

[54] **DISCONNECTING VALVE MECHANISM FOR A SERVO-STEERING SYSTEM OF VEHICLES**

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**FOREIGN PATENTS OR APPLICATIONS**

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[58] **Field of Search** ..... 91/392, 399, 400, 407, 91/437, 401

[57] **ABSTRACT**

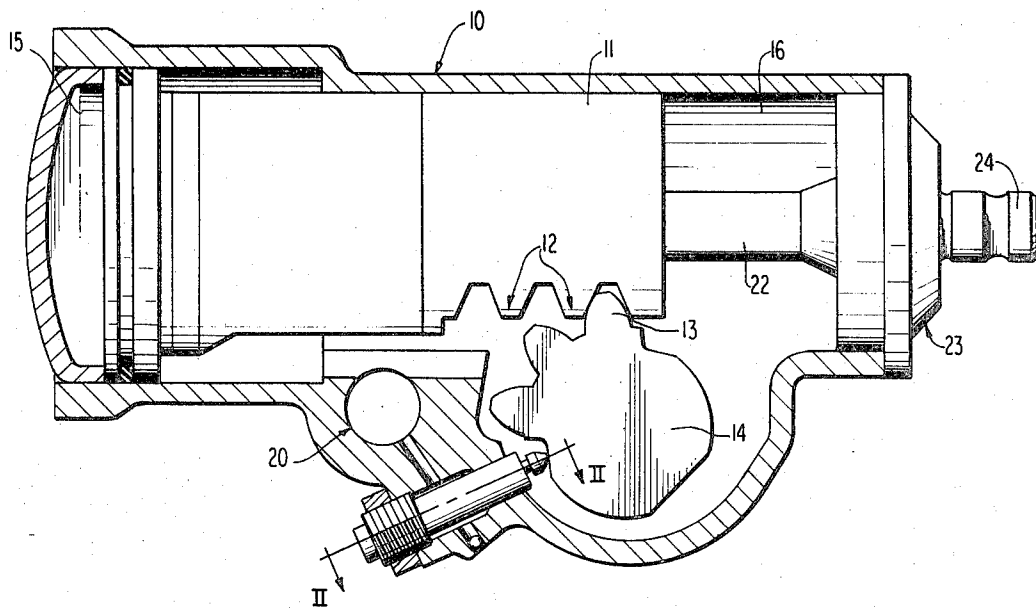
A by-pass valve arrangement for turning off the servo force within the area of the stroke end positions of the working piston of a servo-steering system for vehicles, in which two by-pass valves, which are actuated by control means provided at the steering shaft, open the same working pressure space and in their respective by-pass position also free a mutual connection of the two working pressure spaces.

[56] **References Cited**

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**23 Claims, 5 Drawing Figures**

