Purpose

The purpose of this component is to control the brake pressure of the front axle as a ratio of the actuation of the load-sensing valve on the rear axle, depending on the load carried.

An Empty/Load Valve is installed on the front axle of a towing vehicle provided this also has to be controlled and it is not possible to use a load-sensing valve.

Design types

473 302

Load/Empty Valve 473 302, designed for a pilot pressure of 0.5 bar, is available for the following theoretical pressure reduction ranges:

Order number	Pressure Step-Down (theoretically)	Pressure in bar at port		
		1	2	4
473 302 000 0	1.5 : 1	8.0	2.0	6.0
473 302 001 0	2.0 : 1	8.0	2.0	5.3
473 302 002 0	2.7 : 1	8.0	2.0	4.4

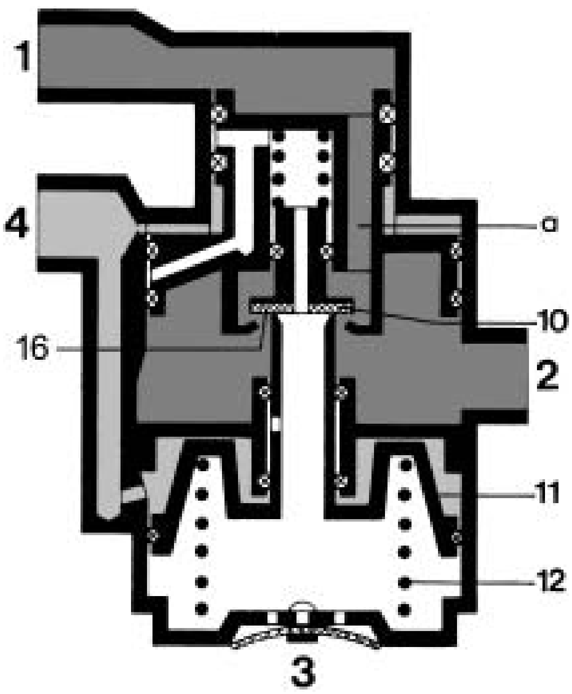
This series is designed in such a way that if load-proportional brake control on the rear axle fails, the pressure reduction for the front axle is neutralized.

Please note

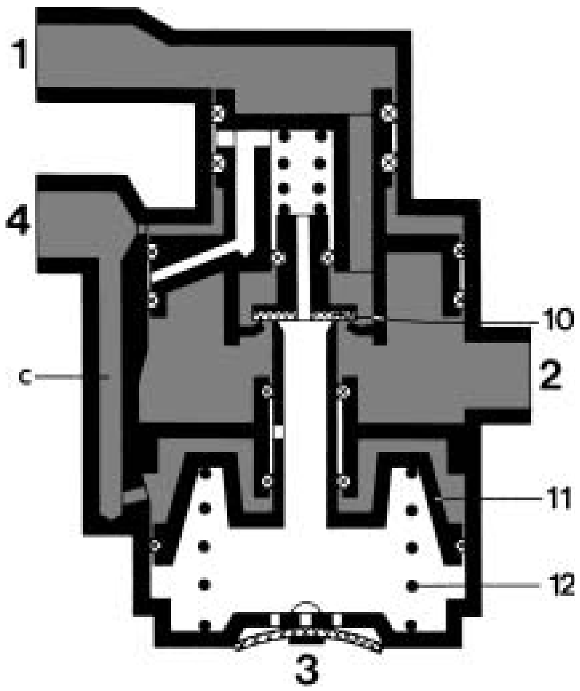
If brake valve **461 319** is used, empty/load valve **473 302** is dispensible since its function is contained in the brake valve itself.

Operation of Empty/Load Valve 473 302 ... 0

a. Pilot Pressure

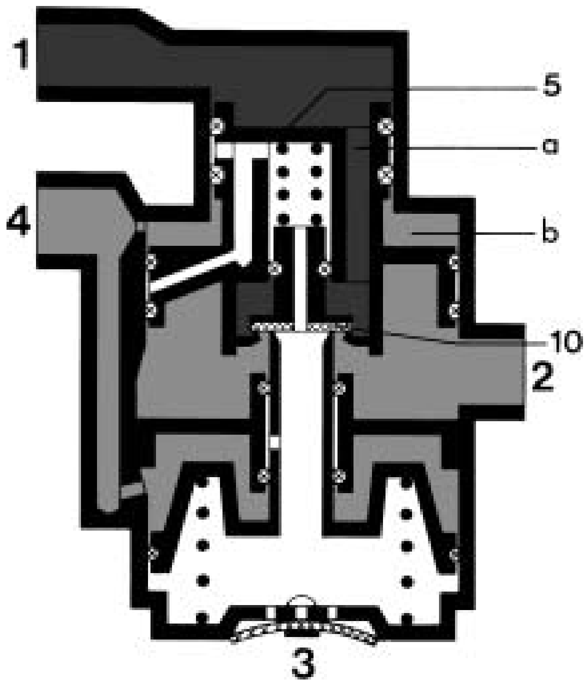


In its non-actuated position, the force of spring (12) holds the piston (11) in its upper position. This keeps the outlet valve (16) closed and the inlet valve (10) open. When the brakes are actuated, it is therefore initially the pressure entering at port **(1)** which is allowed to pass in full via duct (a) to port **(2)**.



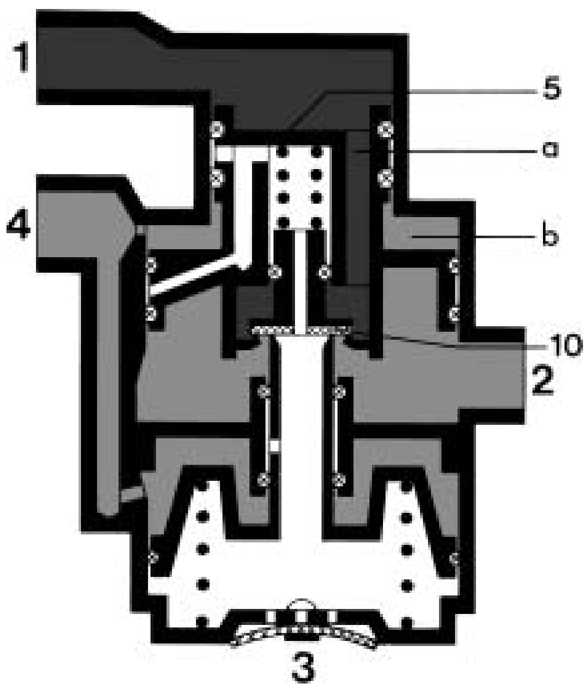
This process is discontinued when the compressed air coming in from the rear-axle circuit at port **(4)** flows through duct (c) and pressurizes the effective surface of the piston (11). This causes the force of spring (12) to be overcome at a maximum pressure of 0.5 bar, and the piston (11) is forced downwards until the inlet valve (10) is closed. Now the pressure in ports **(1)**, **(2)** and **(4)** is balanced at a maximum of 0.5 bar. Pilot control has now been output.

b. Braking Position: "Unladen"



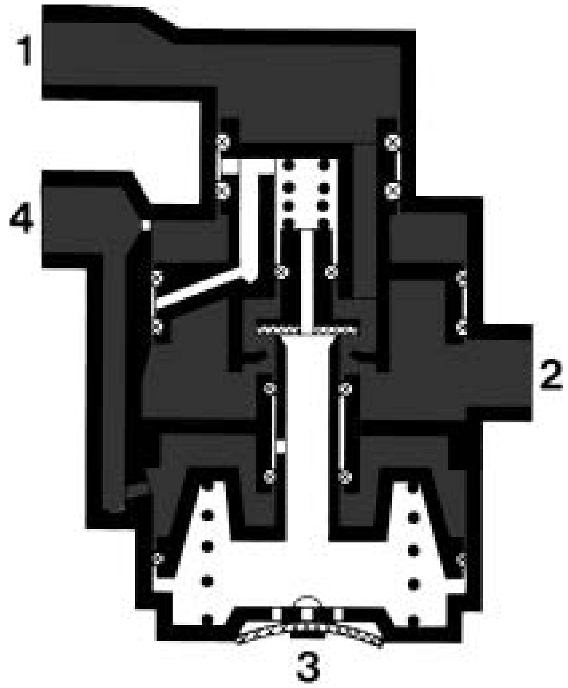
As the pressure in port (1) is increased further, the pressure on the effective surface of the piston (5) is also increased. It is forced downwards, opening the inlet valve (10). This allows the higher pressure to flow via duct (a) into port **(2)**, acting on the larger, lower effective surface of the piston (5). In keeping with the pressure reduction defined by its design - at the same time taking into account the compressed air in chamber (b) from the rear axle circuit - just enough compressed air will build up beneath piston (5) to force it upwards again, thereby closing the inlet valve (10).

c. Braking Position: "Partially Laden"



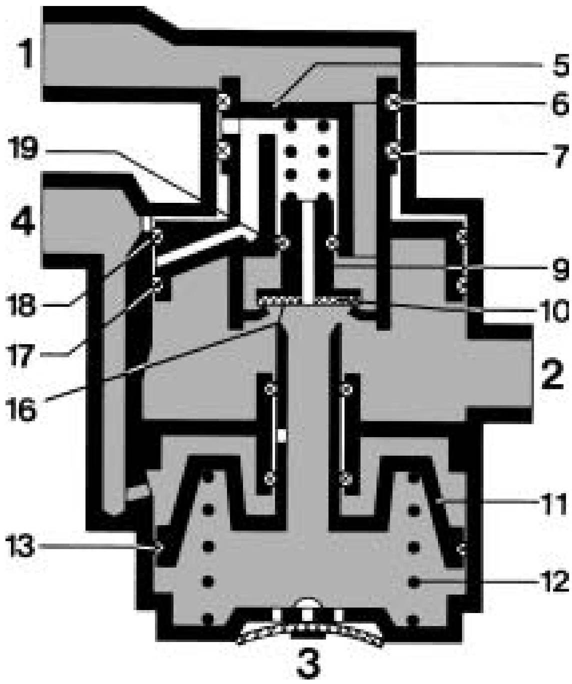
As the weight of the load is increased, so is the pressure in port **(4)** when the brakes are actuated. This of course also causes the pressure reduction ratio to change. As described under **"b"** above, the load/empty valve will reverse and increase the brake pressure in port (2) compared with the braking position "unladen".

