

Fig.20 -Control characteristic of the Linde regulating motor BMR

The motor displacement is varied from V_{\min} to V_{\max} within the pressure range of $P = P_{RE} - P_{RB}$ which is normally about 10 to 15 bar. Despite this relatively narrow band the resolution is very good, because the torque is increased within this by about 2,8 times (depending on the minimum displacement setting).

The regulating motors BMR are also equipped with the purging system for the reasons described in paragraph 3 (circuit diagram according fig.21).

The shuttle valve (11) will open the connection port carrying lower pressure (in this case A), so that the fluid can bleed out of this channel. The escaping amount of fluid is limited to a certain value (about 8 l/min) by means of the discharge valve (12) - a combination of pressure relief valve (response pressure about 5 bar) and 2 way flow control valve - independent of the pressure on the low pressure side.

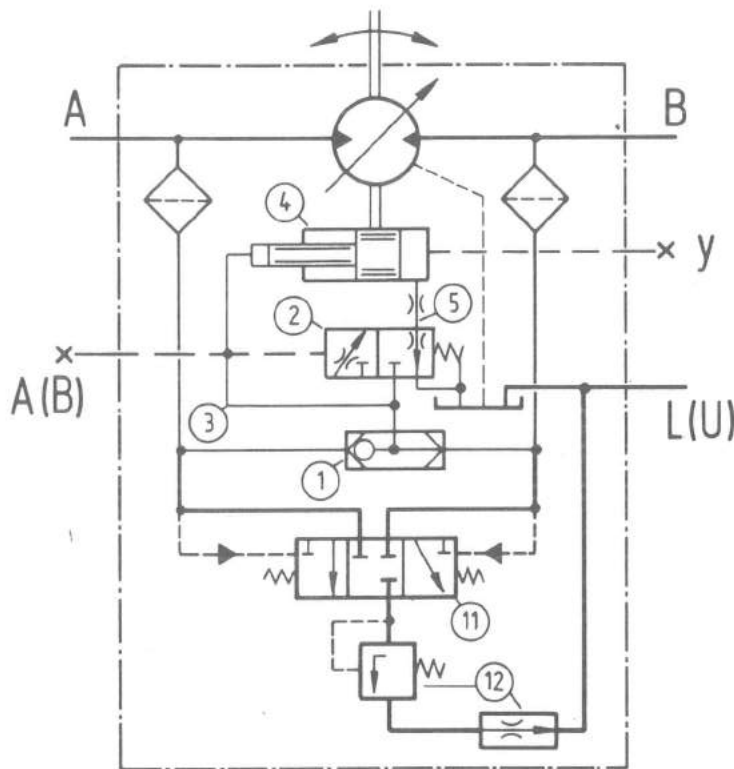


Fig.21 -Linde regulating motor with BMR with purging arrangement and regulator by pass.

5.4.2. "Regulator by-pass"

There are various working conditions requiring the possibility of selecting maximum displacement even below the regulation begin point of the regulating motor, i.e. it must be possible to intentionally override the high pressure signal for precise travel control. For this purpose the regulator must be by passed by connecting port $\times A(B)$ with port $\times Y$ (fig.21). By fitting a shut off valve in this line this feature can be selected on demand.

5.5. Regulating motor BMR with high pressure sensing control and braking pressure shut off

5.5.1. Application criteria

It is a disadvantage of all high pressure control regulating motors in the closed loop that the braking operation will switch the motor to full displacement as soon as the braking pressure exceeds the regulation begin. This has the following consequences:

- a) When a relatively light vehicle travels at high speed while the pump is at full displacement and the motor at reduced displacement, a very harsh deceleration can be caused by braking. Jerky and uncontrolled behaviour would be the result.
- b) Heavy vehicles develop most of the time a very high kinetic energy at maximum travel speed. On starting the deceleration phase hydrostatically the pump delivery is first reduced. Braking pressure builds up activating the regulator of the BMR thus increasing its displacement. The high kinetic energy and inertia do not allow the travel speed and the motor speed to decrease rapidly, so that the response of the regulator leads to a sudden increase of flow in the return line, while the pump is not able to assure a sufficient supply on the other side. This causes a temporary cavitation in the motor. A back pressure will build up in the return line as the occurring high delivery cannot be consumed by the pump.

The high pressure relief valves will open, the circuit will be heated up very quickly!