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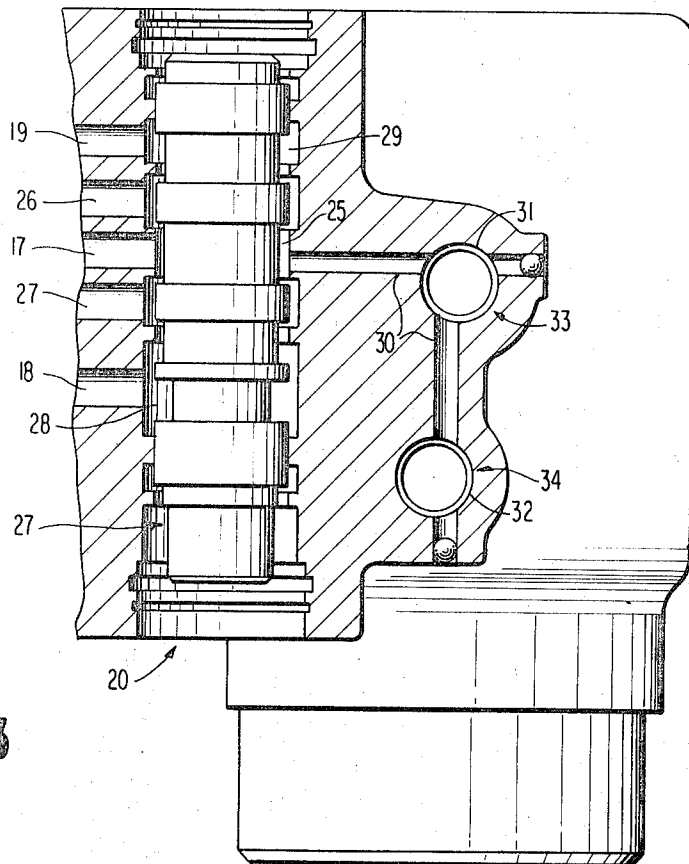
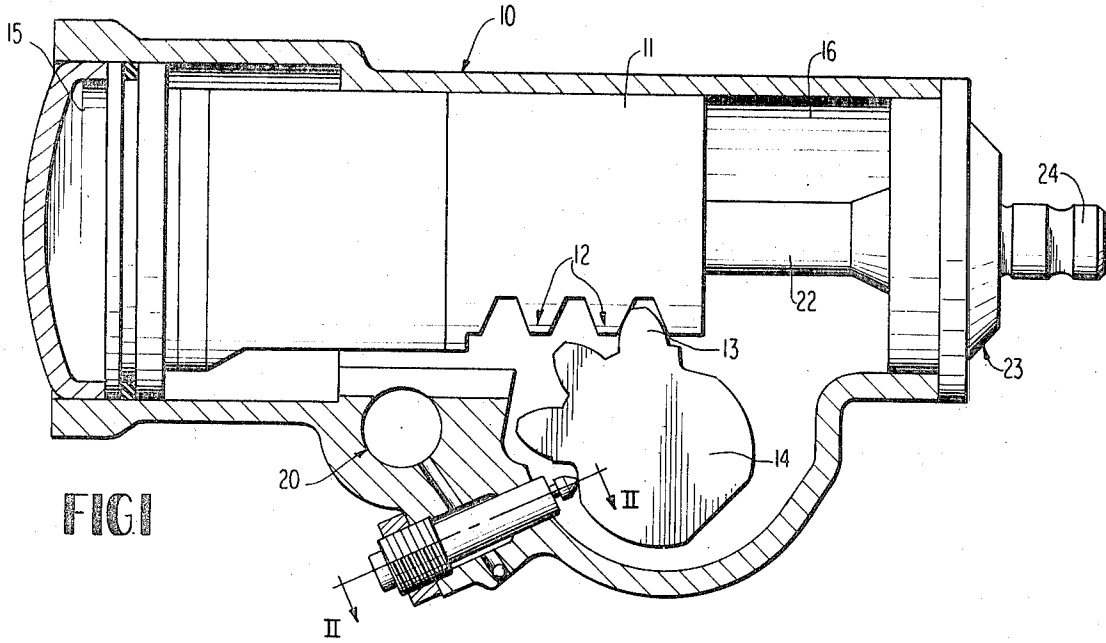
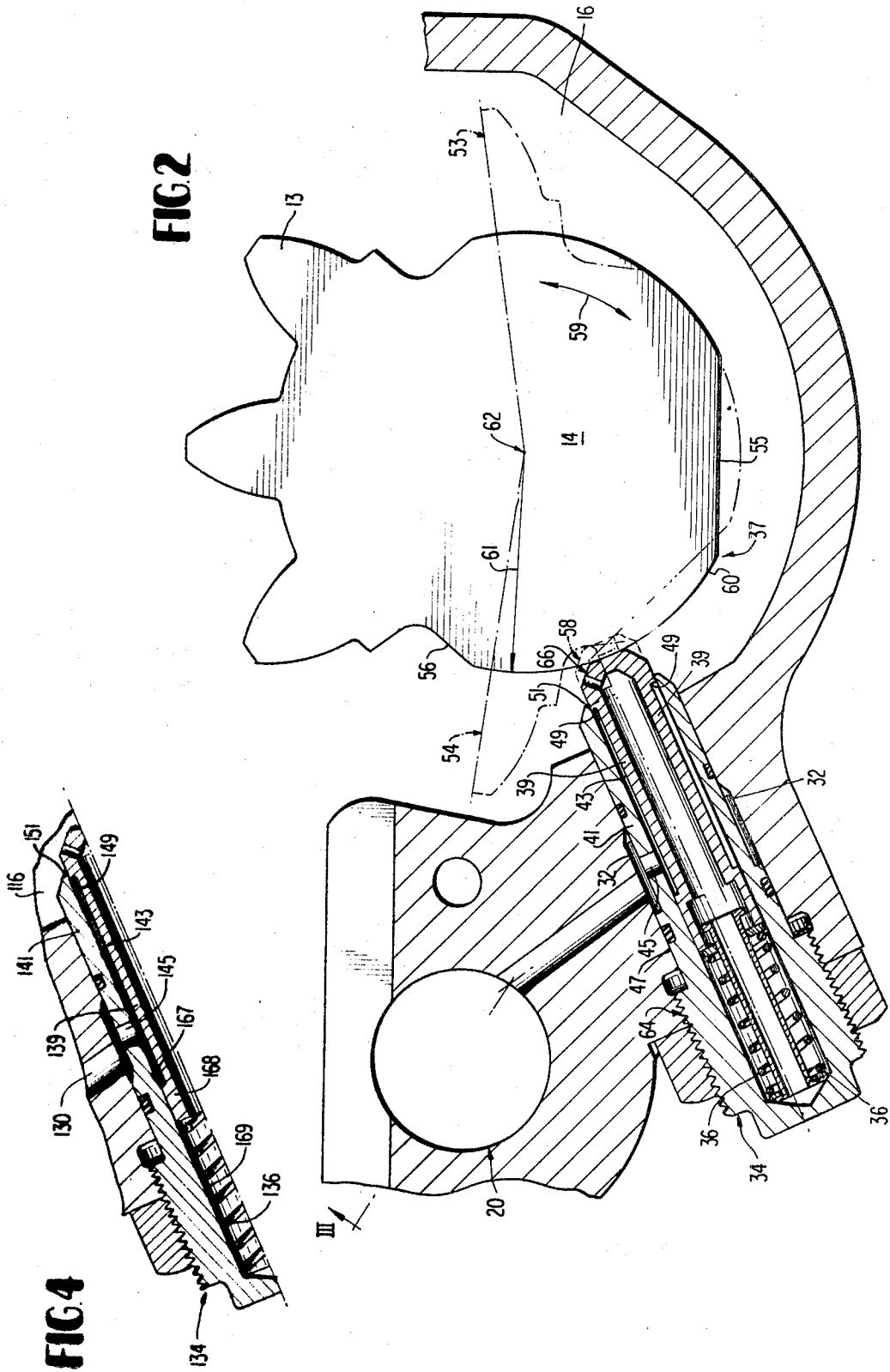


