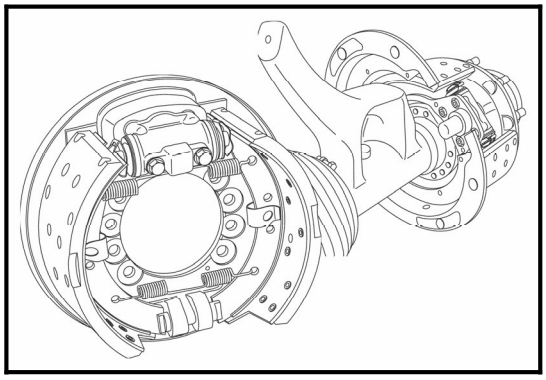


BEML - TATRA 815

26RR36 22 255 6x6.1R/50T, 51T

Workshop manual

Part 9 –BRAKE SYSTEM & AIR PRESSURE SYSTEM

Publication numer: 03-0254-ENG/00

TATRA, a.s. **1-st Edition 28-2-2007**

9 BRAKE SYSTEM & AIR PRESSURE SYSTEM

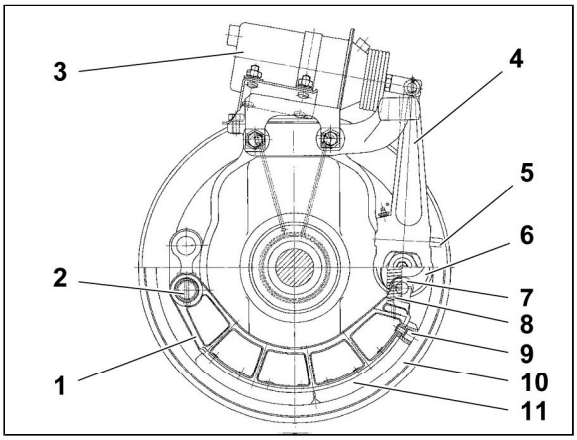
9.1 Description and Main Technical Specifications

The **brake system** of the vehicles BEML - TATRA **T 815 26RR36 22 255 6x6.1R/50T, 51T** incorporates the following brake systems:

- Service brake,
- Emergency brake,
- Parking brake,
- Trailer brake,
- Engine brake.

The **service brake** is an overpressure (pneumatic) foot-actuated dual-circuit brake acting on wheels of all axles.
The **emergency brake** is a mechanical (spring-loaded) manually operated brake controlled by means of the manual control valve with spring brake cylinders acting on wheels of rear axles.
The **parking brake** is a mechanical (spring-loaded) manually operated brake controlled by means of the manual control valve with spring brake cylinders acting on wheels of rear axles.
The **trailer brake** includes two independent systems, one direct-acting with two-hose coupling, and the other indirect-acting with one-hose coupling.
The **engine brake**, actuated electro-pneumatically and acting indirectly.
The **proper wheel brake** (See Fig. **9.1**) is inner, drum and shoe brake.

In addition, the vehicle **pneumatic system** provides the pressure air distribution for the **control system** and for the **Central Tyre Inflation System (C.T.I.S.)**.



Legend: ***1****-brake shoe,* ***2****-anchor pin,* ***3****-brake cylinder,* ***4****-brake cam lever,* ***5****-adjusting screw,* ***6****-brake cam,* ***7****-pulley,* ***8****-return spring,* ***9****-rivet,* ***10****-brake drum,* ***11****-brake lining*

Fig. 9.1 Wheel brake

Note:
The individual pressure air inlets and outlets on main instruments of the pneumatic system are marked with stamped or pre-cast numbers, whose designation is as follows:

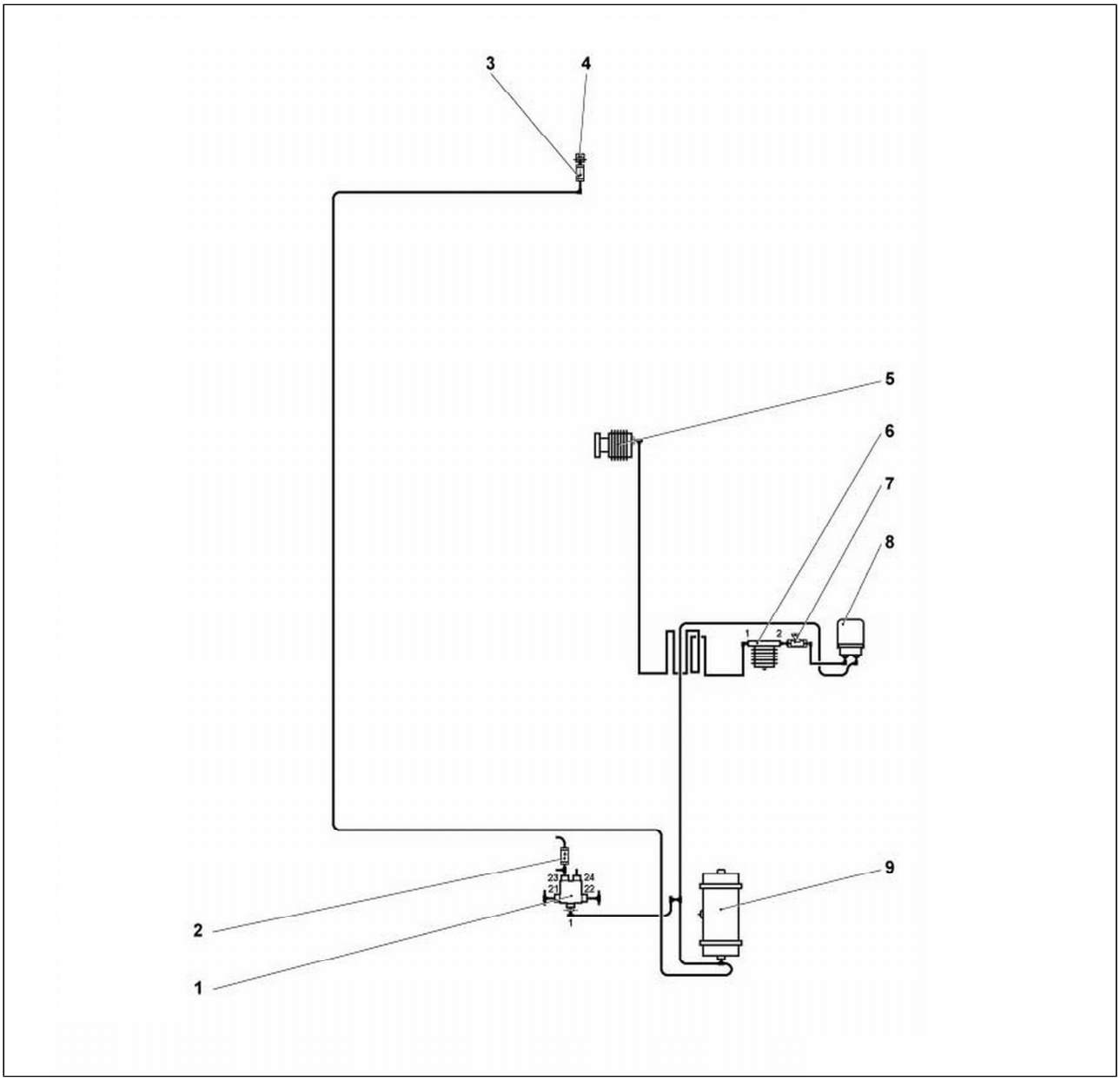
1 - pressure air inlet
2 - pressure air outlet
3 - deaeration
4 - controlled air pressure inlet
If the number is a two-digit one, the second digit means a serial number of the inlet or outlet of the respective kind. The mentioned marking is used in the following diagrams and in further text.

The pneumatic system features the check connections to measure the air pressures in individual parts of the system in compliance with the EEC 13 regulations.

Check connections are situated as follows:

- 1st circuit air reservoir
- 2nd circuit air reservoir
- front axle brake cylinder, RH

The **source system** is designed to provide the pressure air for the common supply of all pneumatic vehicle instruments. The source system works as follows: The air is compressed by means of the compressor **5** (See Fig. **9.2**), which is powered from the engine.



Legend: ***1****-relief valve,* ***2****,****3****-back-pressure valve,* ***4****-end piece to fill the system from the external source,* ***5****-compressor,* ***6****-conensate sump,* ***7****-tire inflator,* ***8****-air drier c/w pressure regulator,* ***9****-source air reservoir*

Fig. 9.2 Diagram of the source pneumatic system

The compressed air is directed through the metal piping, being scroll-mounted along the right-hand longitudinal beam of the auxiliary frame to be long enough to allow a sufficient air-cooling. The condensate of air water vapors and oil vapors coming out of the compressor lubrication accumulates inside the condensate sump **6**, from which it is automatically drained via a drain hole in the bottom. The air in the condensate sump and its firon filter element is continued to be cooled down and cleaned.
The pressure air for the tires inflation or for some other purpose can be taken off from the tire inflator **7** by means of the hose, which is a part of the vehicle equipment. Further on, the air is dried in the air drier **2** with built-in pressure regulator **8**. In the space of the blow-off valve the air drier body is fitted with automatic heating, which prevents the condensate from freezing when the ambient temperature drops below the zero point. The air pressure regulator incorporated in the pneumatic system secures that the air pressure will not exceed the maximum pressure of **0.85 $^{-0.04}$ MPa** (**8.5 $^{-0.4}$ kg/sq.cm**) . After the maximum air pressure has been achieved, the filling of the source system is stopped. The air modified like this is then directed into the source ("wet") air reservoir **9**, which is equipped with a manual drain valve. The source air reservoir provides a sufficient amount of air determined especially to assure a function of the vehicle control system and Central Tire Inflation System, which have no separate air reservoirs.

In addition, the source air reservoir serves also to "calm down" the compressed air being disturbed by the compressor before it enters further circuits. The air flow is then directed to (four-way) relief valve **1**, which provides the air distribution into two brake circuits of the service brake, into circuit of the emergency and parking brake and into circuit of the control system and *Central Tire Inflation System*.
Inlet and outlets of the relief valve are as follows:
„ 1" - inlet of the pressure air,
„21" - outlet of pressure air for 2nd circuit of service brakes,
„22" - outlet of pressure air for 1st circuit of service brakes,
„23" - outlet of pressure air for the circuit of emergency and parking brake *and trailer brake*,
„24" - outlet of pressure air for the circuit of the control system and *Central Tire Inflation System*.
In case of some of these circuits malfunction, the relief valve will separate this faulty circuit and the resting ones will work with the relief pressure.
In case of defect or under workshop conditions, the air can be also delivered into the pneumatic system on emergency by means of the fitting used for filling from the external source **4**, which is attached to the *front bumper* and which is closed with a plug under normal vehicle operating conditions. The location of the coupling for filling the pneumatic system from the external source is illustrated by the arrow in the figure - (See Fig. **9.3**). The air passes through to the source air reservoir via the back-pressure valve **3** during this method of filling.

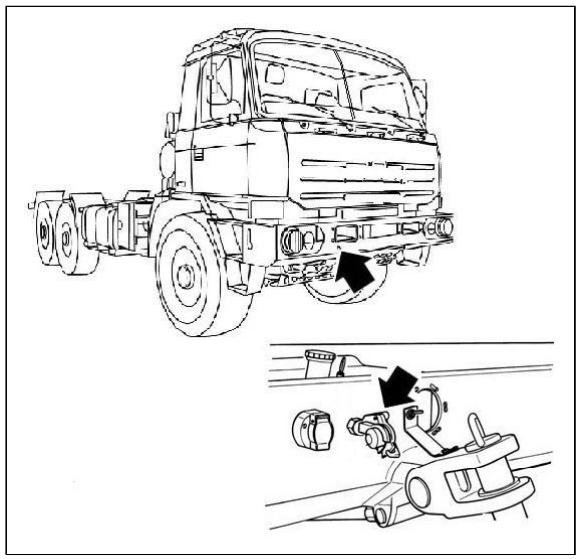
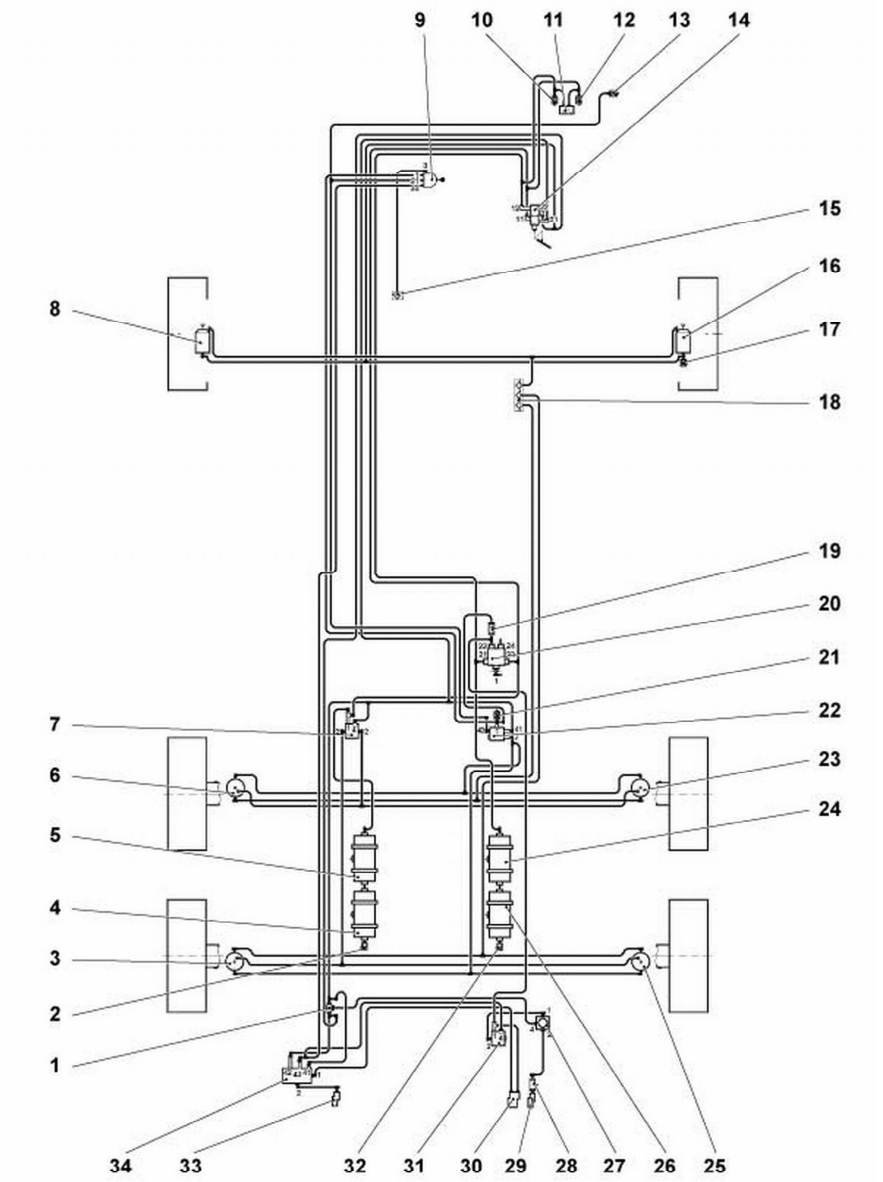


Fig. 9.3 Filler coupling to charge the pneumatic system and its location on vehicle

CAUTION:
While filling the pneumatic system as mentioned above, the air is directed through the back-pressure valve, which is connected by the fitting, directly into the source air reservoir, and not via the air pressure regulator. For that reason, it is unconditionally necessary to watch the air pressure in the system and to switch off the source of the pressure air before the maximum allowable air pressure of 0.85 $^{-0.04}$ MPa (8.5 $^{-0.4}$ kg/sq.cm). is reached.
The dirt contained in the pressure air will cause a malfunction of the brake system instruments resulting in their defects and for that reason, it is necessary for the pressure air from the external source to be got rid of all dirt and no condensate is allowed.



Legend: ***1****-two-way valve,* ***2****,****17****,****32****-check connection,* ***3****,****6****,****23****,****25****-spring-loaded brake cylinder,* ***4****,****5****-1st circuit air reservoir,* ***7****-1st circuit control cylinder,* ***8****,****16****- spring-loaded brake cylinder,* ***9****-manual brake valve,* ***10****-pressure switch of signal lamp indicating the air pressure in 2nd circuit,* ***11****-double air pressure gauge in brake circuits,* ***12****-pressure switch of signal lamp indicating the air pressure in 1st circuit,* ***13****-pressure switch of signal lamp of emergency brake,* ***14****-master brake valve,* ***15****,****18****-vent holes,* ***19****-back-pressure valve,* ***20****-relief valve,* ***21****-pressure switch,* ***22****-emergency brake control valve,* ***24****,****26****-2nd circuit air reservoir,* ***27****-trailer brake valve (one-hose),* ***28****-closing cock,* ***29****-coupling head for one-hose trailer,* ***30****-filler coupling head for two-hose trailer,* ***31****-trailer brake valve (one-hose),* ***33****-control coupling head for two-hose trailer,* ***34****-two-hose trailer brake valve*

Fig. 9.4 Diagram of brake circuits

The **pneumatic brake system** secures the operation of three independent circuits:

1. **Two** circuits of the **service brake** , which can be characterized as an overpressure pneumatic foot-actuated dual-circuit brake acting on all wheels (the first circuit acts on wheels of both rear axles, the second circuit acts on front axle wheels).

2. Circuit of the **emergency** and **parking brake** , which is a mechanical (spring-loaded) brake, manually actuated air-controlled brake, acting on wheels of rear axles.

3. Circuit of the **trailer brake** , which consists of two independent systems - direct-acting brake with two-hose coupling, and indirect-acting brake with one-hose coupling.

The **1st circuit of the service brake** consists of air reservoirs **4** and **5** (See Fig. **9.4**) c/w manual drain valves, constant air pressure check connection **2** on the circuit air reservoir, two-circuit master brake valve **14** (common also for the other circuit), control valve **7** and brake cylinders **3** , **6** , **23** and **25** .

Brake cylinders are of a tandem, spring-loaded type. Into the 1st circuit of the service brake, the pressure air passes through the outlet “22” from the relief valve **20** (which is a part of the source system and is common also for other circuits and pneumatic system equipment). Brake cylinders are water-proof; piston rods are sealed in the cylinder and the inner (non-working) spaces under the piston are connected with the ambient air via the manifold **23**, which is routed above the line of draught.

The **2nd circuit of service brake** consists of air reservoirs **24** and **26** c/w manual drain valves, check connection of constant pressure **32** in the circuit air reservoir **26**, two-circuit master brake valve **14** (which is common with 1st circuit), and single brake cylinders **8** and **16**. The check connection **17** is mounted on the right-hand brake cylinder of front axle wheels brakes. Into 2nd circuit of service brake the pressure air passes through outlet “21” from the relief valve **20**.
Brake cylinders are water-proof; piston rods are sealed in the cylinder and the inner (non-working) spaces under the piston are connected with the ambient air via the manifold **18**, which is routed above the line of draught.

The air pressure value in brake cylinders of rear axle wheels is controlled by the control valve **7** during braking. The control air pressure is delivered from the master brake valve **14** to inlet '4' of the control valve. The outlet pressure from the control valve is directed to brake cylinders of 2nd and 3rd axle wheels.
When the service brake is released, the air pressure from brake cylinders of front axle wheels is released into the ambient air via the master brake valve, and from brake cylinders of rear axles´ wheels via the control valve.
The double air pressure gauge **11** and signal lamp (situated on the instrument board) switched on by pressure switches **10** and **12** are used to check the air pressure in both circuits of the service brake during the vehicle operation. When the signal lamp comes on, it indicates the air pressure drop (malfunction) in some of brake circuits.

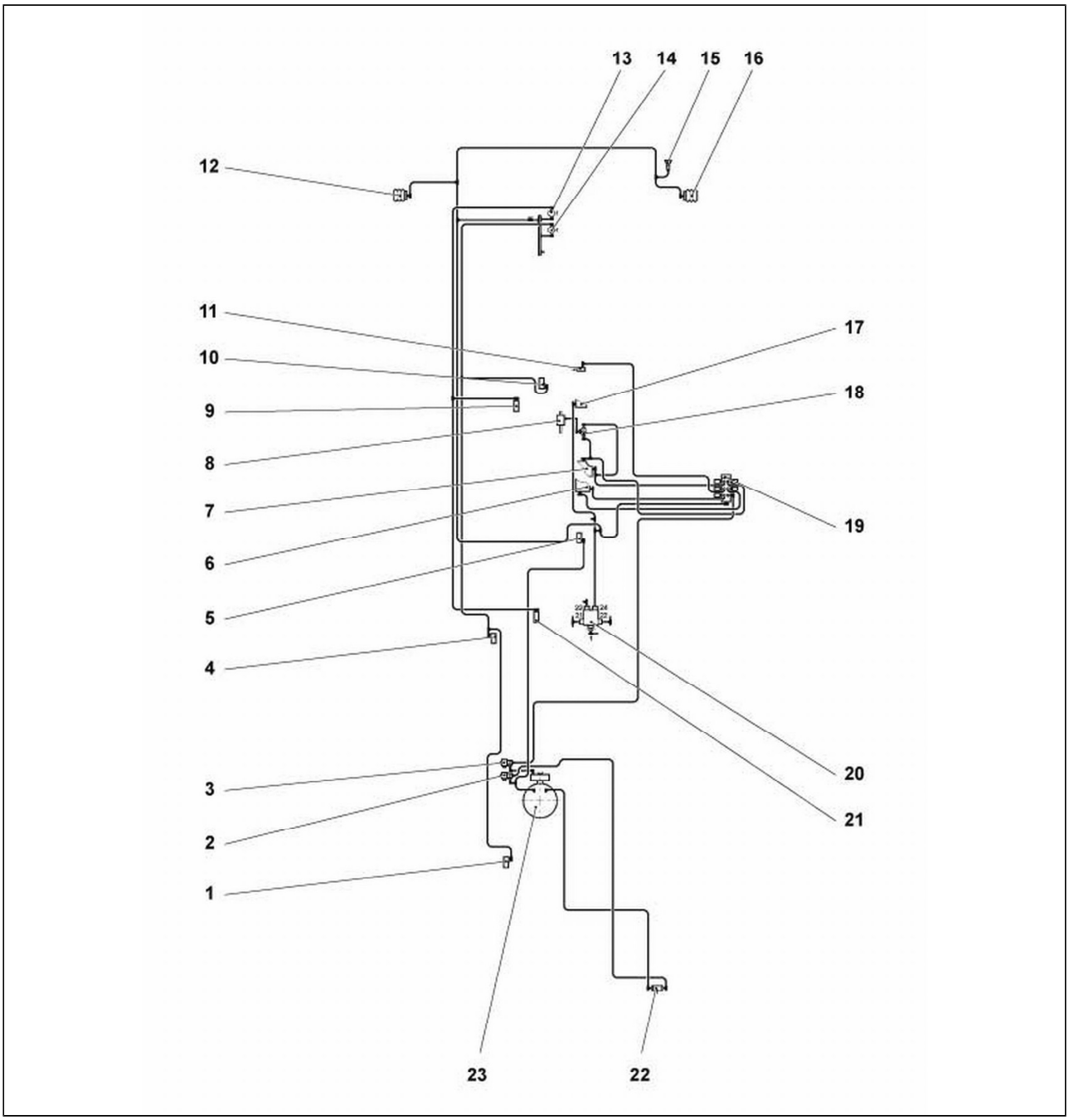
The **emergency and parking brake circuit** consists of the control valve of the emergency and parking brake **22**, manual brake valve **9** and spring-loaded (tandem) brake cylinders of rear axle wheels brakes **3, 6**, **23** and **25**.
The pressure air for the circuit of emergency and parking brake is taken off from the relief valve **20** (via outlet “23” being common with the trailer brake). The air pressure to release the emergency and parking brake is directed - based on the impulse from the manual brake valve - via the control valve into a spring chamber of the tandem (spring-loaded) brake cylinder. The brake is actuated by releasing the pressure air from this chamber via the control valve, manual brake valve and bleeding manifold **15** (situated under the driver’s cabin) into the ambient air. It means that the vehicle is braked applying the force of the spring in a tandem (spring-loaded) brake cylinder. If the service brake is applied together with emergency and parking brake, the effect of the emergency and parking brake is limited or cancelled by its aeration via the control valve **20** due the air pressure, which is delivered onto inlet '41' of the control valve from 1st circuit of service brake. This prevents the system from adding the braking forces and from impairing the stability

during braking and/or damage to components of the wheel brake mechanical components.
The signal lamps on the instrument board are designed to check the operating air pressure, which is routed into a circuit of emergency and parking brake. The pressure switch **13** controls the signal lamp of the parking brake (it comes on when the parking brake is set on), and the pressure switch **21** controls the signal lamp monitoring a sufficient air pressure in the circuit of emergency brake. When this signal lamp comes on, it indicates the air pressure drop (malfunction) in circuit of emergency brake. The switch has been factory set to the pressure of **0.63 MPa** (**6.3 kg/sq.cm**) .

