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(54) **Damming return flow in a rotary power-assisted steering valve**

(57) A rotary slide valve for motor vehicle power-assisted steering systems comprises a rotary valve member 4 having an axial bore 29, a valve bush 6 surrounding the rotary valve member 4 and duct means for distributing the working fluid to a servomotor 8 by way of feed control edges 31, 35 arranged between the rotary valve member 4 and the valve bush 6 and by way of return flow control edges 33 between the rotary valve member 4 and the valve bush 6. Connecting apertures 16, 17 and 18 are formed in the interior of the valve bush 6 and extend longitudinally thereof from the return flow control edges 33 to a return flow connection 9. The control edges are so arranged in relation to one another that in the neutral position of the valve the working fluid flows unthrottled via control edges 31, 32 and 33 to the return flow connection 9, while in the operative condition of the valve all the working fluid passes via at least one constriction 28, 30 between the feed control edges 31, 35 and the return flow control edges 33, 34 in dependence on the direction of rotation of the rotary valve member 4.

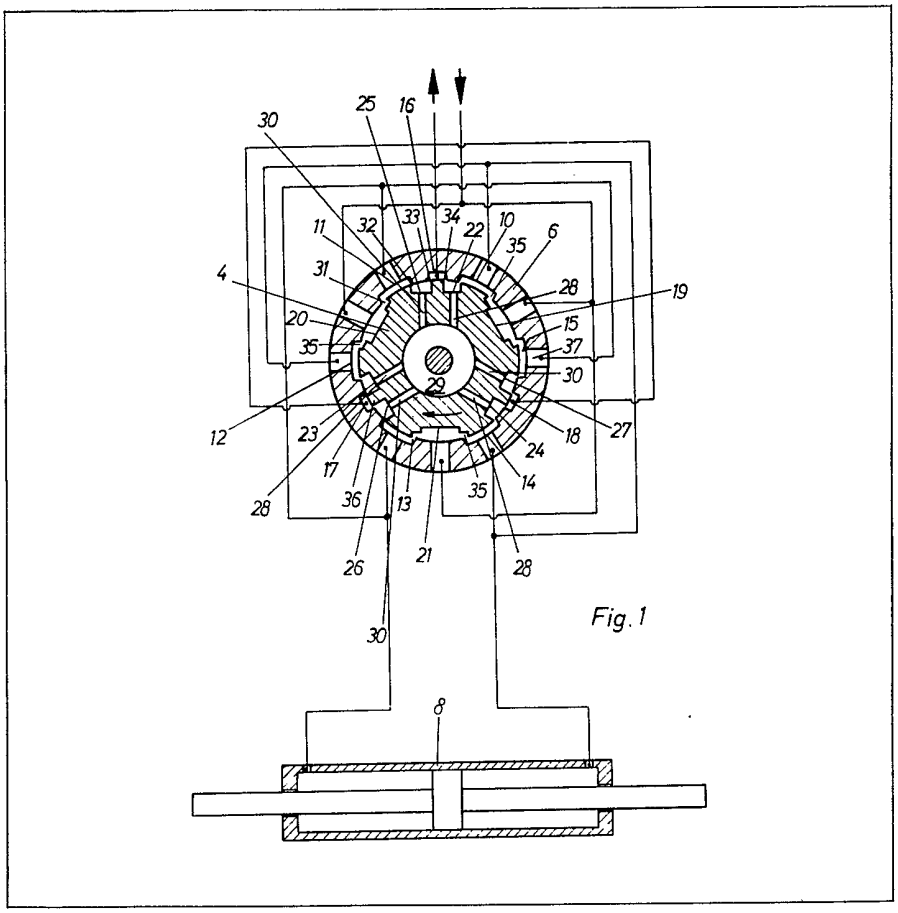

Fig. 1

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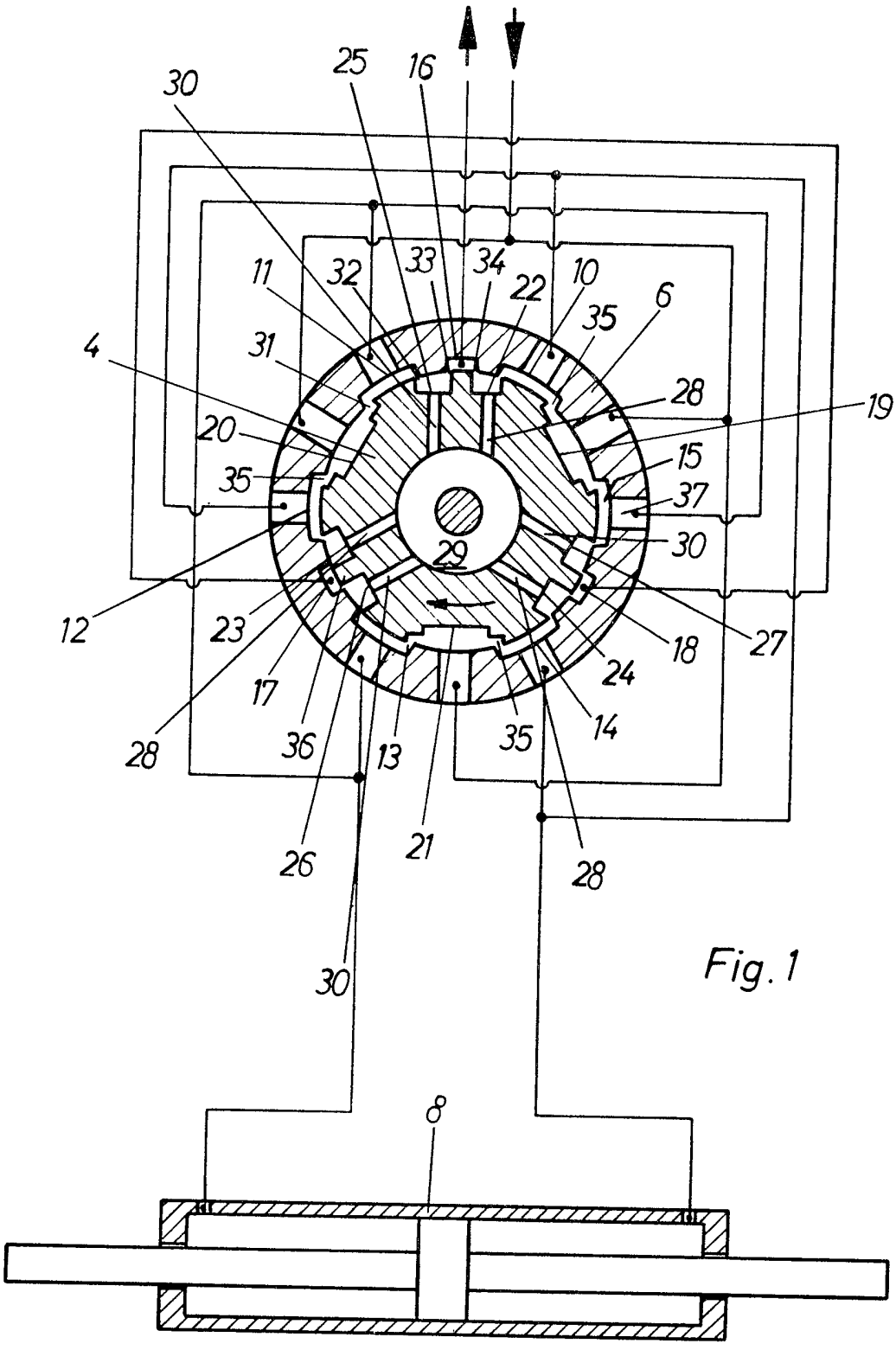