FIG 3





## DISCONNECTING VALVE MECHANISM FOR A SERVO-STEERING SYSTEM OF VEHICLES

The present invention relates to a by-pass valve installation for the disconnection of the servo-force within the area of the stroke end positions of the working piston of a servo-steering mechanism for vehicles, in which one by-pass valve each, actuated by means of control means provided at the steering shaft, is coordinated to the two working pressure spaces of the working pressure cylinder.

In a known installation of this type as described in the German Pat. No. 1,160,318 or U.S. Pat. No. 3,252,380 only one of the two by-pass valves opens directly into one working pressure space whereas the other by-pass valve controls a connection between the return line and a tap line to the other working pressure space. With this prior art installation, the expenditures in pressure medium lines are large and the functioning as well as constructive design of the two by-pass valves are different.

The present invention is concerned with the task to avoid the aforementioned disadvantages with an installation of the aforementioned type. The underlying problems are solved according to the present invention in that both by-pass valves open the same working pressure space as also release in their respective by-pass position a mutual connection of the two working pressure spaces.

In the disconnection installation according to the present invention, two identical more simple by-pass valves may be used and the connection of the valves with the return line required in the prior art installation can be economized.

According to another, independent inventive concept, provision is made for the creation of a simple valve actuation which is applicable also to disconnecting installations of types other than the type proposed herein, that the adjusting members of the two by-pass valves mutually offset in the circumferential direction of the steering shaft cooperate with a non-rotatable control cam of the steering shaft, composed of three sections disposed one behind the other in the circumferential direction, and that the center section has an essentially constant distance with respect to the axis of the steering shaft which is different from that of the two end sections relative thereto so that the two adjusting members within the area of angular rotation of the center section are brought into the rest position thereof closing off the mutual connection of the working pressure spaces whereas within the area of the stroke end positions, the respective associated end section of the control cam actuates exclusively the adjusting member adjacent in the circumferential direction into the by-pass position releasing the mutual connection of the working pressure spaces while the other adjusting member continues to be in operative connection with the center section of the control cam.

