve closes. The TB solenoid valve is switched off and the turbine brake (12) opens.

The pump brake (14) is closed via the PB solenoid valve and the pump impeller is stalled. The pump impeller is additionally decelerated by the converter pressure which still applies; this improves shifting quality.

The spool (5) in the converter outlet is equally pressurized with working pressure valve when the pump brake closes. The spool (5) remains in its initial position because the converter pressure is higher.



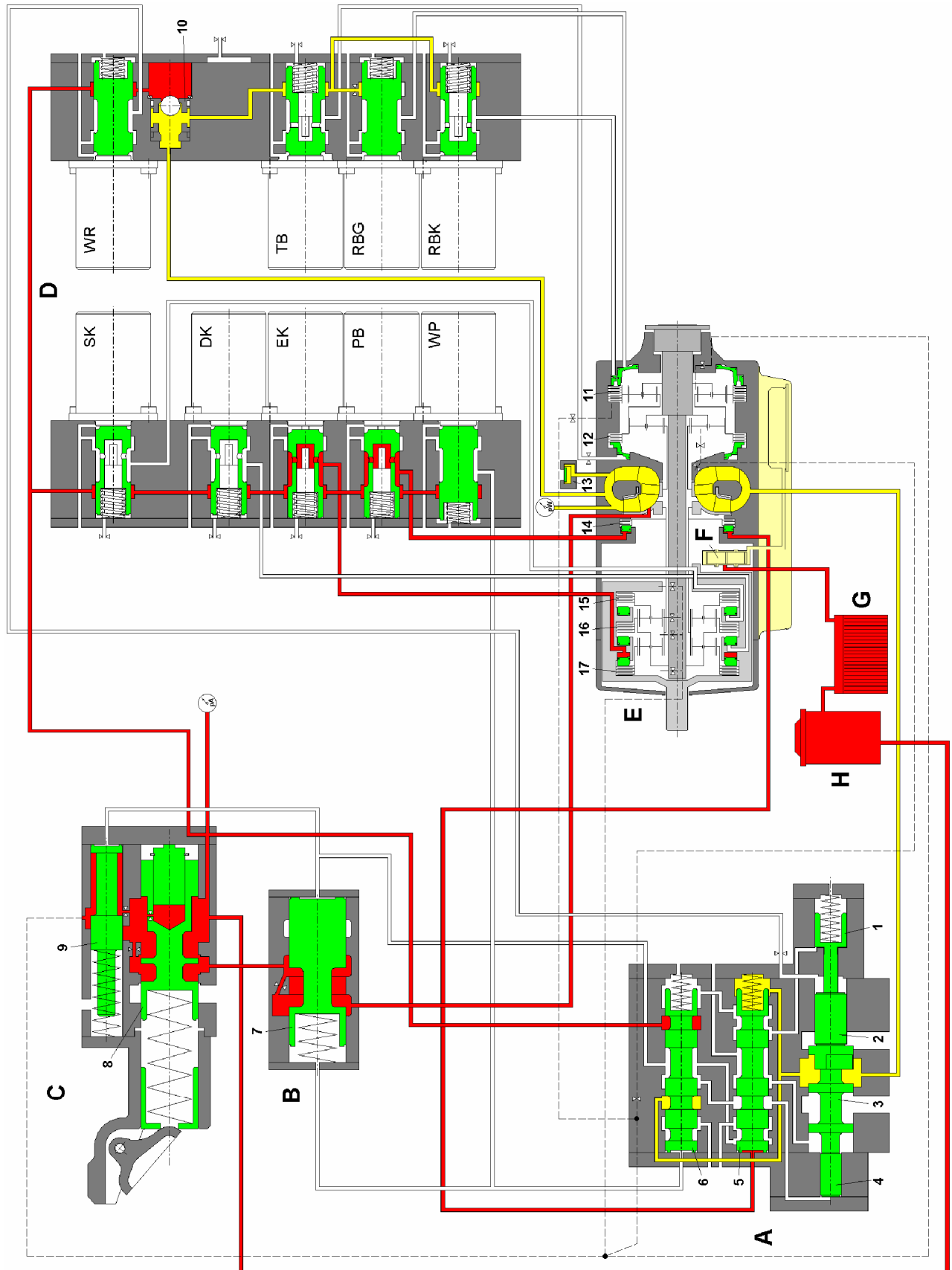
8.6 2nd Gear

The **WP solenoid valve** switches on about two seconds after upshifting from 1st into 2nd gear.

The spool (6) in the **converter outlet valve** assumes the end position, the converter pressure is released via the spool (5) to (4). The spring tension acting on the spool (1) and the converter pressure on (4) effect that a control position is established for the spools (1-4) via the control edge of (3). The converter pressure drops, the spool (5) moves to the end position equally pressurizing the spool (3) with converter pressure. A value of about 0.5 bar is established which is required for the 1st braking stage. The converter is ready to brake when this pressure has been established.

The end position of spool (5) and (6) cause spool (9) of the **working pressure valve** to be pressurized with working pressure. The spool (9) also assumes end position and opens a large lubrication oil bore in the housing of the working pressure valve. As a result, increased transmission lubrication is achieved above the 2nd gear.

Since the working pressure acts on both sides of the spool (7), the **converter inlet valve** remains open. The breather valve is closed.



