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(54) Abstract Title

Electronically-controlled hydraulic power steering system for motor vehicles

(57) A hydraulic power steering system for motor vehicles which is suitable for steer-by-wire operation comprises a steering wheel 14 operated by a driver, a servomotor 9 for steerable vehicle wheels 30, a rotary-slide servovalve 2 and an actuating motor 11 for operating the servovalve 2. A regulating circuit 16 receives inputs from a desired-value encoder 15 operated by means of the steering wheel 14, a steering-angle actual-value encoder 17 operated by means of the steerable vehicle wheels, and operates the actuating motor as a function of a comparison of the desired-value and actual-value steering angles. The system also includes an angle sensor 26 coupled to the relatively-rotatable control parts 2', 2" of the servovalve and the regulating circuit 16 takes this angular position into account when the actuating motor is operated. The actuating motor can be an electric motor 11 or a hydraulic motor controlled by an electrically-operated valve (Fig. 2).

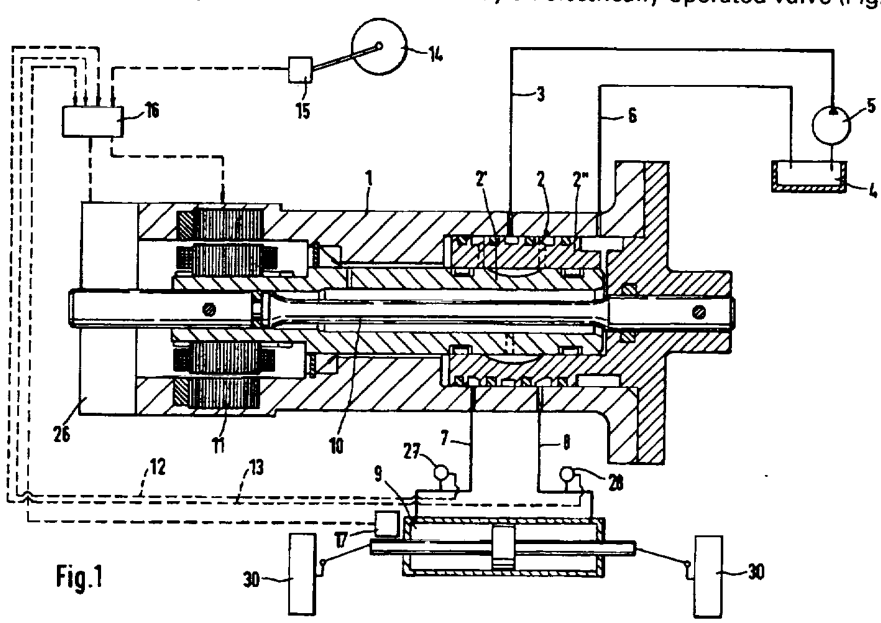

Fig.1

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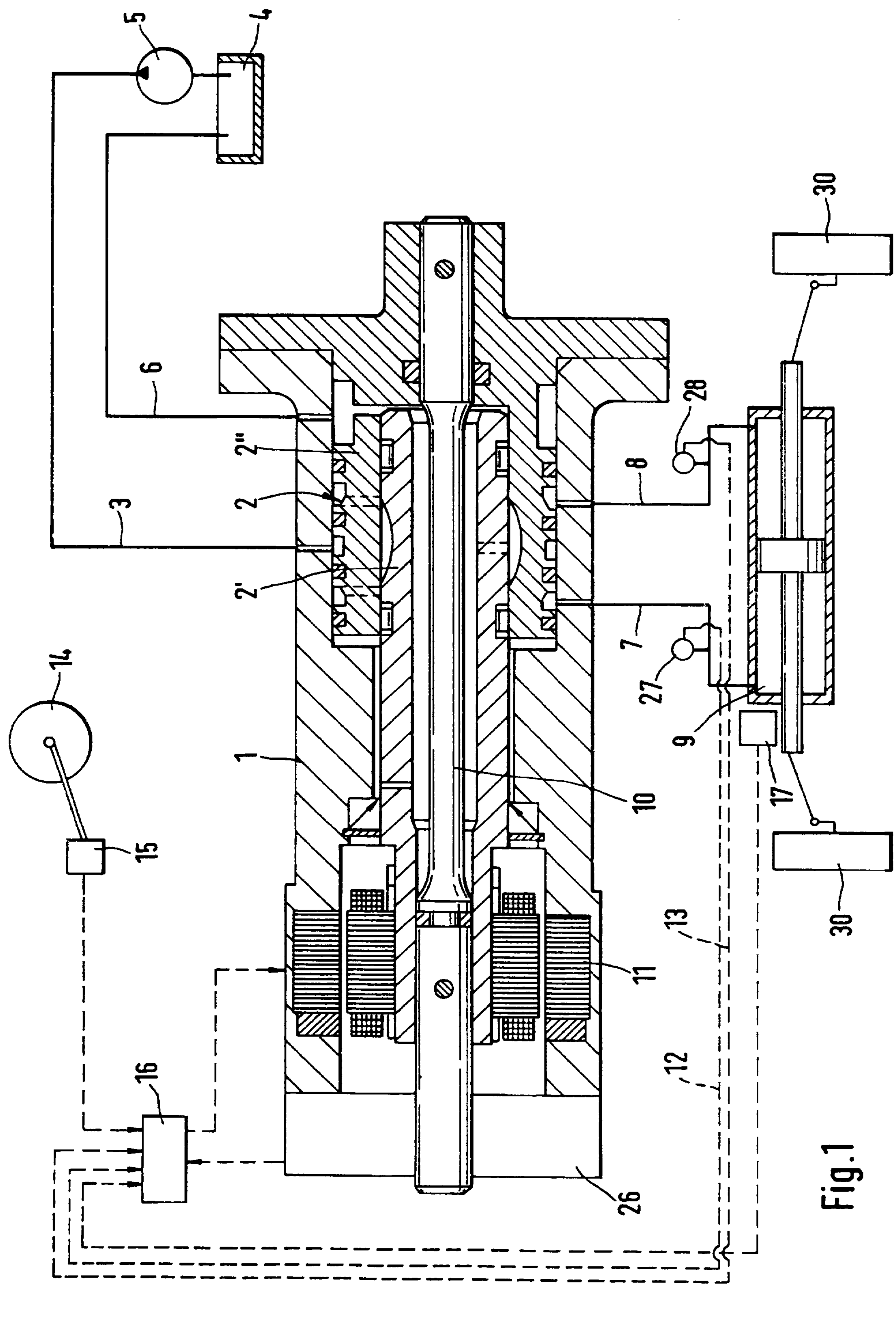