d. Braking Position: "Fully Laden"



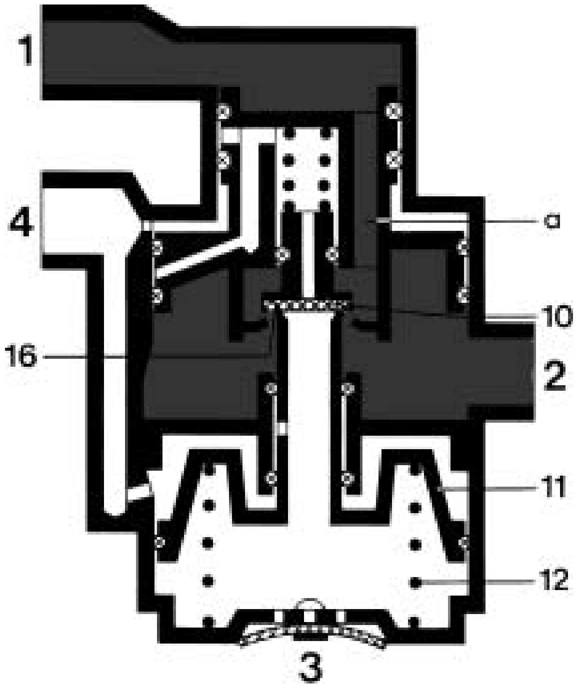
If the vehicle is loaded up to its permissible total weight, the same pressure reaches ports (1) and (4) as the brakes are actuated. This neutralizes the pressure reduction. The pressure in port **(1)** is put through to the brake cylinders via ports (2) at a 1:1 ratio.

e. Release Position



When the brakes are released, air escapes first from ports **(1)** and **(4)**. Whilst piston (5) is raised at once, taking with it valve (9), piston (11) initially remains in its lower position. This causes the inlet valve (10) to be closed, and the outlet valve (16) to be opened. The pressure from the brake cylinders can thus escape via Exhaust (3). During the venting phase, piston (11) is forced upwards once again by the force of spring (12), closing the outlet (16) and opening the inlet valve (10). The residual pressure left in port (2) is now reduced via port (1) on the brake valve.

f. Braking Position "Failure of Rear Axle Circuit"



If the rear axle circuit fails, port **(4)** can no longer be pressurized when the brakes are actuated. This neutralizes the function of the empty/load valve. The pressure coming in at port **(1)** is allowed to pass at a ratio of 1:1 - regardless of the load carried. . This means that if the rear axle fails, the front axle is braked fully to compensate for the failure. In addition, dual-circuit operation is maintained.

Maintenance

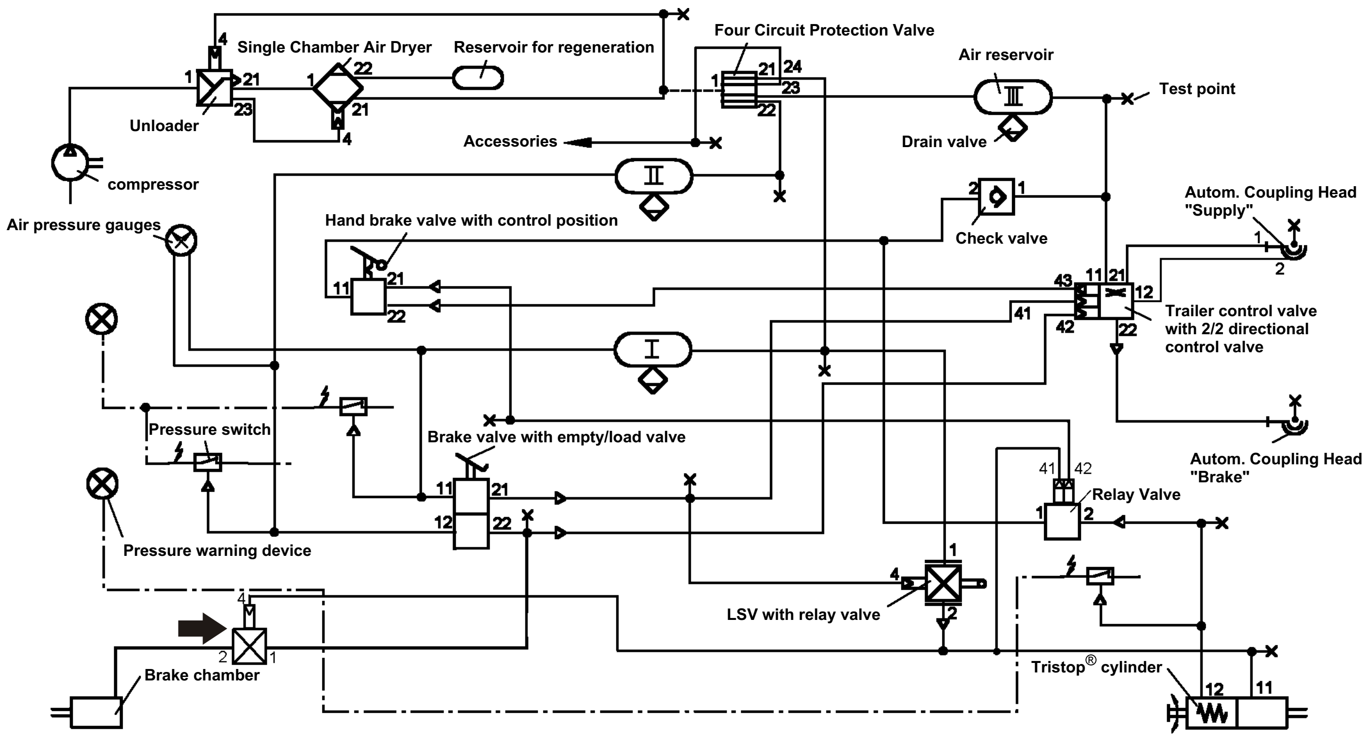
No maintenance is required beyond the checks required by law.

Testing

pilot control: 0.5 ± 0.1 bar
Grading: max. 0.3 bar

For further testing, please refer to the section on **"Testing and Adjustment of Automatic Brake Pressure Control"**.

Schematic for Testing and Installation



Purpose

Load sensing valves are used to adjust the brake pressure of one axle (or on trailers, possibly of both axles) to the load carried. With properly designed braking forces, and assuming a dry road surface, this prevents locking of the wheels when the vehicle is unladen or partially laden.

At mechanical sprung vehicles the regulation happens depending on the spring deflection.

Design types

475 710

a. This valve combines a load-sensing valve and an integrated **relay valve** in one compact unit. Taking into account a pilot pressure of between **0.3 and 0.8 bar**, the load-sensing valve can be used for a control range of up to **8.0 : 1**. The load-sensing valve operates **dynamically**.

In the event of the linkage breaking, a torsion spring automatically sets the load-sensing valve to its **“half laden”** position. Depending on the variant used, the control range is **20°, 30° or 60°**.

475 713

b. This load-sensing valve is a **static** regulator. This unit is available with a **control range of 20° or 36°**. Its pilot pressure is set to **0.5 bar**. The pressure reduction ratio is 8 : 1.

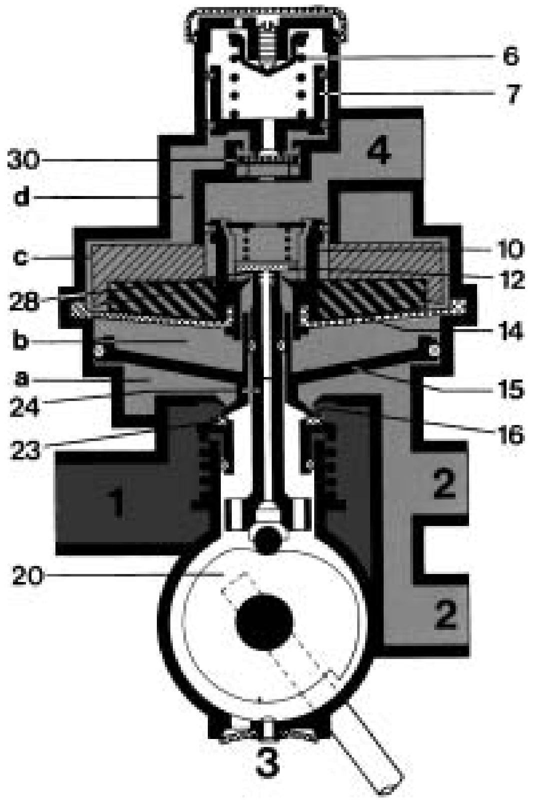
In the event of the linkage breaking, the valve is automatically set to its **fully laden position**. The device is preferably used in trailers and mounted with connecting rope and knuckle joint.

475 720

c. The Load-Sensing valve with integrated **relay valve** and pilot valve can be used for a control range of up to **5.3 : 1** and works dynamically. He has an integrated test valve at the inlet side. This offers together with the miniature design visible installation advantages.

Operation of Load-Sensing Valve 475 710 ... 0

a. Pilot Pressure



When port **(4)** is pressurized, the compressed air flows via the open valve (30) into duct (d) and into chamber (c). The pressure is now above the diaphragm (14).

At the same time, the pressurized piston valve (10) which is firmly attached to the diaphragm (14) is pushed downwards, taking with it the valve tappet (24). When the valve tappet (24) rests on the cam plate (20), outlet valve (28) can close and inlet valve (12) open.