The **circuit of the trailer brake** consists of the trailer brake valve for the one-hose-system **27**, coupling head for the one-hose system **29** c/w closing valve **28,** trailer brake valve **34** for the two-hose system and coupling heads for the two-hose system **30** (filler) and **33** (control). The pressure air for the circuit of the trailer brake is taken off from the relief valve **20** (via outlet “23” common with the emergency and parking brake circuit) passes through into the control valve **31**, through which the pressure air is directed to the trailer brake valve of one-hose system and to the coupling head of one-hose system. At the same time the air passes through into the coupling head for the trailer of two-hose system **30** (filler), and if a trailer of the two-hose system is coupled, also to the trailer brake valve **34**. When the brake is applied, the control air pressure is directed into the trailer brake valve of the two-hose system (via inlets “41” and “42” from circuits of the service brake, via inlet “43” from circuit of the emergency and parking brake) and is routed via the coupling head **33** (control) through the connecting manifold into the trailer pneumatic system. When the brake is released, the air is released from trailer control heads and brake valves into the ambient air. When the emergency and parking brake is applied, the trailer brake valve of the one-hose system is controlled by means of the control valve **31**, and the trailer brake valve of the two-hose system is controlled directly via the inlet “43”.

The **pneumatic control system** is designed to engage the constant meshes in gearbox, to shift “low” and “high” gear speeds in the auxiliary gearbox, to engage the axle differential locks, to engage the front axle drive and inter-axle differential lock, to control the relief exhaust brake, to deliver the pressure air into air-fluid clutch release cylinder, to control the winch PTO drive and/or to provide the pressure air for suspension of driver’s and co-driver’s seats (if the vehicle is fitted with pneumatic seats).

The pneumatic control system takes off the pressure air from outlet “24” of the relief valve **20** of the source system (See Fig. **9.5**).



Legend: ***1***,***4***,***10****-axle differential lock shift cylinder,* ***2****-electromagnetic valve of winch drum,* ***3****-electromagnetic valve of winch brake,* ***5****-winch drive shift cylinder,* ***6****-shift cylinder of constant mesh ("turtle"/ "hare" speeds),* ***7****-auxiliary gearbox shift cylinder (L/H gears),* ***8****-shift booster cylinder,* ***9****-front drive shift cylinder,* ***11****-engine brake cylinder,* ***12***,***16****-air bellows of seat suspension,* ***13****-air cock to shift axle differential locks,* ***14****-air cock to shift inter-axle differential lock and front drive,* ***15****-horn,* ***17****-clutch booster cylinder,* ***18****-two-way valve,* ***19****-block of electromagnetic valves,* ***20****-relief valve,* ***21****-inter-axle differential lock shift cylinder,* ***22****-closing cock,* ***23****-winch*

Fig. 9.5 Diagram of pneumatic control

The air is directed to electromagnetic pneumatic valves **19** (See Fig. **9.5**) situated on the vehicle RH side besides the air pressure regulator together with the air drier (See Fig. **9.6**).

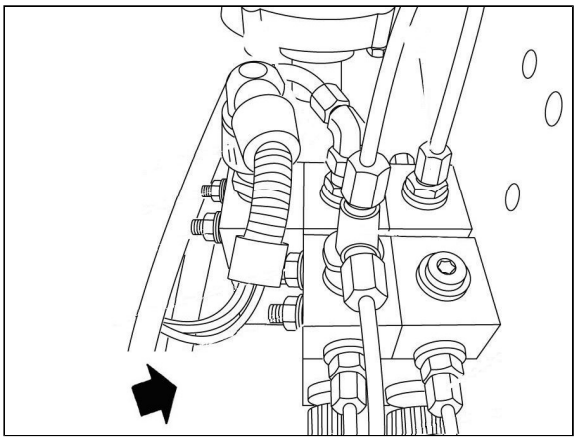


Fig. 9.6 Electromagnetic pneumatic valves

From electromagnetic pneumatic valves, which are situated on the RH side of the vehicle, the air is directed also to electromagnetic pneumatic valves of the winch drive control **2** and **3** (See Fig. **9.5**), which are situated on the frame cross girder ahead of the winch (See Fig. **9.7**)

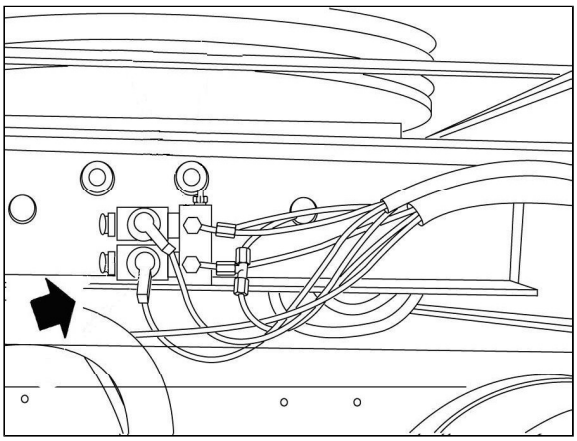
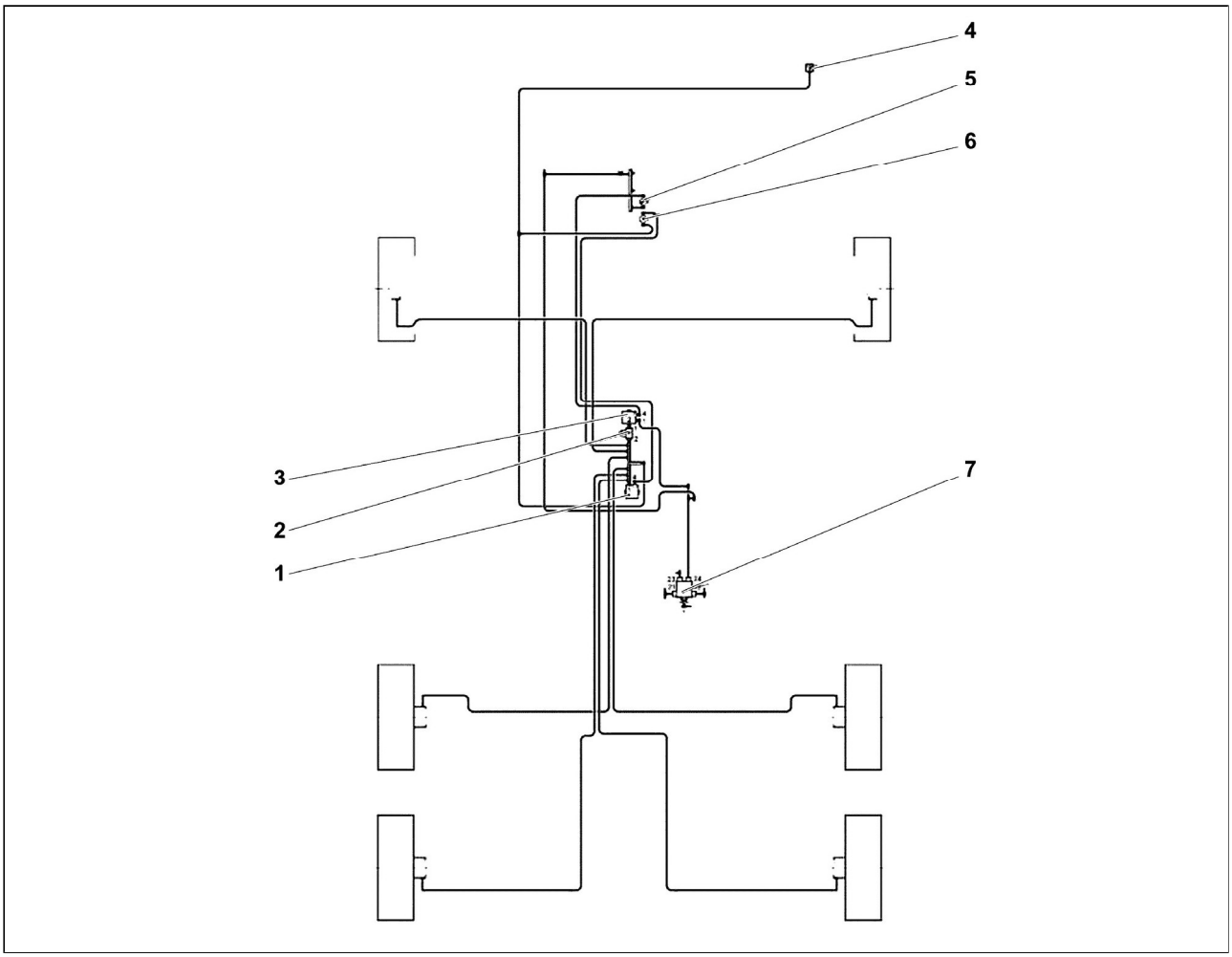


Fig. 9.7 Electromagnetic pneumatic valves of winch control

Further on, the air passes through to cocks for shifting the inter-axle differential lock and front drive **13** and **14** in the system of pneumatic cocks (See Fig. **9.5**) and to the clutch booster cylinder **17**. When respective electromagnetic air valve is actuated by the switch on the instrument board or when the air cock is engaged, the air is directed into respective control cylinder in accordance with the diagram (See Fig. **9.5**). When the electromagnetic valve or cock is disengaged, the control cylinder is deaerated and the drive or lock is disengaged.
The pressure air from the pneumatic control system is also used to control the Central Tyre Inflation System (C.T.I.S.), into which it is routed from the common inlet to system of pneumatic cocks.
The pressure air is routed via the manifold of the control system also to pneumatic bellows of driver's and co-driver's seats suspension **12** and **16**, if fitted.

The **Central Tyre Inflation System** allows changing the air pressures in tyres on the move (deflation to enhance the driving mobility in muddy or sandy terrain followed by the repeated inflation). It allows also a permanent inflation of the punctured tyre for the emergency drive. The air pressure is taken off from outlet "24" of the relief valve **7** (See Fig. **9.8**).



Legend: ***1****-deflation control valve,* ***2****-reducing valve,* ***3****-inflation control valve,* ***4****-pressure gauge,* ***5****-inflation air cock,* ***6****-deflation air cock,* ***7****-relief valve*

Fig. 9.8 C.T.I.S. diagram

From outlet “24” of the reducing valve **7** the air pressure is routed to the inflation control valve **3** and simultaneously to air cocks **5** and **6** for inflation and deflation in the system of air cocks. By moving the respective cock, the “control” air pressure is directed to the inflation or deflation control valve and the air pressure increases or decreases in tires (provided that the shut-off valves in wheels are open). To prevent the tire from damage due to the air pressure increase above the maximum allowable value of **0.41 MPa** (**4.1 kg/sq.cm**), the maximum air pressure is limited by the reducing valve **2**. The control valves **1** and **3** are also designed to keep the residual air pressure in tires on the value of **0.09 MPa** (**0.9 kg/sq.cm**) not to allow the complete air release during tires deflation resulting in damage to tires on the move. The air pressure in tires can be controlled in tires by the pressure gauge **4** on the instrument board.

The main instruments of the pneumatic system are installed by means of brackets and holders mainly on the auxiliary frame and extended central member frame. The other important instruments of the pneumatic system are installed in the driver’s cabin (master brake valve, manual brake valve, etc.).
The individual parts of all pneumatic systems are interconnected by the metal or polyamide pipelines of various cross sections and versions, with the use of screwed connections and fittings. The overall arrangement of individual circuits of the pneumatic system is illustrated in “Diagram of pneumatic system” (See Fig. **9.9**)

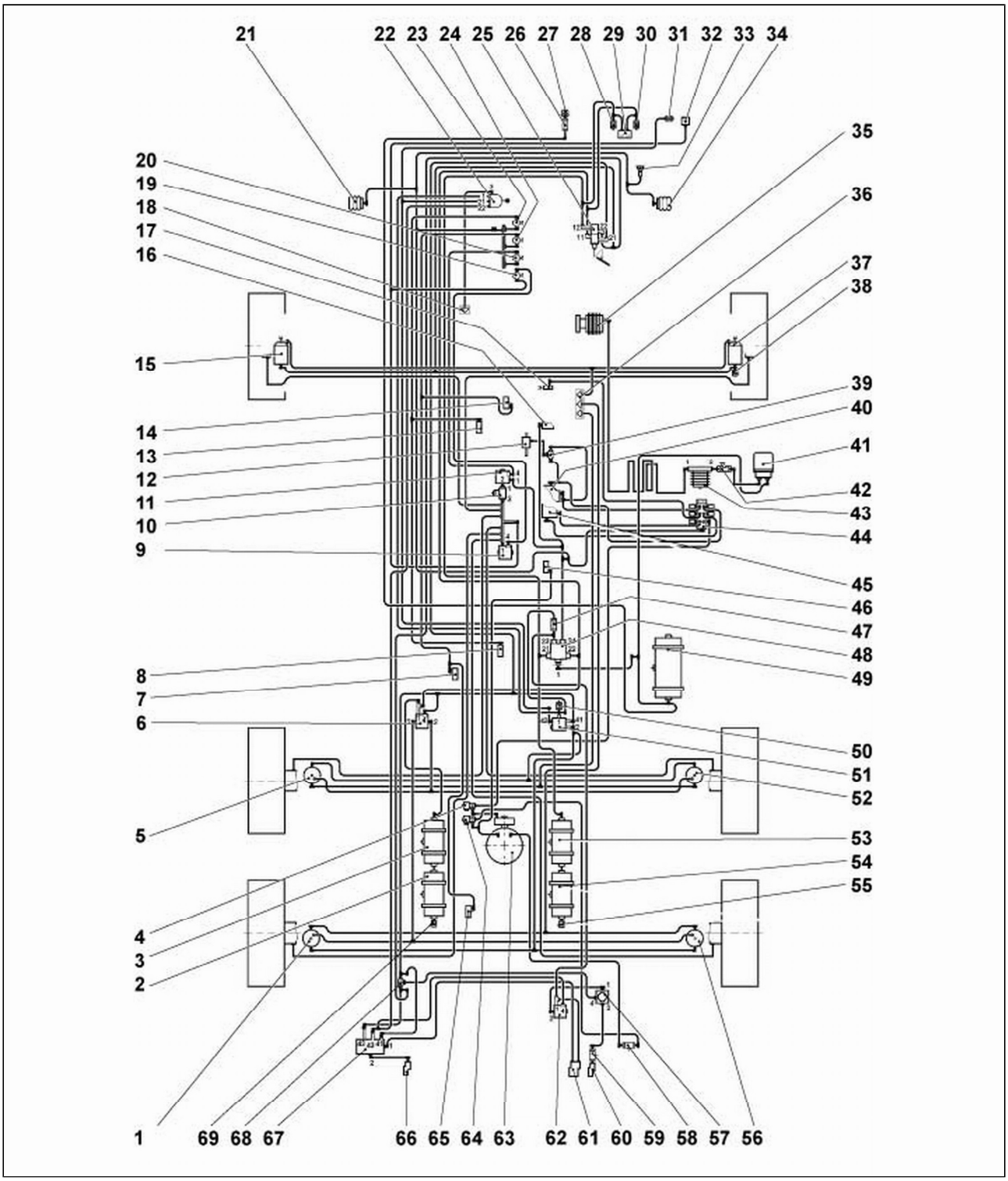


Fig. 9.9 Overall diagram of pneumatic system

Legend:* ***1,5,52,56*-spring brake cylinder, ****2,3****-1st circuit air reservoir, ****4****-electromagnetic valve of winch brake, ****6****-control valve of service brake – 1st circuit, ****7****-shift cylinder of axle differential lock, ****8****-shift cylinder of inter-axle differential lock, ****9****- C.T.I.S. control valve - deflation, ****10****-reducing valve, ****11****- C.T.I.S. control valve - inflation, ****12****-shift booster cylinder, ****13****-front drive shift cylinder, ****14****-axle differential lock shift cylinder, ****15,37****-*

*brake cylinder, **16**-clutch booster cylinder, **17**-engine brake cylinder, **18**-emergency brake bleeding manifold, **19**-tires deflation air cock, **20**-tires inflation air cock, **21**-seat suspension air bellows, **22**-manual brake valve, **23**-air cock to engage axle differential locks, **24**-air cock to engage inter-axle differential lock and front drive, **25**-master brake valve, **26**-back-pressure valve, **27**-coupling for filling the system from the external source, **28**-pressure switch of 2nd circuit air pressure signal lamp, **29**-double air pressure gauge in brake circuits, **30**-pressure switch of 1st circuit air pressure signal lamp, **31**-pressure switch of emergency brake signal lamp, **32**-tires air pressure gauge, **33**-horn, **34**-seat suspension air bellows, **35**-compressor, **36**-brake cylinders bleeding manifold, **38,55,69**-check connection, **39**-two-way valve, **40**-shift cylinder of auxiliary gearbox (L/H gears), **41**-air drier with integrated air pressure regulator, **42**-tires inflator, **43**-condensate sump, **44**-block of electromagnetic valves, **45**-shift cylinder of shifting constant meshes ("turtle"/ "hare" speeds), **46**-winch drive shift cylinder, **47**-back-pressure valve, **48**-relief valve, **49**-source air reservoir, **50**-pressure switch, **51**-emergency brake control valve, **53,54**-2nd circuit air reservoir, **57**-trailer brake valve – one-hose, **58**-closing cock, **59**-closing cock, **60**-trailer coupling head - one-hose, **61**-trailer coupling head – two-hose (filler), **62**-trailer brake control valve, **63**-winch, **64**-electromagnetic valve of drum engagement, **65**-axle differential lock shift cylinder, **66**-trailer coupling head – two-hose (control), **67**-trailer brake valve - two-hose, **68**-two-way valve.*

The main technical specifications of the brake and pneumatic system of the vehicles BEML - TATRA **T 815 26RR36 22 255 6x6.1R/50T, 51T** are mentioned in the below-mentioned table. (See Tab. **9.1**).