Fig.1

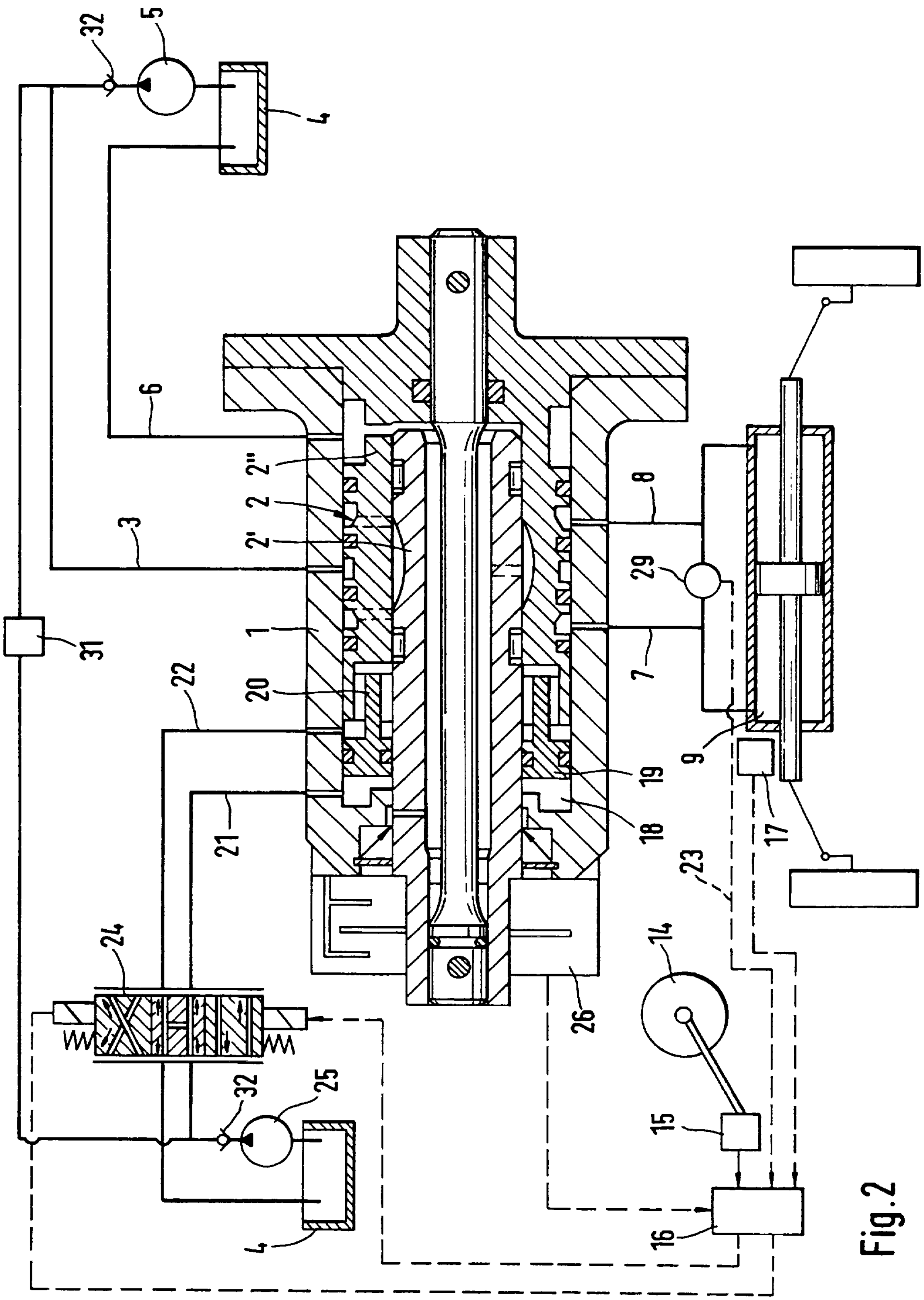

Fig.2

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Power steering system for motor vehicles

The invention relates to a hydraulic power steering system for motor vehicles, which is adapted for use with steer-by-wire operation, including:

a steering handle operable by a vehicle driver in order to steer the vehicle,

a hydraulic servomotor which operates steerable vehicle wheels in order to steer,

a servovalve which operates the servomotor in order to steer and which comprises a rotary-slide arrangement, of which the control parts rotationally moveable relative to one another are urged into a normal position relative to one another by means of a suspension,

an actuating motor directly or indirectly coupled to the control parts of the servovalve for their rotational adjustment relative to one another and which motor operates the servovalve in order to steer,

a steering-angle desired-value encoder which is operated by means of the steering handle,

a steering-angle actual-value encoder responsive to the steerable vehicle wheels, and

a regulating and control arrangement which operates the actuating motor as a function of a comparison of the desired-value and actual-value steering angles in order to steer.

A power steering system of this type is known, for example, from DE 195 41 752 A1. The known power steering system has a steering handle which is designed, for example, as a steering handwheel and which is operated by hand by a driver of the vehicle in order to steer the latter. Moreover, the known power steering system has a hydraulic servomotor, which is drive-coupled to steerable vehicle wheels and which operates these correspondingly in order to steer the vehicle. Furthermore, the power steering system has a servovalve which operates the servomotor and which is designed as a rotary-slide arrangement, of which the control parts rotationally moveable relative to one another are urged into a normal position relative to one another by means of suspension preferably designed as a torsion bar. In addition, the known power steering system has an actuating motor for operating the servovalve, the actuating motor being directly or indirectly drive-coupled to the control parts of the rotary-slide arrangement for the purpose of rotationally adjusting them relative to one another. There are, besides, a steering-angle