This allows the same pressure from port (4) to reach chamber (b) below the diaphragm (14), at the same time acting on the effective surface of the relay piston valve (15). As this moves downwards, outlet valve (16) is closed and inlet valve (23) opened. The reservoir pressure at port **(1)** now passes through opened inlet valve (23) to port **(2)** until the pressure in port **(4)** has risen to the level of the pilot pressure.

At a maximum pressure of 0.8 bar, piston (7) moves upwards against the force of spring (6), closing the pilot valve (30).

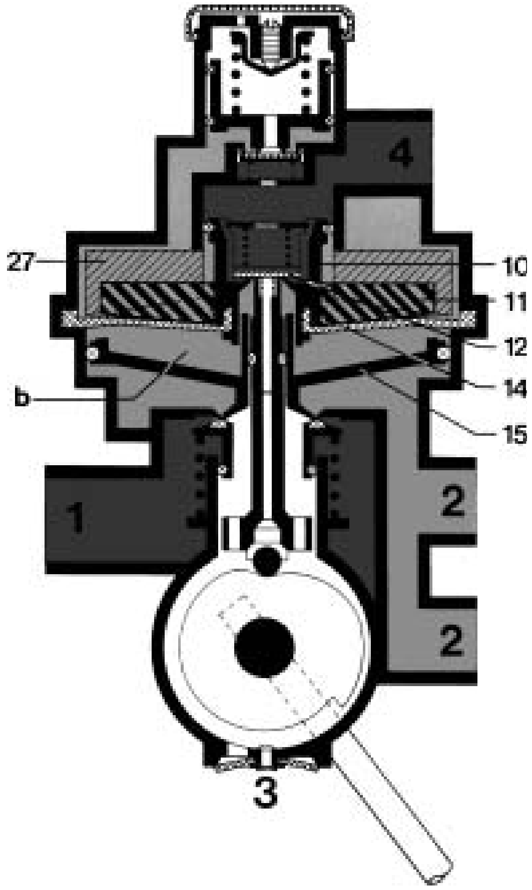
The pressure now prevailing in chamber (a) raises piston (15) until inlet valve (23) is closed. Pilot control of the regulator has now been selected.

Start of the pressure step-down

Any further increase in pressure in port **(4)** automatically causes a proportional reduction of the output pressure at port **(2)**.

This process is achieved by the multiple-disk piston (11) being firmly attached to the piston valve (10) from which multiple-disk piston (27), which is stationary, protrudes. This continuously increases the effective surface of the diaphragm (14) - depending on the valve's setting.

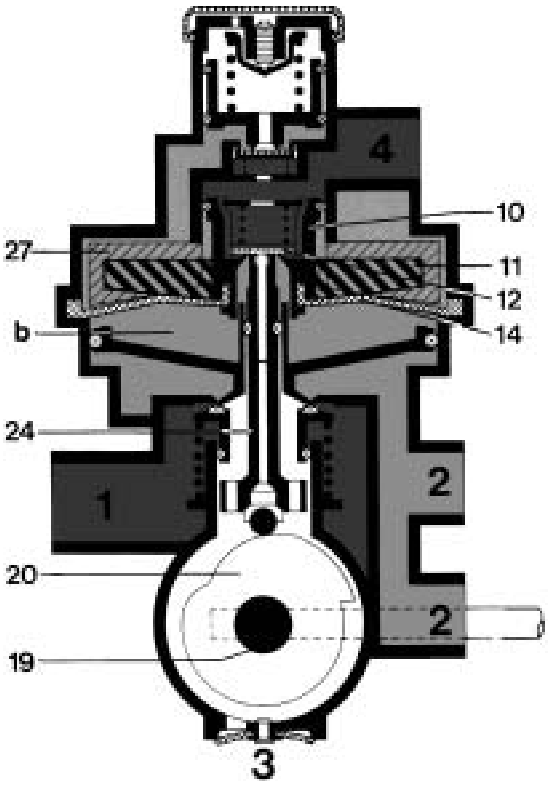
b. Braking Position: “Unladen”



As described under **“a”** above, the pressure passed through builds up in chamber (b) beneath the diaphragm (14).

Since the effective diaphragm surface is greater than that of the piston valve (10) in the **“unladen”** position, a small amount of pressure is sufficient for raising the diaphragm (14) together with the piston valve (10), once again closing inlet valve (12). The pressure now prevailing in chamber (b) actuates the relay piston valve (15). As described under **“a”** above, the pressure in port **(2)**, and thus in the brake cylinders, is increased.

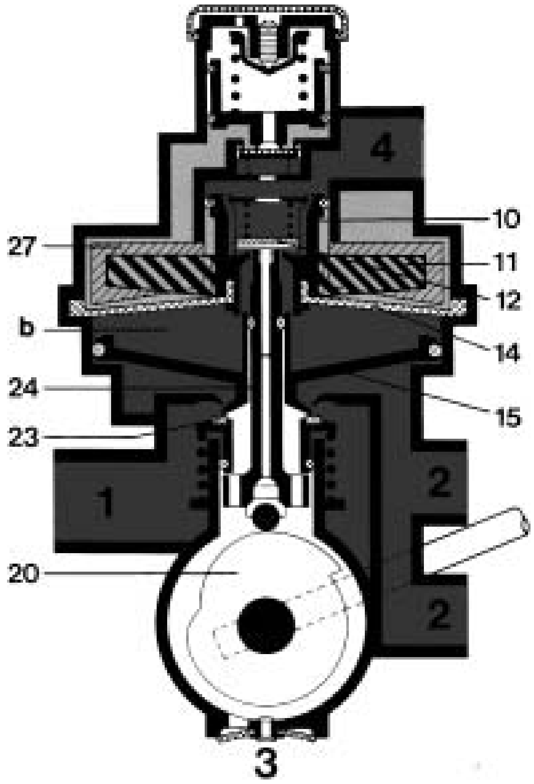
c. Braking Position: “Partially Laden“



When the load on the vehicle is increased, the **load-sensing valve’s linkage** raises the valve tube (24) by means of the cam disk (20) which is firmly attached to the actuating shaft (19). The compressed air entering at port **(4)** when the brakes are actuated pushes the piston valve (10) downwards, as described under **“b”** above Since the valve tube (24) is now in a higher position that it was in the **“unladen”** position, the compressed air flowing into chamber (b) must raise multiple-disk piston (11) higher above the diaphragm (14) in order to close the inlet valve (12). This causes multiple-disk piston (11) to dip into multiple-disk piston (27), thus causing a part of the effective diaphragm surface (14) to rest on multiple-disk piston (27). Since the effective surface of the diaphragm (14) is thus reduced, the pressure in chamber (b) has to be increased. When the forces between the piston valve (1) and the diaphragm (14) are balanced, inlet valve (12) is closed by the upward motion of the piston valve (10).

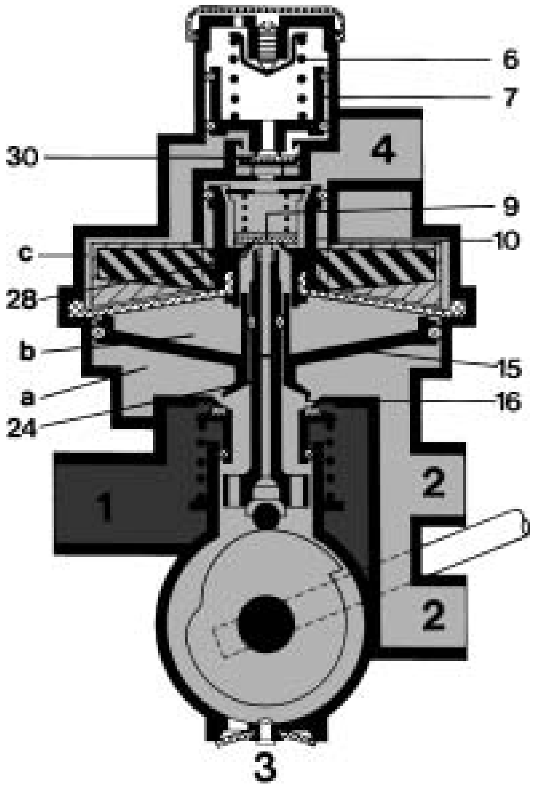
As described under **“b”** above, the pressure prevailing in chamber (b) triggers the relay effect of the load-sensing valve, thereby increasing the pressure in the brake cylinders via port (2), depending on the load added to the vehicle.

d. Braking Position: "Fully Laden"



When the vehicle is loaded up to its permissible total weight, the valve tube (24) is raised further by the cam disk (20), - as described in **"c"** above. When the brakes are actuated, the compressed air entering at port **(4)** moves the piston valve (10) downwards. After relatively short travel, the passage to chamber (b) is released by the opened inlet valve (12). This allows the diaphragm (14), together with the piston valve (10), to be raised again, so that after short travel, multiple-disk piston (11) dips fully into multiple-disk piston (27) and the effective surface of the diaphragm (14) rests on multiple-disk piston (27). The counterforce has thus been neutralized. The pressure coming in at port **(4)** is allowed to pass at a ratio of 1 : 1 - regardless of the load carried. Being fully pressurized, the relay piston valve (15) is forced downwards, opening inlet valve (23). This allows full reservoir pressure to flow from port **(1)** via ports **(2)** and on to the brake cylinders.

e. Release Position

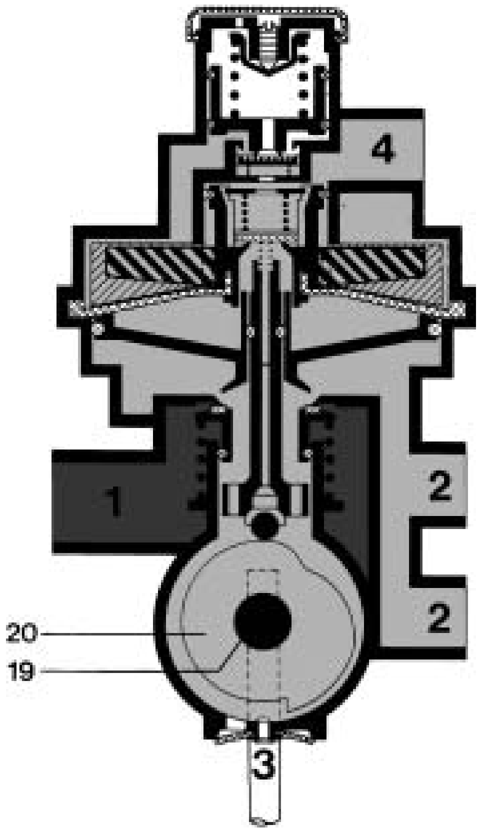


Irrespective of the laden condition, port **(4)** is vented when the brakes are released. At the same time, the pressure acting on the piston valve (10) and valves (9) and (30) is reduced.