This novel disconnecting installation is advantageous in particular in that for the valve actuation no movable coupling elements are necessary in addition to the steering shaft or steering gear. The control cam can be provided directly on a segment of the steering shaft and can be manufactured in one machining operation, for example, by means of broaching.

According to a further inventive concept, the achievement of relatively short pressure lines is made possible in a simple advantageous manner in that the

control valve controlling the working pressure in the two working pressure spaces is mounted in proximity to the steering shaft and in that the by-pass valve are connected with a chamber of the control valve in constant communication with the other working pressure space. With this proposed arrangement of the present invention, the by-pass valves can be located as close as possible to the control valve so that in addition to the short pressure lines a simplification of the housing construction for the three valves is achieved.

Accordingly, it is an object of the present invention to provide a control valve mechanism for a servo-steering system in vehicles which avoids by simple means the aforementioned shortcomings and drawbacks encountered in the prior art.

Another object of the present invention resides in a control valve mechanism for a servo-steering system of motor vehicles which reduces the expenditures in pressure medium lines and permits a simple construction of the by-pass valves.

A further object of the present invention resides in a by-pass valve arrangement for servo-steering systems of vehicles which permits the use of identical simple by-pass valves assuring reliable operation.

Still another object of the present invention resides in a control valve installation of the type described above for servo-steering systems of motor vehicles which permits simple manufacture of the various parts, minimizes the numbers of parts necessary and permits a simple installation with a minimum of connecting lines.

A still further object of the present invention resides in a servo-steering mechanism of the type described above which is characterized by an extraordinarily compact construction and low cost, particularly also as to the housing thereof.

These and further objects, features and advantages of the present invention will become more apparent from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, two embodiments in accordance with the present invention, and wherein:

FIG. 1 is a schematic view, on a reduced scale, of a first embodiment of a by-pass valve mechanism in accordance with the present invention for a servo-steering system of vehicles;

FIG. 2 is a partial cross-sectional view, on an enlarged scale, of certain parts of the by-pass valve mechanism taken substantially along line II—II and pivoted into the plane of FIG. 1;

FIG. 3 is a cross-sectional view taken along line III—III of FIG. 2 illustrating the parts in their normal size;

FIG. 4 is a partial cross-sectional view, corresponding to FIG. 2, through a second embodiment of a servo-steering system according to the present invention; and

FIG. 5 is a partial cross-sectional view, on an enlarged scale, of the pair of bi-pass valves according to the first embodiment of the present invention showing their positioning relative to one another and the steering shaft.

Referring now to the drawing wherein like reference numerals are used throughout the various views to designate like parts, and more particularly to FIG. 1, a working piston 11 is displaceably guided in the steering gear housing generally designated by reference numeral 10 of the first embodiment and constructed as a pressure medium cylinder; the working piston 11 is op-

eratively connected with the steering shaft 14 by means of a toothed rack profile 12 and a toothed segment 13. The working piston 11 subdivides the housing 10 into the two working pressure spaces 15 and 16 which are connected with a control slide valve generally designated by reference numeral 20 by means of lines 17 and 18, 19 (FIG. 3). The spool-type control slide valve member 21 of the valve 20 is deflected from its center position by means of a rigid radial control arm (not shown) of a steering nut (not shown) rotatably but axially non-displaceably supported in the working piston 11, depending on the angular deflection of the steering worm 22 connected with the steering nut to provide spiral movement therebetween as is conventional in the art. Since the steering nut and control arm actuating the control slide valve member 21 are of conventional construction, forming no part of the present invention, a further description and showing thereof is dispensed with herein for the sake of simplicity. The steering worm 22 rotatably but axially non-displaceably supported in the housing cover 23 (FIG. 1) may be connected with the steering hand wheel by way of an external coupling pin 24.

The working pressure space 15 is connected with a valve chamber 25 by means of the line 17 (FIG. 3) which serves for the respective connection of the working pressure space 15 with a pressure-relieved return line 26 or with a working pressure line 27.