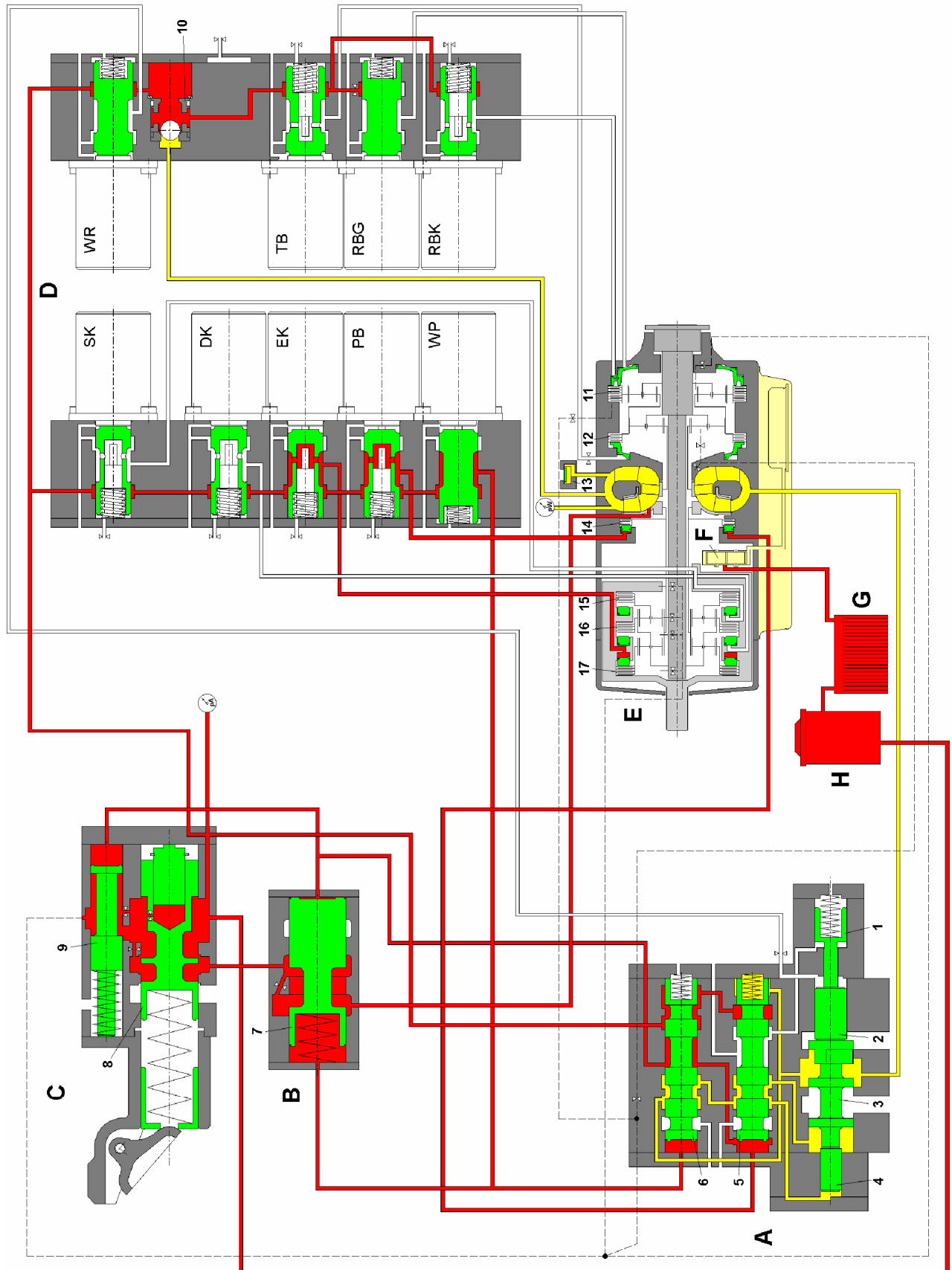
8.7 3rd Gear

The input clutch (17) opens via the EK solenoid valve. The lock-up clutch (16) closes via the DK solenoid valve.

Solenoid valves

- Converter outlet valve,
- Converter inlet valve,
- Working pressure valve and
- Breather valve

remain in the same switching status as the 2nd gear.