This enables the force of spring (6) to move piston (7) downwards once again, opening valve (30). The pilot pressure prevailing in chamber (c) is thus reduced via port **(4)**.

At the same time, the pressure in chamber (b) raises the piston valve (10), thereby opening outlet valve (28). The pressure in chamber (b) is reduced via the valve tube (24), and the braking pressure in chamber (a) pushes piston (15) upwards, opening outlet valve (16). Via vent (3), the pressure from the brake cylinders escapes into the atmosphere.

f. Braking Position: "After Linkage Rupture"



If the connecting linkage breaks, the actuating shaft (19), together with the cam disk (20), is automatically moved into the **"half laden"** position by the force of a spring (not shown in the drawing). Regardless of the load carried, the load-sensing valve will now output a constant pressure when the brakes are actuated.

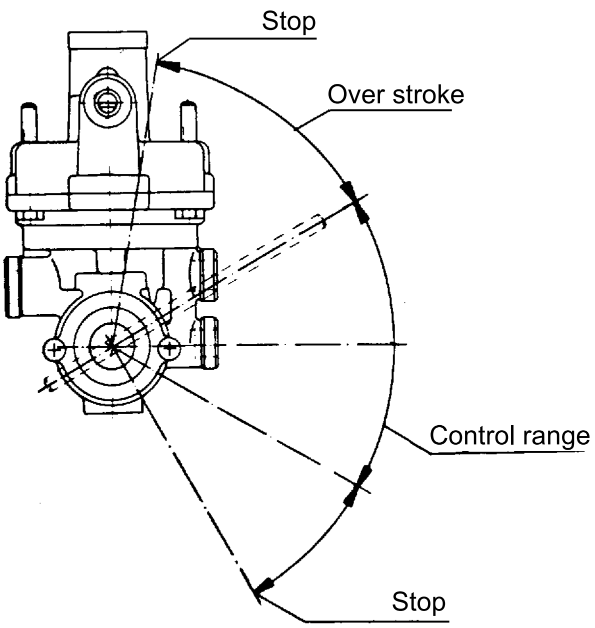
This function ensures that the effect stipulated for the emergency brake is reached.

Maintenance

No maintenance is required beyond the checks required by law.

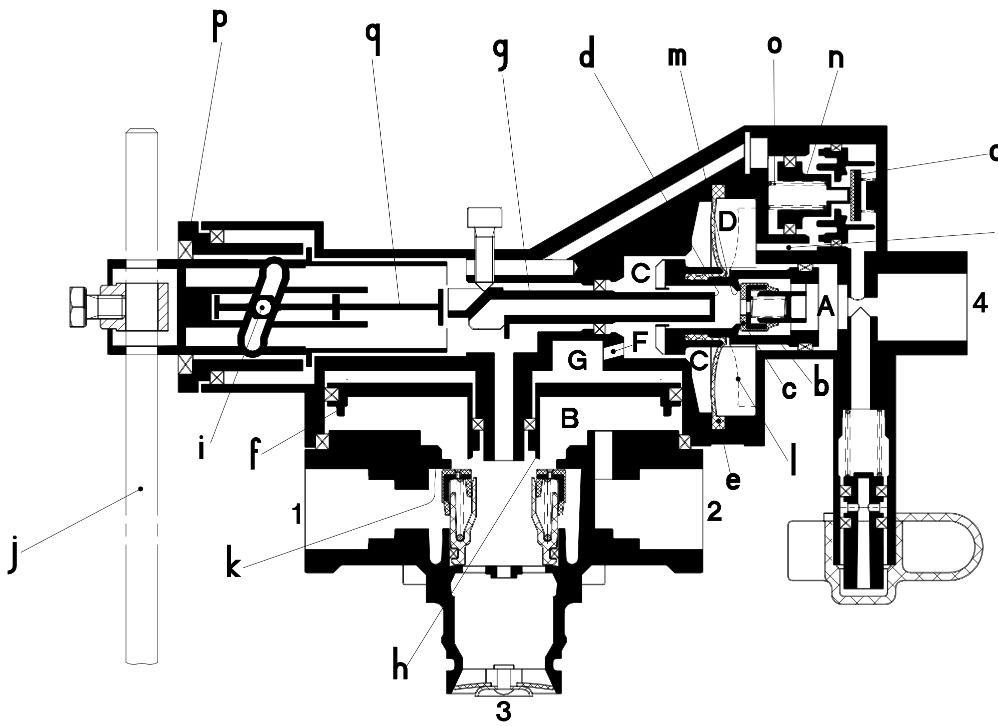
Testing

See "Testing and Settings".



Operation of Load-Sensing Valve 475 720 ... 0

The load sensing valve is fixed on the vehicle frame and connected via a linkage with a fixed point on the axle resp. on the knuckle joint. The distance between the axle and the load sensing valve is the longest in unladen condition, the lever (j) is in its lowest position. When the vehicle is laden, the distance becomes smaller and the lever (j) is moved from its unladen position into full-load direction. The pin (i) which is turned in the same sense with lever (j) moves the rod (q) via cams in the bearing cover (p) and thus the valve tappet (g) into the postion corresponding to the load.



The compressed air supplied by the brake valve in ALB port **4** flows into Chamber A and acts on the piston (b). Piston (b) is moved to the left, closes outlet (d) and opens inlet (m). The compressed air delivered at port **4** flows into room C left of the diaphragm (e), as well as through channel F into room G and pressurizes the active surface of the relay piston (f).

At the same time, compressed air flows via the open valve (a) and channel E into room D and pressurizes the right side of the diaphragm (e). This pressure predominance causes the reduction in the partially-laden range to be neutralized at low actuating pressures.

When the input pressure increases again, the piston (n) is moved against the force of the spring (a) and the valve closes.

The pressure which builds-up in room G moves the relay piston (f) downwards. The outlet (h) closes and the inlet (k) opens. The supply air at port **1** flows now via inlet (k) into room B and reaches via the ports **2** the subsequent air brake cylinders. At the same time, pressure builds up in Chamber B which acts on the underside of the relay piston (f). As soon as this pressure becomes a bit higher than the pressure in room G, the relay piston (f) moves upwards and the inlet (k) closes.

While the piston (b) is moving to the left, the diaphragm (e) touches the washer (l), and thus increases constantly the active surface of the diaphragm. As soon as the force which acts in room C on the left side of the diaphragm, is identic to the force which acts on the piston (b), piston (b) moves to the right. The inlet (m) closes and a final position is reached.

The position of the valve tappet (g), which depends on the position of the lever (j), is decisive for the active surface of the diaphragm and so for the delivered brake pressure. The piston (b) with the washer (l) must make a stroke which corresponds to the position of the valve tappet (g), before the valve (c) starts working. This stroke also causes the effective area of the diaphragm (e) to be changed. In full-load position the active surfaces of diaphragm (e) and piston (b) have the same size. Thus the pressure delivered at port **4** is delivered in 1:1 ratio into chamber C and so also into chamber G. As the relay piston (f) is pressurized with full pressure, the relay part delivers the pressure 1:1. That means, there is no reduction of the input brake pressure.

After the control pressure at port **4** is exhausted, the pressure in room C moves the piston (b) to the right and the pressure in the ports 2 move the relay piston (f) upwards. The outlets (d and h) open and the compressed air escapes to atmosphere via exhaust **3**.