The working pressure space 16 is connected with two valve chambers 28 and 29 by means of the lines 18 and 19, of which the chamber 28 serves for the connection of the working pressure space 16 with the working pressure line 27 and the chamber 29 serves for the connection of the working pressure space 16 with a return line 26.

A by-pass channel 30 extending at right angle is connected with the valve chamber 25 which is in constant communication with the working pressure space 15 by way of the line 17; the by-pass channel 30 is in constant communication (see FIGS. 3 and 5) with two valve chambers 31 and 32 of two by-pass valves generally designated by reference numerals 33 and 34 which close off the working pressure space 16 with respect to the channel 30. One by-pass slide valve member 38 or 39 is interconnected between a respective valve chamber 31 or 32 (FIGS. 2 and 5) and the working pressure space 16. The by-pass valve members 38 and 39 which engage under the effect of a valve spring 35 and 36 at a control cam generally designated by reference numeral 37 slide within a respective valve bush 40 and 41 inserted into the housing bore 46 and 47 of the respective valve chamber and are provided at the circumference with axial grooves 42 and 43, respectively, which cooperate with radial apertures, for example, aperture 45 shown in FIG. 2 in the valve bush 41 for the connection of the valve chamber 31 and 32 with the working pressure space 16. The axial grooves 42 and 43 are delimited at the slide valve member end facing the working pressure space by radial control edges 48 and 49 which cooperate with the internal end surfaces 50 and 51 of the valve bushes 40 and 41.

The by-pass valves 33 and 34 which are not disposed in one and the same plane (see FIG. 3), are mutually offset in the circumferential direction of the steering shaft 14 by a predetermined distance so that in the end positions of the steering shaft 14, indicated at 53 and 54 and associated with the area of the stroke end posi-

tions of the working piston 11, the by-pass slide valve member 38 or 39 coming into engagement with the respective end section 55 or 56 of the control cam 37 is brought into its by-pass position 58 (FIG. 5) by the spring 35 or 36, respectively. In the by-pass position 58 the control edges 48 and 49 emerge out of the valve bushes 40 and 41 so that the two working pressure spaces 15 and 16 are connected with each other.

In the center positions of angular rotation of the steering shaft 14 the by-pass slide valve members 38 and 39 cooperate with a central cylindrical section 60 of the control cam 37 whose radius 61 is so dimensioned relative to the axis 62 of the steering shaft 14 that the control edges 48 and 49 are disposed in center positions of the steering shaft 14 inside of the valve bushings 40 and 41 so that the connection between the valve chambers 31 and 32 and the working pressure space 16 is closed off.

According to the present invention the two by-pass valves 33 and 34 close off the same working pressure space 16 whereby these valves are interconnected in a channel 30 establishing a mutual connection of the two working pressure spaces 15 and 16. In this manner both valves 33 and 34 can be completely identical. Furthermore, the expenditures as regards lines for these valves is limited to a single line. A direct connection from the by-pass valves 33, 34 to the return line 26 is not required with the installation according to the present invention.

Both by-pass slide valve members 38 and 39 are actuated by the same control cam 37 which can be broached in a single machining operation so that separate coupling members between steering shaft 14 and by-pass valves 33, 34 are not necessary. The connecting line 30 is very short in that this line is led to a valve chamber 25 (FIG. 3) of the control valve 20 arranged in proximity to the steering shaft 14, which is in constant communication with the other working pressure space 15. As a result of the arrangement of the by-pass valves 33, 34, on the one hand, and of the control valve 20, on the other, directly adjacent one another, the housing expenditures for all three valves remain small.

The seat or the position of the valve bushings 40 and 41 is adjustable relative to the position of the control edges 48 and 49 by means of the threaded securing means 63 and 64 (FIGS. 2 and 5) so that the point of disconnection, i.e., when the servo-force is turned off, is adjustable to any desired position of the respective stroke end range. After the disconnection of the servo-force, the steering shaft 14 can be further actuated manually up to its end position.

The illustrated rest position of the by-pass valves 38 and 39, closing off the by-pass channel 30 with respect to the working pressure space 16 are indicated by reference numerals 65 and 66 (FIGS. 2 and 5) respectively.