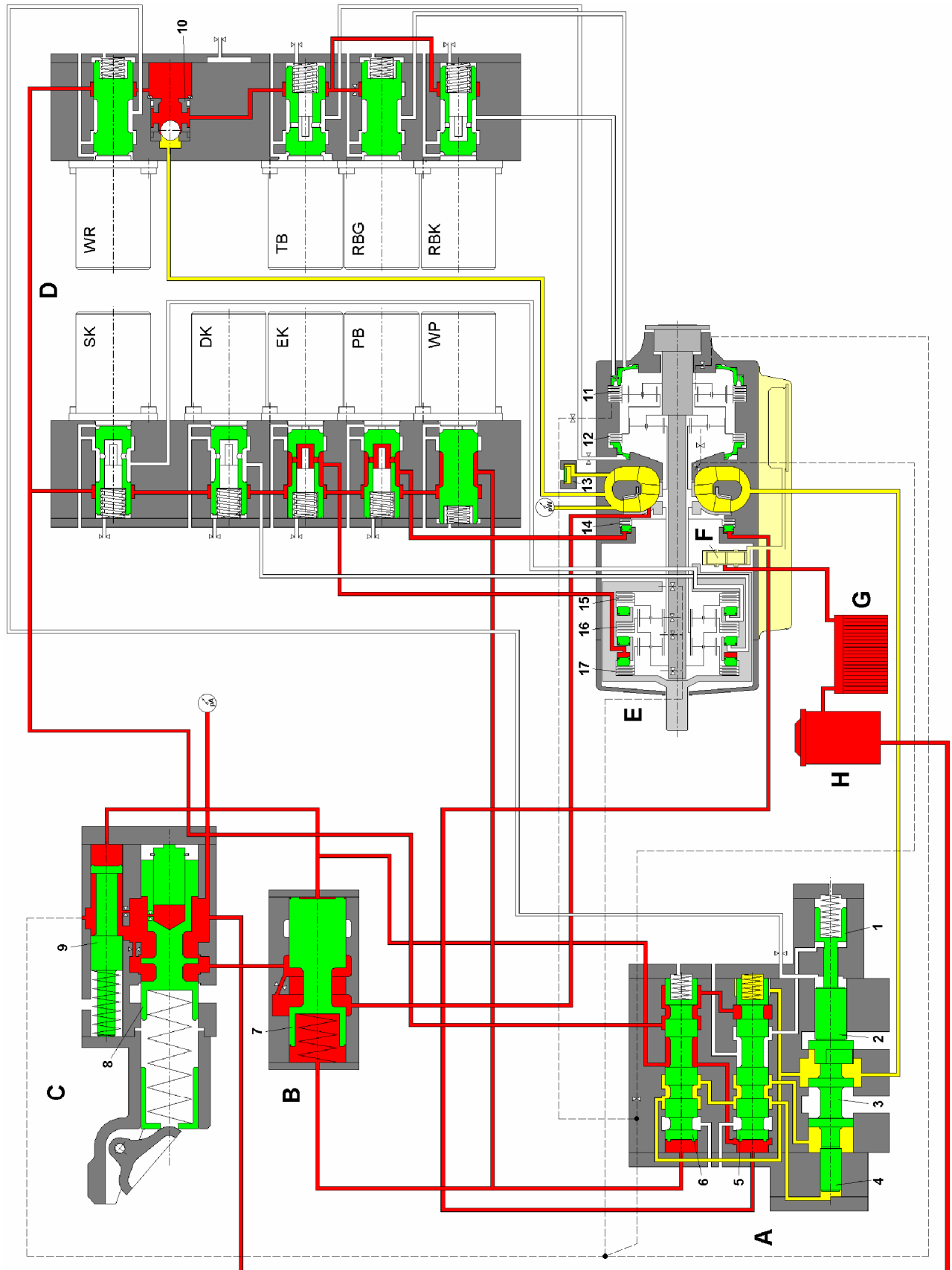
8.8 4th Gear

The lock-up clutch (16) is disengaged via the DK solenoid valve. The overdrive clutch (15) closes via the SK solenoid valve.

Solenoid valves

- Converter outlet valve,
- Converter inlet valve,
- Working pressure valve and
- Breather valve

remain in the same switching status as the 2nd gear.



8.9 Converter Filling Control CFC (3rd - 4th gear)

The multi-disc brakes and clutches are set as in 3rd and 4th gear.