Tab. 9.1 Main technical specifications of the brake and pneumatic system

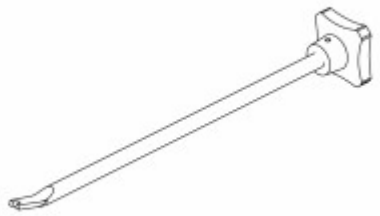
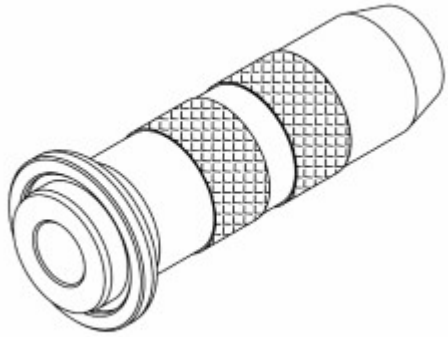
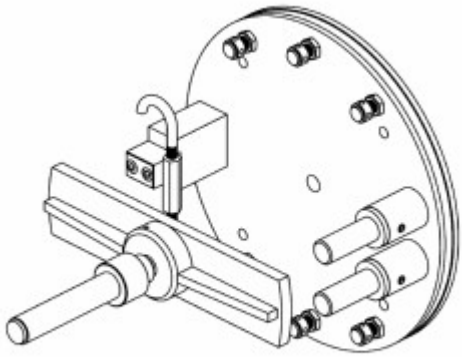
Data	Unit	Value
Diameter of front axle brake cylinders	mm	100
Diameter of rear axle brake cylinders	mm	115
Brake drum diameter	mm	420
Brake lining width: - front axle / - rear axle	mm	160 / 160
Overall braking effective area	cm^2	6,900
Effective braking area of emergency and parking brake	cm^2	4,600
Maximum pressure in the pneumatic source system	MPa	$0.85^{-0.04}$
	kg/sq.cm	$8.5^{-0.4}$
Operating air brake system pressure	MPa	0.83 ± 0.20
	kg/sq.cm	8.3 ± 2.0

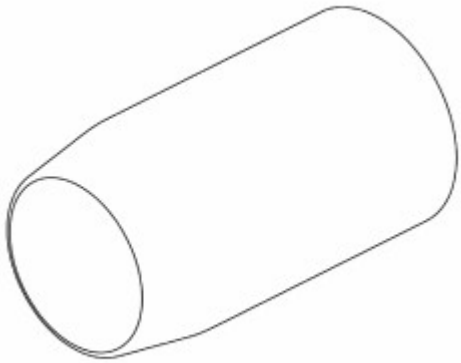
9.2 Faults Causes, Symptoms and Troubleshooting

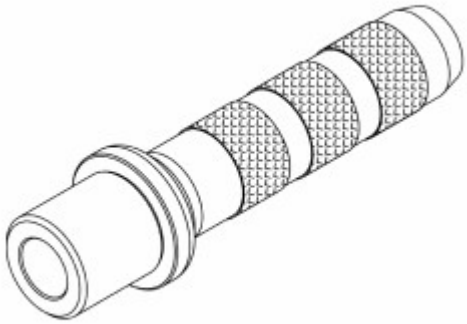
Fault	Cause	Troubleshooting	Mentioned in:
Manifold air leakage. Pressure drop in individual circuits of the pneumatic system.	Damaged (broken, worn) manifold.	Repair or replace the faulty part of the manifold.	(See Subchapter **9.5.20**)
Air leakage from instruments threaded joints of the pneumatic system and manifold pipe unions. Pressure drop in the respective circuit of the pneumatic system.	The manifold pipe unions leakage or leakage from screwed joints among instruments and manifold.	Tighten the pipe union and replace the damaged sealing elements. Should the instrument threads have been damaged, replace the instrument.	In accordance with the working procedure of the respective instrument.
Insufficient air pressure in brake circuits. Slow filling of brake circuits with the pressure air.	Faulty compressor.	Replace or repair the compressor.	(See Part **1**)
Slow filling of brake circuits with the pressure air. An excessive condensate leakage from the tire inflator after installation of the tire inflation hose.	Polluted firon filter element of the condensate sump.	Clean or replace the firon filter element and clean the condensate sump.	(See Subchapter **9.5.2**)
An excessive condensate amount leaks through manual drain valves on air reservoirs. Slow filling of brake circuits with the pressure air.	Polluted air drier filter element.	Replace the air drier filter element.	(See Subchapter **9.5.3**)
The condensate freezing in instruments of the pneumatic system in the winter period (some of pneumatic system circuits shows the zero or too low air pressure).	Faulty heating of the automatic air drier.	Check the electric current supply to the air drier. If the electric supply is OK, replace the air drier with integrated air pressure regulator.	(See Part **15**), (See Subchapter **9.5.8**)
The air pressure in brake circuits does not reach the prescribed values **$0.85^{-0.04}$ MPa ($8.5^{-0.4}$ kg/sq.cm)**. It takes a long time to fill the brake circuits to reach the value of **$0.85^{-0.04}$ MPa ($8.5^{-0.4}$ kg/sq.cm)**. A frequent pressure drop below the minimum value indicated by the signal lamps lighting on the instrument board.	Faulty or poorly adjusted air pressure regulator.	Replace the air drier with integrated air pressure regulator.	(See Subchapter **9.5.8**)

Fault	Cause	Troubleshooting	Mentioned in:
The parking brake cannot be released or the parking brake is being applied spontaneously on the move.	Faulty emergency and parking brake control valve.	Replace emergency and parking brake control valve.	(See Subchapter **9.5.16**)
The transfer mechanism referring to the respective electro-pneumatic valve cannot be controlled.	Faulty electro-pneumatic valve in control circuits.	Check the electric current supply to the electro-pneumatic valve. If the electric current supply is OK, replace the valve.	(See Part **15**), (See Subchapter **9.5.19**)
The air pressure releases from the brake cylinder during braking.	The brake cylinder piston cup is leaky.	Replace the cylinder.	(See Subchapter **9.5.22**)
The braking efficiency is decreased.	Excessively worn or burnt brake lining.	Replace the brake lining (on the whole axle).	(See Subchapter **9.5.23**), (See Subchapter **9.5.24**)
	Greasy brake lining due to the lubricating grease escaping from wheel hubs.	Replace the brake lining (on the whole axle).	(See Subchapter **9.5.23**), (See Subchapter **9.5.24**)
	Excessively worn brake drum	Replace or turn- off the brake drum	(See Subchapter **9.5.23**)

9.3 List of Special Tools

Name: Brake springs mounting lever *Tool number:* PRM 3816	
Name: Driver of shaft seal 35x50x7 *Tool number:* PRM 0742	
Name: Tool to machine brake lining 420x160 *Tool number:* PRM 3071	

Name: Mounting sleeve of brake cam *Tool number:* PRM 3119	

Name: Driver of brake cam bushing *Tool number:* PRM 3137	

9.4 Survey of Torque Specifications

Tab. 9.2 Tightening specifications prescribed for hollow and other screws of the brake and pneumatic system

Data – Screw Dimension	Unit	Value
M 10 x 1	Nm	16 - 20
M 12 x 1.5		22 - 26
M 14 x 1.5		26 - 30
M 16 x 1.5		32 - 38
M 22 x 1.5		36 - 44

9.5 Working Procedures

9.5.1 Principal Rules for the Replacement of the Pneumatic System Components

a) Reason for Replacement

1. Faulty function of some brake system component.

b) Technical Conditions

1. The damaged or faulty pneumatic system components are not repaired, but replaced with new ones of the same type and mark.
2. Removed sealing elements (gaskets, sealing rings) are replaced with new ones during installation.

c) Replacement Rules

1. Before starting with removal of pneumatic system components for the reason of their periodical maintenance and/or replacement of any part of the pneumatic system, the pressure gauges both of the front and rear axle brake circuits must indicate the zero pressure.
2. Before removal of the pneumatic system components, make sure first that the system is not pressurized also by means of manual drain valves on all vehicle air reservoirs.
3. Remove screwed unions from all necks of removed parts and plug the necks carefully.
4. Clean the parts surface. Do not apply petrol, diluting agent or water to clean them.
5. Fit the part with a hanging tag and put down the vehicle identification number, kilometres covered, engine hours worked out and characteristics of the operation of the vehicle, from which the part was removed and a short description of the fault.
6. Send the part prepared in such a manner to the authorized service station for the repair.
7. Before installation of new or repaired parts make sure first that the unified classification number given on the part label corresponds to the part number, which is prescribed for the respective vehicle.
8. Remove plugs from all necks of a new part without their damage, do not damage threads and contact surfaces for the face gaskets. These surfaces must be clean. Take care that rests of plugs do not fall inside the part interior during its possible damage. If it occurs, the rest must be removed without the part dismantling.
9. Before installation of the fitting threaded unions into respective necks, make sure first whether the threads have not been damaged.
10. Gently apply the grease to the face and conical sealing surfaces and threads of pipe unions before installation.
11. Take care that the face gaskets are aligned with the fitting threaded unions after screwing on and tightening.
12. Fitting threaded unions, which are secured with a counter-nut in the part against release, can be sealed with WABCO sealing rings only. Do not apply any sealant or paint to threads of such fitting threaded unions before installation into the part necks.
13. Before reinstallation of pipes onto the pneumatic system component make sure first that the seal rings surfaces have not been damaged and gently apply the grease to threads. Should the gaskets be needed in pipe unions, use the new or undamaged ones.
14. Each pipe union must be tightened so that it is tight. Components connections (dividing planes) must be tight too.
15. Tighten cap nuts or fitting screwed unions to prevent the manifold pipe unions from leakage. Keep

the tightening specifications as mentioned in (See Tab. **9.4**).

16. In case that the leakage cannot be removed, replace the fitting, the damaged gasket or the pneumatic system component with a new one.
17. Tighten the polyamide pipe unions so that the pipes are not distorted.

CAUTION:
The polyamide pipes are used in the pneumatic system. Carefully protect them especially during the welding to prevent their damage.

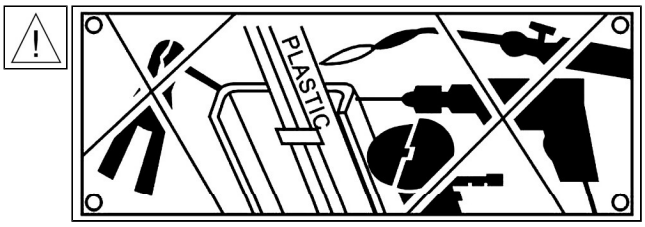


Fig. 9.10 Warning plate

9.5.2 Cleaning or Replacement of the Filter Element in the Condensate Sump

a) Reasons for Cleaning or Replacement

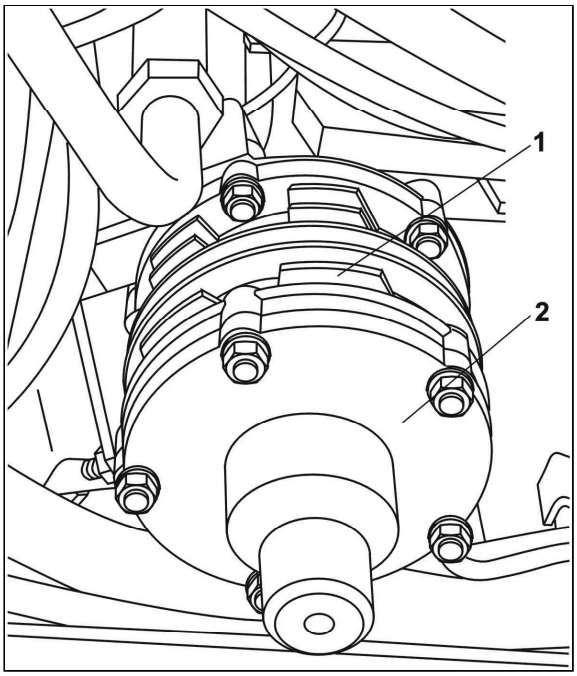
1. After covering every **20,000** km, after working of **600** eng. hrs and/or after consuming **8,000** ltr of fuel.

b) Technical Conditions

1. The length of the filter element must not be less than **3 cm** shorter than the bushing in which it is situated in the separator.

c) Cleaning or Replacement Procedure

1. Remove the lower cover **2** of the condensate sump **1**.



Legend: ***1****- condesate sump body,* ***2*** *- lower cover of condesate sump.*

Fig. 9.11 Condensate sump diassemly

2. Remove the ribbed bushing with the filter element.

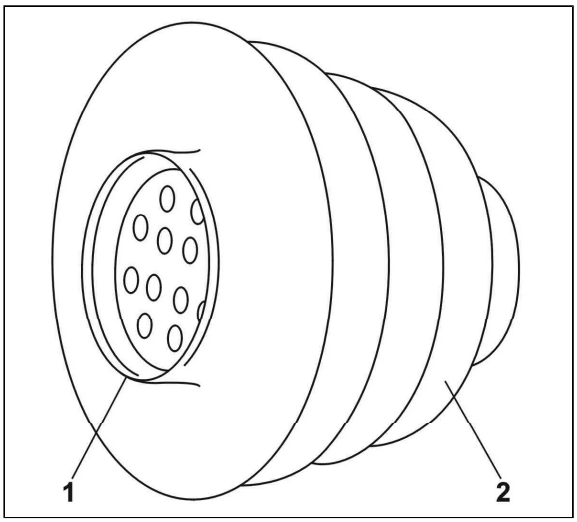
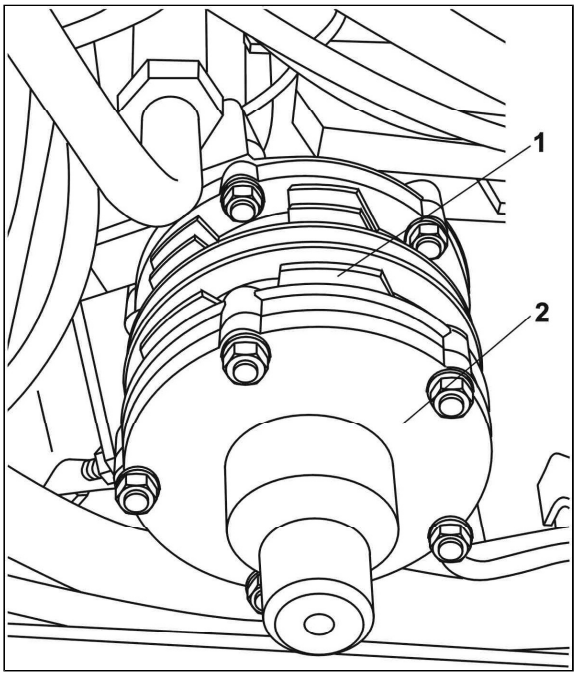


Fig. 9.12 Condensate sump insert

3. Clean the filter element and the ribbed bushing in the cleaning petrol. If the filter element is more than **3 cm** shorter than the bushing in which it is placed in the separator, replace the filter element with a new one.
4. Reinstall the filter element into the ribbed bushing and use the perforated cap to close it.
5. Reinstall the ribbed bushing into the condensate sump body **1** and and the lower cover **2**.



Legend: ***1****- condesate sump body,* ***2*** *- lower cover of condesate sump.*

Fig. 9.13 Condensate sump assembly

CAUTION:
Make sure that the sealing ring in the upper part of the condensate sump is in a good condition and take care that it does not suffer damage during installation.

9.5.3 Replacement of the Air Drier Filter

a) Reasons for Removal and Installation

1. Always after two years of operation.
2. Reduce the filter replacement interval to a half when the vehicle operates permanently in the dusty or humid environment.

b) Technical Conditions

1. At replacement install a new filter of such according to the Catalogue of Spare Parts.
2. Dispose of the used filter as the dangerous waste.

c) Removal Procedure

1. Drain the air from the pneumatic system using the manual drain valves installed on air reservoirs.

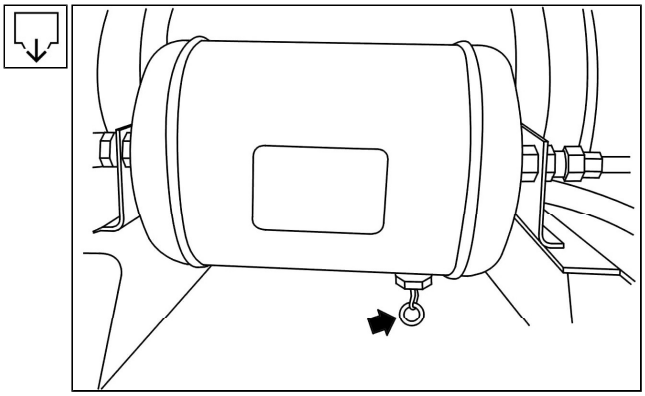


Fig. 9.14 Drain valve location

2. Manually turn the filter **1** anticlockwise to release it from the condensate drier body (and/or you can use the filter band wrench ∅ 160 mm).

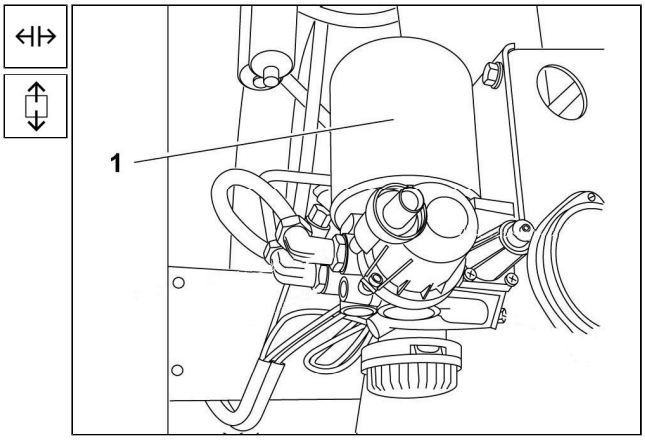


Fig. 9.15 Air drier filter removal

d) Installation Procedure

1. Clean the filter thread and apply the grease to the sealing ring on a new filter.
2. Install a new filter **1** and tighten it manually (tightening specification is about **20 Nm**).
3. Make sure that joints and threaded unions of the air drier are not leaky (check an audible sound of leaky spots).

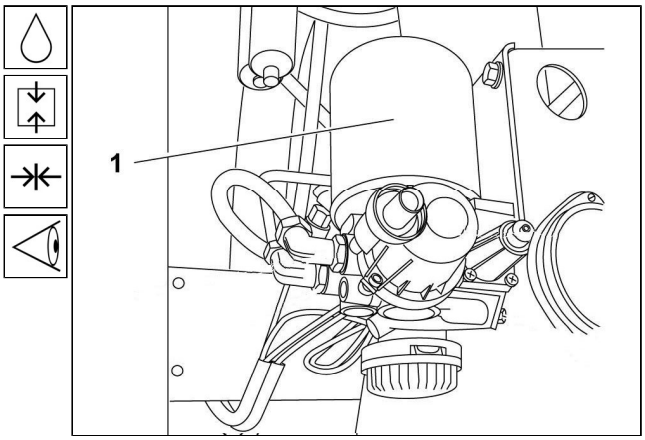


Fig. 9.16 Air drier filter installation

9.5.4 Inspection of the Tightness and Function of the Pneumatic System

a) Reason for the Inspection

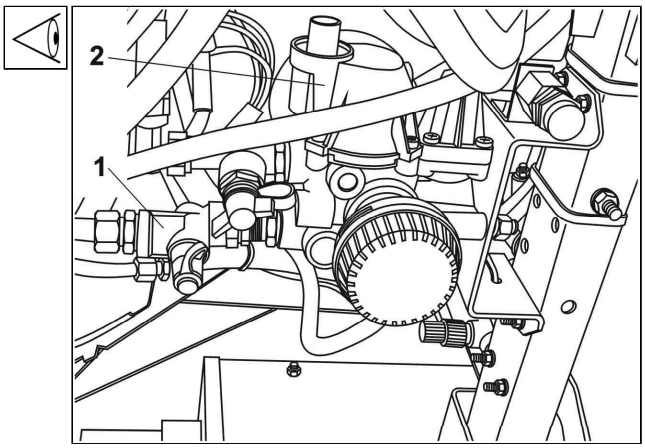
1. Under a cloud of the pneumatic system leakage.

b) Technical Conditions

1. The pneumatic system has been pressurized to the maximum operating pressure.
2. The vehicle is secured with the parking brake and chocks against motion and the engine is at standstill.

c) Inspection Procedure

1. Leave the engine running to fill the vehicle pneumatic system with the pressure air to the maximum operating pressure – check the course of the pressure air filling on the signal lamp indicating the air overpressure in the circuit of the emergency and parking brake (must switch off at **0.63 MPa** (**6.3 kg/sq.cm**)), on the signal lamp indicating the air overpressure in both circuits of the service brake (must switch off at)and on the double air pressure gauge on the instrument board.
2. Use your ears to check whether there is no air leakage from pipe unions and threaded unions of the pneumatic system instruments. In case that you are not quite sure about it or you cannot identify the leakage spot precisely, use the brush to apply the soap water to this place – the air bubbles will go out at the air leakage.
3. Should you find the air leakage, proceed according to chapter (See Subchapter **9.5.1**) and/or other chapters referring to the replacement of individual pneumatic system components.



Legend: ***1*** *- tire inflator,* ***2*** *- air drier with integrated pressure regulator*

Fig. 9.17 Tire inflator location

4. Visually check the manifolds, hoses, pipe unions, air reservoirs, fastening elements and individual instruments of the pneumatic system if they are in a good condition. Check whether they are attached properly, check if they have not been damaged or corroded.
5. Make sure that the tyre inflator **1** (thread is in a good condition, check whether it is not leaky and if it works properly so that you install the inflation hose out of the vehicle equipment to it. The tyre inflator is situated ahead of the air drier **2**. When the hose is screwed on, the air leaks from the tyre inflator. Before its installation (after removal of the closing nut from the tyre inflator) and after its removal, no air must escape from the tyre inflator.

6. Should you find that the tyre inflator is faulty, replace it (See Subchapter **9.5.9**).
7. Check the hand-operated drain valves on air reservoirs for function so that you deflect the lever (See Fig. **9.18**).

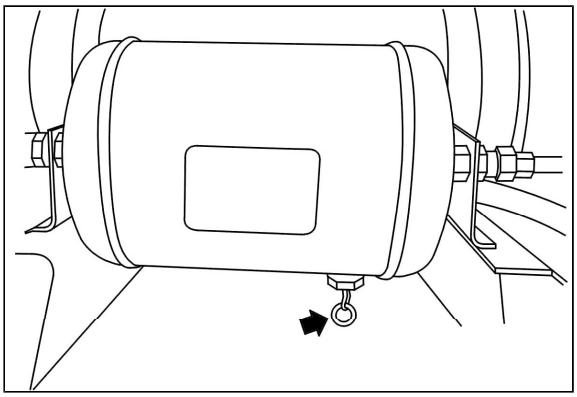


Fig. 9.18 Drain valve location

Note:
The condensate may settle in air reservoirs during operation in the very humid environment. Deflect the lever of the manual drain valve under the operating air pressure in the pneumatic system to drain the condensate. Should the condensate occur repeatedly under the normal operating humid conditions, it is necessary to replace the air drier filter element in accordance with the procedure mentioned in chapter (See Subchapter **9.5.3**) and/or to clean the condensate sump in accordance with the chapter (See Subchapter **9.5.2**). After moving the lever of the manual drain valve to the initial position, no air must escape from the drain hole of the manual drain valve.

8. Should you find that the manual drain valve is faulty, replace it.
9. Check whether the brake pedal has been installed properly – move it to check its attachment and travel, proceed according to the chapter (See Subchapter **9.5.5**).

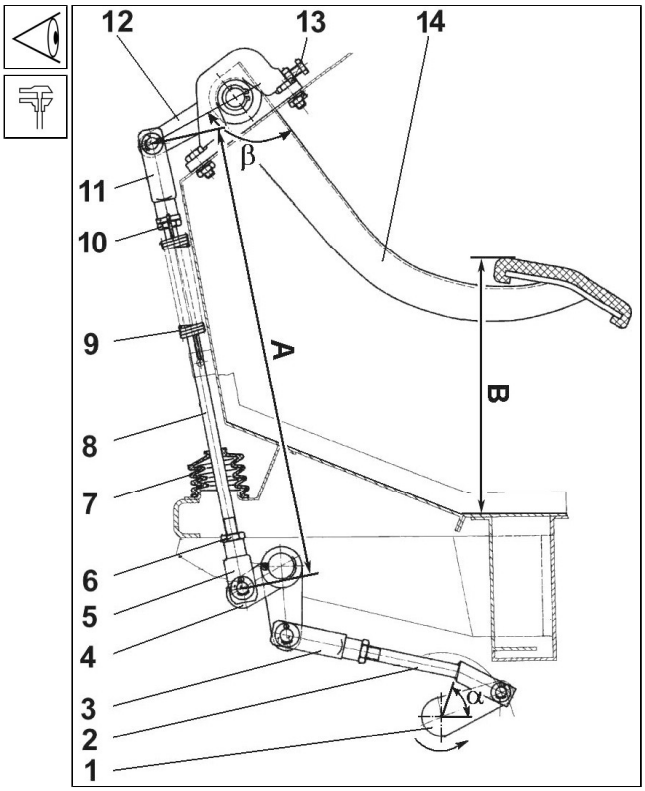
9.5.5 Inspection and Adjustment of the Master Brake Valve

a) Reasons for the Inspection

1. It seems that the master brake valve control works improperly.
2. After replacement of the master brake valve.
3. After removal and installation of the master brake valve control mechanism.

b) Technical Conditions

1. The vehicle is secured with the parking brake, the engine is at standstill and the pneumatic system is pressurized to the operating pressure.
2. Setting and checking values -
   A = 357 mm
   B = 197 mm
   α = 50°
   B = 97° ± 1°



Legend: ***1,4,12****-lever,* ***2,8****-tie-rod,* ***3,5,11****-fork,* ***6,10****-nut,* ***7****-bushing,* ***9****-return spring,* ***13****-adjusting screw,* ***14****-brake pedal*

Fig. 9.19 Master brake valve control mechasnism

Note:
At the full brake pedal **5** depressing the pedal must not touch the cab's floor or other cab's parts with its lower edge.

c) Inspection Procedure

1. Check the tie-rods and levers of the control equipment for a good condition - no visible deformations are allowable.
2. Check the distance **'A'** (See Fig. **9.19**), if need be, adjust it by screwing or unscrewing the fork **11.**

Prior to start with setting, it is necessary to loosen the adjusting nut **10** and to disconnect the fork **11** from the lever **12** by sliding the connecting pin out (after removal of split pin) **.** On termination of setting, connect the fork **11** to the lever **12** again by sliding in the connecting pin, secure with a split pin (use a new one) and tighten the lock nut **10** .