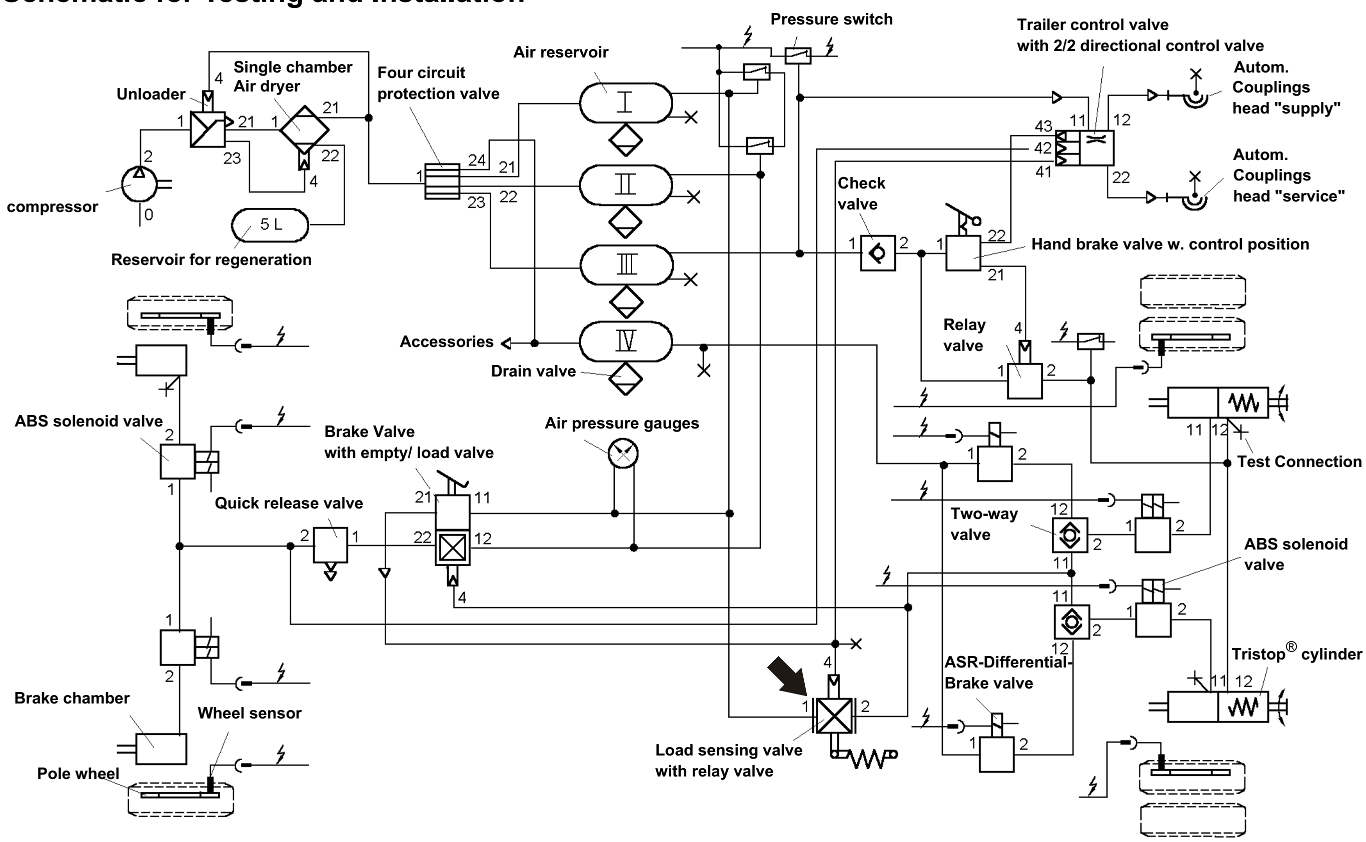
Maintenance

No maintenance is required beyond the checks required by law.

Testing

See “Testing and Settings“.

Schematic for Testing and Installation



Operation of Load-Sensing Valve 475 713

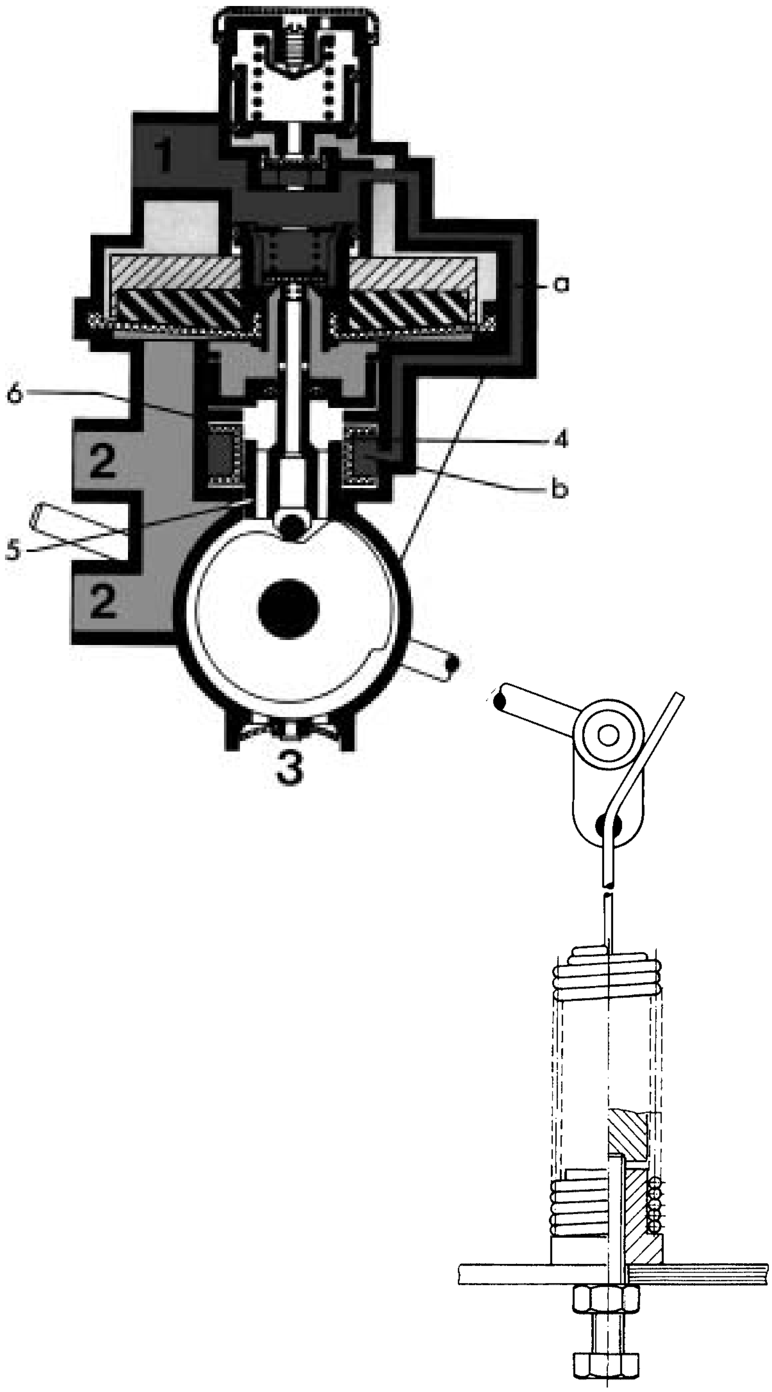
N.B.

Design and function of this load-sensing valve are identical with those of **load-sensing valve 475 710,** except for the absence of the relay piston valve, and the clamping fixture (4).

Braking position

The difference in its function is merely that when port **(1)** is pressurized, the command pressure flows through duct (a) and into chamber (b) where it pushes the washer (4) against the valve tappet (5). This achieves a power connection between valve tappet (5) and housing (6). Any changes in spring travel as a ratio of dynamic axle load transfer can thus not be transmitted to the output braking pressure **(static control)**.

After Linkage Rupture a torsion spring sets the device lever in the **"Fully Laden Position"**.



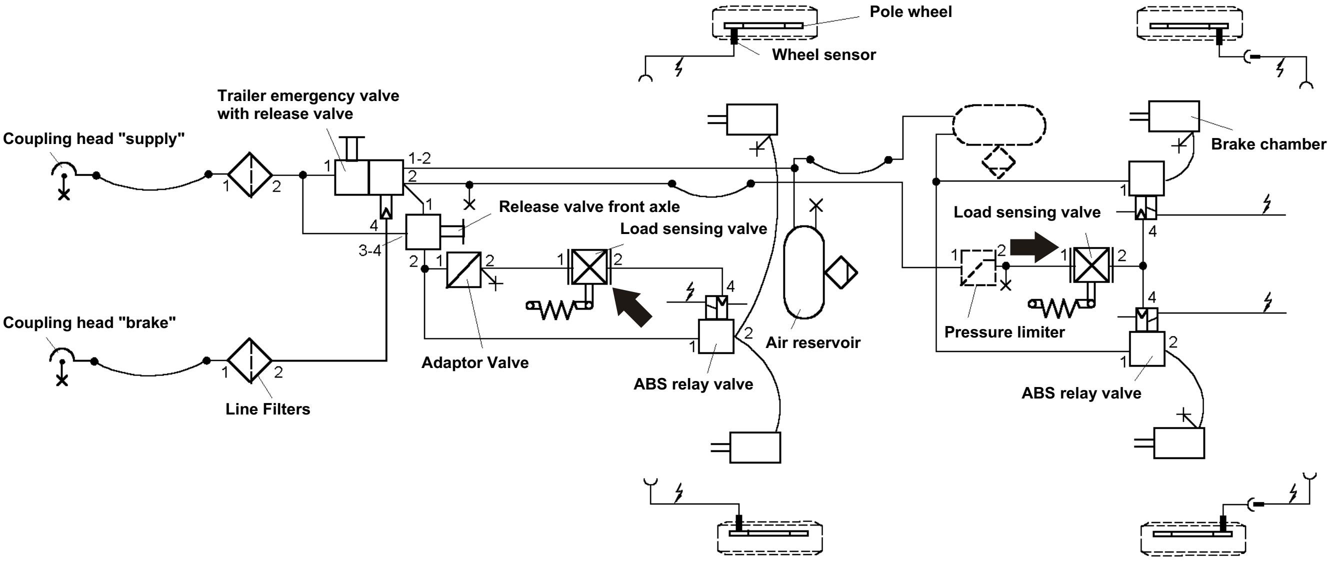
Maintenance

No maintenance is required beyond the checks required by law.

Testing

See "Testing and Settings".

Schematic for Testing and Installation



Purpose

Knuckle joints are needed to act as a linkage for load-sensing valves. Its purpose is to transmit the various loads carried, as a ratio of spring travel, to the load-sensing valve.

In addition, by means of its deflection ability, the knuckle joint prevents damage to the load-sensing valve if the whole of the adjusting range is exceeded. This may be the case, for instance, if the vehicle is overloaded, or can be the consequence of dynamic factors.

Design types

Knuckle joints vary in the type of linkage used, and in its length, depending on deflection from the centre upwards or downwards.

433 302

a. Knuckle Joint with Angle Joint

433 302

b. Knuckle Joint with Rubber Connector

433 306

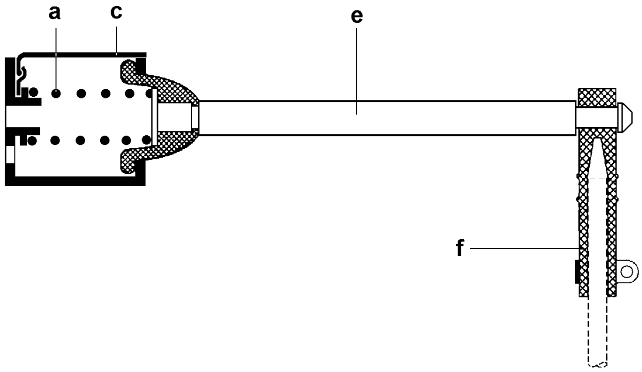
c. Reinforced Knuckle Joint with Angle Joint

Please note

When replacing a defective knuckle joint, it is important that the same type and variant is used.