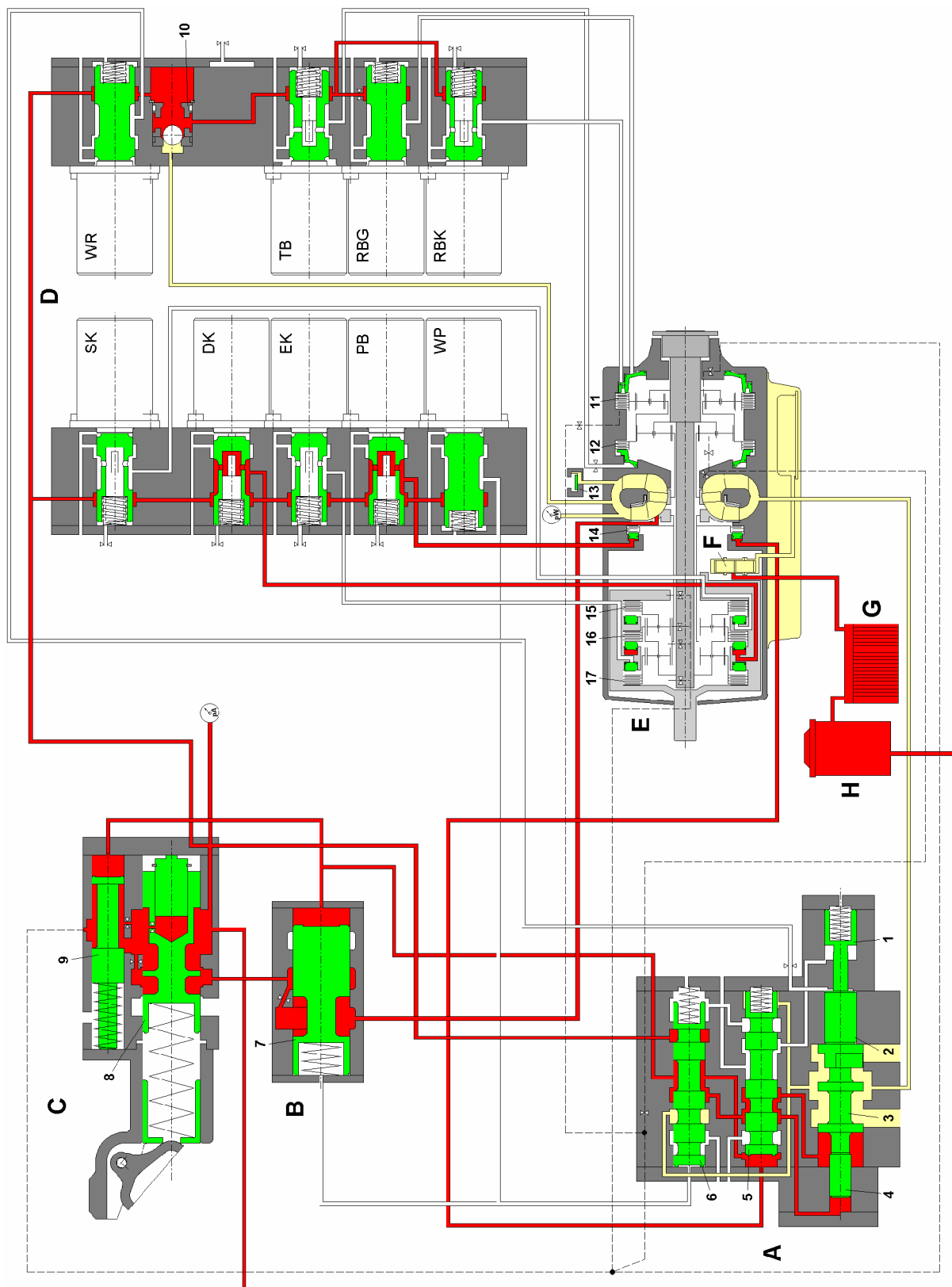
The **WP solenoid valve** is switched off above a certain limit speed of the transmission output $n_2 \geq 2000-2200$ 1/min. As a result, the **converter outlet valve** is fully opened.

The corresponding spring moves the spool (6) to its initial position allowing the working pressure to act on spools (3) and (4) via (5). The spools (1-4) assume end position. The converter pressure drops to values of **nearly 0 bar**.

The **breather valve** opens allowing air into the converter oil circuit.

Switching off the WP valves also causes the working pressure to act only on one side of the spool (7) of the **converter inlet valve**. This spool assume end position. The converter is then supplied only with a reduced oil volume via the throttle port in the housing of the converter inlet valve.

The WP solenoid valve switches back on below the limit speed and the switching status is the same as in the 3rd or 4th gear without CFC.



8.10 Activating the Converter Brake via the Converter Filling Control (3rd-4th gear)

Braking with CFC is a transitional function active for a limited time above the limit output speed.

All multi-disc brakes, clutches and solenoid valves are initially set as in traction in the 3rd or 4th gear with CFC.

The RBK solenoid valve switches on after the converter brake has been applied. It allows the working pressure to act on the small piston surface of the reverse gear brake (11). As a result, the reverse gear transmission is synchronised, i.e. its outer crown gear is braked to stop.

The low pressure, the oil/air mixture and the reduced oil supply to the converter reduce the braking torque when the turbine wheel begins to move, thereby facilitating synchronisation of the reverse gear discs when the vehicle is travelling at high speed.

8.11 1st Braking Stage with Previous CFC (3rd-4th gear)

The overdrive clutch SK (15) and the pump brake PB (14) are closed. The reverse gear transmission was synchronised by switching the RBK solenoid valve [⇒ Page 84]

The RBG solenoid valve is switched on. This allows the working pressure to act on the large piston surface of the reverse gear brake (11) and the pressure on the piston to be increased.

Subsequently, the WP valve is switched on. Spool (6) in the converter outlet valve assumes end position allowing the converter pressure to act on (3) and (4) via (5). The spools (1-4) assume control position, the converter pressure and the braking torque increase to the values for the 1st braking stage.

The converter inlet valve opens and the breather valve closes.

8.12 1st Braking Stage without Previous CFC (2nd-4th gear)

The overdrive clutch SK (15) and the pump brake PB (14) are closed as in traction in 4th gear.

The reverse gear discs are synchronised after the converter brake is actuated. This synchronisation is performed by the RBK solenoid valve and thus the drive of the turbine wheel.

The RBG solenoid valve is then switched on allowing the working pressure to act on the large piston surface of the reverse gear brake (11). This causes the pressure on the reverse gear brake to increase.

8.13 2nd and 3rd Braking Stage (2nd-4th gear)

The multi-disc brakes and clutches are initially in the same positions as for traction. In addition, the reverse gear brake is activated as in the 1st braking stage.

The WR solenoid valve (for converter pressure control) is activated to increase the braking force for the 2nd and 3rd braking stages channeling the pressure on the spool (2) in the converter outlet valve and in doing so changes the braking force via the converter pressure.