The second embodiment of the servo-steering system of the present invention shown in FIG. 4, in which similar parts are designated by similar reference numerals of the 100 series, differs from the first embodiment essentially only by the arrangement of abutment means for the limitation of the valve opening movement in the direction toward the working pressure space. The by-pass valve generally designated by reference numeral 134 is operatively connected between the one working pressure space 116 of the working piston (not shown) and a by-pass channel 130 which is in constant communication with the other working pressure space of the

working piston. The by-pass channel 130 is further connected by way of bores 145 in the valve bushing 141 with a slide valve longitudinal channel 143 at the circumference of the by-pass slide valve member 139 guided within the valve bushing 141, whose control edge 149 closing the channel 143 cooperates with the end face 151 of the valve bushing acting as counter control edge.

Provision is made according to the present invention that the opening movement of the by-pass slide valve member 139 (as also that of the by-pass slide valve member 38 and 39) is directed toward the working pressure space 116. As a result thereof, the end face 151 of the valve bushing which can be machined in a simple manner, can be utilized as control edge. In order to avoid during the disassembly of the steering shaft that the by-pass slide valve member 139 is displaced too far into the space 116 either by gravity or by the valve spring 136, so that the reassembly of the steering shaft is impaired, a splined pin 167 is inserted tangentially into the valve bushing 141, whose axial central area projects into the bushing bore 169 and cooperates with a collar 168 of the by-pass slide valve member 139.

The steering shaft and the part thereof cooperating with the by-pass slide valve member 139 may be provided with a beveled surface which during the insertion of the steering shaft into the housing forces the by-pass slide valve member 139 into the bore 169.

While we have shown and described two embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art and we, therefore, do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

We claim:

1. An installation for disconnecting the servo force in a vehicle power steering unit, comprising: a housing, a working piston disposed in said housing dividing same into two working pressure spaces, a steering shaft operated by said working piston, passage means for interconnecting said two working pressure spaces, a pair of normally closed by-pass valve means disposed in said interconnecting means and opening into the same working pressure space with each by-pass valve means having an actuating means in said same working pressure space for opening said interconnecting means to said same working pressure space upon actuation, and means movable by said steering shaft for maintaining said by-pass valve means in said normally closed position and for opening one of said by-pass valve means when said working piston is in one end position and for opening the other of said pair of by-pass valve means when said piston is in the opposite end position, whereby said by-pass valve means, in their respective by-pass position, communicate with said interconnecting means to disconnect the servo force in the steering unit.

2. An installation according to claim 1, characterized in that said passage means is a by-pass channel.

3. An installation according to claim 1, wherein each of said actuating means includes a bushing, a spring loaded adjusting member disposed in said bushing cooperating with said control means, means on said ad-

justing members for defining with said bushing a longitudinal channel closed at one end and extending in the axial direction of said bushing, shoulder means on said adjusting members, cooperating, with said bushings for closing the other end of said longitudinal channel whereby, in response to said control means, said channel is opened by said adjusting members being displaced under spring force out of said bushing.

4. An installation according to claim 1, wherein said by-pass valve means are mutually offset in the circumferential direction of said steering shaft, said means for maintaining and opening said by-pass valve means includes a control cam fixed with respect to the steering shaft having three sections circumferentially disposed, a first section of said control cam having an essentially constant radius over a predetermined circumferential distance with respect to the axis of the steering shaft, the remaining sections disposed on each side of said first section, having different distances with respect to said axis, and wherein said actuating means each include an adjusting member in direct engagement with said control cam whereby when said adjusting members engage the first section of said control cam the passage means are closed, whereas, within the areas of the remaining sections of said control cam, only the adjusting member adjacent in the circumferential direction to one of the remaining sections opens the passage means while the other adjusting member continues to remain in operative engagement with the first section of said control cam.

5. An installation according to claim 4, further comprising a control valve means for controlling the working pressure in said two working pressure spaces, supported in proximity of the steering shaft, said control valve means including a chamber, means for communicating said by-pass valve means with said chamber of said control valve means which is in constant communication with the other working pressure space.

6. An installation according to claim 5, wherein said control valve means and said by-pass valve means are arranged substantially perpendicularly to one another.