Fig. 1

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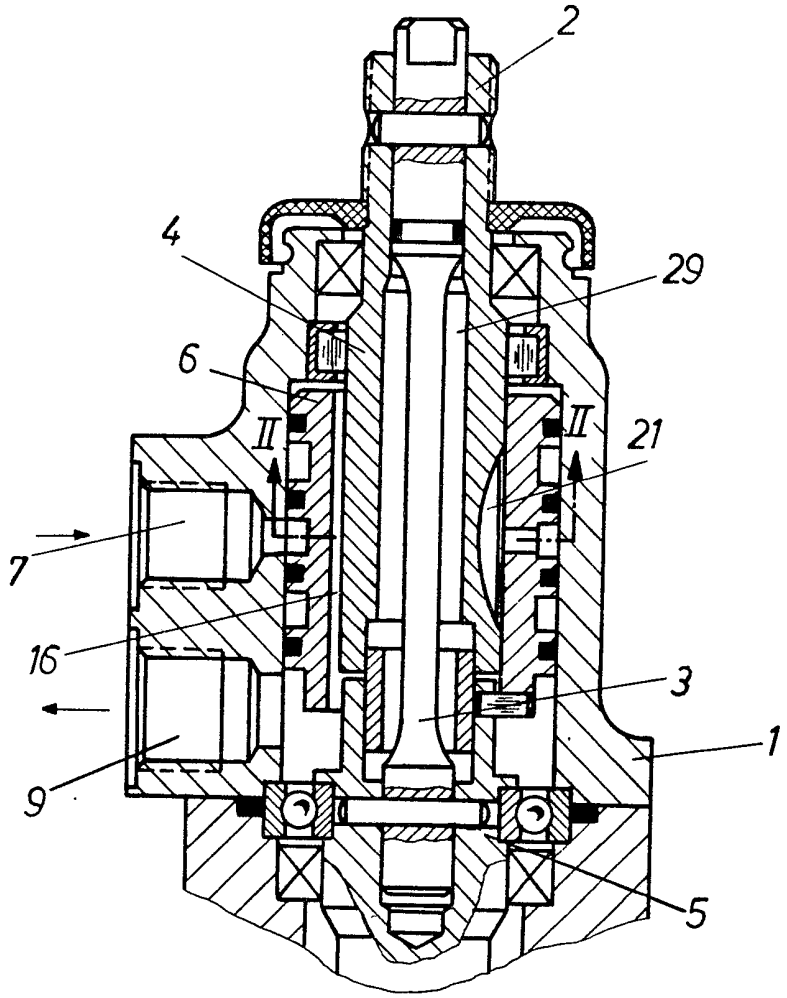
Fig. 2



SPECIFICATION

Rotary slide valve for power-assisted steering systems.

This invention relates to a rotary slide valve for motor vehicle power-assisted steering systems, of the kind which comprises a rotary valve member, a valve bush enclosing the rotary valve member, and duct means for distributing the working fluid to a servomotor via feed control edges arranged between the rotary valve member and the valve bush, and return flow control edges between the rotary valve member and the valve bush, connecting bores extending from the return flow control edges to a return flow connection.

In rotary slide valves of the foregoing kind, it is known that from a predetermined pressure level onwards disturbing noises can distinctly be heard. These are mainly unpleasant hissing noises which arise at the control edges of the rotary slide valves. The hissing noises depend on the pressure ratio of the pressures upstream and downstream of the control edges. The higher the pressure gradient, the more unpleasant the hissing noises become.

It is therefore known to alter the pressure ratios at the control edges suitably by damming the return oil flow. The damming of the return oil eliminates or at any rate at least appreciably damps the flow noises. However, a disadvantage is that the return damming raises problems when the steering valve is inoperative. Amongst other things, vehicle reverse travel deteriorates. There is also a useless heating up of the hydraulic fluid and wasting of energy.

It is therefore an object of the invention to provide a rotary slide valve for motor vehicle power-assisted steering systems in which the required return damming pressure is produced when the steering valve is operated, while with the steering valve inoperative the steering function is not adversely affected.