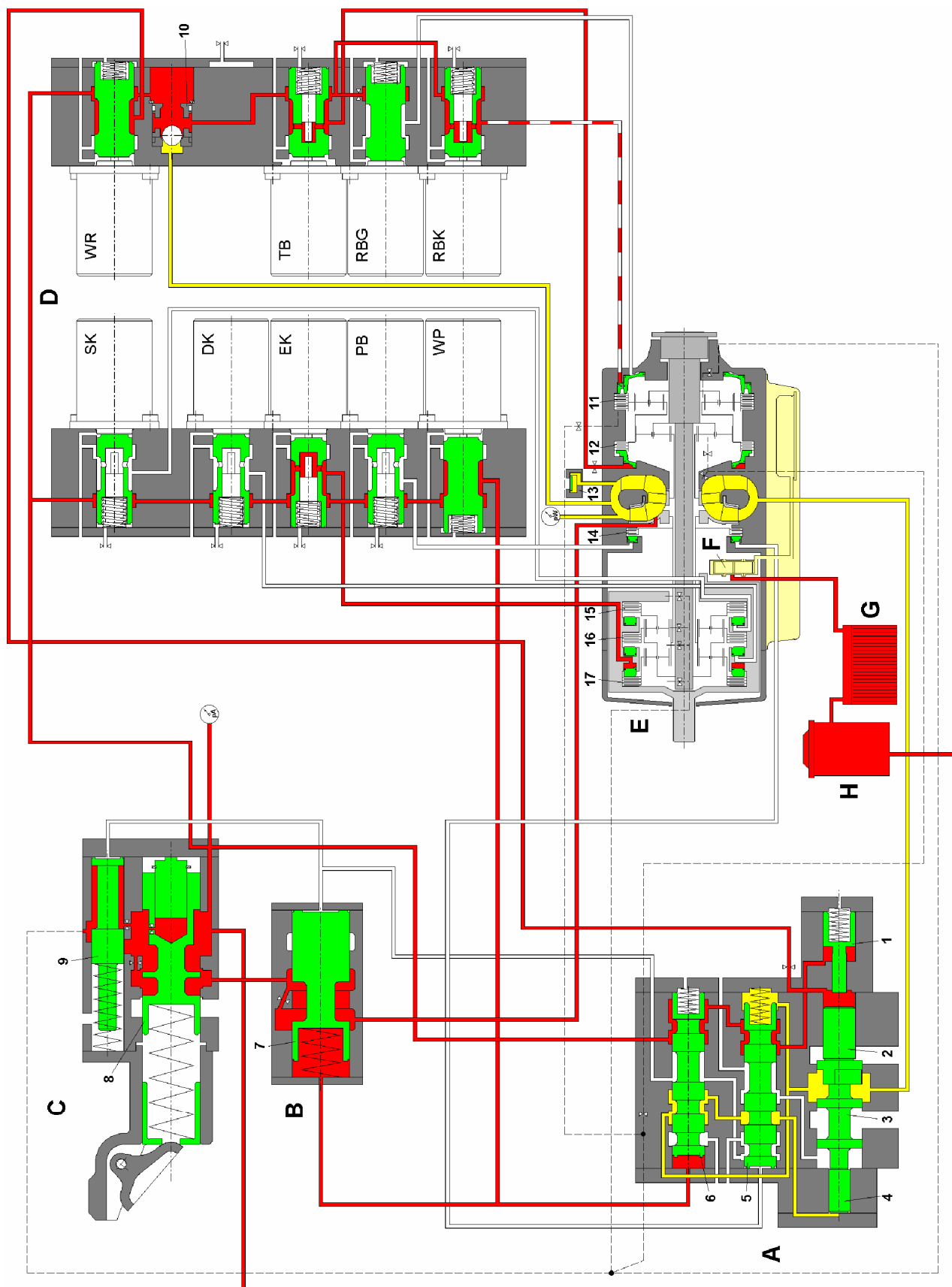
8.14 Braking in 1st Gear Driving Range

The **solenoid valves RBG and RBK** are switched off for the downshift from 2nd to 1st gear with the converter brake active. This means that the reverse gear brake (11) is released.

The **pump brake PB (14)** is then equally opened and the **turbine brake (12)** is subsequently closed. In this operating status, the transmission is initially shifted as for traction in 1st gear.

In order to re-activate the reverse gear brake, the pressure is increased to the corresponding level by the RBK solenoid valve while the RBG solenoid valve remains switched off. At the end of the switch-on time, a pressure of about 1.2 bar acts on the small piston surface of the reverse gear brake. In this status, the predominant braking force for the vehicle is provided only by the slipping RB discs. The RBK pressure is reduced continuously as the vehicle decelerates until a value of about 0 bar is reached when the vehicle has come to a halt.

The RBK pressure is then increased to about 2.5 bar in order to lock up the transmission by means of the two brakes RB and TB.