3. Check the distance **'B'** , if need be, adjust it to the specified value by the adjusting screw **13** after loosening its lock nut. Retighten the lock nut after adjustment again.
4. Check the angle **' '** (a free travel of the lever **1**), if need be, adjust it by screwing or unscrewing the fork **3** on the tie-rod **2** . Adjust the free travel of the lever **1** in the arrow direction.
5. On termination of adjustment, depress the brake pedal and make sure that the brake pedal does not come in contact with the cab's floor.

9.5.6 Inspection of the Air Pressure Regulator

a) Reasons for Inspection

1. When it seems that the air pressure regulator is not functioning properly;
2. During technical servicing after covering **2,500 - 3,000 km** and after covering the first **10,000 km** or after **6 months of operation** (whichever occurs first).

b) Technical Conditions

1. The vehicle parking brake is set on, chocks are put behind the wheels to secure the vehicle against motion and the engine is cold.
2. The authorized service station may carry out this inspection.
3. Use the check pressure gauge with the range of **1.5 MPa** (**15 kg/sq.cm**) and the accuracy class up to **1.5 %** to check the air pressures.

c) Inspection Procedure

1. Use manual drain valves to drain the compressed air from all air reservoirs.

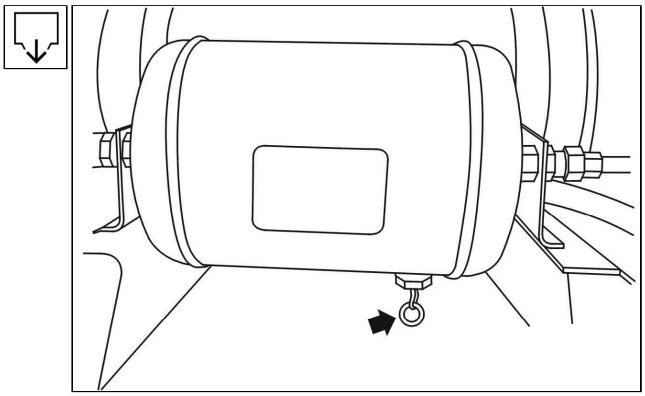
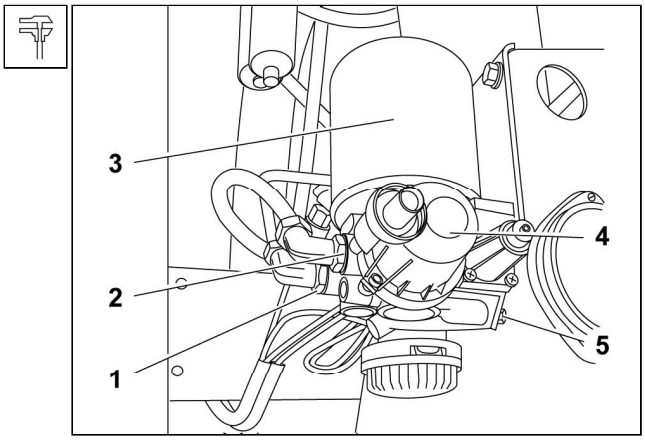


Fig. 9.20 Drain valve

2. Dismount the pipe elbow **2** from outlet '2' on the air drier body with integrated pressure regulator **4**.



Legend: ***1***,***2****-pipe elbow,* ***3****-filter,* ***4****-air drier c/w pressure regulator,* ***5****-nut*

Fig. 9.21 Air pressure regulator

3. Mount the check pressure gauge to outlet “2” on the air drier body with integrated pressure regulator.
4. Start the engine and leave it running at idle speed.
5. Watch whether no air leaks from the noise damper in the bottom of air drier c/w pressure regulator body in the space of air drier c/w pressure regulator location.
6. Watch the “blow-off” of the air pressure regulator via the noise damper, which should come after reaching the maximum air pressure in the system, i.e. **0.85 $^{-0.04}$ MPa** (**8.5 $^{-0.4}$ kg/sq.cm**), (measured by the check pressure gauge on the outlet “2”) and make sure that the pressure is not increasing any more. The “blow-off” must be audibly heard and the sound should be sharp.
7. After the “blow-off” the compressor release follows (you can hear that noise and knocking sound level of the compressor are decreased) and the compressed air is blown off via the noise damper in the bottom of the air drier with integrated air pressure regulator.
8. Shut the engine off.

9.5.7 Removal and Installation of the Condensate Sump

a) Reasons for Removal

1. Mechanical damage to the body of condensate sump or its ribbing.
2. Mechanical damage to threads.

b) Technical Conditions

1. No pressure in the pneumatic system.
2. Use new WABCO “O” sealing rings during installation.

c) Removal Procedure

1. Release all the air from all air reservoirs via manual drain valves.

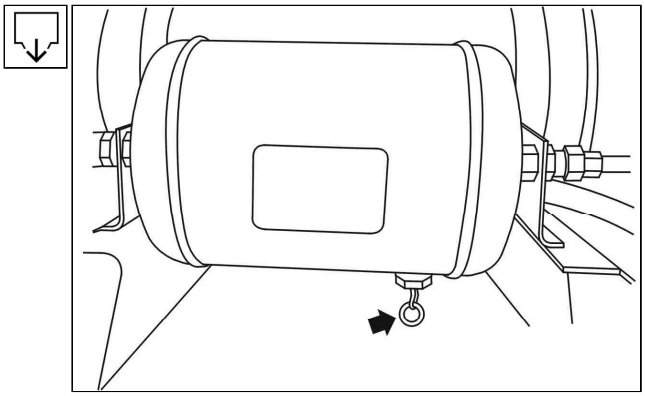
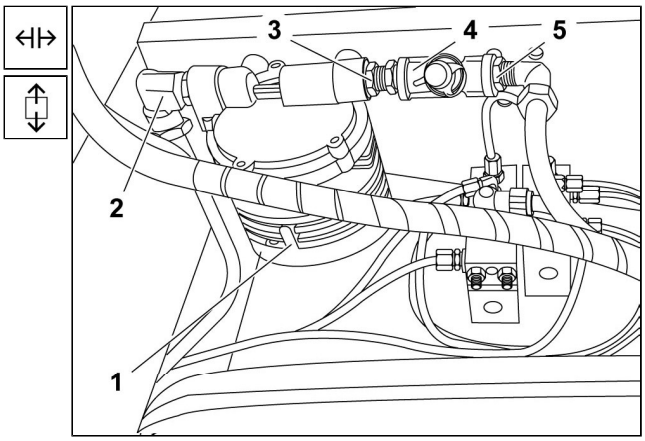


Fig. 9.22 Drain valve

2. Disconnect the air manifold from the pipe elbow **2** of the condensate sump **1** and unscrew the pipe elbow.



Legend: ***1****-condensate sump,* ***2****-pipe elbow,* ***3****,****5****-nut,* ***4****-tyre inflator*

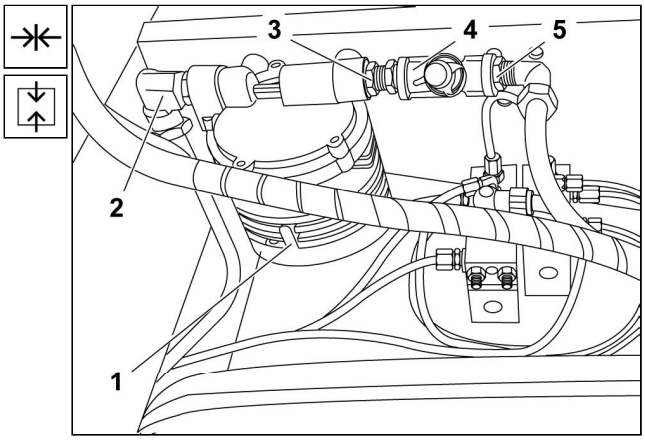
Fig. 9.23 Removal of condensate sump

3. Loosen nuts **3** and **5** and dismount the tire inflator **4**.
4. Unscrew nuts, which attach the condensate sump **1** to bracket and move the condensate sump out.

5. Further on, proceed as mentioned in general instructions for the replacement of pneumatic system components (See Subchapter **9.5.1**).

d) Installation Procedure

1. Unplug holes of a new condensate sump.
2. Screw the pipe elbow **2** and screwed connection with the tire inflator **4** into necks of the condensate sump **1**.



Legend: ***1****-condensate sump,* ***2****-pipe elbow,* ***3****,* ***5****-nuts,* ***4****-tyre inflator*

Fig. 9.24 Installation of condensate sump

3. Tighten the nut **3** to secure the tire inflator in position.
4. Fit the condensate sump with stud bolts into holes in the bracket and screw the sump to bracket using nuts and spring washers.
5. Attach the air manifold to the pipe elbow **2**.
6. Start the engine and check it for function while focusing on air leakage from screwed connections which were dismounted.

9.5.8 Removal and Installation of the Air Drier c/w Pressure Regulator

a) Reasons for Removal

1. If the air pressure behind the instrument in the source circuit does not reach the specified values **0.85 $^{-0.04}$ MPa** (**8.5 $^{-0.4}$ kg/sq.cm**).
2. If the instrument freezes at ambient temperature below the freeze point (heating is not functioning).
3. Mechanical damage to threads.

b) Technical Conditions

1. No air pressure in the pneumatic system.
2. Tightening torques of screwed connections on the pressure regulator for attachment of PA pipes: **22 - 26 Nm** for screw **M 12** and **36 - 44 Nm** for screw **M 22**.
3. Use new sealing rings and WABCO “O” rings during installation.

c) Removal Procedure

1. Drain all air from all air reservoirs via manual drain valves.

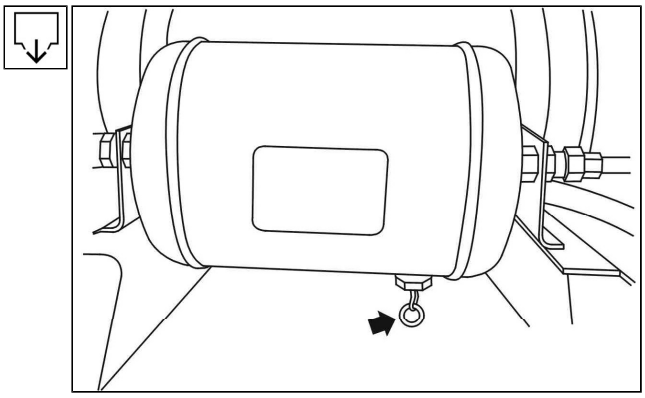
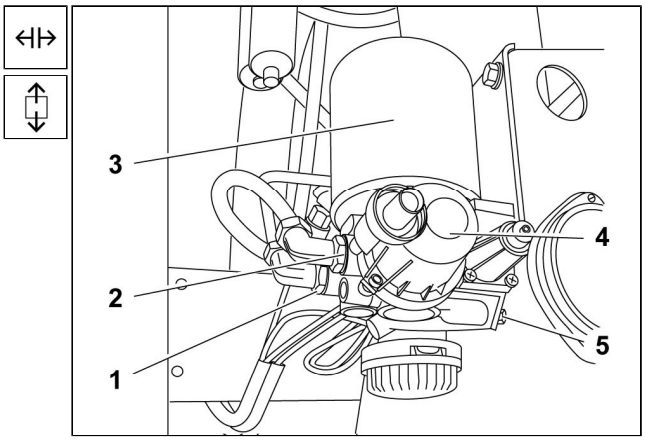


Fig. 9.25 Drain valve

2. Dismount pipe elbows **1** and **2**, which attach the air manifolds to the air pressure regulator **4**.



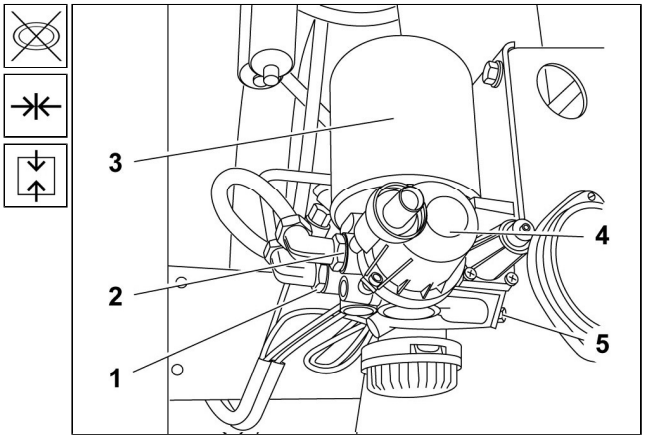
Legend: ***1***,***2****- pipe elbow,* ***3****-filter,* ***4****-air drier c/w integrated pressure regulator,* ***5****-nut*

Fig. 9.26 Removal of air drier c/w pressure regulator

3. Unplug the heating electrical connector.
4. Unscrew nuts **5** and move the air drier c/w pressure regulator **4** away from bracket.
5. Further on, proceed as per general instructions valid for the replacement of pneumatic system components (See Subchapter **9.5.1**).

d) Installation Procedure

1. Unplug holes of a new air drier c/w pressure regulator.
2. Screw the pipe elbows **1** and **2**, fit the air drier c/w pressure regulator with stud bolts into holes in the bracket, fit washers, spring washers and tighten the nuts **5**.



Legend: ***1***,***2****- pipe elbow,* ***3****-filter,* ***4****-air drier c/w integrated pressure regulator,* ***5****-nut*

Fig. 9.27 Installation of air drier c/w pressure regulator

3. Attach disconnected air manifolds to pipe elbows **1** and **2** on the body of the pressure regulator.
4. Plug the heating electrical connector.
5. Start the engine and check the air drier c/w pressure regulator for a correct function while focusing on air leakage from screwed connections which were dismounted.

Note:
The inspection procedure of the pressure regulator is mentioned in the Subchapter (See Subchapter **9.5.6**).

9.5.9 Removal and Installation of the Tyre Inflator

a) Reasons for Removal and Installation

1. During leakage – it manifests in air leakage after removal of the closing nut or after unscrewing the hose for the tyre inflation.
2. At mechanical damage to the tyre inflator threads.

b) Technical Conditions

1. No pressure in the pneumatic system.
2. Use new sealing rings for screwed joints during installation.

c) Removal and Installation Procedure

CAUTION:
The tyre inflator removal and installation is a part of the working procedure mentioned in (9.5.7)

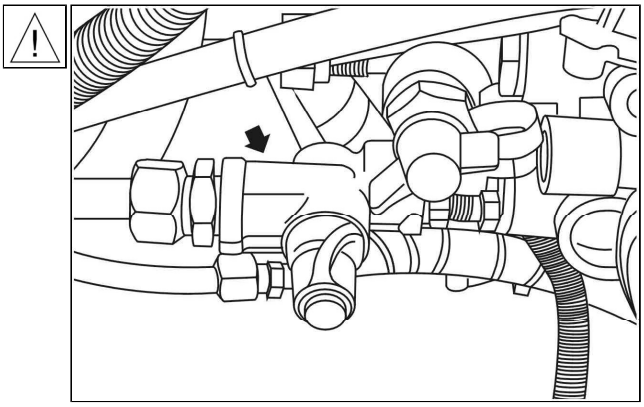


Fig. 9.28 Tire inflator

9.5.10 Removal and Installation of the Four-circuit Valve

a) Reasons for Removal and Installation

1. The four-circuit relief valve does not work properly (some of the circuits is not filled).
2. The four-circuit relief valve is leaky.
3. Some inner thread in the four-circuit relief valve has been damaged.

b) Technical Conditions

1. There is no pressure in the pneumatic system.
2. Tightening torques of screwed connections: **32 - 38 Nm** for screw **M16**
3. Use of new sealing rings of pipe unions and a new cable clamp during installation.
4. Use of pressure gauges with the range of **1.5 MPa** (**15 kg/sq.cm**) and the accuracy class to **1.5 %** (3 pcs).

c) Removal Procedure

1. Brake up the vehicle with the parking brake and shift the neutral in the transmission.
2. Drain all the air from all air reservoirs through drain valves.

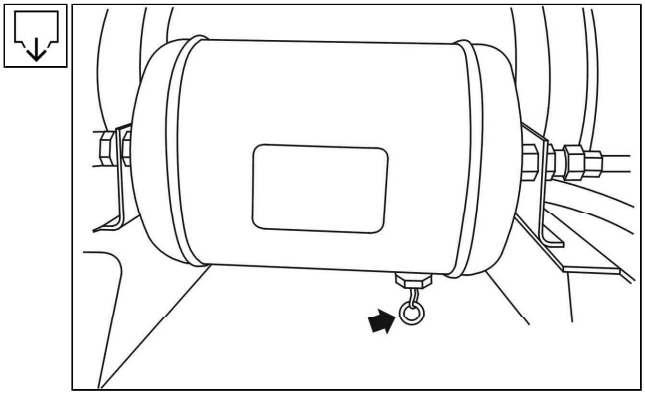
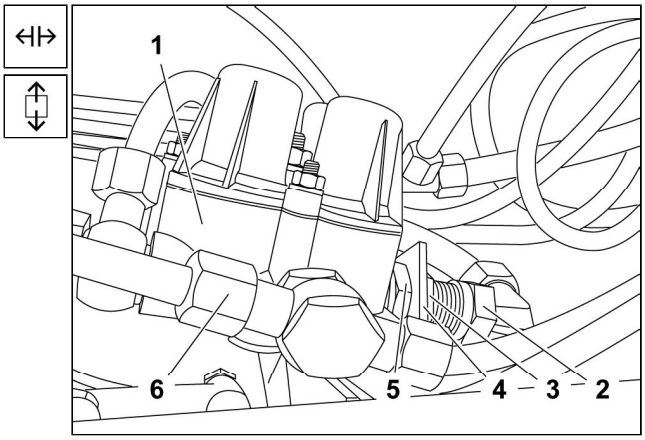


Fig. 9.29 Drain valve

3. Remove the plastic cable clamp, which connects the individual air manifolds leading to the relief valve **2** (into one bundle.
4. Mark and detach all air manifolds from the four-circuit relief valve. Figures on the four-circuit relief valve body mark the individual necks as follows:

- *„1“*– air inlet,
- *„21“* – air outlet for the 2nd axle circuit,
- *22“* - air outlet for the 1st axle circuit,
- *„23“* – air outlet for the circuit of emergency an parking brake,
- *„24“* – air outlet for the circuit of the control system.



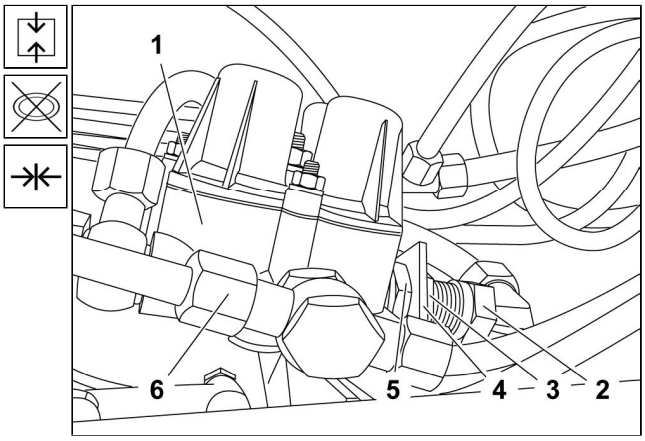
Legend: ***1*** *- four circuit valve,* ***2, 6*** *- air manifold,* ***3, 5*** *- nut,* ***4*** *- bracket*

Fig. 9.30 Four-circuit valve removal

5. Loosen the nut **3** and move the four-circuit valve **1** out of the orifice in a bracket **4** of the auxiliary frame.
6. Further on, continue in accordance with the general rules for the replacement of pneumatic system components (See Subchapter **9.5.1**).

d) Installation Procedure

1. Unplug holes of a new relief valve.
2. Install respective pipe unions and manifolds and gently tighten them only. Use the new sealing rings.
3. Put the four-circuit valve **1** in the orifice of the bracket **4** of the auxiliary frame, screw on and tighten the nut **3**.
4. Firmly tighten pipe unions of connected manifolds.
5. Use a new cable clamp to connect the attached manifolds in the distance of about **20 cm** from the four-circuit relief valve.
6. Start the engine and pressurize the system to the operating pressure.
7. Shut off the engine and check the brake system for function while focusing on the air leakage from the screwed pipe unions of the four-circuit relief valve, which were removed. You can recognize the air leakage by an audible sound.



Legend: ***1*** *- four circuit valve,* ***2, 6*** *- air manifold,* ***3, 5*** *- nut,* ***4*** *- bracket*

Fig. 9.31 Four-circuit valve installation

e) Four-circuit valve functional check

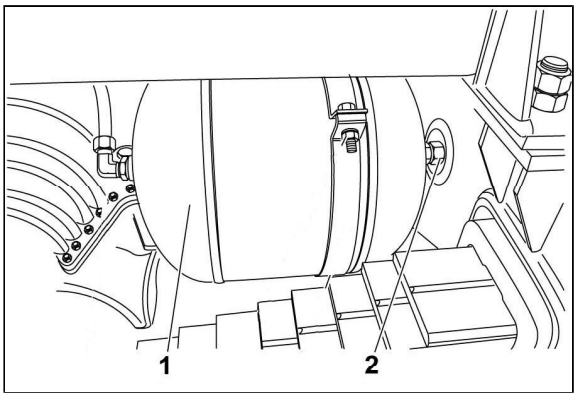
1. Connect 3 pieces of the pressure gauges to the relief valve individual outlets in order according to the following table.

Tab. 9.3 Air pressure measuring during the relief valve functional check

Outlet	Measurements order and pressures			
	1.	**2.**	**3.**	**4.**
'21'	**fault**	500 kPa (5.0 kg/sq.cm)	500 kPa (5.0 kg/sq.cm)	500 kPa (5.0 kg/sq.cm)
'22'	500 kPa (5.0 kg/sq.cm)	**fault**	500 kPa 5.0 kg/sq.cm)	500 kPa (5.0 kg/sq.cm)
'23'	520 kPa (5.2 kg/sq.cm)	520 kPa (5.2 kg/sq.cm)	**fault**	520 kPa (5.2 kg/sq.cm)
'24'	500 kPa (5.0 kg/sq.cm)	500 kPa (5.0 kg/sq.cm)	500 kPa (5.0 kg/sq.cm)	**fault**

Four-circuit valve outputs to connect the pressure gauges as follows:

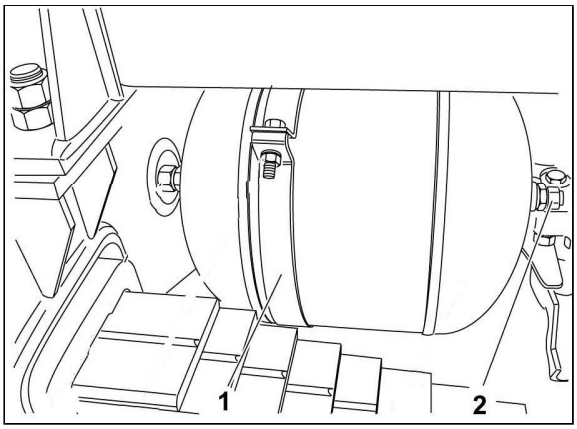
- Output Nº *"21"* – check connection on the air reservoir of the 2nd brake circuit.



