Oct. 23, 1951 J. H. EDMAN 2,572,705

FLUID CONTROL VALVE WITH SELECTIVE FLOAT POSITION

Filed May 4, 1950

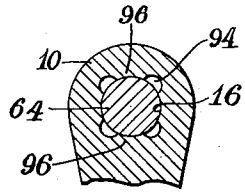


Fig. 4

Fig. 1

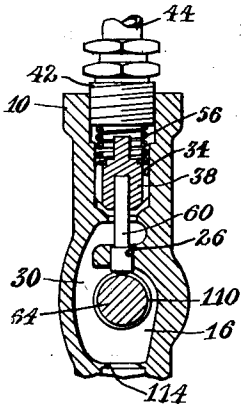


Fig. 3

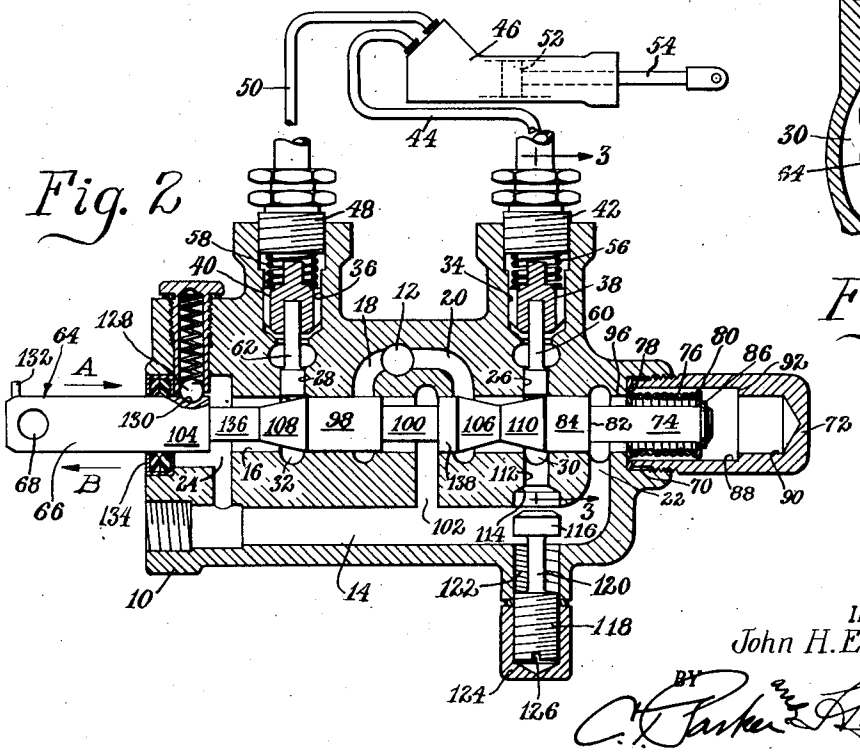


Fig. 2

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Patented Oct. 23, 1951 2,572,705

UNITED STATES PATENT OFFICE

2,572,705

FLUID CONTROL VALVE WITH SELECTIVE FLOAT POSITION

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Application May 4, 1950, Serial No. 160,077

7 Claims. (Cl. 277—51)

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This invention relates to a fluid-pressure or hydraulic system and more particularly to an improved control valve assembly therefor.

The invention contemplates and has for its principal object the provision of an improved control valve assembly having a valve member selectively operative in either a first status or a second status to secure different operational characteristics of the valve assembly and the means—such as a fluid motor—connected thereto. The valve is preferably symmetrically formed and arranged for angular positioning in a valve bore in the valve casing so that in either status it has capacity to control the transmission of fluid to and the return of fluid from the fluid motor. To this end, the casing has a pair of motor ports, each of which has a check valve therein normally biased to closed position against the return flow of fluid. The valve is constructed to positively open one check valve or the other, depending upon the direction of movement of the valve and further depending upon the desired operational phase of the fluid motor. In at least one status, the valve has means for positively opening both check valves so that, in conjunction with a by-pass passage, the fluid inlet is connected to the reservoir passage, as are both motor ports, whereby the system, with the check valves positively held open, is enabled to freely circulate fluid at no appreciable pressure, the result being that the motor parts are free to float.

The characteristics outlined generally above are particularly important in the adaptation of the control valve assembly to the hydraulic system of an agricultural tractor and attached implement. In the case of certain implements, it is desired to provide for only two implement positions, such as a ground-working position and a transport or idle position in which the implement is withdrawn from the ground. In the cases of other implements, it may be desirable to provide, in addition to these two positions, for free floating movement of the implement, that is, a position in which the implement is not hydraulically locked in either position.