desired-value encoder operated by means of the steering handle and the steering-angle actual-value encoder operated by means of the steerable vehicle wheels as well as a regulating and control arrangement, this regulating and control arrangement operating the actuating motor as a function of a comparison of the desired-value and actual-value steering angles in order to steer the vehicle.

In the case of servovalves designed as a rotary-slide arrangement, production tolerances may lead to hydraulic asymmetries of the servovalve. Frictional losses, for example in gaskets, may also lead to hysteresis effects and, consequently, to idle times in the servovalve which are detrimental to an exact regulation of the position of the servomotor and therefore to the vehicle keeping an exact course.

The present invention is concerned with the problem of improving the regulating behaviour in a power steering system of the type mentioned in the introduction.

According to the present invention there is provided a hydraulic power steering system for motor vehicles adapted for use with steer-by-wire operation, including:

a steering handle operable by a vehicle driver in order to steer the vehicle,

a hydraulic servomotor which operates steerable vehicle wheels in order to steer,

a servovalve which operates the servomotor in order to steer and which comprises a rotary-slide arrangement, of which the control parts rotationally moveable relative to one another are urged into a normal position relative to one another by means of a suspension, an actuating motor directly or indirectly coupled to the control parts of the servovalve for their rotational adjustment relative to one another and which motor operates the servovalve in order to steer,

a steering-angle desired-value encoder which is operated by means of the steering handle,

a steering-angle actual-value encoder responsive to the steerable vehicle wheels, and

a regulating and control arrangement which operates the actuating motor as a function of a comparison of the desired-value and actual-value steering angles in order to steer, wherein an angle sensor is provided, which is directly or indirectly coupled to the control parts of the servovalve and which detects their angular position relative to one another, the regulating and control arrangement taking this relative angular position into account when the actuating motor is operated.