These vehicle depending braking situations are beyond the driver's control, and they can be easily remedied by preventing the braking pressure getting to the pressure regulator irrespective of the sense of rotation. Under this condition the BMR will develop its full torque only for acceleration while the motor stays or goes into the minimum displacement position for braking, so that hydrostatic deceleration is effected gently.

This measure provides a gentle deceleration. With the objective of having the entire variation range and, therefore, the maximum hydraulic motor torque available also when reversing, the pressurisation of the regulating device is correlated with the direction of travel by means of an electric selection valve.

The BMR with brake pressure shut off has proven to be the ideal motor for hydrostatic transmissions with automotive control and continuous primary-secondary-variation.

The acceleration and deceleration behaviour is very progressive and the regenerative load of the vehicle on the prime mover is limited. Hydraulic motor cavitation is avoided.

Sensitive driver controlled, dynamic braking is taken over by the mechanical brakes. The hydrostatic transmission has a supporting function according to the selected minimum displacement of the hydraulic motor.

5.5.2. Brake pressure shut off

Description of function

In the circuit diagram according to fig.22 the two main connection ports of the BMR motor are marked A and B. Two connection channels a and b lead from the main channels A and B to a hydraulically operated 3/2 way valve (3). Strainers are fitted in the lines a and b for protecting the control device against coarse contamination.

Valve (3) determines which of the two lines a or b are connected with the regulator (2) and the small piston area (1). Control piston (1) determines the position and, therefore, the displacement of the BMR motor.

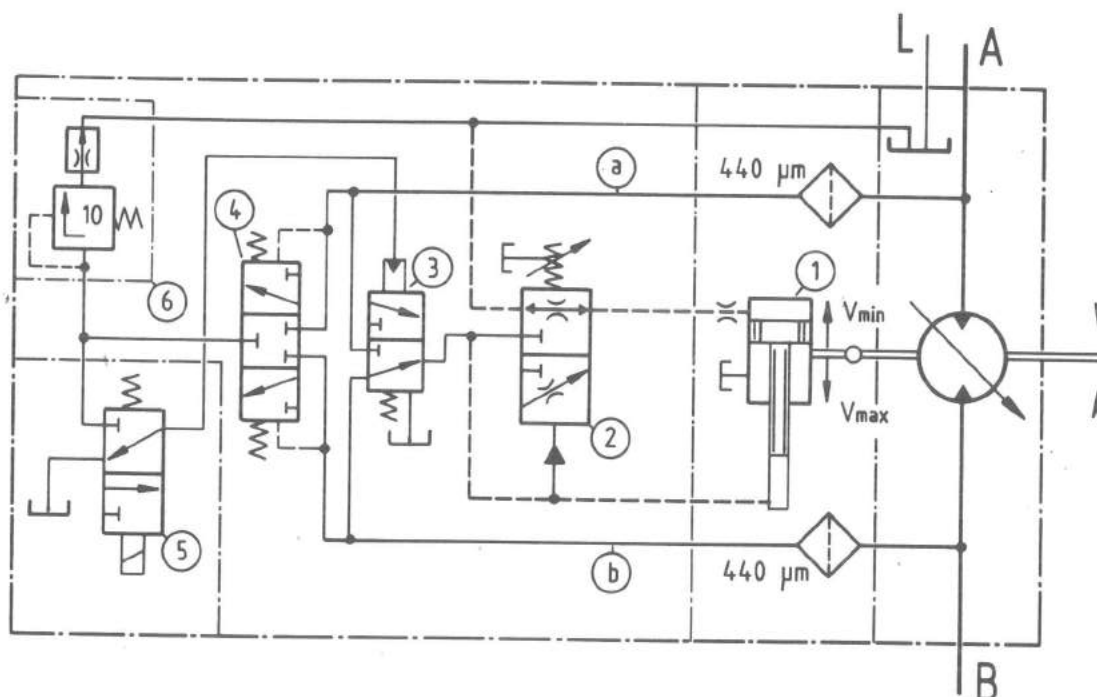


Fig. 22 - Brake pressure shut off

Via the two channels a and b the two main connection ports A and B are also connected to the shuttle valve (4). The function of this valve is such that the lower of the two pressures is connected with the flow limiting discharge valve (6) and to the solenoid 3/2 valve (5).