Legend: ***1****-air reservoir,* ***2****-check connection*

Fig. 9.32 Check connection of the 2nd brake circuit

- Output Nº *"22"* – check connection on the air reservoir of the 1st brake circuit.



Legend: ***1****-air reservoir,* ***2****-check connection*

Fig. 9.33 Check connection of the 1st brake circuit

- Output Nº *"23"* – on the relief valve body after removal of the screwed joint.
- Output Nº *"24"* – on the relief valve body after removal of the screwed joint.

2. Pressurize the system to the operating pressure (breaking pressure after air pressurer regulator „blow-off").
3. Simulate step by step the faults at outlets No."21" to „24" (by bleeding to the zero overpressure – at the table marked as **„fault"**) and check the pressure values at remaining circuits by pressure ganges. Circuit pressure values should be the same or greater than values from (See Tab. **9.3**).

9.5.11 Removal and Installation of the By-pass Valve

a) Reasons for Removal and Installation

1. The by-pass valve is not working properly (the required air pressure is not available in air bellows springs).
2. The by-pass valve is leaky.
3. Some inner thread in the by-pass valve has been damaged.

b) Technical Conditions

1. No air pressure in the pneumatic system including air bellows springs.
2. Use new sealing rings for screwed joints during installation.

c) Removal Procedure

1. Drain all the air from all air reservoirs using the manual drain valves.

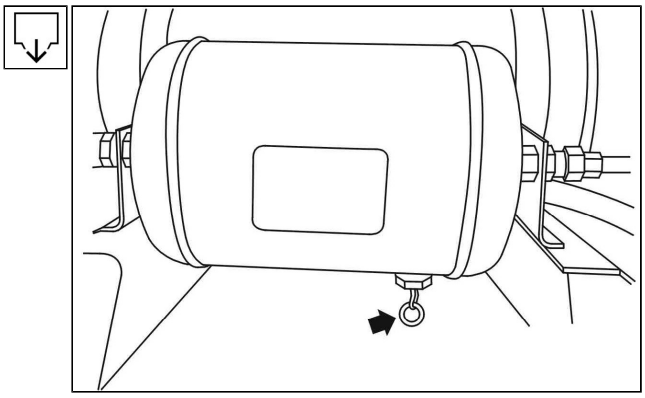


Fig. 9.34 Drain valve

2. Unscrew the connected manifold and pipe elbow **1**.
3. Unscrew the pipe extension **2** from the body of the back-pressure valve **3** .
4. Unscrew the back-pressure valve **2** from the screwed connection **4** of the relief valve.

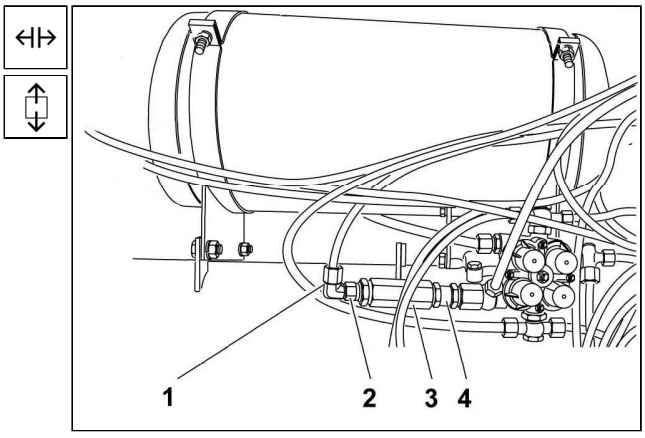


Fig. 9.35 Removal of the by-pas valve

d) Installation Procedure

1. Mount the back-pressure valve **3** c/w new sealing ring on the screwed connection **4** of the four-circuit valve and tighten it .

   Note:
   Keep the correct position so that the **arrow stamped on the body of the back-pressure valve 3 is directed away from the relief valve !**

2. Mount the pipe extension **2** and pipe elbow **1** into the back-pressure valve. Use a new sealing ring!
3. Attach the disconnected manifolds of the pipe elbow **1** .
4. Start the engine, pressurize the vehicle pneumatic system to the operating pressure and check the brake system for air leakage while focusing on the air leakage from the screwed connections, which were removed. Listen to the connection if no sound of air leakage comes out.

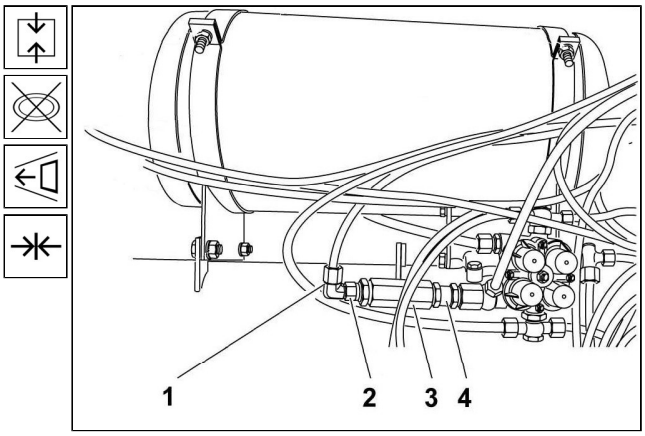


Fig. 9.36 Installation of the by-pas valve

9.5.12 Removal and Installation of Air Reservoirs

a) Reasons for Removal and Installation

1. At mechanical damage.
2. When the air reservoir jacket has corroded.
3. Because of the air reservoir inspection.

b) Technical Condition

1. The pneumatic system is not pressurized
2. Use of new sealing rings during installation.

c) Removal Procedure

1. Drain the pressure air from all air reservoirs.

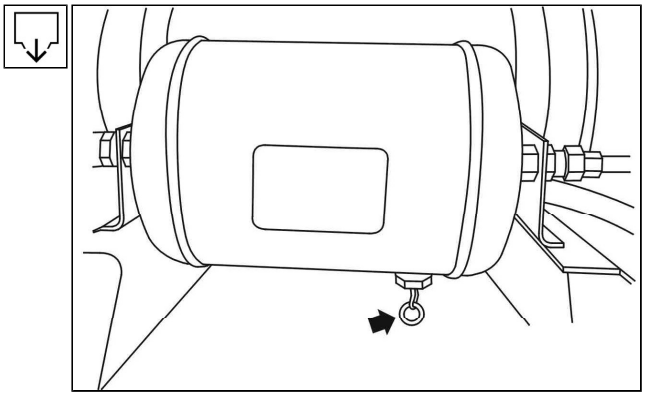


Fig. 9.37 Drain valve

2. Remove the individual air manifolds pipe unions from the air reservoir body.
3. Dismount screwed joints **3**, which attach the air reservoir holders **1** to backbone tube brackets or auxiliary frame (according to the variants of air freservoirs).
4. Remove air reservoirs with holders.
5. Loose and unscrew the connecting screws **2** of air reservoir holders and shift the air reservoirs out of holders.
6. Further on, continue in accordance with the general rules for the replacement of pneumatic system components (**9.5.1**).

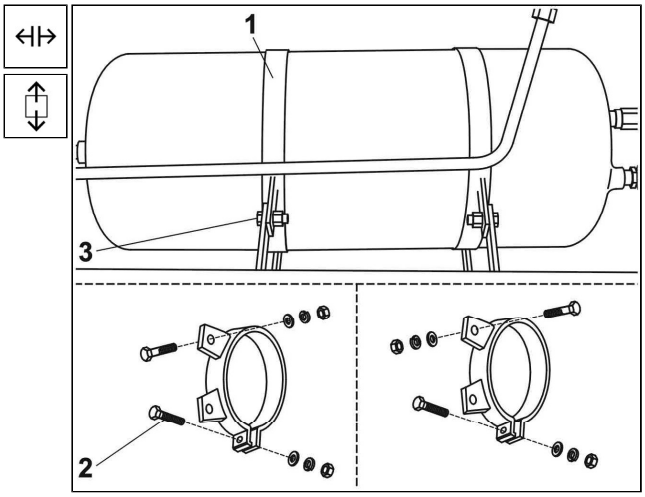


Fig. 9.38 Air Reservoirs - removal

d) Installation Procedure

1. Unplug holes of a new air reservoir.
2. Install the air reservoir holders **1** to the respective air reservoir.
3. Install air reservoir holders with air reservoirs to the backbone tube bracket or auxiliary frame (in accordance with the version of the pertaining air reservoir). Use screw **3** for bracket attachment.

   Note:
   Keep the vertical position of all drain valves and the reducing valve at the source air reservoir.

4. Firmly tighten the connecting screws **2** of air reservoir holders.
5. Install and tighten the individual pipe unions of air manifolds into the air reservoir body. Use the new sealing rings.
6. Start the engine and check it for function while focusing on the air leakage from pipe unions, which were removed.

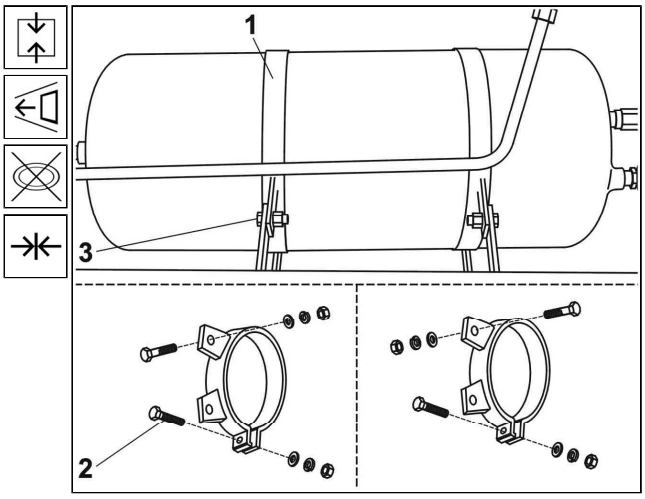


Fig. 9.39 Air Reservoirs - installation

9.5.13 Removal and Installation of the Master Brake Valve

a) Reasons for Removal

1. The master brake valve is leaky, the air leaks permanently from vent holes during braking or after brake releasing.
2. A slow air pressure drop after releasing of the brake pedal in the pneumatic system.
3. Some of inner threads of the brake valve threads have been stripped or sealing surfaces have been damaged and the brake valve has become leaky.

b) Technical Conditions

1. There is no pressure in the pneumatic system.
2. Tightening torques of screwed connections: **32 - 38 Nm** for screw **M 16**, and **24 Nm** for fastening bolt nuts **M 8**.
3. Use of pressure gauges with the range of **1.5 MPa** (**15 kg/sq.cm**) and the accuracy class to **1.5 %** (2 pcs).

c) Removal Procedure

1. Fully release (to zero value) the pressure air from both circuit air reservoirs and from the source air reservoir by means of manual drain valves.

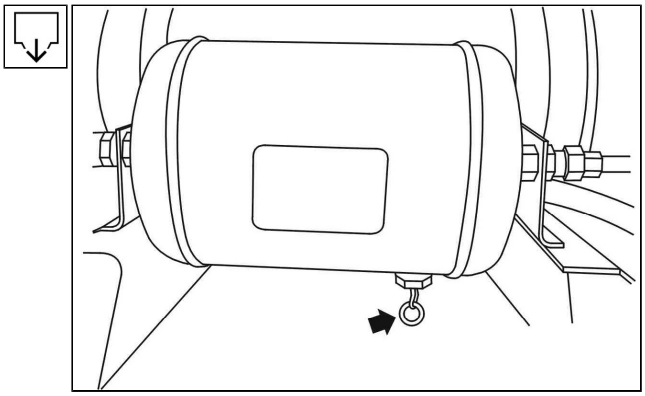
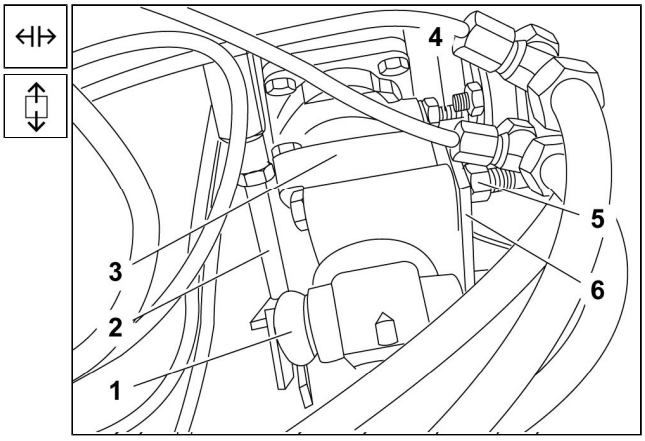


Fig. 9.40 Drain valve

2. Lift the cab's front bonnet.
3. Mark and detach air manifolds from the master brake valve **3**.



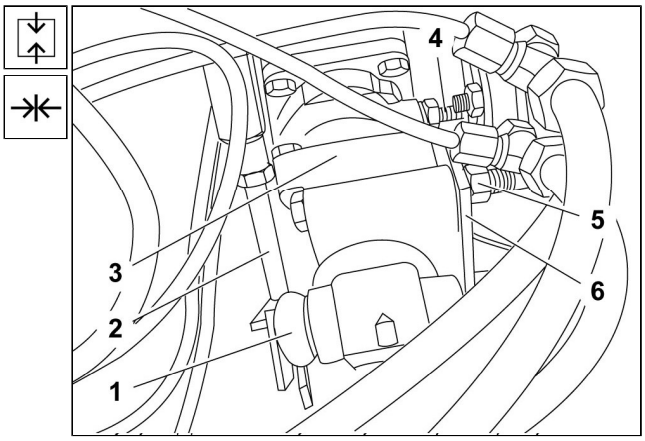
Legend: ***1****-lever,* ***2****-tie-rod,* ***3****-master brake valve,* ***4****-screw,* ***5****-nut,* ***6****-holder*

Fig. 9.41 Removal of master brake valve

4. Disconnect the control tie-rod **2** from lever **1** (See Subchapter **9.5.5**)
5. Loosen nuts **5** , which attach the master brake valve **3** by means of bolts **4** to holder **6** .
6. Move the master brake valve c/w bolts **4** away from the holder **6.**
7. Remove the master brake valve from vehicle.
8. Dismount all necks with pipe elbows from the brake valve and plug the holes in the brake valve to protect the space of master brake valve from dirt.
9. Further on, proceed as per valid principles for the replacement of pneumatic system components (See Subchapter **9.5.1**).

d) Installation Procedure

1. Mount respective necks and pipe elbows into outlets of a new or repaired master brake valve **3.**



Legend: ***1****-lever,* ***2****-tie-rod,* ***3****-master brake valve,* ***4****-bolt,* ***5****-nut,* ***6****-holder*

Fig. 9.42 Installation of master brake valve

2. Fit the master brake valve prepared as mentioned above with stud bolts into holes in the holder **6**.
3. Fit washers, spring washers and mount nuts **5** on bolts of the master brake valve **4**.
4. Tighten the nuts **5** to the specified torque as per point **b)**.
5. Screw all air manifolds on screwed connections of the master brake valve as marked. Tighten the through-bolts of connected air manifolds to the specified torque as per point **b)**.
6. Connect the tie-rod of the control equipment **2** to the brake valve control lever **1** and adjust the control equipment of the master brake valve (See Subchapter **9.5.5**).

Note:

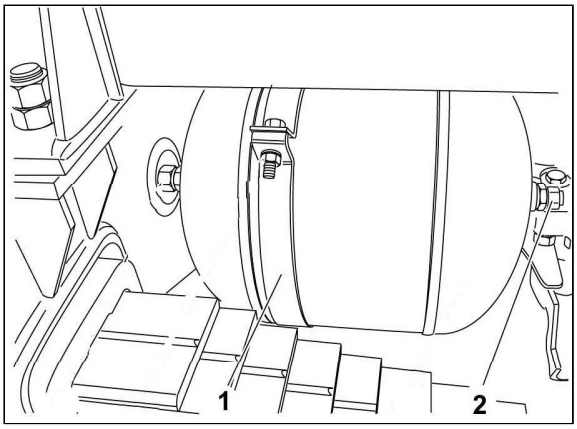
The numerical designations on the body of master brake valve:

- “11” - air inlet to brake valve for 1st circuit,
- “21” - control pressure for 1st circuit,
- “12” - air inlet to brake valve for 2nd circuit,

- "22" - control pressure for 2nd circuit.

e) Inspection Procedure of the Master Brake Valve Function:

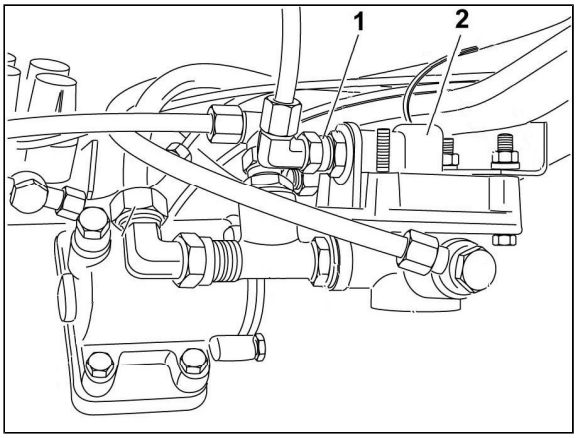
1. Start the engine and pressurize the pneumatic system to the specified pressure before checking the function.
2. To carry out the 1st circuit function inspection, install the check pressure gauge "**A**" on the check connection of the constant pressure, it means on the 1st circuit outlet ("22") from the relief valve. The check connection is situated on the rear 1st circuit air reservoir on the LH side of the vehicle.



Legend: ***1****-air reservoir,* ***2****-check connection*

Fig. 9.43 1st circuit check connection

3. Connect the check pressure gauge **"B"**to the screwed connection of the pipe elbow **1** after its disconnection from body of the control valve (inlet '4'), it means to inlet of 1st circuit "control" pressure (See Fig. **9.43**).



Legend: ***1****-pipe elbow,* ***2****-control valve*

Fig. 9.44 Connecting point of the pressure gauge to check the 1st circuit control pressure

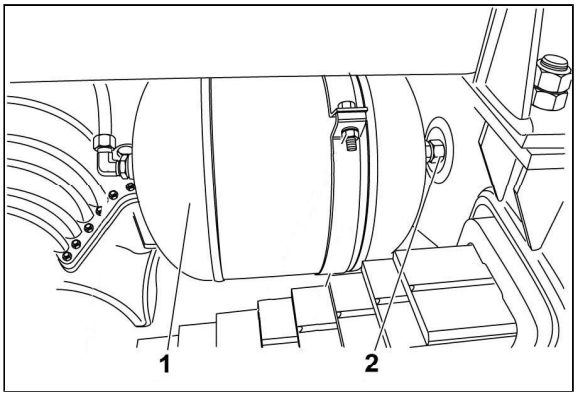
4. Carry out the inspection as mentioned below:

- with the brake pedal not depressed, the check pressure gauge **"B"** on the inlet of the 1st circuit control pressure on the control valve must indicate the zero pressure;
- clearance of the master brake valve control must correspond with the adjustment performed as per the procedure mentioned in the Subchapter (See Subchapter **9.5.5**);
- with the brake pedal fully depressed, the pressure on the pressure gauge **"B"** on the inlet of the 1st circuit control pressure on the control valve must be by max. **0.01 - 0.03 MPa** (**0.1 - 0.3 kg/sq.cm**) lower than the value **"A"** on the check pressure gauge (value of the instantaneous pressure in the system);

- with the brake pedal fully depressed, the brake pedal must not touch the cab's floor with a lower edge of the pedal part;
- no air leakage is allowed from screwed and other connections between the two-circuit master brake valve and connected manifolds.

5. To check the function of 2nd circuit, install the check pressure gauge **"A"** on the check connection of the 2nd circuit brake pressure on the brake cylinder of the 1st axle right-hand wheel.

6. Connect the check pressure gauge "**B**" to the check connectionof the constant pressure, it means to the 2nd circuit outlet ("22") from the relief valve. The check connection is situated on the rear 1st circuit air reservoir on the RH side of the vehicle.
7. Carry out this inspection: With the brake pedal not depressed, the pressure gauge "**A**" must indicate the zero pressure and the pressure gauge "**B**"must indicate the constant pressure in the circuit. When the brake pedal is fully depressed, the pressure gauge "**B**" must indicate the constant pressure and the pressure gauge "**A**" must indicate the pressure by **0.01 - 0.03 MPa** lower than that on the pressure gauge "**B**".



Legend: ***1****-air reservoir,* ***2****-check connection*

Fig. 9.45 2nd circuit check connection

9.5.14 Removal and Installation of the Manual Brake Valve

a) Reasons for Removal

1. The valve causes a permanent air leakage from the pneumatic system.
2. Some of inner threads have been stripped or seal surfaces have been damaged and the manual brake valve has become leaky.

b) Technical Conditions

1. No air pressure in the pneumatic system.
2. Tighten the screwed connection to the torque of **32 - 38 Nm** for screw **M 16**.
3. To check the air pressures, use the check pressure gauges with the range of **1.5 MPa** (**15 kg/sq.cm**) and the accuracy class to **1.5 %** (2 pcs).

c) Removal Procedure

1. Fully release (to zero value) the pressure air from all air reservoirs by means of manual drain valves.

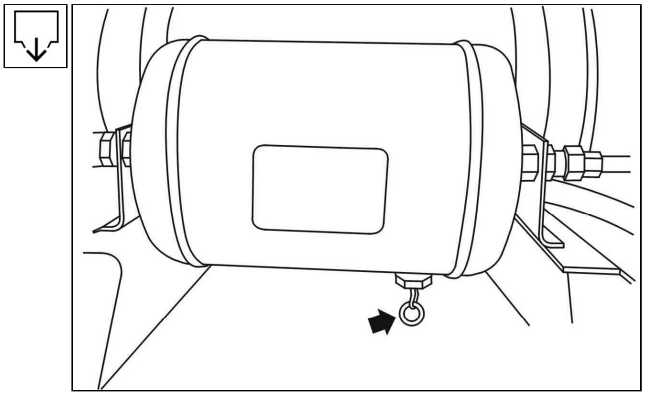
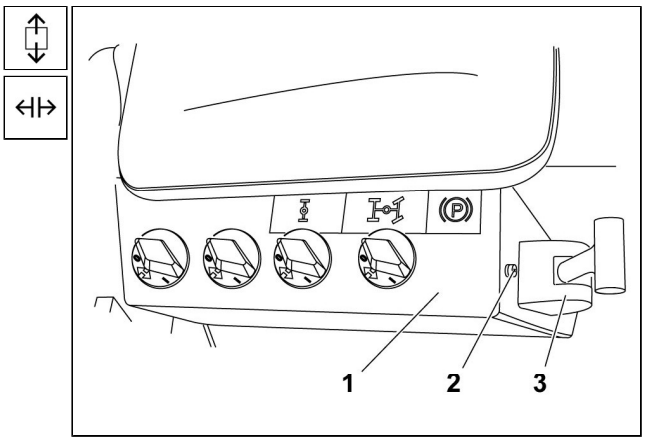


Fig. 9.46 Drain valve

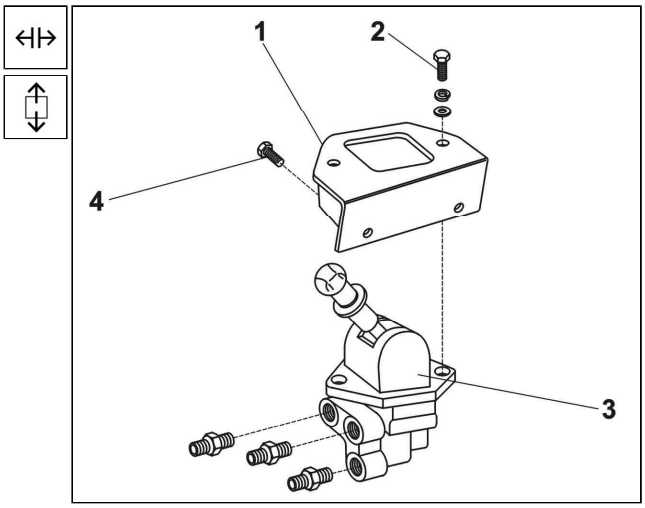
2. Unscrew screw **2**, withdraw heads of manual air cocks and dismount the plastic cover **1** (See Fig. **9.46**).