Operation of Knuckle Joints 433 302 ... 0

a. Function



As the vehicle is loaded or unloaded, the change in spring travel is transmitted by the knuckle joint to the load-sensing device. Since the actuating force required for the knuckle joint is greater than that of the load-sensing device, the rocking lever (e) is not actuated.

If, however, in the event of severe axle ascillations, the load-sensing valve makes contact with the housing on the lever side, the rocking lever (e) is moved up or down after overcoming the force of the spring (a).

b. The Connection with the Load-Sensing Valve

The various knuckle joints are connected to the load-sensing valve either by an 8 mm round rod (older version), or an 8 mm tube. The length of the connection depends on the mounting of the load-sensing valve on the vehicle. It is fastened either by means of counter-nuts (older version), or pipe clamps.

Please note

A reinforced knuckle joint 433 306 … 0 is used for load-sensing valves which automatically reverse in the event of the linkage braking. 0.

Maintenance

No maintenance is required beyond the checks required by law.

Testing

The knuckle joint should be checked for proper functioning of the spring (2) by raising or lowering the rocking lever (1) several times. At the same time, the fastening elements must be checked.

Introduction

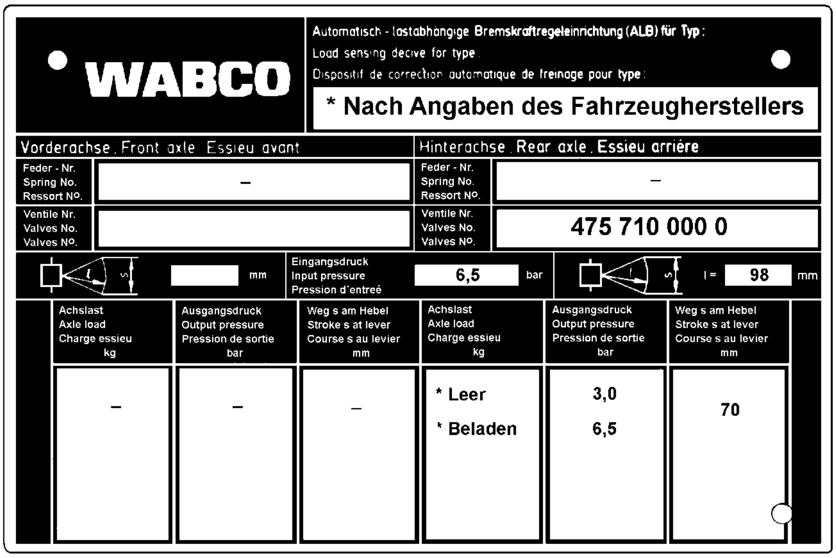
Taking into account the requirements for braking systems according to Supplementary Directive 75/524 (EEC), automatic load-sensitive control of the braking force is fitted by the vehicle manufacturer as a standard if it is required to meet these requirements.

For this reason we shall assume that such a control system does not have to be subsequently installed in the workshop. Therefore, the method of calculation does not have to be explained at this point.

The Reference Plate for the Load-Sensing Device

When checking a controlled vehicle axle, the information on the reference plate for the load-sensing device must be used as a basis. This plate is affixed in a prominent position by the vehicle manufacturer

Example



What must be tested?

1. **The input pressure (p_{in})**
2. **The output pressure for the laden and the unladen (empty) vehicle (p_{out})**
3. **The lever length (L) between the two fulcrums**

Please note

If the static spring travel has changed on a vehicle - or if a new spring has been fitted - the lever length **(L)** of the load-sensing device needs to be determined once again. For this the regulating ratio **(i_R)** and the static spring travel (s) need to be computed.

The nomographs for the individual variants of load-sensing devices are available from your WABCO-partner.

Example

Für den ALB-Regler **475 710 000 0** mit einem Lenkbereich von **60°** und einer Vorsteuerung p_d = 0,8 bar.

The Control Ratio (i_R)

$$i_R = \frac{p_{in} - (p_d + 0.3)}{p_{out} - p_d} = \frac{p_{in} - 1.1}{p_{out} - 0.8}$$

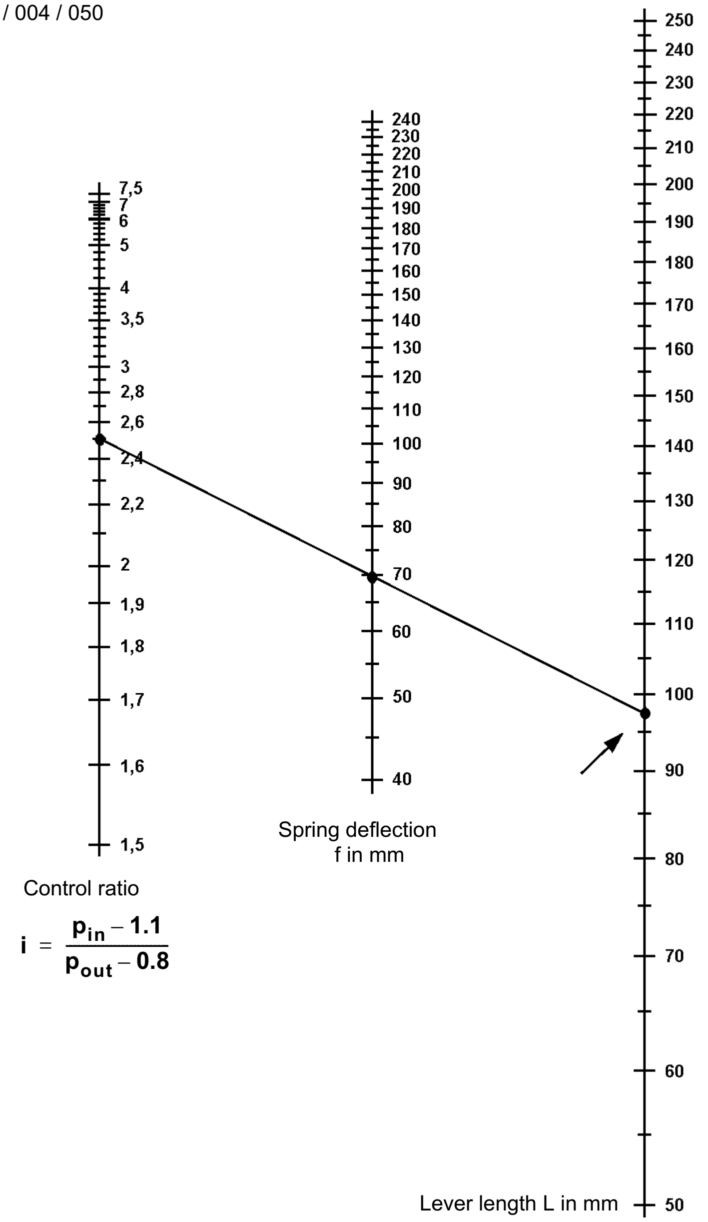
Technical Data (from reference plate for load-sensing device)

input pressure (p_{in}) = 6.5 bar
output pressure (p_{out}) = 3.0 bar
spring travel (s) = 70 mm

Determining the Lever Length (L)