The invention is based, here, on the general idea of detecting the actuating travel of the servovalve with the aid of an angle sensor and using this actuating travel as an additional correcting variable in order to improve regulation. For example, the actuating force capable of being generated by the servomotor depends on the actuating travel of the servovalve, usually designed as a proportional control valve, so that the actuating force on the servomotor can be metered more effectively by detecting the actuating travel. A desired change of steering angle can then also be carried out with less regulation and, in particular, more quickly, when the regulating and control arrangement of the power steering system in each case sets the suitable actuating travel on the servovalve.

Furthermore, in the case of servovalves equipped with a so-called "open centre", particular advantages are gained in the stabilisation of lateral forces acting externally on the vehicle wheels. In the case of a servovalve with an open centre, all the connections of the servovalve communicate with one another when the latter assumes its normal position. The great advantage of a servovalve with an open centre is that a pressure source of the hydraulic system, which is preferably a hydraulic-medium pump, can make hydraulic pressure constantly available. When the servovalve is in the normal position, the hydraulic pressure not required is expanded via its open centre into a corresponding reservoir. If the servomotor is to be operated, the hydraulic pressure necessary is immediately available.

When the servovalve is in the normal position, however, lateral wheel forces may, via the open centre of the servovalve, bring about an adjustment of the servomotor and, consequently, a change in the steering angle. In order to counteract this, a suitable counter-actuating force must be generated on the servomotor by corresponding operation of the servovalve. Since, in the power steering system according to the invention, directed metered servovalve adjustment can be carried out in a particularly simple way, the power steering system according to the invention, can react appropriately to lateral wheel forces, without a great amount of regulation being required. This is because, as soon as a disturbing force acts on the steerable vehicle wheels, a metered counterforce can be exerted as a function of the disturbing force via a correspondingly directed servovalve control.

Moreover, because there is an overall reduction in the regulation required, the entire steering system is stabilised, and, in particular, natural oscillations in the closed loop cannot build up.

According to an advantageous embodiment of the power steering system according to the invention, pressure-measuring means may be provided, which serve for determining a differential pressure between two hydraulic connections of the hydraulic servomotor, the hydraulic connections being loaded with hydraulic pressure by the servovalve in order to operate the servomotor. With the aid of the differential pressure prevailing between the hydraulic connections of the servomotor, a variable correlating with the actuating force of the servomotor can be determined in a simple way. It is thereby also possible to set the actuating force necessary for setting a desired steering angle or to determine a disturbing force acting on the steered vehicle wheels.

Furthermore, according to a development of the power steering system according to the invention, coordination between the differential pressures at the hydraulic connections of the servomotor and the relative angular positions of the control parts of the rotary-slide arrangement in relation to one another can be carried out. Likewise, coordination between the relative angular positions of the control parts of the rotary-slide arrangement and the valve throughflow quantity and, consequently, the speed of adjustment of the servomotor and of the steered wheels can be carried out. In addition, means for determining the current viscosity of the hydraulic medium may then also be provided, with the aid of which the valve throughflow quantity can be determined more accurately. The hydraulic-medium viscosity can be determined, for example, by temperature measurement. With the aid of coordinations of this type, which in each case form a characteristic curve of the servovalve, it is possible to compensate or balance out tolerance-related deviations in the hydraulic symmetry of the servovalve electronically by means of a corresponding calibration of the coordination. The power steering system thereby becomes independent of manufacturing tolerances and can therefore ensure that the servomotor is regulated accurately, and therefore that the vehicle keeps an exact course in both steering directions.

It is possible, in particular, to design the regulating and control arrangement in such a way that the said coordination between the relative angular position of the control parts of the rotary-slide arrangement and the differential pressure between the hydraulic connections of the servomotor is constantly updated. As a result, on the one hand, signs of wear of the hydraulic system can be constantly compensated. On the other hand, in particular, a diagnosis of the hydraulic system in terms of its operating reliability can be carried out, for example by constantly comparing with predetermined threshold values.

Other important features and advantages of the power steering system according to the invention will become apparent from the subclaims, from the drawings and from the associated description of the figures with reference to the drawings.

It goes without saying that the abovementioned features and those yet to be explained hereafter can be used not only in the combination specified in each case, but also in other combinations or alone.