By means of the electrically controlled valve (5) it is determined which of the main ports A or B can pressurise the regulator (2) of the motor. A solenoid linked with the travel direction selector of the pump control determines the position of valve (5). The illustration shows the solenoid unenergised. The centering spring of the valve determines the position shown in which the connection of valve (3) is unloaded and the position of valve (3) is defined by a spring as shown in the picture. Through channel b port B of the hydraulic motor is connected with the control device (2) and the small area of the control piston (1).

Below the begin of regulation which is defined by the spring of the regulator (2) pressure loading the small area of piston (1) keeps the motor in minimum displacement position V_{min} . The large area is unloaded. As the rolling resistance and, therefore, the pressure rises above the regulation begin, the large area of the regulator is also pressurised from connection port B; the force differential moves the motor to its maximum displacement position V_{max} .

According to the required torque any intermediate position between V_{min} and V_{max} can be reached and maintained steplessly!

When pressure in B drops below the regulation begin, the large area of piston (1) is discharged again; the motor moves into its V_{min} position. When braking the pressure changes from B to A! The small piston area is then only loaded by the boost pressure and keeps the motor in V_{min} , while the higher pressure in port A and channel 'a' cannot get to the regulator!

The BMR motor stays in its V_{min} position even if the braking pressure exceeds the regulation begin.

When changing the sense of travel or rotation, the solenoid of valve (5) is energised and valve (5) switches over to that position which pressurises the control port of valve (3). Valve (3) changes and connects 'a' with the control valve (2) and the small area of the control piston (1).

Connection port A has now become inlet port; the flow in this channel goes to the hydraulic motor. When due to rising travel or movement resistance in A pressure exceeds the set regulation begin (2), the motor will respond.

When braking the sense of rotation and flow remain the same, but higher pressure will occur in B. This has, however, no influence on the regulator. The motor remains in its V_{min} position or goes back to this position.

It will brake with the torque resulting from V_{min} leading to vehicle slowing down gently.

6. Setting of minimum displacement

The method of setting the minimum displacement is different according to size and age of the motors. Basically there are two varieties:

6.1. Limitation by head screw (fig.23)

The end stop plate (3) is connected to the V_{\max} side of the control piston (1) by means of snap ring (2). The compression spring (4) presses this stop plate on the snap ring.

Fig 23 Setting of the minimum displacement
(limitation by head screw)

The shoulder of the bolt (5) serves as an end stop for minimum swash angle limitation secured with the self sealing nut (6). To change the minimum displacement bolt (5) must be turned after loosening the nut (6):

Screwing in $\hat{=}$ V_{\min} becomes smaller

Screwing out $\hat{=}$ V_{\min} becomes bigger

The maximum swash angle of the motor of 28 is limited by piston (1) contacting cover (7).

6.2. Limitation by threaded stud (fig.24)

There is a threaded stud (1) located at the V_{\min} side of the motor housing secured by the self sealing nut (2).

In the V_{\min} position the valve plate (3) of the complete rotating assembly is stopped by this stud.

For changing the minimum displacement the stud (1) has to be turned after loosening nut (2).

Screwing in $\hat{=}$ V_{\min} becomes larger

Screwing out $\hat{=}$ V_{\min} becomes smaller

Due to the length of the threaded stud the range of adjustment of the minimum displacement is limited (minimum swash angle 8° to 16°).

Bigger minimum swash angles hence larger minimum displacements are possible upon request to the factory.