$$i_R = \frac{6.5 - 1.1}{3.0 - 0.8} = \frac{\dot{2}5}{1}$$

Variant: 000 / 004 / 050

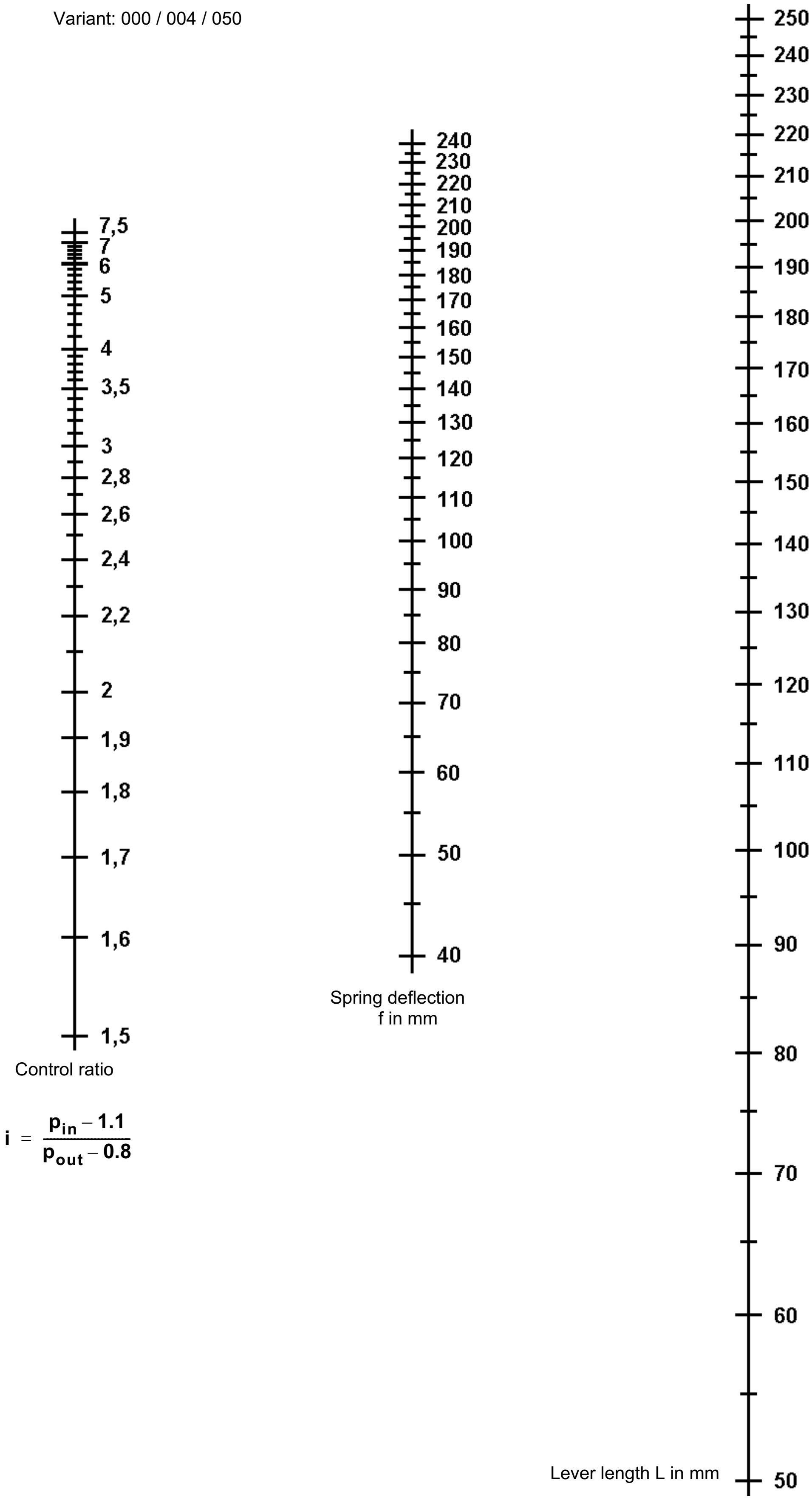


Result

The lever length **(L) = 98 mm**

Nomograph Example

For load-sensing valve **475 710 0** with a deflection angle of **60°** and pilot control pd = 0.8 bar.

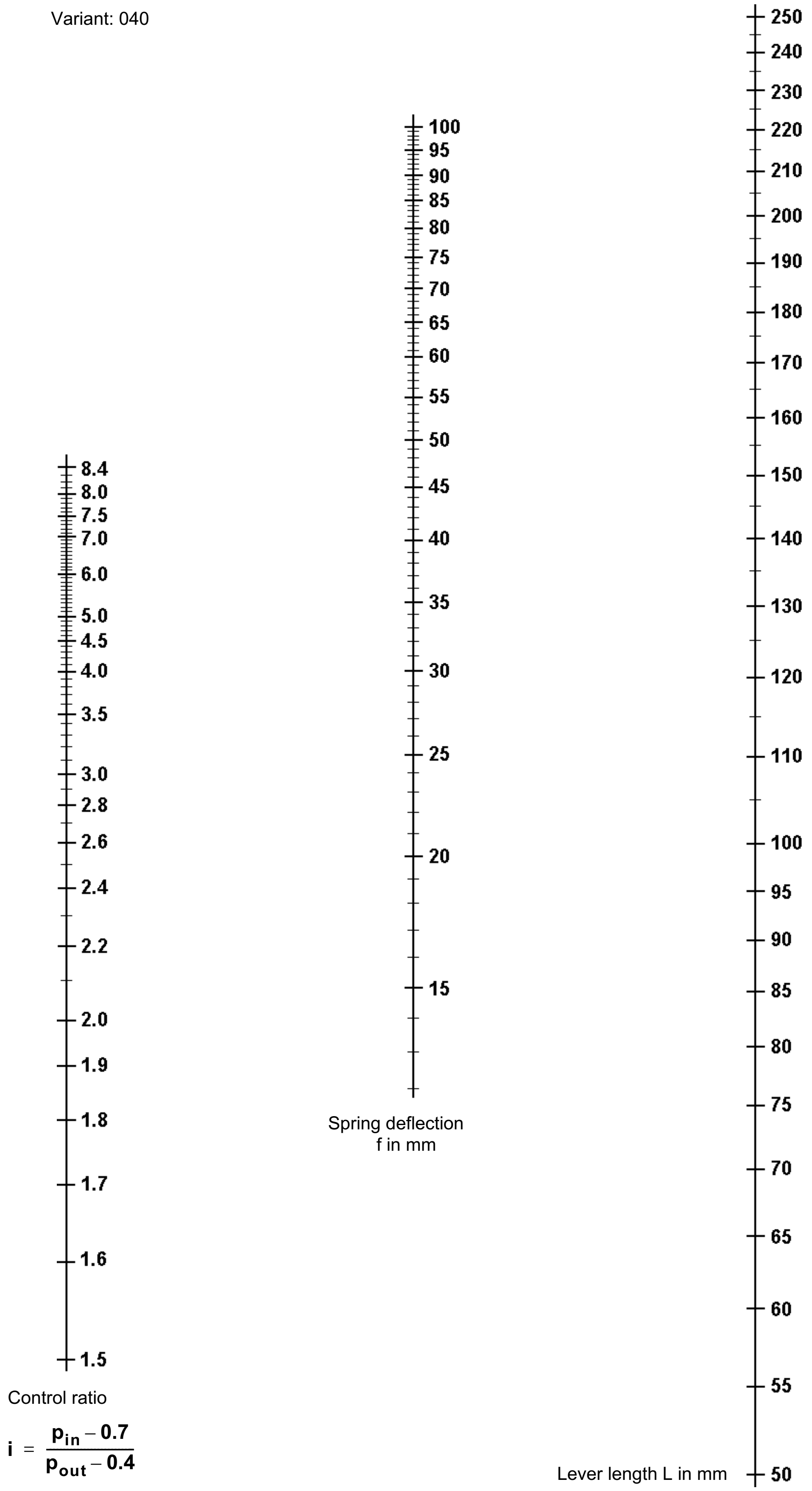


$$i = \frac{p_{in} - 1.1}{p_{out} - 0.8}$$

Nomograph Example

For load-sensing valve **475 710 0** with a deflection angle of **20°** and pilot control pd = 0.4 bar.

Variant: 040



Basic Settings for Load-Sensing Valve 475 713

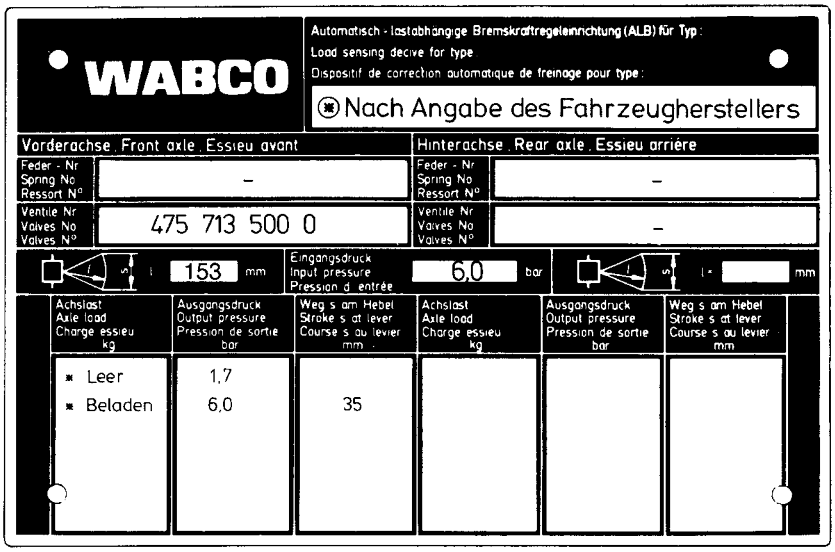
Introduction

The basic values have to be reset whenever spring travel has changed, or when a new load-sensing valve is installed.

Requirement

If spring travel has changed, the control ratio (i_R) and the effective lever length (L) need to be determined from a nomograph.

Example



Determining the control range (i_R)

input pressure (p_{in}) = 6.0 bar
output pressure (p_{out}) = 1.7 bar

Example

$$i_R = \frac{p_{in} - 0.8}{p_{out} - 0.5} = \frac{6.0 - 0.8}{1.7 - 0.5} = 4.3$$

Spring Travel (s)

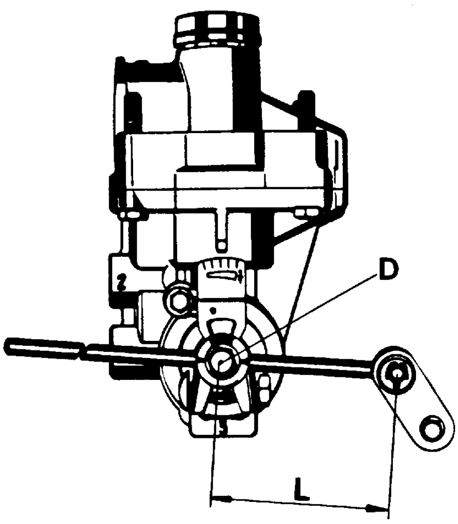
According to the reference plate for the load-sensing valve, spring travel (s) = 35 mm.

Determining the Lever Length (L)

On the nomograph's entry (A), the control ratio (i_R = 4.3) and on the nomograph's entry (B), the spring travel (s = 35 mm) are marked off. The extension of these two items gives us intersecting point (C) and thus lever length (L).