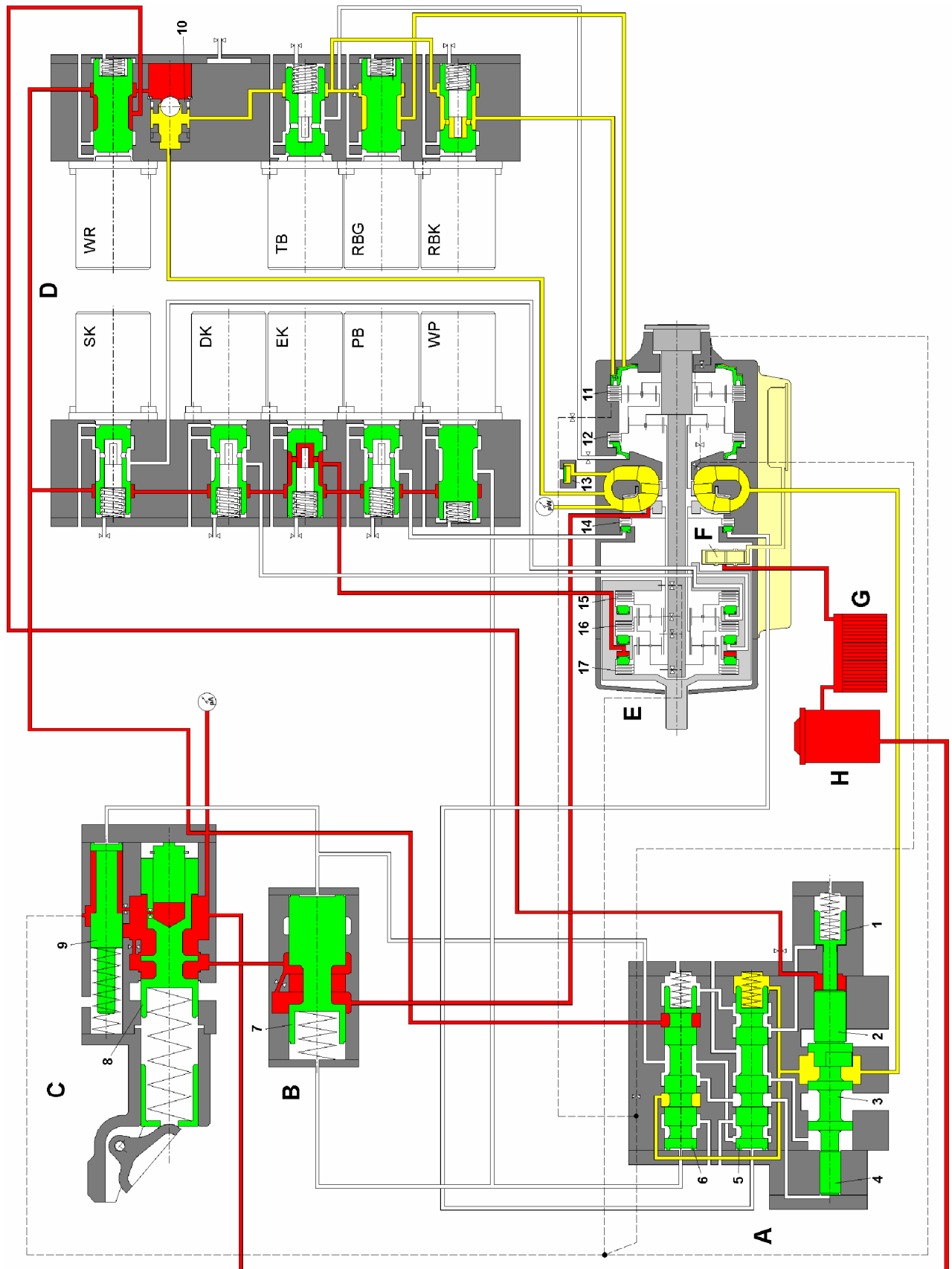
8.15 Reverse Gear up to 1 km/h

This operating state is usually only effective for a short time when setting off in reverse.

The input clutch (17) is disengaged via the EK solenoid valve and the reverse gear brake (11) is applied via the solenoid valves RBK and RBG.

The spool (2) in the **converter outlet valve** is pressurized with working pressure via the fully opened WR solenoid valve. This reinforces the spring force applied to the spool (1), and the spools (1-4) assume their initial position. The converter outlet valve closes and the converter pressure rises to values corresponding to the engine speed.

Because the converter plays an active role in power transmission, the working pressure in this service condition is lower than the converter pressure. Therefore, the shuttle valve (10) releases the higher converter pressure to the solenoid valves TB, RBG and RBK.