7. An installation according to claim 5, including a valve housing for each of said by-pass valve means, wherein a movement of the adjusting member of at least one by-pass valve means is directed toward a working pressure space and abutment means for limiting said movement are provided between said at least one adjusting member and the valve housing.

8. An installation according to claim 7, wherein said abutment means includes a notched pin and a collar.

9. An installation according to claim 8, wherein said control valve means and by-pass valve means are arranged substantially perpendicularly to one another.

10. An installation according to claim 9, wherein said passage means is a by-pass channel.

11. An installation according to claim 1, further comprising a control valve means for controlling the working pressure in said two working pressure spaces, supported in proximity of a steering shaft, means for communicating said by-pass valve means with said control valve means, and additional communication means for maintaining a constant communication between said control valve and the other working pressure space.

12. An installation according to claim 11, wherein said control valve means and said by-pass valve means are arranged substantially perpendicularly to one another.

13. An installation according to claim 1, including a valve housing for each of said by-pass valve means, wherein said actuating means includes an adjusting member, wherein movement of the adjusting member of at least one by-pass valve means is directed toward a working pressure space and abutment means for limiting said movement are provided between said at least one adjusting member and the valve housing.

14. An installation according to claim 13, wherein said abutment means includes a notched pin and a collar.

15. An installation for effectively turning off the servo force in a servo steering system, comprising: a working cylinder, a working piston arranged in said cylinder and defining two working pressure spaces, a steering shaft operatively connected to said working piston displaceable between two end portions, a by-pass line operatively connected to said two working spaces, a pair of normally closed by-pass valve means arranged in said by-pass line and opening into the same working pressure space, each of said by-pass valve means having an actuating means in said same working space for opening said by-pass line to said same working pressure space upon actuation, and control means movable by said steering shaft for maintaining said by-pass valve means in said normally closed position and for opening one of said by-pass valve means as said working piston approaches one of said two end positions and for opening the other of said by-pass valve means as said piston approaches the other of said two end positions thereby selectively turning off the servo force in the servo-steering system.

16. An installation according to claim 15, wherein only a single by-pass line is used which contains both said by-pass valve means.

17. An installation according to claim 15, wherein said control means includes a control surface substantially coincident with the axis of said steering shaft and rotatable in unison therewith, said pair of by-pass valve means being arranged in spaced relationship along the circumference said control surface.

18. An installation according to claim 17, wherein said control surface includes a control cam, non-rotatably connected with said steering shaft, having a central section of substantially constant radial dimension and two end sections of a radial dimension differing from said constant radial dimension, a respective by-pass valve means being displaced into its opening position when in engagement with a respective end section of the control cam.

tion of the control cam.

19. An installation according to claim 18, wherein said by-pass line is in constant communication with one of said working pressure spaces and includes a control valve means for controlling the working pressure in said working pressure spaces.

20. An installation according to claim 15, wherein said control means includes a control cam, non-rotatably connected with said steering shaft, having a central section of substantially constant radial dimension and two end sections of a radial dimension differing from said constant radial dimension, a respective by-pass valve means being displaced into an open position when in engagement with a respective end section of the control cam.

21. An installation according to claim 15, wherein said by-pass line is in constant communication with one of said working pressure spaces and includes a control valve means for controlling the working pressure spaces.

22. An installation according to claim 18, wherein each of said actuating means includes a bushing having disposed therein a spring loaded adjusting member, means on said adjusting member for defining with said bushing a longitudinal channel, closed at one end, in the axial direction of said bushing, means on said adjusting member cooperating with said bushings for closing the other end of said channel whereby said longitudinal channel is opened when a respective adjusting member engages a respective end section of said control cam and is displaced under the spring force out of said bushing.

23. An installation according to claim 15 wherein said control means includes a control surface coincident with the axis of said steering shaft and rotatable therewith, and wherein each of said actuating means includes a bushing, a spring loaded adjusting member, disposed in said bushings, engageable with said control surface, means on said adjusting member for defining with said bushing a longitudinal channel closed at one end and extending in the axial direction of said bushing, shoulder means on said adjusting members, cooperating with said bushings, for closing the other end of said longitudinal channel whereby, in response to a predetermined movement of said control surface, said longitudinal channel is opened by said adjusting members being displaced under spring force out of said bushings.

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