Another important object of the invention is to provide in a selective control valve of the type referred to position-retaining means operative when the control valve is in one status but inoperative when the control valve is in its other status. This means enables use of the control valve assembly under ordinary circumstances without bringing in the effectiveness of the position-retaining means, since in some cases it is

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desired that the control valve be automatically returned to neutral. In other cases, when the valve occupies another status, the position-retaining means is effective to hold the control valve in that position thereof in which both check valves are positively held open and both motor ports are connected for free circulation to the exhaust passage or reservoir.

It is an important object of the invention to simplify the construction of the control valve assembly in general and to provide an assembly of the character specified that is of adequate design, that lends itself to low-cost production, and that is easily serviceable.

The foregoing and other important objects and desirable features inherent in and encompassed by the invention will become apparent as the disclosure of a preferred embodiment of the invention progresses in the following detailed description and accompanying sheet of drawings.

In the drawings:

Figure 1 is a combined sectional and schematic view, illustrating the control valve assembly in longitudinal section and showing schematically the connection thereto of a two-way fluid motor;

Figure 2 is a similar view, but showing the control valve in its second status and in a different position;

Figure 3 is a fragmentary sectional view taken substantially on the line 3—3 of Figure 2; and

Figure 4 is a fragmentary sectional view taken on the line 4—4 of Figure 1.

The control valve assembly includes a casing 10 provided with inlet means in the form of an inlet port 12 and exhaust means in the form of an exhaust passage 14. The inlet port may be suitably connected to any conventional type of fluid pump, and the exhaust or reservoir passage may be appropriately connected to a reservoir. Neither the pump nor the reservoir has been shown, since these parts may be conventional and form no part of the present invention.

The casing is provided with an elongated valve bore 16 to which the inlet port 12 leads via a pair of axially spaced branches 18 and 20, and to which the reservoir or exhaust passage 14 leads via a pair of exhaust or reservoir ports 22 and 24.

The casing is further provided with a first motor port 26 and a second motor port 28. These motor ports are axially spaced along the valve bore 16 to either side of the inlet branches 18 and 20 and are further respectively adjacent to but axially spaced from the first and second

exhaust portions 22 and 24. These motor ports lead to or communicate with the valve bore 16 respectively via substantially annular passages 30 and 32 and further communicate respectively with outlet chambers 34 and 36.

The motor port 26 is controlled by a check valve 38 in the chamber 34, and the motor port 28 is controlled by a similar check valve 40 in the chamber 36. The chamber 34 opens exteriorly of the casing and is internally threaded to receive a fitting 42 which communicates by a fluid-transmitting line 44 to one end of a two-way cylinder 46 comprising one of the parts of a motor representative of the type of means that can be controlled by the control valve assembly. The chamber 36 for the motor port 28 also opens exteriorly and is internally threaded to receive a fitting 48 that is connected by a fluid line 50 to the other end of the cylinder 46. The cylinder carries for reciprocation a piston 52 having a piston rod 54 that may be appropriately connected to any type of mechanism that it is desired to operate.

The check valves 38 and 40 are respectively spring-loaded by compression springs 56 and 58 reacting respectively against the fittings 42 and 48 and normally biasing the check valves to close the motor ports 26 and 28 to return flow of fluid from the cylinder 46. The check valves are respectively controlled by plungers 60 and 62 which respectively slidably fit the motor ports 26 and 28 and which enter radially into the valve bore 16 to be controlled by a control valve member designated generally by the numeral 64.

This control valve member is shown as an elongated cylindrical member having portions thereof symmetrically cylindrically and conically reduced or formed to effect connection or disconnection between certain passages and ports in a manner to be presently described. The valve bore 16 extends completely through the casing 10 and at one end thereof the control valve member 64 has an exteriorly axially projecting portion 66 provided with an opening 68 through which connection may be made to a suitable actuating means (not shown). The valve bore 16 opens at the other end of the casing to an outwardly opening internally threaded counterbore 70 which receives a bored closure cap 72 into which the right-hand end of the valve member 64 projects. This end of the valve member 64 is provided with an integral portion 74 of reduced diameter surrounded by a centering spring 76 confined between a pair of washers 78 and 80. The washer 78 seats against a shoulder 82 on an integral cylindrical spool portion 84 of the valve member 64. The washer 80 seats against a snap ring 86 carried in a groove at the extreme right-hand end of the reduced valve member portion 74.