Preferred embodiments of the invention are illustrated in the drawings and are explained in more detail in the following description. In the drawings, in each case diagrammatically,

Figure 1 shows a sectional diagram of a first embodiment, in which an electric actuating motor is provided, and

Figure 2 shows a corresponding sectional diagram of a modified embodiment, in which the control parts of the servovalve are adjustable relative to one another by means of a hydraulic actuating assembly.

According to Figure 1, a largely conventional servovalve 2, designed in the manner of a rotary-slide arrangement, is arranged in a housing 1 and consists essentially of a rotary-slide part 2' and of a rotary-slide bush 2" coaxial to the latter and arranged fixedly on the housing. This servovalve 2 possesses a pressure connection 3 which is connected to the delivery side of a boost pump 5 connected on the suction side to a hydraulic reservoir 4. Furthermore, the servovalve 2 possesses a low-pressure connection 6, communicating with the reservoir 4, and two motor connections 7 and 8 which are connected in each case to one side of a double-acting piston/cylinder assembly provided as a servomotor 9.

The servovalve 2 possesses a so-called open centre, that is to say all the connections 3 and 6 to 8 communicate with one another when the control parts of the servovalve 2, that is to say the rotary-slide part 2' and the rotary-slide bush 2", assume a normal or middle position relative to one another. When the rotary-slide part 2' and the rotary-slide bush 2" are rotated relative to one another in one direction or the other with respect to the middle position, with the boost pump 5 working, a greater or lesser controllable pressure difference is generated in one direction or the other between the motor connections 7 and 8, with the result that the servomotor 9, in turn, generates a correspondingly high actuating force in one direction or the other.

The rotary-slide part 2' and rotary-slide bush 2" are connected to one another by means of a spring element, here by means of a torsion bar 10 arranged in an axial bore of these parts. In this case, the spring element or the torsion bar 10 seeks to hold the two parts 2' and 2" in their middle position relative to one another.

The rotor of an electric motor 11 arranged in the housing 1 is arranged on that end of the rotary-slide part 2' which is on the left in Figure 1, the said rotor being capable of rotating in one direction or the other relative to the rotary-slide bush 2" counter to the force of the torsion bar 10 when current is supplied to the rotary-slide part 2'.

Moreover, an angle sensor 26 is mounted on that end of the housing 1 which is on the left according to Figure 1, the said angle sensor, on the one hand, being coupled fixedly in terms of rotation to the housing 1 and therefore indirectly also fixedly in terms of rotation to the rotary-slide bush 2", since the latter, in turn, is fastened fixedly in terms of rotation to the housing 1. On the other hand, the angle sensor 26 is coupled fixedly in terms of rotation to the torsion bar 10 and therefore indirectly also fixedly in terms of rotation to the rotary-slide part 2', since the latter, in turn, is fastened fixedly in terms of rotation to the torsion bar 10. The angle sensor 26 can thereby detect the relative position between the rotary-slide part 2' and the rotary-slide bush 2" and deliver this relative position, or a signal value correlating with it, via a corresponding signal line to a regulating and control arrangement or regulating circuit 16. Here, this regulating circuit 16 contains or comprises, for the servovalve 2, a controller which sets the predetermined differential angles between the control parts 2' and 2" with high accuracy, for the steering system a controller which sets the piston travel or the wheel angle according to the respective desired value, and, for the vehicle, a controller which, for example, could determine computationally the pressure difference between the connections 7 and 8 of the servomotor 9, so that relevant pressure-measuring sensors can be checked or are superfluous. The controllers are preferably designed as electronic controllers, in particular in the form of a computer.

Moreover, the hydraulic connections 7 and 8 of the servomotor 9 are in each case assigned pressure-measuring sensors 27 and 28 which communicate in each case with one of the hydraulic connections 7 and 8 and measure the pressure prevailing in these or in the corresponding chambers of the servomotor 9. The measurement results, or signal values correlating with the pressures prevailing in the motor connections 7 and 8, are delivered to the regulating circuit 16 via corresponding signal lines 12 and 13.

The arrangement of Figure 1 works as follows:

By means of a steering handwheel 14 operated by the driver of the respective vehicle, a desired-value encoder 15 is operated, the signals of which in each case predetermine a desired value for the steering angle to be set of the steerable vehicle wheels 30 operated by the servomotor 9 and are fed to one input of the regulating circuit 16. The regulating circuit 16 compares the desired value with the respective actual value detected by means of an actual-value encoder 17 which cooperates with a steering-gear part positively coupled to the steerable vehicle wheels 30 or, as illustrated, to the piston rod of the servomotor 9. According to the result of the desired-value/actual-value comparison, the regulating circuit 16 activates the electric motor 11, so that the latter rotates in one direction or the other and adjusts the servovalve 2 to a greater or a lesser extent in one direction or the other. A corresponding pressure difference is consequently generated in one direction or the other between the motor connections 7 and 8, and the servomotor 9 is driven with greater or lesser force in one direction or the other, so that the steerable wheels 30 are adjusted.