Legend: ***1****-cover,* ***2****-screw,* ***3****-manual brake valve*

Fig. 9.47 Removal of the manual brake valve cover

3. Dismount holder of the manual brake valve **1** .
4. Loosen screws **2** and dismount the manual brake valve **3** .
5. Carefully mark the individual manifolds of the manual brake valve (pay attention not to confuse them) and disconnect them.
6. Remove the valve from holder.
7. Further on, proceed as per valid principles valid for the replacement of pneumatic system components (See Subchapter **9.5.1**).



Legend: ***1*** *- holder,* ***2,4*** *- screw,* ***3*** *- manual brake valve*

Fig. 9.48 Removal of the manual brake valve

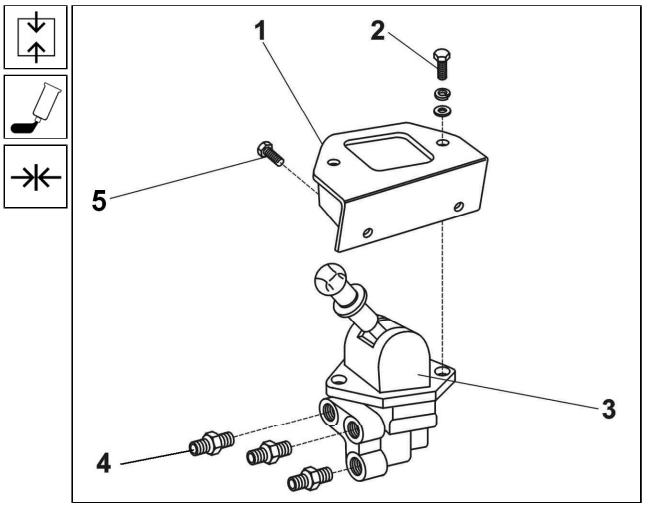
d) Installation Procedure

1. Unplug necks from a new manual brake valve.
2. Screw the screwed connection **4** into the valve and tighten to **32 - 38 Nm** .
3. Connect individual manifolds to screwed connections as marked.

   Note:
   The individual necks are marked on the body of the manual brake valve as follows:

   - *„1“*-pressure air inlet,
   - *„21“*-pressure air outlet to the emergency and parking brake control valve,
   - *„22“*-connection between the manual brake valve and trailer brake valve,
   - *„3“*- vent hole.

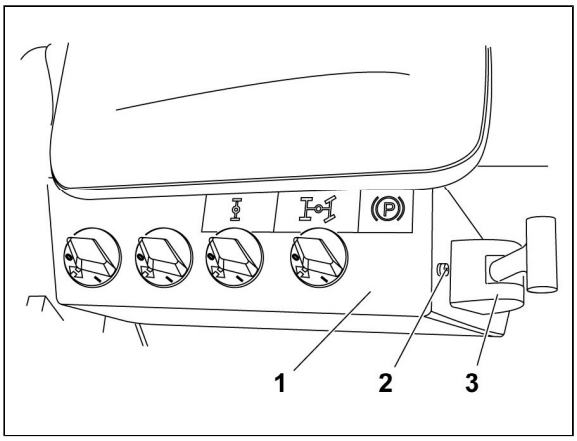
4. Install the manual brake valve **3** to holder **1** and tighten the screws **2** c/w washers and spring washers.
5. Gently apply the sealant **Loctite 270** to threads of screws **5** and attach the holder **1** c/w manual brake valve to the initial position.
6. Check the manual brake valve for a correct function as per article **e)**.



Legend: ***1*** *- holder,* ***2,5*** *- screws,* ***3*** *- manual brake valve,* ***4*** *- screwed connection*

Fig. 9.49 Installation of the manual brake valve

7. Reinstall the plastic cover **1** and fit heads of manual air cocks.

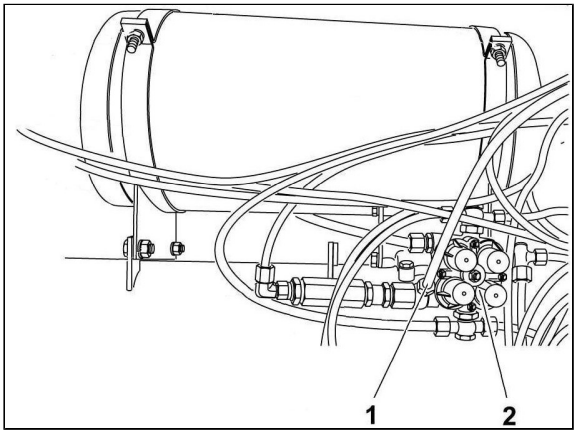


Legend: ***1****-cover,* ***2****-screw,* ***3****-manual brake valve*

Fig. 9.50 Installation of the manual brake valve cover

e) Inspection Procedure of the Emergency and Parking Brake Circuit Function

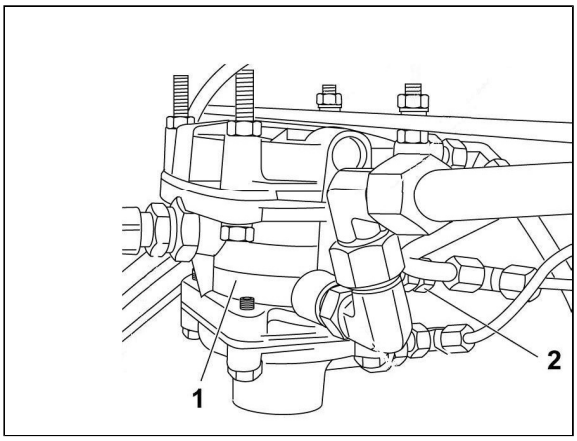
1. Dismount the connected air manifolds **1** from the outlet “23” of the four circuit valve.



Legend: ***1****-spot to connect the check pressure gauge,* ***2****-four-circuit valve*

Fig. 9.51 Inspection of the manual brake valve function - I

2. Connect the check pressure gauge " **A** " to outlet "23" of the four-circuit valve.
3. Detach the connected air manifolds **2** from inlet "43" of the multi-circuit trailer brake valve.
4. Connect the check pressure gauge " **B** "to inlet "43" of the multi-circuit trailer brake valve.



Legend: ***1****-trailer brake valve (multi-circuit),* ***2****-spot to connect the check pressure gauge*

Fig. 9.52 Inspection of the manual brake valve function II

5. Move the lever of the manual brake valve to the position "released" (I).

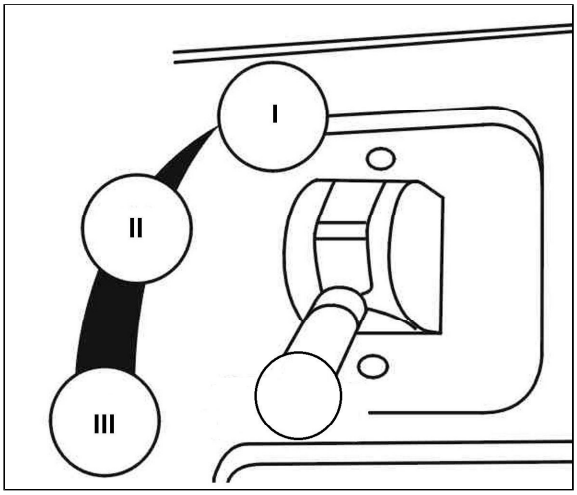


Fig. 9.53 Positions of the manual brake valve during inspection

6. Start the engine and pressurize the pneumatic system to the operating pressure.
7. Check pressures on pressure gauges: the pressure gauge "**A**"must indicate the instantaneous overpressure **0.85** $^{-0.04}$ **MPa** (**8.5** $^{+0.4}$ **kg/sq.cm**), the pressure gauge "**B**"must indicate the lower overpressure (**min. 0.60 MPa** (**6.0 kg/sq.cm**) - given by the characteristics of the control valve) than the instantaneous overpressure indicated on the pressure gauge "**A**".
8. Move the lever of the manual brake valve to position of the "maximum braking intensity" (II).
9. Check pressures on pressure gauges: the pressure gauge "**A**" must indicate the instantaneous overpressure in the pneumatic system; the pressure gauge "**B**" must indicate the zero overpressure.
10. Move the lever of the manual brake valve to position of "parking brake" (III).
11. Check pressures on pressure gauges: the pressure gauge "**A**"must still indicate the initial overpressure, the pressure gauge "**B**"must indicate the zero overpressure.
12. Dismount the pressure gauge from outlet '23' of the four-circuit valve and from inlet '43' of the multi-

circuit trailer brake valve and reconnect the disconnected manifolds.

13. Check all connections, which were dismounted, for leaks by listening whether no air comes out of them.

9.5.15 Removal and Installation of the Pressure Switch in the Emergency and Parking Brake Circuit

a) Reasons for Removal

1. At a defect in the electrical equipment - no air pressure is indicated in the circuit of emergency and parking brake (see Section Electrical and Special Equipment).
2. Some of inner threads have been stripped or sealing surfaces have been damaged and so the pressure switch has become leaky.
3. Use a new sealing ring during installation.

b) Technical Conditions

1. No air pressure in the pneumatic system.
2. Torque specification of the switch screwed connection: **36 - 44 Nm** for screw **M 22**.

c) Removal Procedure

1. Use drain valves on air reservoirs to release air from all air reservoirs.

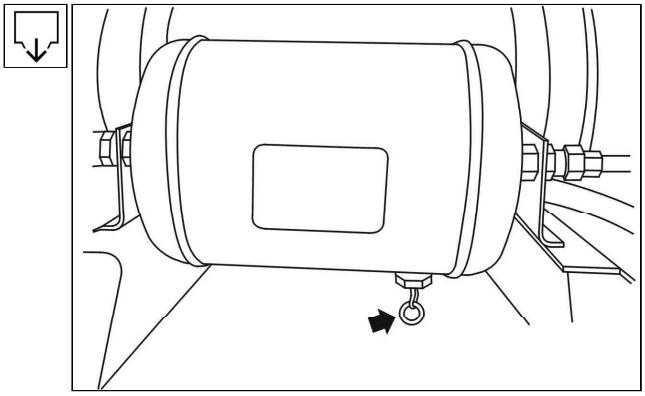
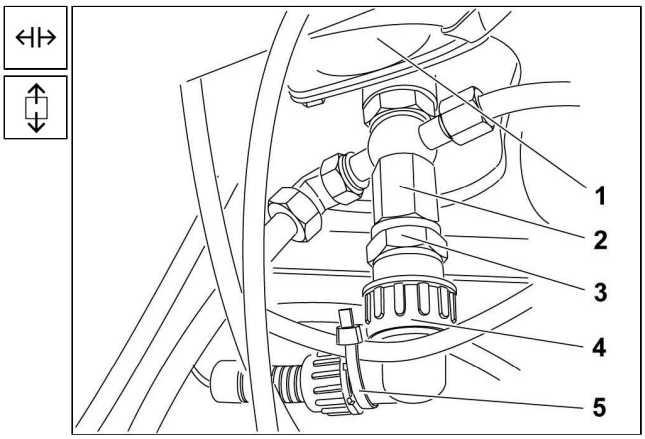


Fig. 9.54 Drain valve

2. Remove the cable clip **5** in the vicinity of the pressure switch **3**.



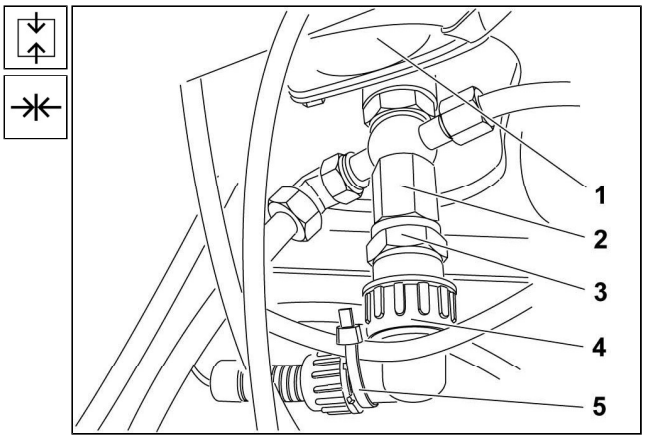
Legend: ***1****-control valve of emergency and parking brake,* ***2****-screwed connection,* ***3****-pressure switch,* ***4****-union nut,* ***5****-cable clip*

Fig. 9.55 Removal of pressure switch

3. Unscrew the union nut **4** from connector and move the connector out of the body of the pressure switch **3**.
4. Unscrew the pressure switch **3** from the screwed connection **2**.

d) Installation Procedure

1. Fit a new sealing ring on the screwed connection **2** and screw and tighten the pressure switch **3** .
2. Fit the connector on body of the pressure switch **3** and mount and tighten the union nut **4** .
3. Use the cable clip **5** to connect the air manifold near to switch with the switch connector.



Legend: ***1****-control valve of emergency and parking brake,* ***2****-screwed connection,* ***3****-pressure switch,* ***4****-union nut,* ***5****-cable clip*

Fig. 9.56 Installation of pressure switch

9.5.16 Removal and Installation of the Emergency and Parking Brake Control Valve

a) Reasons for Removal and Installation

1. A slow filling of brake cylinders behind the control valve – it results in a slow emergency and parking brake release.
2. The permanent air leakage from the pneumatic system through holes of the control valve noise damper.
3. Some inner thread was stripped or sealing surfaces were damaged and the control valve is leaky.

b) Technical Conditions

1. The pneumatic system is not pressurized.
2. Use of new screwed joints sealing rings, WABCO “O” rings and cable clamps during installation.
3. Tightening torques of screwed connections on the pressure regulator for attachment of PA pipes: **32 - 38 Nm** for screw **M 16** and **36 - 44 Nm** for screw **M 22**.

c) Removal Procedure

1. Drain the pressure air from all air reservoirs.

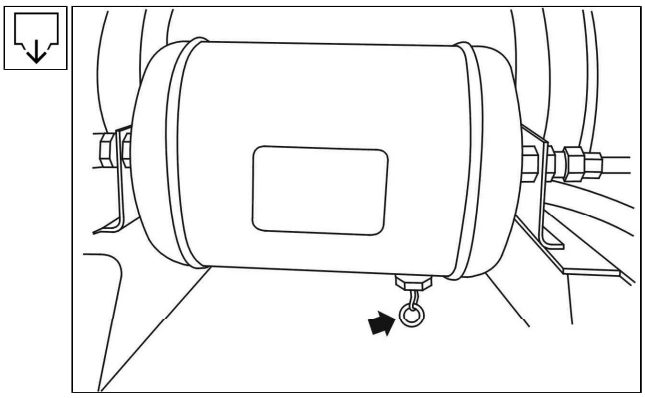
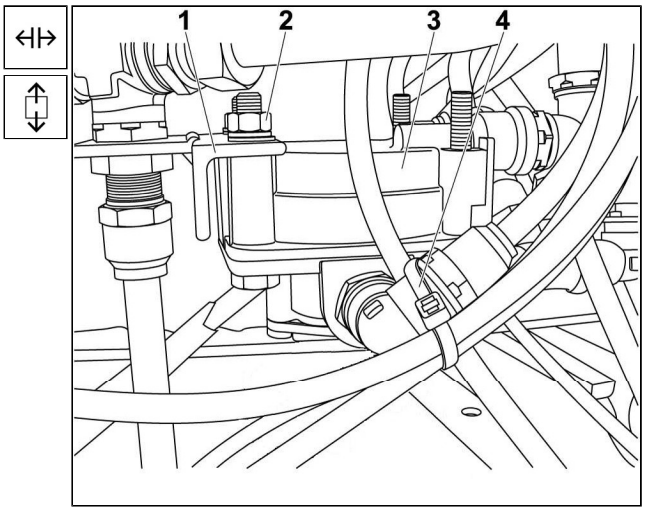


Fig. 9.57 Drain valve

2. Remove cable clamps **4** next to the control valve **3**.
3. Release individual screwed joints, which attach the air manifolds to the control valve body **3**.
4. Carefully mark the air manifolds from the control valve (beware of the confusion) and dettach them.



Legend: ***1****-holder,* ***2****-nut,* ***3****-control valve,* ***4****-cabl*e clamp

Fig. 9.58 Emergency and parking brake control valve - removal

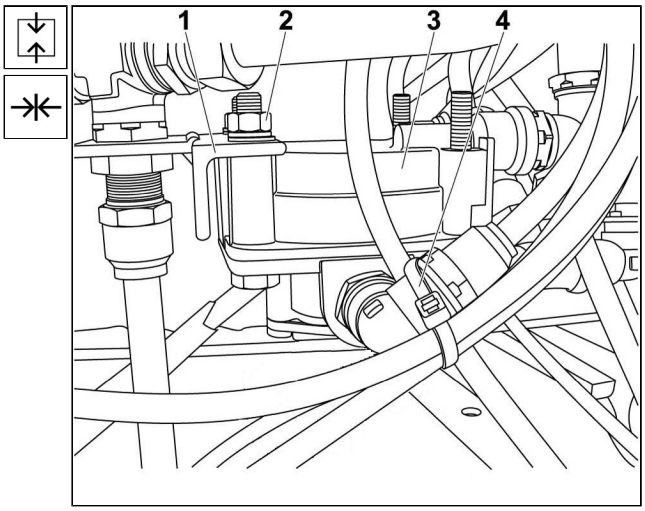
Note:
Necks on the control valve body are marked as follows:

- *„1 “-inlet of the constant air pressure from the four-circuit valve,*
- *„2“-outlet of the pressure air to spring brake cylinders,*
- *„41“-inlet of the pressure air from 1st circuit of service brake,*
- *„42“-inlet of the controlled air pressure from the manual brake valve.*

5. Dismount the pressure switch (See Subchapter **9.5.15**).
6. Unscrew the fastening nuts **2** a remove the valve.
7. Further on, continue in accordance with the general rules for the replacement of pneumatic system components (**9.5.1**).

d) Installation Procedure

1. Unplug holes of a new manual brake valve.
2. Install individual screwed joints to the control valve body **2**.
3. Mount the pressure switch (See Subchapter **9.5.15**)
4. Fit the control valve with fastening bolts into holes in the holder **1** on the vehicle auxiliary frame.
5. Fit washers, spring washers and nuts **2** on fastening bolts. Tighten nuts firmly.
6. Connect the individual lines according to marking.
7. Use the cable clamp to connect the air manifolds next to the control valve into one bundle.
8. After the control valve attachment fill the pneumatic system with the pressure air to the operating pressure in order to carry out an inspection of joints for function and leaks.
9. Depress fully the brake pedal and check the pneumatic system for function while focusing on the leakage of joints, which were removed.
10. Carry out the inspection of the emergency and parking brake circuit for function according to the point **e)** (See Subchapter **9.5.14**).



Legend: ***1****-holder,* ***2****-nut,* ***3****-control valve,* ***4****-cabl*e clamp

Fig. 9.59 Emergency and parking brake control valve - installation

9.5.17 Removal and Installation of the Trailer Brake Valve

a) Reasons for Removal and Installation

1. The air leaks from the air pressure system through holes of the trailer brake valve noise damper when the trailer is coupled.
2. Slow pressure drop in the trailer brake system after the brake releasing.
3. Some inner thread has been stripped or sealing surfaces have been damaged and the trailer brake valve has become leaky.

b) Technical Conditions

1. No pressure in the pneumatic system.
2. The torque specification of screwed joints fixing the PA manifolds to the instrument: **36 - 44 Nm** for screw **M 22.**
3. Use check pressure gauges with the range to **1.5 MPa** (**15 kg/sq.cm**) and the accuracy class to **1.5%** (2 pcs) to check the air pressures.

c) Removal Procedure

1. Drain the pressure air from all air reservoirs (using drain valves on air reservoirs).

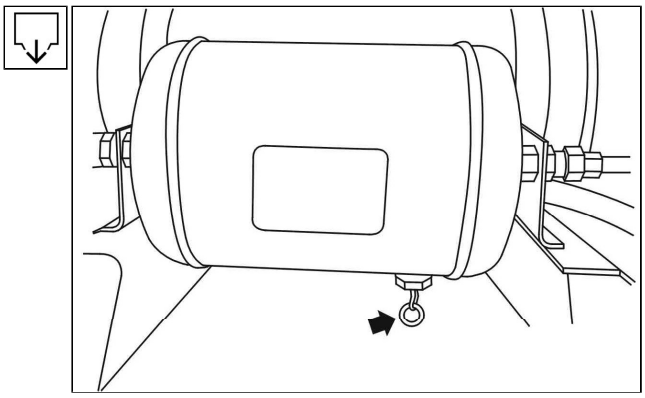
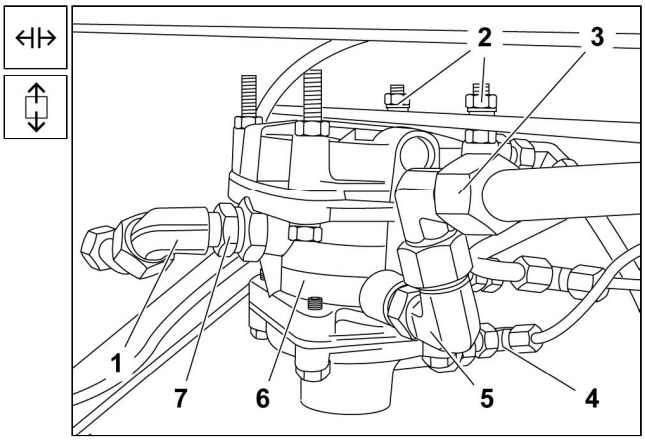


Fig. 9.60 Drain valve

2. Loosen individual threaded unions, which attach pneumatic manifolds to the trailer brake valve body **6**.



Legend: ***1,4,5****-pipe elbow,* ***2,7****-nut,* ***3****-sleeve nut,* ***6****-trailer brake valve*

Fig. 9.61 Removal of trailer brake valve

3. Mark pneumatic manifolds of the trailer brake valve (take care not to confuse them) and disconnect them.

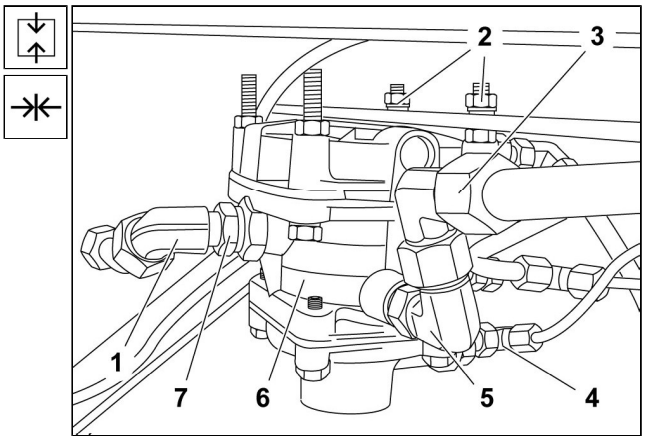
   Note:
   Necks on the trailer brake valve body are marked as follows:

   - „1“ - inlet of the constant air pressure from the air reservoir (it is under pressure after the trailer coupling),
   - „2“ - outlet of the pressure air to the coupling (control) head,
   - „41“ - inlet of the “control” air pressure from 1st service brake circuit,
   - „42“ - inlet of the pressure air from 2nd service brake circuit,
   - „43“ - inlet of the “control” air pressure from the circuit of emergency and parking brake.