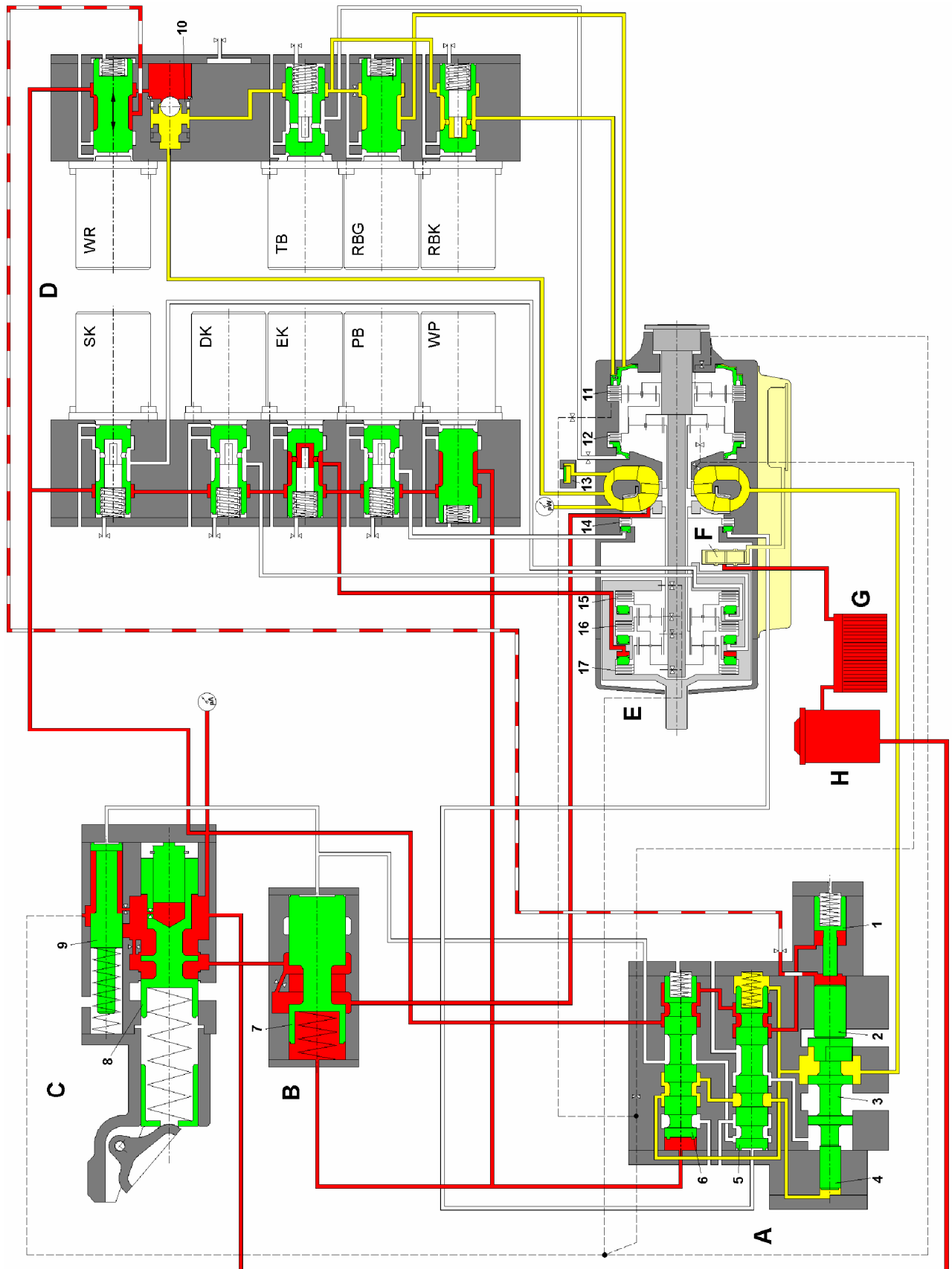


8.16 Reverse Gear above 1 km/h

The WP solenoid valve is activated in addition to the gearshift operations in reverse gear up to 1km/h.

The spool (6) in the converter outlet valve assumes end position. Spool (5) and (6) allow the converter pressure to act on spool (4) which equally moves to its end position.

The pressure of the WR solenoid valve is controlled according to the engine speed and applies at spool (2). It is thus possible to control the converter pressure between approx. 0 and 20 bar via the control edge of the spool (3).