Accordingly, the present invention consists in a rotary slide valve for motor vehicle power-assisted steering systems, comprising a rotary valve member, a valve bush enclosing the rotary valve member, and duct means for distributing the working fluid to a servomotor by way of feed control edges arranged between the rotary valve member and the valve bush, and return flow control edges between the rotary valve member and the valve bush, connecting bores extending from the return flow control edges to a return flow connection, characterised in that the control edges are so arranged in relation to one another that in the neutral position of the valve the working fluid flows unthrottled via control edges to the return flow connection, while in the operative condition of the valve all the pressure medium flow passes via at least one constriction between the feed control edges and the return flow control edges, in dependence on the direction of rotation of the rotary valve member.

The control of the hydraulic fluid according to the invention therefore ensures that there is no return damming pressure even with the steering valve inoperative. In contrast, when the steering valve is operated, the working fluid passes via a constriction, resulting in a return flow damming pressure. In this way the disturbing flow noises are eliminated. One or more constrictions may be incorporated, in dependence on requirements.

In the construction of the invention, when the rotary slide valve is in the neutral position, there is a direct, unthrottled connection between the feed control edges and the return flow control apertures extending to the return connection, while in the operative condition at least one constriction is provided for the return flow between the feed control edges and the return flow control edges.

In the neutral position of the valve the return flow control apertures produce a short-circuit line between the feed control edges and the return flow connection. In the operative condition the short-circuit line is closed and the return flow takes place via the constriction. This way of guiding the flow is a very simple step which can be put into effect at low cost.

One very simple solution as regards the return flow control apertures is that they are constructed as return flow slots in the valve bush or rotary valve member and extend over the whole length of the valve bush or the rotary valve member. The working fluid is guided in a very simple manner via the return flow slots to the return flow connection.

One very advantageous solution of the problem to which the invention relates for the guidance of the working fluid is that in the operative condition the feed control edges and the return flow control edges are connected via a constriction extending into an axial bore of the rotary valve member, and a second constriction extending from the bore to the exterior.

Conveniently, the grooves in the rotary valve member for the working fluid return flow each take the form of double grooves having dividing webs in the centre.

This step means that no appreciable expenditure is called for as regards the control slots in producing the steering valve, since the extra slots required can be produced in one operation, using a suitable milling tool.

In order that the invention may be more readily understood, reference is made to the accompanying drawings which illustrate diagrammatically and by way of example an embodiment thereof, and in which:-

Figure 1 is a cross-section through the steering rotary slide valve according to the invention (without the steering casing), and

Figure 2 is a longitudinal section through the steering rotary slide valve.

For purposes of simplification, the distributing grooves are shown in Figure 1 in one plane and in the form of lines (ducts). Except for the control edges according to the invention, the steering rotary slide valve is of known construction, so that its construction will be merely briefly discussed hereinafter. The steering rotary slide valve is arranged in a steering casing 1. The rotary motion is transmitted via a steering spindle 2 connected to a steering wheel, and a torsion rod 3 to a steering pinion 5 (only the upper part is shown). In accordance with the steering force initiated, a rotary valve member 4 makes a

movement in relation to a valve bush 6 enclosing the rotary valve member 4. In conventional manner, the relative movement controls the pressure medium. The pressure medium, usually oil, is fed via a feed connection 7, while after the appropriate actuation of the servomotor 8, the pressure medium is removed from the steering casing 1 via a return connection 9.

Figure 1 shows the steering rotary slide valve in the neutral position. Three small return grooves 16, 17 and 18 are broached in the valve bush 6, in addition to the six pounded, arcuate grooves 10 - 15. The three small return grooves 16, 17 and 18 extend over the whole length of valve bush 6, so that on both ends they are open to the return connection 9. Of the conventional six grooves three are left on the rotary slide valve 4, namely grooves 19, 20 and 21.

The three other grooves 22, 23 and 24 are so plunge-milled using a gang cutter that a web is left in the centre of the grooves, the result being three further grooves 25, 26 and 27. Each of the grooves 22, 23 and 24 is connected via a constriction 28 to an axial bore 29 of the rotary valve member 4. Also from the bore 29 a constriction 30 extends to each of the grooves 25, 26 and 27.