4. Unscrew nuts **2** from screws, which attach the trailer brake valve to the holder and remove the valve.
5. Further on, proceed according to general rules valid for the replacement of pneumatic system components (See Subchapter **9.5.1**).

d) Installation Procedure

1. Unplug holes of a new trailer brake valve.
2. Install individual threaded unions into a body of the trailer brake valve **6**.
3. Use fastening screws to install the trailer brake valve into holes in the holder on the vehicle auxiliary frame.
4. Fit washers, spring washers and nuts **2** on fastening screws. Properly tighten the nuts.
5. Attach individual manifolds according to marking.
6. After installation of the trailer valve, fill the pneumatic system with the pressure air to achieve the operating pressure in order to check it for function and to check connections for leaks.



Legend: ***1,4,5****-pipe elbow,* ***2,7****-nut,* ***3****-sleeve nut,* ***6****-trailer brake valve*

Fig. 9.62 Installation of trailer brake valve

3. Slide and use the clip **5** to attach the noise damper **4** to the reducing piece in a body of the trailer brake valve **1** (if the noise damper is not a part of a new trailer brake valve).
4. Use fastening screws to install the trailer brake valve into holes in the holder **3** on the vehicle auxiliary frame.
5. Fit washers, spring washers and nuts **2** on fastening screws. Properly tighten the nuts.
6. Attach individual manifolds according to marking.
7. After installation of the trailer valve, fill the pneumatic system with the pressure air to achieve the operating pressure in order to check it for function and to check connections for leaks.

e) Function Inspection Procedure of the Trailer Brake Valve

1. Secure the vehicle with wheel chocks.
2. Connect the check pressure gauges to counter-pieces of trailer coupling heads.
3. Release the parking brake.
4. After pressurizing the pneumatic system to the operating pressure (until you can hear an audible pressure regulator blow-off), the pressure gauge on the **coupling (filling) head** must indicate the overpressure of **0.83 ± 0.02 MPa** (**8.3 ± 0.2 kg/sq.cm**) and the pressure gauge on the **coupling (control) head** must indicate the zero overpressure.
5. Fully depress the service brake pedal and check air pressures on both coupling heads. When the brake pedal is fully depressed, the pressure gauge on the **coupling (filling) head (red)** must indicate the instantaneous overpressure of **0.77 ± 0.02 MPa** (**7.7 ± 0.2 kg/sq.cm**) and the pressure gauge on the **coupling (control) head (yellow)** must also indicate the same overpressure **0.77 ± 0.02 MPa** (**7.7 ± 0.2 kg/sq.cm**).
6. When the brake is released, the pressure gauge on the **coupling (filling) head** must indicate the instantaneous overpressure of **0.83 ± 0.02 MPa** (**8.3 ± 0.2 kg/sq.cm**) (at full operating pressure in the pneumatic system) and the pressure gauge on the **coupling (control) head** must indicate the zero overpressure.

9.5.18 Removal and Installation of the Trailer Coupling Heads

a) Reasons for Removal and Installation

1. Leaky coupling heads.
2. Mechanical damage to the coupling head or to the dust cover.
3. The inner thread in the coupling head has been damaged.

b) Technical Conditions

1. No pressure in the pneumatic system.
2. Keep the position of coupling heads during installation – outlet holes of coupling heads must point to the right.

c) Removal of the Coupling (Control) Head

1. Drain all air from all air reservoirs by means of manual drain valves.

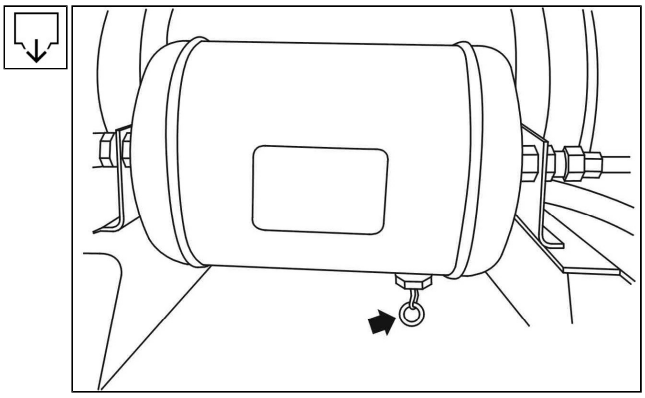
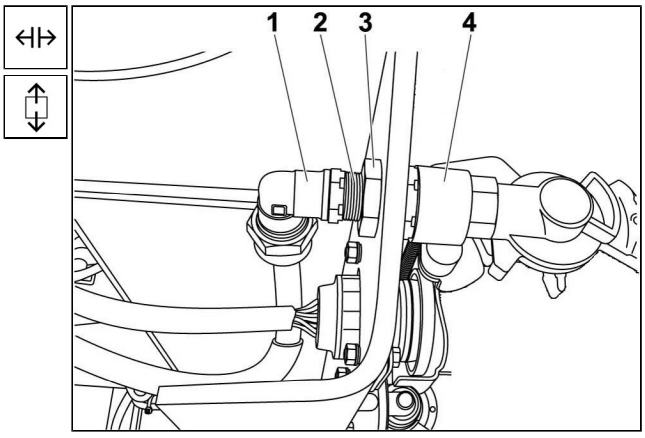


Fig. 9.63 Drain valve

2. Disconnect the elbow pipe **1** from neck **2**.
3. Unscrew nut **3** and move the coupling head **4** out of the hole in the rear cross-girder on the frame.
4. Further on, proceed according to general rules valid for the replacement of pneumatic system components (See Subchapter **9.5.1**).

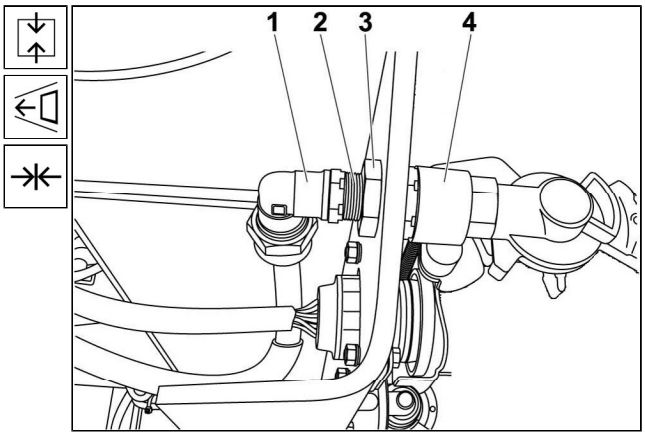


Legend: ***1*** *- elbow pipe,* ***2*** *- neck,* ***3*** *- nut,* ***4*** *- coupling head*

Fig. 9.64 Removal of the coupling (control) head

d) Installation Procedure

1. Slide the coupling head **4** c/w installed neck **2** into a hole in the rear cross-girder on the frame.
2. Set the coupling head into a correct position with its hole pointing to the right and mount nut **3** on the thread of neck **2**.
3. Tighten the nut **3**.
4. Mount the elbow pipe **1**.



Legend: ***1*** *- elbow pipe,* ***2*** *- neck,* ***3*** *- nut,* ***4*** *- coupling head*

Fig. 9.65 Installation of the coupling (control) head

5. Start the engine and pressurize the pneumatic system to the operating pressure.
6. Shut off the engine and check the pneumatic system for function as per point **e)** (See Subchapter **9.5.13**).

Note:
The removal/installation procedures for the coupling (filling) head are identical.

9.5.19 Removal and Installation of Electromagnetic Pneumatic Valves

a) Reasons for Removal and Installation

1. The electromagnet core does not move, its guide has been polluted – it results in an insufficient function of electromagnetic pneumatic valves.
2. The electromagnet coil winding has been burnt – the electromagnetic pneumatic valve does not work at all.
3. Some inner thread was stripped or the sealing surfaces were damaged and the electromagnetic pneumatic valve is leaky.

b) Technical Conditions

1. No pressure in the pneumatic system.
2. Accumulator batteries are turned off using the cut-off switch.
3. Use new sealing rings for threaded unions, WABCO “O” sealing rings and cable clips during installation.

c) Removal Procedure

1. Drain the pressure air from all air reservoirs.
2. Use the cut-off switch to turn off the accumulators.

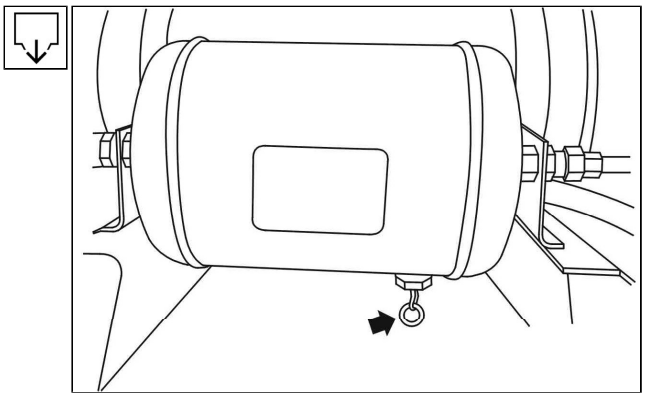


Fig. 9.66 Drain valve

3. The electromagnetic pneumatic valves are placed on the RH side behind the driver´s cab.

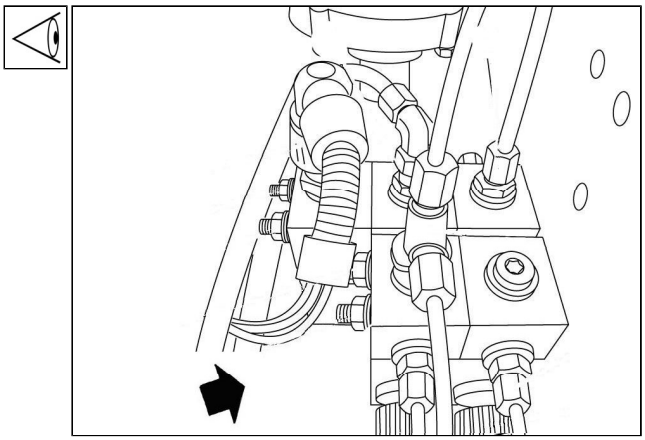
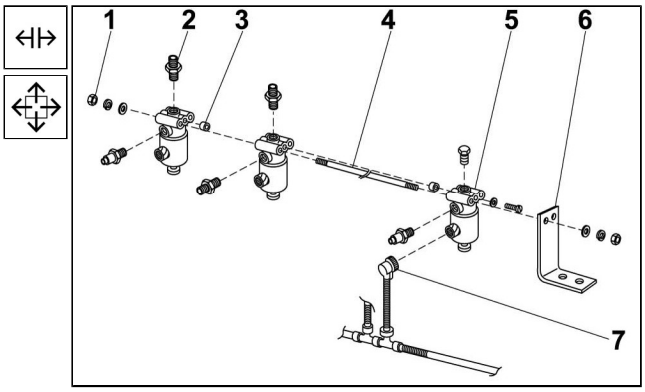


Fig. 9.67 Electromagnetic pneumatic valves

4. Loosen union nuts from electrical connectors **7** and remove connectors to disconnect the electric line.

   Note:
   Each electromagnetic pneumatic valve carries the marking, which corresponds to the marking on the respective electric line connector. In case that this marking is illegible or worn due to the vehicle operation, you should mark the individual lines to avoid the confusion during installation.



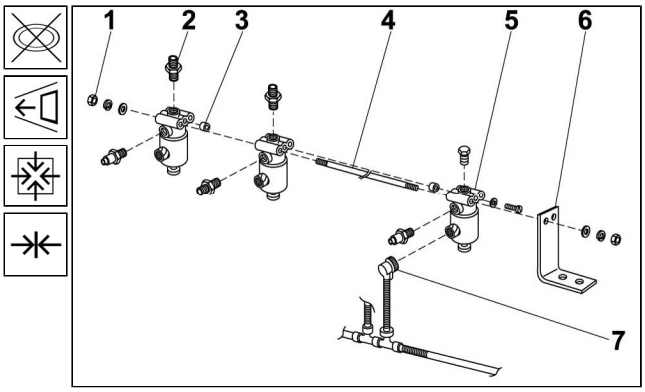
Legend: ***1****-nut,* ***2****-fiffings,* ***3****-sealing ring,* ***4****-screw,* ***5****-electromegnetic pneumatic valve,* ***6****-holder,****7****-conector*

Fig. 9.68 Electromagnetic pneumatic valves - removal

5. Remove cable clamps next to the electromagnetic pneumatic valve **5**.
6. Release individual fittings **2**, which attach the pneumatic manifolds to bodies of all electromagnetic valves **5**.
7. Carefully mark the air manifolds from the electromagnetic pneumatic valve (beware of the confusion) and detach them.
8. Dismount nuts **1** and remove electromagnetic pneumatic valves **5** c/w sealing rings **3** from screws **4** one after another.
9. Move screws **4** out of the holder **6**.
10. Further on, continue in accordance with the general rules for the replacement of pneumatic system components (**9.5.1**).

d) Installation Procedure

1. Unplug holes of a new electromagnetic pneumatic valve.
2. Pull screws **4** through the holder **6** , slide individual valves **5** and individual sealing rings **3** of all electro-magnetic air valves on screws **4**. Use new sealing rings!
3. Put on washers, spring washers and tighten nuts **1**.
4. Install individual screwed joints **2** of air manifolds into a body of the electromagnetic pneumatic valve.
5. Plug electric connectors **7** in accordance with their marking.
6. Use the cable clamp to connect the air manifolds into one bundle in the vicinity of the electromagnetic pneumatic valve. Use new cable clips.

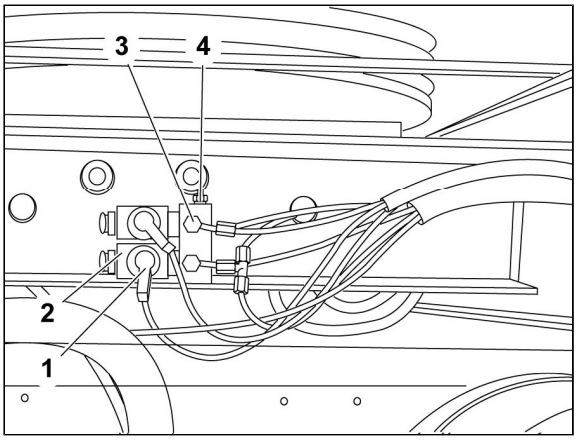


Legend: ***1****-nut,* ***2****-fiffings,* ***3****-sealing ring,* ***4****-screw,* ***5****-electromegnetic pneumatic valve,* ***6****-holder,****7****-conector*

Fig. 9.69 Electromagnetic pneumatic valves - installation

7. Turn on the accumulator's cut-off switch, start the engine and fill the pneumatic system with the pressure air to achieve the operating pressure in order to check the valves for function and to check the joints for leaks.

Note:
Removal and installation of the electromagnetic pneumatic valves for the winch are similar. They are placed on the cross girder behind the winch.



Legend: ***1****-connector,* ***2****-electromagnetic pneumatic valve,* ***3****-air manifold connection,* ***4****-screw*

Fig. 9.70 Electromagnetic pneumatic valves for winch

9.5.20 Repair and Replacement of Polyamide Pipes

a) Reasons for Repair or Replacement

1. Damage due to a wrong installation.
2. Mechanical breakage.
3. Damage due to the excessive temperature.
4. Weld drops stain.

b) Technical Conditions

1. When pipes outside bundles and **shorter than 1 m** are damaged, replace the whole pipe. (It holds so for manifolds fitted with union nuts).
2. When pipes outside bundles and **longer than 1 m** are damaged, replace only its damaged section. (It holds so for manifolds fitted with union nuts).
3. When pipes in bundles are damaged, replace either the damaged section only (if it is possible to replace the whole damaged pipe sectioon outside the bandaged part) and/or replace the whole pipe (in this case cut off the ends of the damaged pipe outside the bandaged section and use the connecting strip to attach a new pipe to bundles).
4. Screwed pipe unions must be clean and greased before installation.
5. Free ends of polyamide pipes, which are inserted, must be clean and undamaged.
6. The radius of the installed polyamide pipe must not be smaller than the mentioned minimum value for the specified pipe diameter.

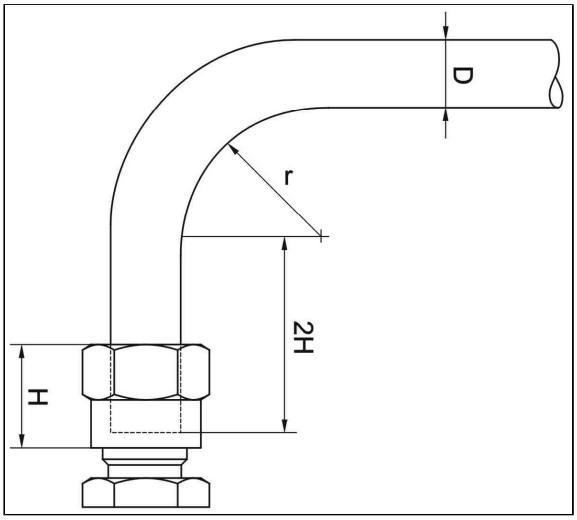


Fig. 9.71 Polyamide pipe bend

Tab. 9.4 Maximum bend of pipes

Plastic pipe diameter	Maximum bend R_{max}(mm)
ø 6x1	R 50
ø 8x1	R 70
ø 10x1	R 90
ø 15x1.5	R 120

7. Fix the individual polyamide pipes into bundles or clamp them to steel pipes according to a situation on the vehicle.
8. After installation of polyamide pipes the pipes, which are not clamped together, must not touch each other.
9. On places where polyamide pipes touch the sharp edges these must be protected using the pipe bushing (tube spring) and rubber border.

10. Check the pneumatic system for leaks after installation. At the nominal pressure of **1.2 MPa** (**12 kg/sq.cm**) the pressure drop must not exceed **0.01 MPa** (**0.1 kg/sq.cm**) during **10 minutes.** Carry out the measurement on the check connection on the air drier of the pneumatic system with the parking brake released.

c) Repair and Replacement Procedure

1. During installation of polyamide pipes screwed joints, cut off the pipe perpendicularly (the maximum permissible bevel **á < 5°**) to the required length; take care that the pipe surface is not damaged or deformed. No burrs on the outer edge are allowed.
2. Gently apply the grease to the pipe end.

When assembling the pipes with sleeve nuts, proceed as follows:

1. Slide the cap nut **4** onto the pipe **2** and greased sealing ring **3**.

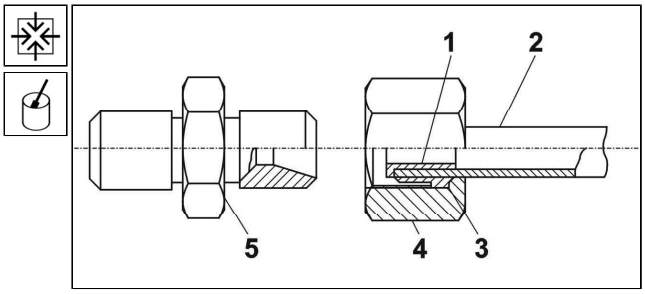


Fig. 9.72 Connection of polyamide pipes

4. Push the spacer insert **1** into the pipe fully home.
5. Install the pipe with nut onto the pipe union **5**, firmly hand-tighten the cap nut **4**, then use the wrench to tighten the pipe union properly to prevent the air leakage.
6. Check the pipe union for leaks.

The following table gives operating pressures of polyamide pipes fitted with quick couplings related to the pipe diameters.

Tab. 9.5 Operating pressures of polyamide pipes fitted with quick couplings

Pipe diameter (mm)	**Operating pressure at 20°C** (bar)
ø 6 x 1	27
ø 8 x 1	19
ø 10 x 1	15
ø 15 x 1.5	15

When assembling the pipes with quick couplings, proceed as follows:

1. The pipe must be cut in the right angle. The maximum permissible angle deviation makes 5^{o}.

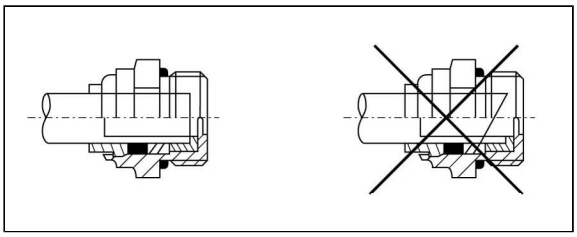


Fig. 9.73 Pipe installation

2. It is recommended to mark the limit sliding-in length **L** on the pipe for the mounting inspection (sliding-in) and for later service inspection.

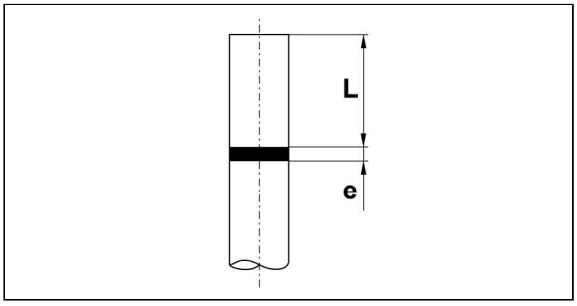


Fig. 9.74 Push-in lenght marking

Tab. 9.6 Pipes push-in lenghts and forces

Pipe diameter (mm)	**Push-in lenght L** (mm) ±0,5mm	**Push-in force**(N)
Ø 6 x 1	20	<100
Ø 8 x 1	21	<120
Ø 10 x 1	25	<120
Ø 15 x 1.5	27	<150

3. Apply the recommended sliding-in force to insert the pipe fully to the stop into connector. To make the sliding-in of the pipe into the connector easier, gently rotate the pipe.