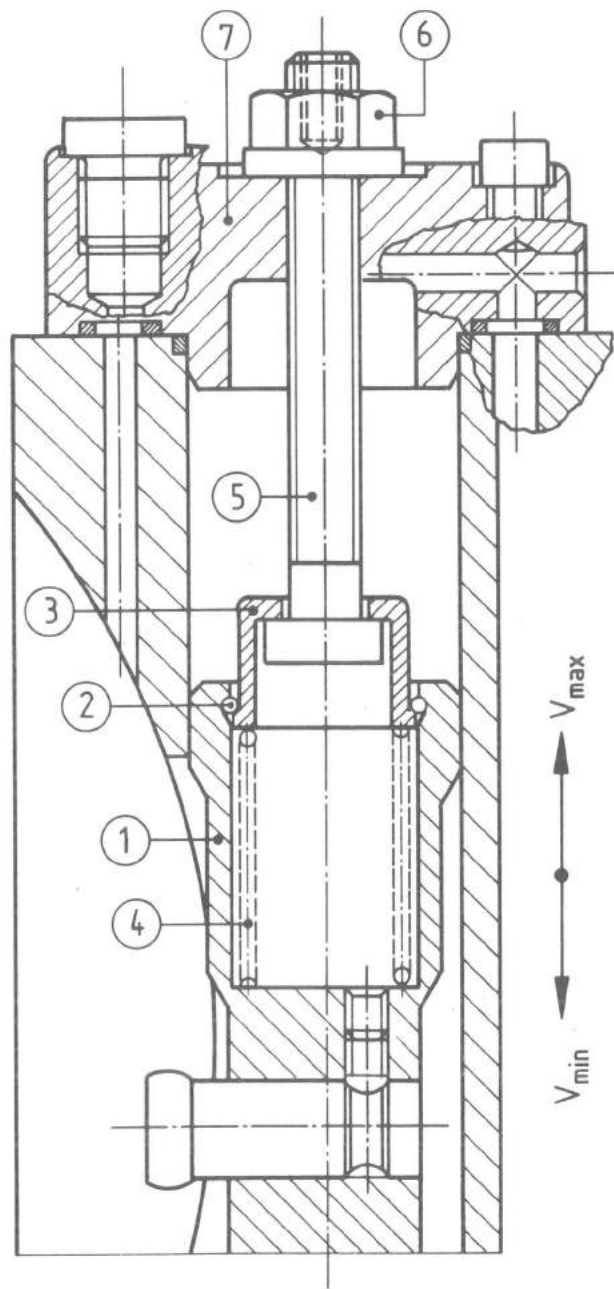


Fig.23 - Setting of minimum displacement
(limitation by head screw)

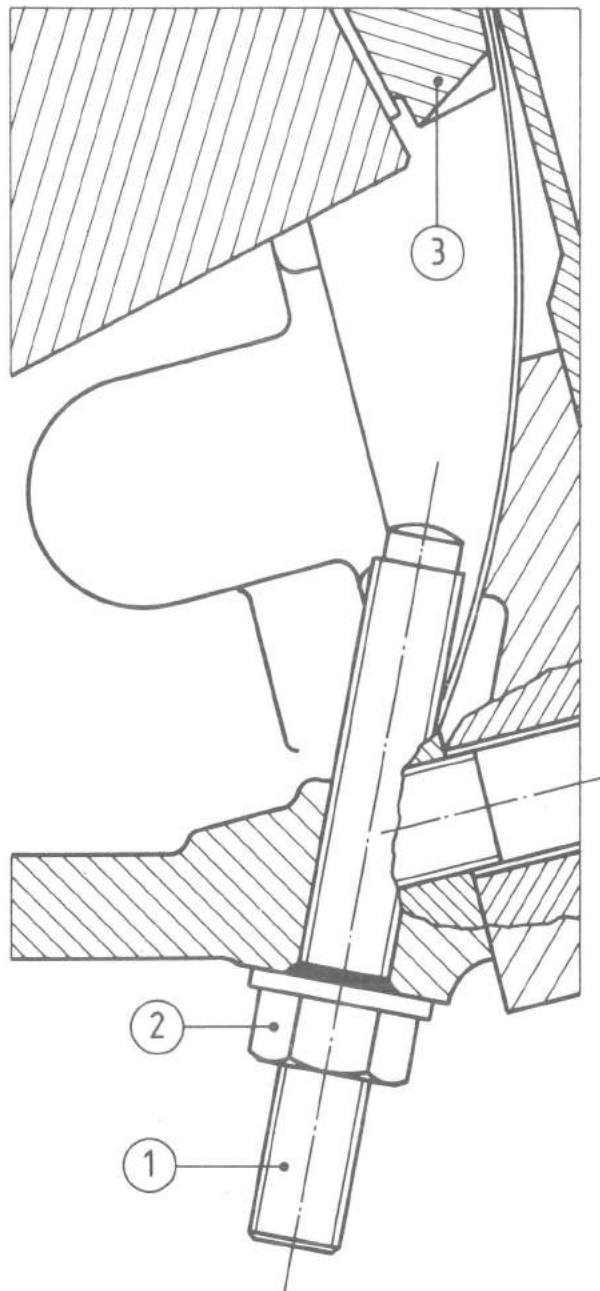


Fig.24 - Setting of minimum displacement
(limitation by threaded stud)





Linde AG, Werksgruppe Flurförderzeuge und Hydraulik
P.O.Box 62, D-63736 Aschaffenburg
Phone (int. + 60 21) 99-0, Telex 41 88 0118 lg d,
Fax (int. + 60 21) 99-1579