The steering rotary slide valve operates as follows (for the sake of clarity, the pressure medium flow being explained only with reference to one co-operating pair of control edges):

The grooves 16, 17 and 18 in the valve bush 6 represent the return control apertures to the return connection 9. In the neutral position of the valve, illustrated in Figure 1, the hydraulic oil can pass directly to the return connection 9 via open feed control edges 31, an open control edge 32, return control edge 33 and groove 16 (return control aperture). Return can also take place to the groove 17 via grooves 20, 12 and 23, which are in communication in this position. With this flow of the hydraulic oil no return damming pressure is set up.

When the rotary valve member 4 is rotated in relation to the valve bush 6 in the direction indicated by the arrow, the control edges 32, 34 are closed. The working pressure is then controlled by control edges 35, through which hydraulic oil flows. The pressure medium flows from a pump (not shown) via a bore 37 into groove 15, and partly via the control edge 35 controlling the operating pressure. From there it flows via groove 10 into groove 22 of the rotary valve member 4, and from there via the constriction 28 to the bore 29 of the rotary valve member 4. From there it passes via the second constriction 30 into the groove 25, and from there via return control edge 33 back to return groove 16, from which the hydraulic oil passes to the return connection 9. The hydraulic oil returns via the four other constrictions in the same manner.

The level of the damming pressure can be determined by the size of the constrictions 28, 30. Since the constrictions 28, 30 are connected in series the damming pressure is also reduced in steps. The stepwise reduction of the damming pressure is advantageous since disturbing noises may also occur even when the damming pressure is reduced via only one constriction. Another advantage is that the shaft sealing rings experience only the low return pressure hitherto customary.

Instead of the constrictions 28, 30 being introduced into the bore 29 of the rotary valve member 4, another course is also possible. For example, the two constrictions connected in series can alternatively be arranged in the valve bush 6. It is only essential that all the return oil must be guided via the constrictions, for the gradual reduction of pressure.

To simplify manufacture, the grooves 22,25; 23,26; 24,27 in the rotary valve member 4, via which the pressure medium returns, are constructed as double grooves having separating webs 36 in the centre.

CLAIMS

1. A rotary slide valve for motor vehicle power-assisted steering systems, comprising a rotary valve member, a valve bush enclosing the rotary valve member and duct means for distributing the working fluid to a servomotor by way of feed control edges arranged between the rotary valve member and the valve bush, and return flow control edges between the rotary valve member and the valve bush, connecting bores extending from the return flow control edges to a return flow connection, characterised in that the control edges are so arranged in relation to one another that in the neutral position of the valve the working fluid flows unthrottled via control edges to the return flow connection, while in the operative condition of the valve all the pressure medium flow passes via at least one constriction between the feed control edges and the return flow control edges, in dependence on the direction of rotation of the rotary valve member.

2. A rotary slide valve as claimed in claim 1, wherein when the rotary valve member is in the neutral position, there is a direct, unthrottled connection between the feed control edges and the return flow control apertures extending to the return flow connection, while in the operative condition of the valve member at least one constriction is provided for the return flow between the feed control edges and the return flow control edges.

3. A rotary slide valve as claimed in claim 2, wherein the return flow control apertures are constructed as return flow grooves in the valve bush or in the rotary valve member and extend over the whole length of the valve bush or rotary valve member.

4. A rotary slide valve as claimed in claim 3, wherein in the operative condition of the valve the feed control edges and the return flow control edges are connected via a constriction extending into an axial bore of the rotary valve member, and a second constriction extending from the axial bore to the exterior.

5. A rotary slide valve as claimed in claim 4, wherein the grooves in the rotary valve member for the working fluid return flow are each constructed as double grooves having dividing webs in the centre.

6. A rotary slide valve for motor vehicle power-assisted steering systems, substantially as herein described with reference to and as shown in the accompanying drawings.

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