   CAUTION:
   Do not use any tools!

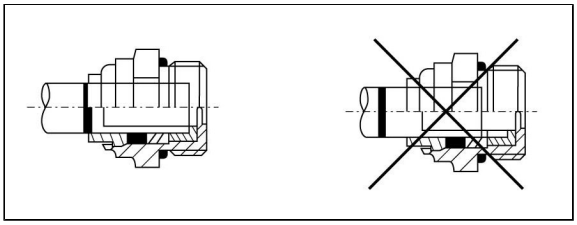


Fig. 9.75 Pipe installation

4. After sliding-in of the pipe, check the strength of the connection so that you pull the pipe by the force of **20 to 50 N**.

   CAUTION:
   For safety reasons it is not allowed to disconnect the joint once connected!

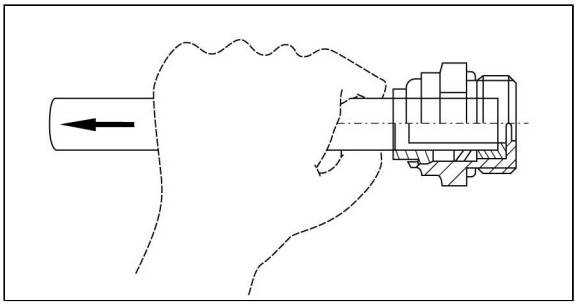


Fig. 9.76 Checking of the strength of the pipe connection

9.5.21 Inspection of the Brake Lining Thickness

2. Carry out an inspection of the brake lining wear and condition on the leading (front) brake shoe **1**.
3. Check the wear of the brake lining according to its check edge.

a) Reasons for Inspection

1. The visual inspection of the brake lining should be carried out at regular intervals after consuming every 4,000 ltr of fuel (300 eng. hrs) and/or after covering 10,000 km, which occurs the first.

b) Technical Conditions

1. Replace the brake lining when it has been worn to the edge marked on the side of the brake lining or when it has been damaged (burnt, vitreous, oiled or broken).
2. If the brake lining is replaced, it must be replaced on both wheels of the pertaining axle at a time.
3. After the inspection was carried out, replace the damaged rubber plugs with new ones.
4. Carry out the inspection of the brake lining wear on the leading shoe only.

c) Inspection Procedure

1. Remove rubber plugs from sheet coverings (it is valid for the front axle). On rear axles, except for plugs, remove also the sheet caps from oval holes.

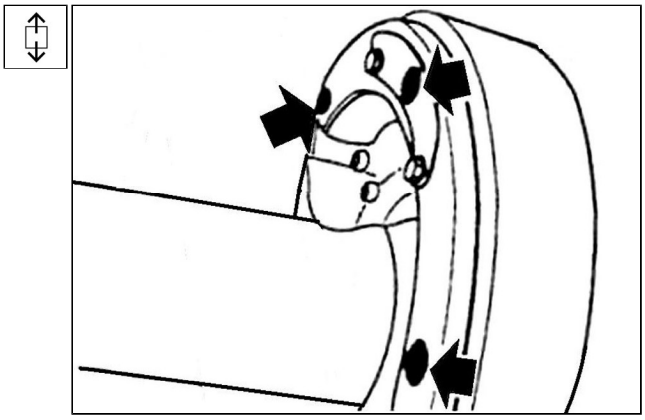


Fig. 9.77 Plugs of inspection holes for measurement of the brake lining thickness – removal

2. Carry out an inspection of the brake lining wear and condition on the leading (front) brake shoe.
3. Check the wear of the brake lining according to its check edge.

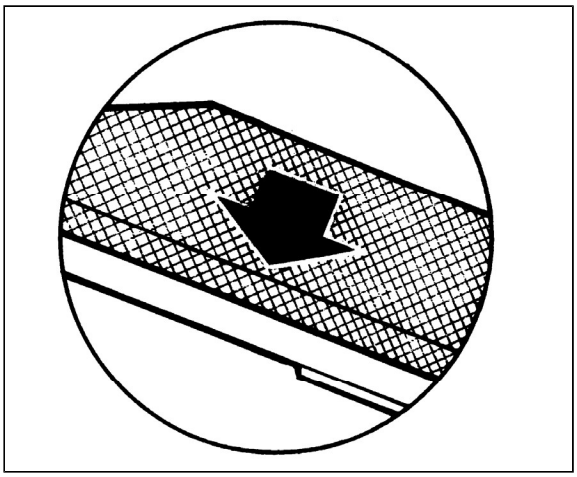


Fig. 9.78 Check of brake lining

4. After inspection, reinstall rubber plugs.

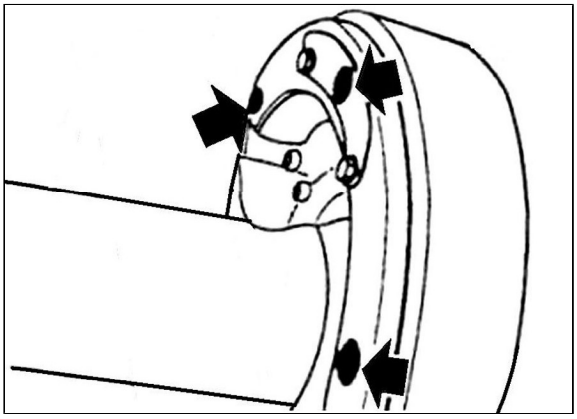


Fig. 9.79 Plugs of inspection holes for measurement of the brake lining thickness – installation

9.5.22 Removal and Installation of the Brake Cylinder

a) Reasons for Removal

1. Repairs of axle and vehicle wheel hub.
2. Leaky brake cylinder.
3. Slow return of the piston rod into the initial position.

b) Technical Conditions

1. Use new sealing rings for necks and flanges of air inlet manifolds.
2. Place chocks behind the wheels to prevent the vehicle from motion.

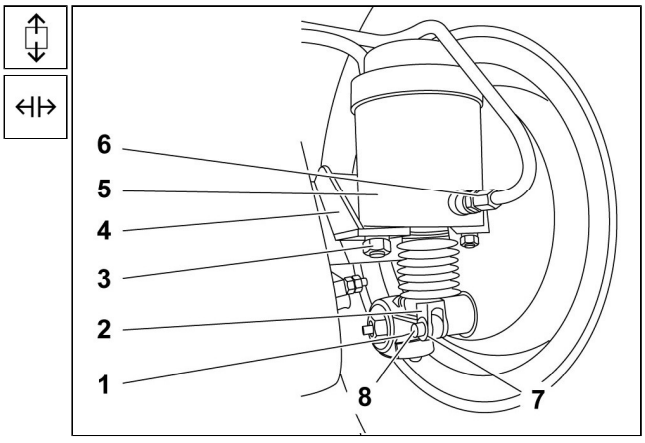
In addition, for adjustment of piston rods as per point **e)** it holds:

1. Pressure in the brake system must be **0.78 MPa** (**7.8 kg/sq.cm**)
2. Released emergency and parking brake
3. Greased brake cams
4. Thickness of brake lining min. **6 mm**

c) Removal Procedure

1. Release the brake cylinder, i.e. unscrew the piston rod through a center hole in the cylinder body on the axle, which is fitted with a spring-loaded cylinder.

2. Detach the air inlet manifold **6** from the brake cylinder.



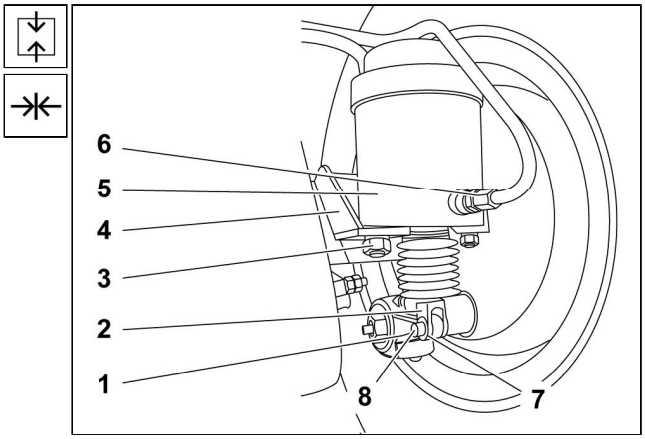
Legend: ***1****-brake cam lever,* ***2****-fork,* ***3****-nut,* ***4****-holder,* ***5****-brake cylinder,* ***6****-manifold,* ***7****-pin,* ***8****-split pin*

Fig. 9.80 Removal of spring-loaded brake cylinder

3. Unscrew the union nut **6** of the air inlet manifold to the brake cylinder **5**.
4. Remove the split pin **8** and press the pin **7** out of the fork eye **2** on the piston rod of the brake cylinder.
5. Unscrew nuts **3** fixing the brake cylinder to the holder **4** and withdraw spring washers.
6. Remove the brake cylinder from location.

d) Installation Procedure

1. Fit the brake cylinder **5** with stud bolts into holes of the holder **4**.



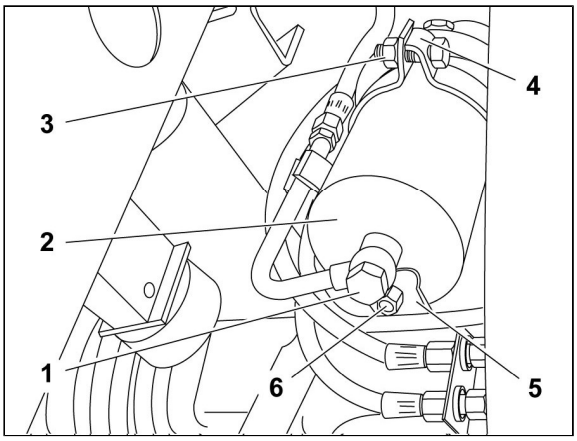
Legend: ***1****-brake cam lever,* ***2****-fork,* ***3****-nut,* ***4****-holder,* ***5****-brake cylinder,* ***6****-manifold,* ***7****-pin,* ***8****-split pin*

Fig. 9.81 Installation of spring-loaded brake cylinder

2. Fit spring washers and mount nuts.
3. Use the pin **7** to connect the brake cam lever **1** with fork **2** on the piston rod and secure with a split pin **8**.
4. Mount the union nut **6** c/w sealing ring of the air inlet manifold to the brake cylinder **5**.
5. Adjust the stroke of brake cylinders piston rods as per a procedure mentioned in article **e)**.
6. Check the brakes for a correct function.

Note:
The spring-loaded cylinder must be in the released position during installation; it means that the center bolt of the cylinder body must be unscrewed.

Note:
The replacement procedure for single-type brake cylinders is similar - they need not be mechanically released before removal and installation.



Legend: ***1****-through-bolt,* ***2****-brake cylinder,* ***3,6****-nut,* ***4,5****-holder*

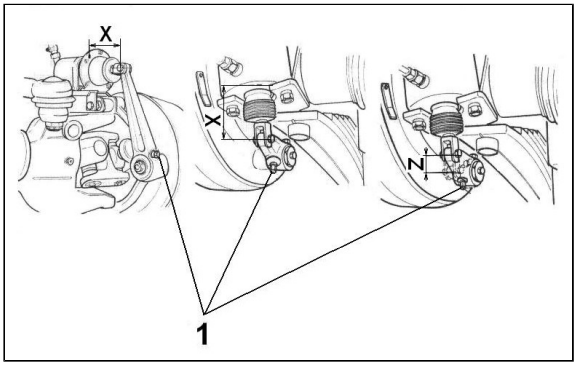
Fig. 9.82 Removal of brake cylinder (single-type)

e) Adjustment of piston rods stroke

1. Check the initial position of brake cylinders piston rods - the center of holes for the pin in the fork of the piston rod must be in the distance of ' **X** ' from the cylinders bottom (See Tab. **9.7**).

   Note:
   If the specified value is not measured, it is necessary to check the respective brake cam for condition and a correct function.

2. Turn the adjusting screw **1** , until the specified stroke ' **Z** ' of brake cylinders piston rods is reached.
3. Keep depressing the brake pedal with a full air pressure in the brake system during adjustment to check the stroke.



Legend: ***1****-adjusting screw,* ***X****-initial position of the brake cylinder piston rod,* ***Z****-stroke of brake cylinder piston rod*

Fig. 9.83 Adjustment of piston rods stroke

Tab. 9.7 Values for adjustment of brake cylinders piston rods stroke

Axle	Value			
	X (mm)		Z (mm)	
			after repair	max. allowable stroke in operation
front	103 to 108	A	60 to 65	80
		B	45 to 55	80
rear	87 to 93	A	25 to 30	35
		B	20 to 25	35

Notes:

1. Explanations for the table:
   A - value of the stroke for the first adjustment with a new brake lining (during running-in of vehicles).
   B - value of the stroke during further adjustment
2. Proceed in the same manner to adjust the brakes on all vehicle wheels.
3. After you adjust the stroke of brake cylinders piston rods on rear axles, the emergency and parking brake is adjusted too.

9.5.23 Removal and Installation of the Brake Drum and Brake Shoes

a) Reasons for Removal

1. Axle and vehicle wheel hub repairs.
2. The brake drum needs to be replaced:

- if there are transverse cracks on the friction area of the drum,
- the drum has been deformed or ribbed,
- the brake drum has been worn to maximum diameter (Ø **420 mm**).

3. Brake lining needs to be replaced:

- if the thickness of brake lining is below the check edge,
- if much polluted with grease, resulting in soaking of the brake lining, which causes that the braking efficiency is much decreased (it is not enough to degrease it only),
- glassy, burnt or otherwise damaged brake lining.

b) Technical Conditions

1. Replace return springs of brake shoes after two years of operation.
2. Wear of the brake drum must not exceed the below-mentioned values

    - drum of the original dimension - max. **420.0 mm**,

3. Brake lining width must be **160** $^{-1}$ **mm** on all axles.
4. When you replace the brake drum on one wheel of the axle, it is necessary to replace the brake drum on the other wheel of the same axle too.
5. It is not allowable to mount the brake drums with different diameters of the friction area on individual half-axles.
6. When you replace the brake lining on one wheel of the axle, it is necessary to replace the brake lining on the other wheel of the same axle too.
7. After you replace the brake shoes, it is necessary to run-in the shoes by covering of 500 km at least. The temperature of the brake drum must not exceed 200^{o} C and short-term 230 ^{o} C during this period.

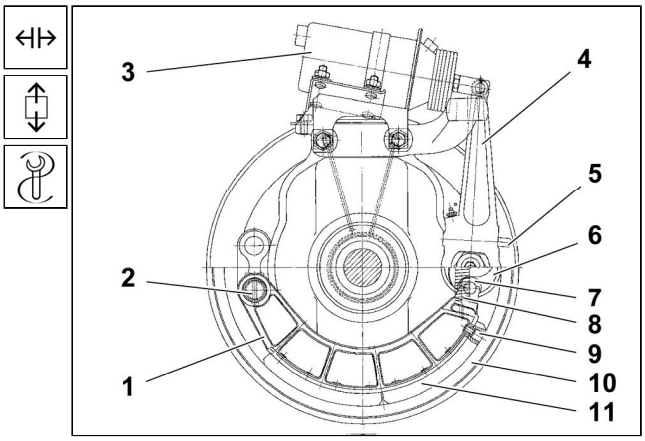
    CAUTION:
    Use new brake shoes of the corresponding dimension.

c) Removal Procedure

1. Dismount the complete vehicle wheel from axle.
2. Unscrew fastening bolts from the brake drum.
3. Use the force-off bolts M12x60 to dismount (withdraw) the brake drum from the wheel hub and hang it on a proper tool.

    Note:
    The brake cylinder must be released.

4. Remove split pins from holes on pins of brake shoes and withdraw the lock washer.
5. Use the tool **PRM 3816** to withdraw the return springs **8** of brake shoes **1** (See Fig. **9.1**).
6. Dismount brake shoes **1** - unhook them out of anchor pins **2**.

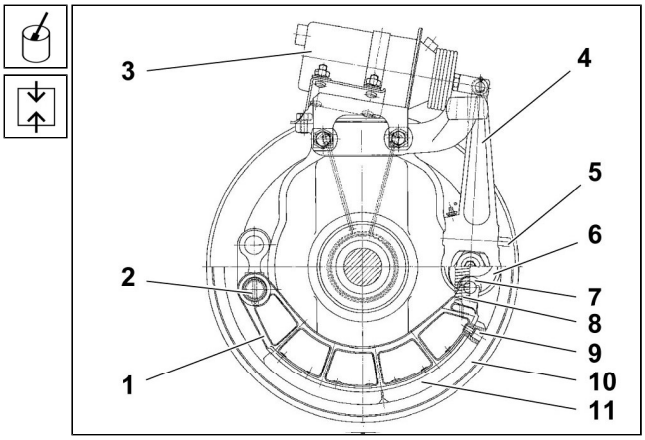


Legend: ***1****-brake shoe,* ***2****-anchor pin,* ***3****-brake cylinder,* ***4****-brake cam lever,* ***5****-adjusting screw,* ***6****-brake cam,* ***7****-pulley,* ***8****-return spring,* ***9****-rivet,* ***10****-brake drum,* ***11****-brake lining*

Fig. 9.84 Wheel brake

d) Installation Procedure

1. Install brake shoes **1** on cleaned and degreased anchor pins **2**.



Legend: ***1****-brake shoe,* ***2****-anchor pin,* ***3****-brake cylinder,* ***4****-brake cam lever,* ***5****-adjusting screw,* ***6****-brake cam,* ***7****-pulley,* ***8****-return spring,* ***9****-rivet,* ***10****-brake drum,* ***11****-brake lining*

Fig. 9.85 Wheel brake

2. Fit pulleys **7** and tension the spring **8**.

   CAUTION:
   The return springs must be installed so that they do not come in contact with the wheel hub.

3. Fit the lock washer and secure it with split pins.
4. Fit the brake drum and mount fastening bolts.

5. Mount the vehicle wheel.
6. Adjust the stroke of brake cam levers (See Subchapter **9.5.22**), part **e)**.

9.5.24 Replacement of Brake Shoes Lining

a) Reasons for Replacement

1. The brake lining has been worn up to the check edge.
2. The brake lining must be replaced if much polluted with grease because it will soak through and itsbraking efficiency will be much decreased. It is not enough to degrease it only.

b) Technical Conditions

1. When you replace the brake lining on one wheel of the axle, it is necessary to replace the brake lining on the other wheel of the same axle too.
2. It is necessary to mount them in pairs - the shoes, which were machined together, must be installed on one half-axle.
3. Only the shoes with lining made of the same material may be mounted on the axle.
4. Pressing-down of the brake lining in two spots, when clamping the shoes, does not matter.
5. Only the specified brake lining and of the type approved by the vehicle manufacturer may be used for the replacement of the brake lining performed by the riveting method.
6. It is necessary to use only such device for the riveting, which allows the repeated riveting with the same parameters as on the initial lining including clamping to the shoe so that a correct strength of the connection is achieved.

Note:
The specified and approved types of brake linings: PAGID 320, FERODO 3070, DON 7115, BERAL 1525.

c) Procedure

Preparation before Riveting

1. Use a drill Ø **8.5 mm** to drill off or to unrivet the original brake lining.
2. Check the brake shoes for condition, if deformed, replace them. Replace the shoes also when the shoes area has become extremely uneven, when deformed in the shoes contact area during braking and when holes for rivets have been damaged - allowable deviations are illustrated.
3. Remove rusty spots, dirt and grease from the bearing surface for the lining. Do not use the grinding machine, agents containing the mineral oils and sharp tools which may damage the brake shoe.

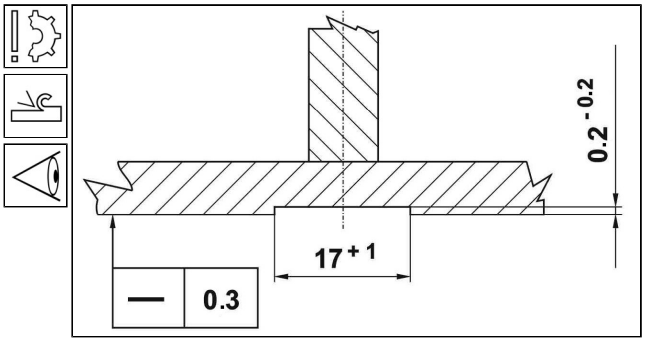
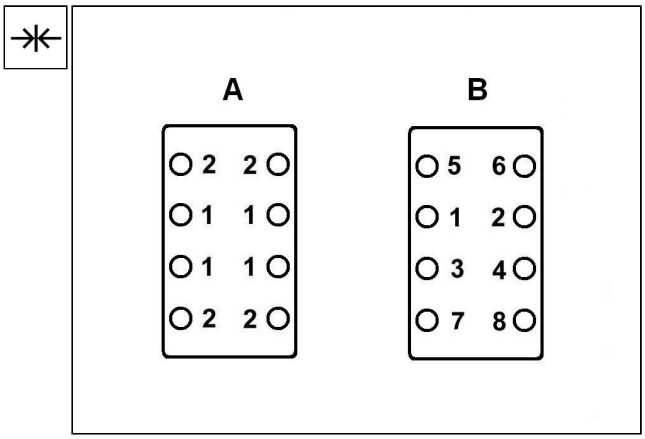


Fig. 9.86 Checking the bearing surface for the brake lining on the brake shoe

Riveting Procedure

CAUTION:
Use tubular steel rivets with antirust protection, annealed and with hardness of 80 - 100 HB for riveting.

4. Fit a new brake lining on the shoe and secure it with two rivets to protect them from motion on the shoe.
5. Prior to start with riveting, check whether the lining bears on the shoe with its outer edges. The loose outer edges are not allowed (they cause rolling of the lining on the shoe).
6. The brake lining must bear on the shoe with the whole area so that it must be riveted starting from the center. Keep the riveting order.



Legend: ***A****-machine riveting,* ***B****-manual riveting*

Fig. 9.87 Riveting order of the brake lining

7. The riveting force makes **24,000 ± 1,000 N**, with a gradual increase in about **3s**, the maximum force may last for **1** to **2** seconds as a maximum. If the force has been set incorrectly, the following defects may occur: cracks in the area of rivets, damage to the rivet bottom, a wrong shape of the head, forcing-in of the rivet with a possible partial lifting of the brake lining.
8. Machine the lining to the dimension of Ø **420 h11** after riveting on the shoe.
9. On termination of the riveting, check the following:

   - a gap between the brake lining and brake shoe, which should be max. **0.1 mm** in length, max. **0.15 mm** in width and **10 mm** in depth. In the spot of rivet the brake lining must be tightened without any clearance.
   - check whether there are no cracks along the whole surface of the brake lining.