The closure cap 72 is internally bored at 88 to loosely encircle the centering spring 76 and washers 78 and 80 and is further provided with a reduced counterbore 90 at the junction of which and the bore 88 is formed a shoulder 92 against which the washer 80 may seat. The right-hand end of the valve bore is formed as shown in Figure 4, being relieved at 94 to provide a plurality of intermediate shoulder portions 96 against which the washer 78 seats when the control valve member 64 is moved to the left as shown in Figure 2. The passages 94 provide for free communication of fluid between the exhaust port 24 and the interior of the cap 72. The centering spring 76 thus operates as means to maintain

the neutral position of the control valve member 64 as illustrated in Figure 1.

The control valve member 64 has a central or intermediate cylindrical spool portion 98 which, when the control valve member is in its neutral position as shown in Figure 1, blocks off or disconnects the inlet passage 18 from the valve bore 16. Adjacent and to the right of the spool portion 98, the control valve member has a reduced cylindrical portion 100 which, when the control valve member is in its neutral position, leads the inlet port 12 to the valve bore 16 via the branch passage 20, whence fluid circulates relatively freely through a short exhaust passage 102 to the main exhaust passage 14.

At its left-hand end, the control valve member 64 has the cylindrical portion 66 previously described. This portion is carried inwardly to be received by the left-hand end of the valve bore 16 to provide a cylindrical portion 104 that controls communication between the valve bore 16 and the first exhaust port 24. The portion 104 is similar to the portion 84 at the inner end of the control valve member. When the control valve member is in its neutral position, the portion 84 blocks off or disconnects the first exhaust port 22.

The control valve member 64 includes to the right of the reduced portion 100 a conical portion 106 which cooperates with the check valve plunger 60 to open the check valve 38 when the control valve 64 is shifted to the right, or in the direction of the arrow A in Figure 1. At the left of the cylindrical spool portion 98, the control valve member includes a second conical portion 108 which has no effect on the check valve plunger 62 when the control valve member is shifted to the right but which operates to connect the inlet port 12 via the passage 18 to the motor port 28, hence effecting opening of the check valve 40 by pump pressure.

The conical portion 108 functions in conjunction with the check valve plunger 62 to positively open the check valve 40 when the control valve member 64 is shifted to the left in the direction of the arrow B in Figure 1. Hence, the portions 106 and 108 respectively constitute means connected to the control valve for positively and selectively opening the check valves 38 and 40, depending upon the direction of shifting movement of the control valve.

It is an important feature of the invention to provide means connected to the control valve member for positively opening both check valves when the control valve member is shifted in one direction. In the preferred embodiment illustrated, this means includes a conical portion 110 reversed with respect to the conical portion 106 and disposed intermediate this portion 106 and the cylindrical spool portion 84. Therefore, when the control valve member 64 is shifted to the left or in the direction of the arrow B, both check valves 38 and 40 are opened.

Another feature of the invention resides in the provision of means for selectively connecting or by-passing one of the motor ports to the exhaust passage. For this purpose, the casing is provided with a by-pass passage 112 opening through a valve seat or port 114 to the exhaust passage 14. Means is carried by the casing 10 for controlling the port 114. This means comprises a manually controlled member having a valve head 116 and a threaded control portion 118 connected to the head 116 by a reduced shank 120. The threaded portion 118 is received by a tapped bore 122

formed integral with the casing 10 and further receives a sealing cap 124. The portion 118 has formed therein a slot 126 which is rendered accessible to a screw driver or equivalent tool upon removal of the cap 124, whereby the valve member 116—118 may be turned into or out of seating or closure relationship with respect to the valve seat 114 in the by-pass passage 112. In operation of the control valve assembly under ordinary circumstances in which positive control of the motor 46—52 is desired, the by-pass passage 112 will be closed, otherwise fluid pressure from the inlet port 12 via the passage 20 would flow directly to the exhaust passage 14 rather than to the motor port 26 when the control valve member 64 is shifted to the left or in the direction of the arrow B.

When the control valve is operated as set up in Figure 1, the centering spring 76 operates to return the control valve member 64 to neutral from either of its active positions. However, the assembly is provided with position-retaining means which are effective only when the assembly is used as set up in Figure 2. Part of this means is carried by the casing and comprises a first element in the form of a spring-loaded detent ball 128 at times cooperative with a second element in the form of a detent-receiving notch or recess 130 provided in the left-hand end portion 66 of the control valve member 64. Since the control valve member 64 is optionally or selectively angularly positionable in the valve bore 16, the position-retaining means may be rendered operative or inoperative as desired. Since the position-retaining means is enclosed within the casing, it is desired to have means exteriorly of the casing to indicate to the user the angular position or status of the control valve member. For this purpose, there is provided on the left-hand end portion 66 of the control valve member an indicating member in the form of a short pin 132. This member or indicating means is angularly phased with respect to the detent-receiving notch 130, so that the position of the pin 132 indicates the position of the notch 130.