The amount of rotation of the electric motor 11 and, consequently, the actuating travel of the servovalve 2, the control parts 2' and 2" of which are rotationally adjusted relative to one another by means of the electric motor 11, are detected by the angle sensor 26 and communicated to the regulating circuit 16. There may be provision, here, for the regulating circuit 16 to determine, at the start of the actuating operation, the actuating travel of the servovalve 2 suitable for the desired steering-angle setting or steering-angle change and to set the said actuating travel on the servovalve 2 by means of the electric motor 11 under the control of the angle sensor 26. Predetermining the actuating travel on the servovalve 2 suitable for the respective steering-angle change makes it possible to reduce the amount of regulation required within the framework of the desired-value /actual-value comparison, so that the regulation aim, that is to say the desired steering-angle actual value, can be achieved quickly and with few valve adjustments.

The regulation principle is not affected, here, by whether a specific differential pressure, which is derived from an angular position between the control parts 2' and 2" of the servovalve 2, is to be set at the motor connections 7 and 8 via the servovalve 2, or whether a specific angular position between the control parts 2' and 2" of the servovalve 2 is to be set on the latter, resulting in a corresponding pressure difference between the motor connections 7 and 8. In other words, it does not matter, for purposes of regulation, whether the angular position (with which a differential pressure is coordinated) or the differential pressure (with which an angular position is coordinated) forms a command variable for regulation. At all events, it is possible, with the aid of the arrangement according to the invention, in each case to coordinate a specific pressure difference between the motor connections 7 and 8 with the relative angular positions between the rotary-slide part 2' and the rotary-slide bush 2", and vice versa.

There may be provision, at the same time, while the servovalve 2 is being operated, for the regulating circuit 16 to coordinate an associated pressure difference between the motor connections 7 and 8 in each case with all the relative positions between the control parts 2' and 2" and thus measure out a kind of characteristic curve of the servovalve 2 and file this in a corresponding memory. In order then to set a specific pressure difference, that is to say a specific actuating force, on the servomotor 9, the associated relative angle between the control parts 2' and 2" of the servovalve 2 can be determined from the stored characteristic curves, in particular also by interpolation or the like. The desired pressure difference can thereby be set quickly, and with little regulation required, by means of directed activation of the electric motor 11.

A particularly important advantage of the arrangement according to the invention is to be seen in that, by the plotting of the characteristic curve of the servovalve 2, where the relative angular position between the control parts 2' and 2" of the servovalve 2 can also be plotted as a function of another parameter of the power steering system, an asymmetric behaviour of the servovalve 2, caused by manufacturing tolerances, can be eliminated by corresponding calibration of the measured characteristic curve.

Another important advantage of the steering system according to the invention is to be seen in that additional parameters, specifically, for example, angular position and differential pressure, are available to the steering system. These parameters allow additional monitoring of the steering system in terms of its operating reliability and safety of operation.

The embodiment according to Figure 2 differs from the embodiment illustrated in Figure 1, inter alia, in that the electric motor 11 is absent and within the housing 1 is arranged an annular space 18, the inner circumferential wall of which is formed by a cylindrical axial portion of the rotary-slide part 2' and the outer circumferential wall of which is formed by the inner wall of the housing 1. This annular space 18 is subdivided into two annular chambers by means of an axially displaceable annular piston 19. The annular piston 19 possesses a cylindrical extension 20 which is provided both on the outside and on the inside with grooves and webs oriented obliquely to one another. These grooves and webs engage into exactly matching grooves and webs which are arranged, on the one hand, on an axial portion of the outer circumference of the rotary-slide part 2' and, on the other hand, on an inner circumferential portion of the rotary-slide bush 2" or of the housing 1 which is stationary relative to the rotary-slide bush 2". Since the webs and grooves on the outside of the extension 20 run obliquely to the grooves and webs on the inside of the extension 20, the extension 20 and the annular piston 19 positively execute an axial stroke as soon as the rotary-slide part 2' and the rotary-slide bush 2" are rotated relative to one another. Correspondingly, the control parts 2' and 2" are positively rotated relative to one another in one direction or the other when the annular piston 19 is displaced axially in one direction or the other.