9 Tools

9.1 Tool for Detaching the Cable Plugs from the Solenoid Coils

Order number H68.153510

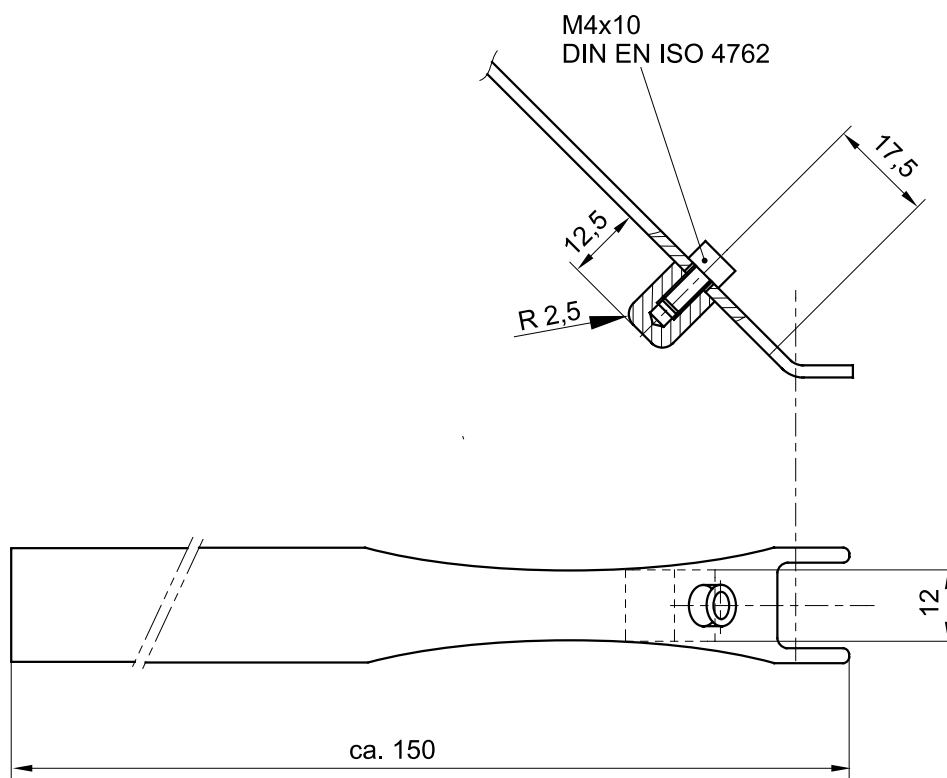


Fig. 26 Tool for Detachating the Cable Plugs from the Solenoid Coils

9.2 Tool for Inserting the Cable Plugs at the Solenoid Coils

Order number 150.00014510

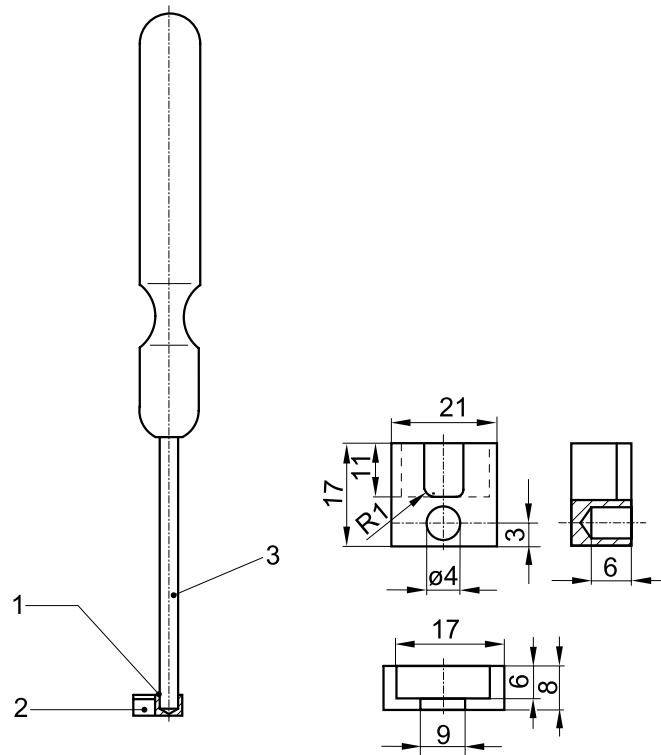


Fig. 27 Tool for Inserting the Cable Plugs at the Solenoid Coils

- 1 – brazed
- 2 – 150.00014410
- 3 – Screw driver DIN 5265-C-A 0,8x4, tip removed

9.3 Tool for Detaching the Cable Plugs from the Cable Harness

Order number H68.153410

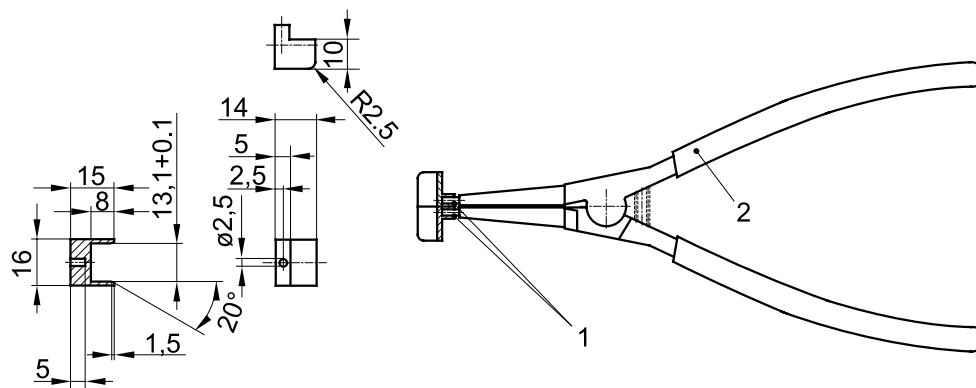


Fig. 28 Tool for Detaching the Cable Plugs for the Temperature Sensor from the Cable Harness

- 1 – brazed
- 2 - pliers DIN 5254-A40-gl

9.4 Tool for Inserting the Cable Plugs at the Cable Harness

Order number H68.153310

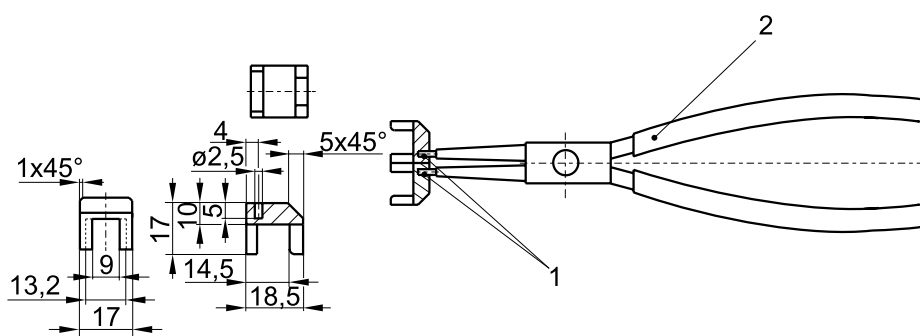


Fig. 29 Tool for Inserting the Cable Plugs for the Temperature Sensor at the Cable Harness

- 1 – brazed
- 2 - pliers DIN 5256-C40-gl

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