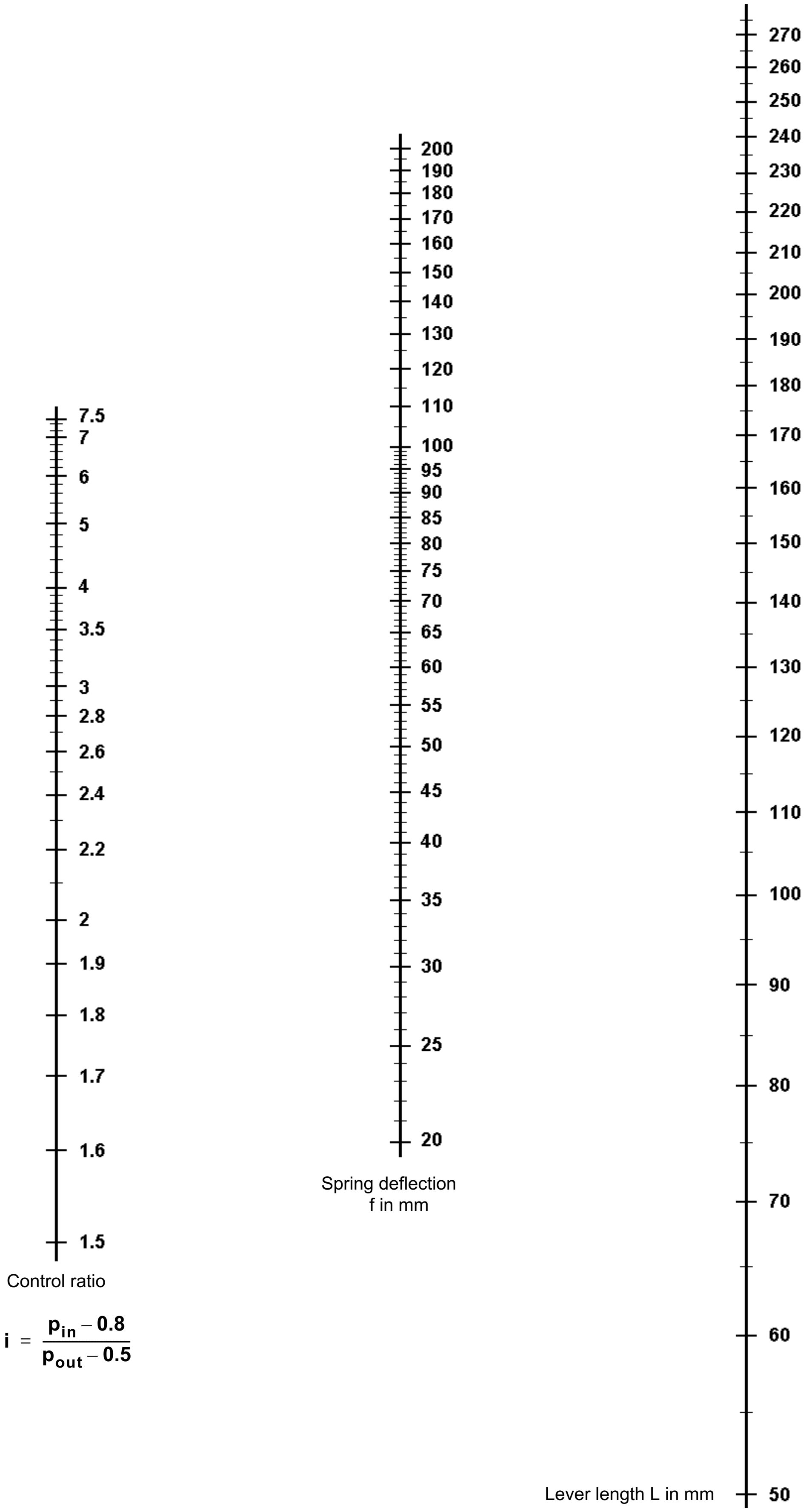
Result

The lever length (L) from fulcrum to fulcrum is 153 mm. It is set by means of the adjusting screw (D).



Nomograph

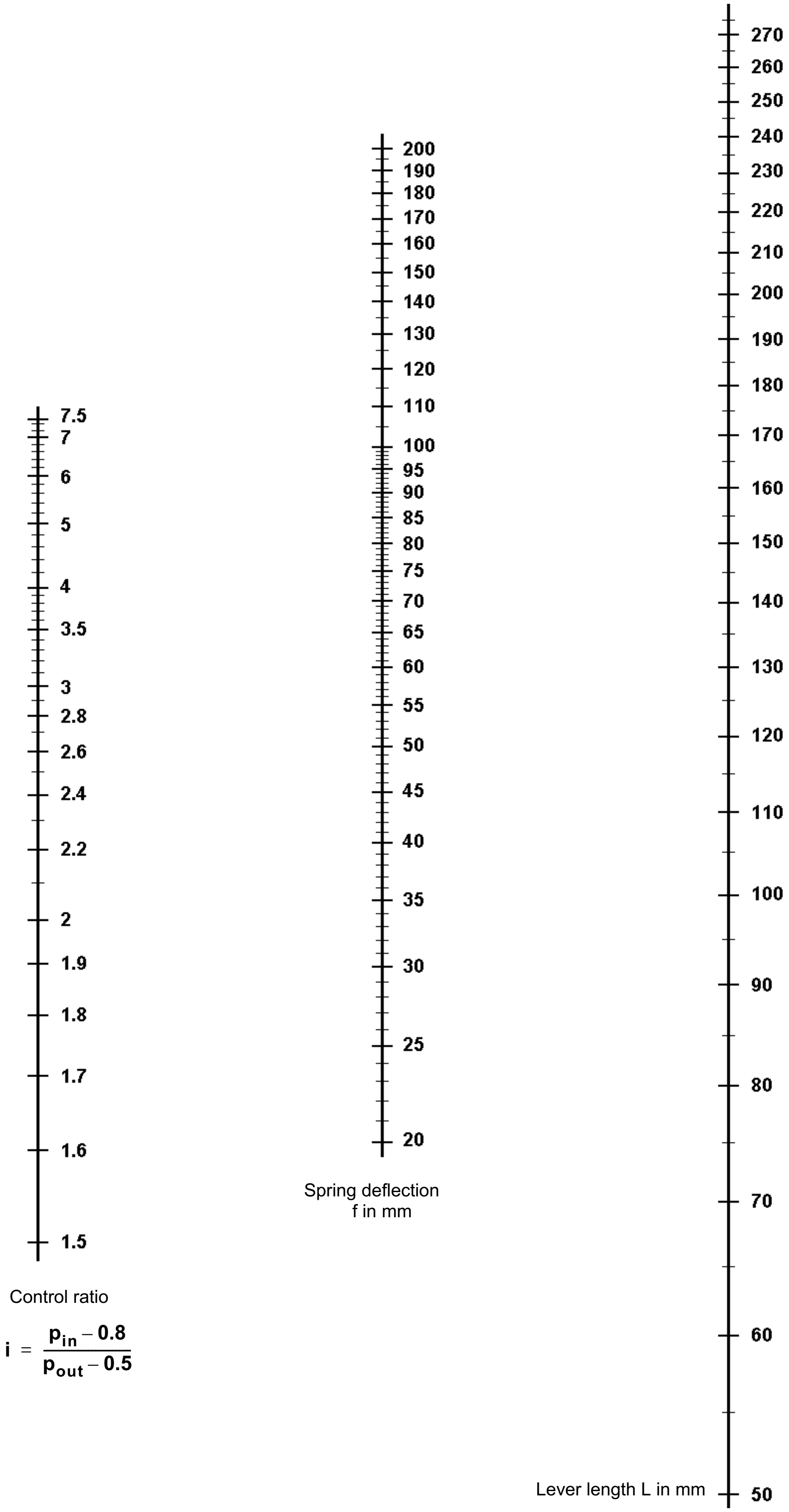
For Load-Sensing Valve **475 713 500 0** (Control range **20°**)



$$i = \frac{p_{in} - 0.8}{p_{out} - 0.5}$$

Nomograph

For Load-Sensing Valve **475 713 501 0** (Control range **36°**)

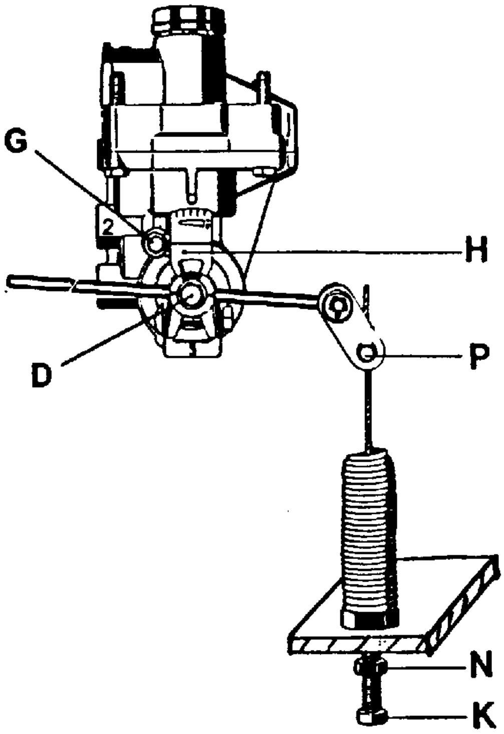


Installation of Load-Sensing Valve

Using the nomograph, the required lever length for the load-sensing valve is determined and set on the unit. After releasing screw D, the lever can slide in the shaft.

The load-sensing valve must be installed in such a way that the connecting rope hangs down vertically. The spring of the knuckle joint is prestressed by approx. 15 mm using screw K.

Setting the Brake Pressure “Unladen”



Prior to any changes on the load-sensing valve (rope length, lever position, etc.), it must be pressureless.

The load-sensing valve’s lever is brought into the position in which the brake pressure “unladen” is output. With a pin 3 mm in diameter, the linkage can be fixed with hole H and adjusting screw G. Then the rope is tightened and clamped with screw P.

When the pin is now removed and the brakes are actuated once again after releasing them for a short time, the brake pressure “unladen” needs to be output once again. Small adjustments can be made on screw K after releasing counternut N.

– Turn screw K clockwise = to increase the pressure
– Turn screw K anticlockwise = to reduce the pressure

Testing the Braking Pressure “Laden”

When the “unladen” braking pressure is right, the lever is raised by the applicable spring travel (difference in unladen/laden weights).

When pressurized again, the load-sensing valve must output the input pressure.

– **If the output pressure is less than the input pressure**
  shorten lever and start again by setting the braking pressure “unladen”.

– **if the output pressure is equal to the input pressure**
  lower lever by approx. 10 % of spring travel. The output pressure must now be less than the input pressure. If this is the case, the setting is achieved. If not: Extend lever and start again by setting the braking pressure “unladen“.