The annular chambers divided off from one another in the annular space 18 by the annular piston 19 are capable of being connected to a pump 25 and to the hydraulic reservoir 4 via lines 21 and 22 as well as a control valve 24, so that, when the control valve 24 is appropriately operated, a greater or lesser pressure difference can be generated in one direction or the other between the two annular chambers in the annular space 18. Consequently, the annular piston 19 can then be displaced in one axial direction or the other, with the result that the servovalve 2 is adjusted and a pressure difference is generated between the motor connections 7 and 8 of the servomotor 9. The servomotor 9 can then thereby execute an actuating stroke, by means of which the vehicle steering is adjusted.

In the embodiment according to Figure 2, too, an angle sensor 26 is once again arranged on the left-hand side of the housing 1. In this case, the angle sensor is again, on the one hand, coupled fixedly in terms of rotation to the rotary-slide bush 2" of the servovalve 2 indirectly via the housing 1. On the other hand, in this embodiment, the angle sensor 26 is coupled fixedly in terms of rotation directly to the rotary-slide part 2' of the servovalve 2.

Moreover, arranged between the hydraulic connections 7 and 8 of the servomotor 9 is a differential pressure sensor 29 which communicates with both motor connections 7 and 8, in order to measure the differential pressure prevailing between these connections 7 and 8 and to deliver the said differential pressure, or signal value correlated with this, to the regulating circuit 16 via a corresponding signal line 23.

Furthermore, the delivery sides of the pumps 5 and 25 are connected to one another via corresponding hydraulic lines and a switchable stop valve 31, and, moreover, additional non-return valves 32 may be arranged upstream of the pumps 5 and 25.

The arrangement of Figure 2 works as follows:

Once again a desired value for the steering angle to be set of the steerable vehicle wheels 30 is predetermined by the desired-value encoder 15 operated by means of the steering handwheel 14. The regulating circuit 16, once again, compares this desired value with the actual value communicated by the actual-value encoder 17 and operates the valve 24 when a desired-value/actual-value deviation occurs. Depending on the direction of the desired-value/actual-value deviation, the control valve 24 is then displaced in one direction or the other, with the result that the annular piston 19 is displaced in one direction or the other, as a consequence of which a greater or lesser pressure difference is then set in one direction or the other at the motor connections 7 and 8 of the servomotor 9 and the servomotor 9 executes an actuating stroke for compensating the desired-value/actual-value deviation, that is to say the steerable vehicle wheels 30 are set according to the respective desired value. Here too, the operation of the hydraulic motor 18, 19 and, consequently, the actuating travel of the servovalve 2 can be controlled by means of the angle sensor 26, so that a predetermined actuating travel or actuating angle can be set on the servovalve 2 via metered operation of the hydraulic actuating motor 18, 19, this leading to a more accurate steering-angle setting.

It is also possible and advantageous to arrange the electric motor 11 and the hydraulic motor 18, 19 in combination, so that the servovalve 2 can be controlled by means of two assemblies independent of one another. In this case, if appropriate, the electric motor 11 may be adjusted analogously to the desired values of the desired-value encoder 15, whilst the hydraulic motor 18, 19 is operated by an autonomous control which detects other parameters, for example cross-wind influences, by means of separate sensors and stabilises them by steering actions.

The electric motor 11 may also be designed as a so-called rotary magnet.

In the event that, as illustrated in the embodiment, two separate pumps 5 and 25 are provided for supplying hydraulic pressure to the servomotor 9, on the one hand, and to the hydraulic motor 18, 19, on the other hand, it is possible, with the aid of the stop valves 31 and the connection of the delivery sides of the two pumps 5 and 25, to operate both the hydraulic motor 18, 19 and the servomotor 9 by means of only one of the two pumps 5 or 25 in an emergency mode when one of these has failed. This affords a redundancy system which has increased fail safety.

Claims

1. A hydraulic power steering system for motor vehicles adapted for use with steer-by-wire operation,

a steering handle operable by a vehicle driver in order to steer the vehicle,

a hydraulic servomotor which operates steerable vehicle wheels in order to steer,

a servovalve which operates the servomotor in order to steer and which comprises a rotary-slide arrangement, of which the control parts rotationally moveable relative to one another are urged into a normal position relative to one another by means of a suspension,

an actuating motor directly or indirectly coupled to the control parts of the servovalve for their rotational adjustment relative to one another and which motor operates the servovalve in order to steer,

a steering-angle desired-value encoder which is operated by means of the steering handle,

a steering-angle actual-value encoder responsive to the steerable vehicle wheels, and

a regulating and control arrangement which operates the actuating motor as a function of a comparison of the desired-value and actual-value steering angles in order to steer, wherein an angle sensor is provided, which is directly or indirectly coupled to the control parts of the servovalve and which detects their angular position relative to one another, the regulating and control arrangement taking this relative angular position into account when the actuating motor is operated.

2. A power steering system according to Claim 1, wherein pressure-measuring means are provided, which serve for determining a differential pressure between two hydraulic connections of the hydraulic servomotor, the hydraulic connections being loaded

with hydraulic pressure by the servovalve in order to operate the servomotor.

3. A power steering system according to Claim 2, wherein the regulating and control arrangement carries out coordination between the relative angular position of the control parts of the rotary-slide arrangement and the differential pressure of the hydraulic connections of the servomotor and/or the speed of actuation of the servomotor or of the steered vehicle wheels and takes into account this differential pressure or this actuating speed when the actuating motor is operated.

4. A power steering system according to Claim 3, wherein the regulating and control arrangement constantly updates the coordination.

5. A power steering system according to Claim 3 or 4, wherein the regulating and control arrangement uses the coordination for the diagnosis of the power steering system.

6. A power steering system according to any one of Claims 2 to 5, wherein the pressure-measuring means have a differential-pressure sensor which communicates with both hydraulic connections.

7. A power steering system according to any one of Claims 2 to 5, wherein the pressure-measuring means have two pressure-measuring sensors which in each case communicate with one of the hydraulic connections.

8. A power steering system according to claim 1, wherein the said suspension comprises a torsion bar.

9. A hydraulic power system for vehicles, substantially as described herein with reference to and as illustrated in the accompanying drawings.

Amendments to the claims have been filed as follows

Claims

1. A hydraulic power steering system for motor vehicles adapted for use with steer-by-wire operation,

a steering handle operable by a vehicle driver in order to steer the vehicle,

a hydraulic servomotor which operates steerable vehicle wheels in order to steer,

a servovalve which operates the servomotor in order to steer and which comprises a rotary-slide arrangement, of which the control parts rotationally moveable relative to one another are urged into a normal position relative to one another by means of a resilient member,

an actuating motor directly or indirectly coupled to the control parts of the servovalve for their rotational adjustment relative to one another and which motor operates the servovalve in order to steer,

a steering-angle desired-value encoder which is operated by means of the steering handle,

a steering-angle actual-value encoder responsive to the steerable vehicle wheels, and

a regulating and control arrangement which operates the actuating motor as a function of a comparison of the desired-value and actual-value steering angles in order to steer, wherein an angle sensor is provided, which is directly or indirectly coupled to the control parts of the servovalve and which detects their angular position relative to one another, the regulating and control arrangement taking this relative angular position into account when the actuating motor is operated.

2. A power steering system according to Claim 1, wherein pressure-measuring means are provided, which serve for determining a differential pressure

between two hydraulic connections of the hydraulic servomotor, the hydraulic connections being loaded with hydraulic pressure by the servovalve in order to operate the servomotor.

3. A power steering system according to Claim 2, wherein the regulating and control arrangement carries out coordination between the relative angular position of the control parts of the rotary-slide arrangement and the differential pressure of the hydraulic connections of the servomotor and/or the speed of actuation of the servomotor or of the steered vehicle wheels and takes into account this differential pressure or this actuating speed when the actuating motor is operated.

4. A power steering system according to Claim 3, wherein the regulating and control arrangement constantly updates the coordination.

5. A power steering system according to Claim 3 or 4, wherein the regulating and control arrangement uses the coordination for the diagnosis of the power steering system.

6. A power steering system according to any one of Claims 2 to 5, wherein the pressure-measuring means have a differential-pressure sensor which communicates with both hydraulic connections.

7. A power steering system according to any one of Claims 2 to 5, wherein the pressure-measuring means have two pressure-measuring sensors which in each case communicate with one of the hydraulic connections.

8. A power steering system according to claim 1, wherein the said resilient member comprises a torsion bar.

9. A hydraulic power system for vehicles, substantially as described herein with reference to and as illustrated in the accompanying drawings.

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Application No: GB 9914841.3
Claims searched: 1 - 8
Examiner: Tom Sutherland
Date of search: 14 September 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): B7H (HXG, HHM)

Int Cl (Ed.6): B62D 5/083, 6/00

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2266499 A	(ROVER) Note page 1, last three lines.	
A	EP 0472878 A	(BOSCH) Note Fig. 1, sensor 22.	
A	US 5845736	(BOHNER et al) Figs 1 and 2.	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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A Document indicating technological background and/or state of the art.
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E Patent document published on or after, but with priority date earlier than, the filing date of this application.