The left-hand end of the casing is appropriately sealed by a seal 134.

In addition to the portions of the member 64 previously described, there is a reduced cylindrical portion 136 between the portions 104 and 108; and a short cylindrical portion 138 between the portions 100 and 106.

Operation—Figure 1

In this aspect of the use of the control valve assembly, the control valve member 64 is in its first status in which the position-retaining means is ineffective to retain the control valve member in any position. In short, the detent-receiving notch 130 is disposed downwardly, the indicating pin 132 designating this status of the member 64 exteriorly of the housing.

When the member 64 is in its neutral position as shown, the inlet 12 is connected to the reservoir or exhaust passage 14 via the passages 20 and 102. Both check valves 38 and 40 are closed. The check valve plunger 60 seats or rests at the junction of the reversely conical portions 106 and 110; and the check valve plunger 62 seats or rests at the reduced portion of the conical portion 108. Hence, the motor ports 26 and 28 are closed, or disconnected from the inlet 12. The first and second exhaust ports 22 and 24 are blocked off or closed respectively by means of the valve member portions 84 and 104. The by-pass passage 112 is closed by seating of the valve 116 of the member 116—120.

Since both check valves are closed and since inlet pressure is circulated to the reservoir, the position of the piston 52 in the cylinder 46 is hydraulically locked. The neutral position of the control valve member 64 is maintained by the centering spring 76.

When the control valve member 64 is shifted in the direction A to its first active position, the valve member portion 106 positively opens the first check valve 38. The valve member portion 110 moves into the first exhaust port 22 so that the motor port 26 is connected to the exhaust port 22. At the same time, the valve member portion 138 maintains the disconnection between the inlet 12 and motor port 26. Further, the valve member portion 98, moving to the right, disconnects the inlet 12 from the exhaust passage 14 (by blocking off the short passage 102), and the portion 108 serves to connect the inlet via the branch passage 18 and bore 16 to the second motor port 28, whereupon the check valve 40 is opened by pressure. Fluid is therefore transmitted through the line 50 to one end of the cylinder 46 and fluid returns through the line 44 and through the motor port 26 and exhaust port 22 to the reservoir 14. Movement of the control valve member 64 to the right is, of course, effective to compress the centering spring 76, so that when the operator releases the control valve member 64, the spring 76 serves to return the control valve member to its neutral position.

When the control valve member 64 is shifted to its second active position in the direction of the arrow B, the reverse conditions obtain; that is, the valve member portion 108 positively opens the check valve 40, the portion 104 moves out of the end of the valve bore 16 and effects connection between the bore and the second exhaust port 24, whereby fluid returning through the line 50 and motor port chamber 36 and motor port 28 passes to the reservoir or exhaust passage 14. At the same time, the valve member portion 138, moving to the left, disconnects the inlet branch passage 20 from the exhaust passage 102, and the conical portion 106 establishes communication between the inlet 12 and inlet branch passage 20 through the first motor port 26. The valve member portion 84 disconnects the first motor port from the first exhaust passage 22.

In that phase of the operation just described, there is one important difference in operation that does not follow exactly as a reversal of the conditions that obtain when the control valve member 64 is shifted in the direction A. This results from that feature of the invention residing in the provision on the control member 64 of the conical portion 110, which serves as means for positively opening the check valve 38. Hence, when the control valve member 64 is shifted to the left, or in the direction of the arrow B, both check valves 38 and 40 are positively opened. Nevertheless, in this phase of the operation or use of the control valve assembly, the opening of the check valve 38 by the conical portion 110 is relatively unimportant, since this check valve would be opened by pressure from the inlet 12 via the passage 20 to the motor port 26. Although this result (positive opening of the check valve 38) may be said to tbe superfluous in this stage of the operation, it plays an important part in the capacity of the control valve assembly, as will appear below in the description

of the operation of the assembly when constituted as in Figure 2.

Continuing with the above description, it will be remembered that the by-pass control valve 116—120 closes the by-pass passage 112. Therefore, the general function of the assembly is somewhat similar to the conventional two-way control valve. Upon movement of the control valve member 64 in the direction B, the centering spring 76 is compressed because of contact between the washer 78 and the portions 96 (Figure 4). Therefore, when the control valve member is released, the centering spring will return the control valve member to its neutral postion.

Operation—Figure 2

The control valve assembly may be utilized as constituted in this figure for the purpose of securing floating action of the piston 52 in the cylinder 46. Or it may likewise be used with a one-way motor. It is during this phase or status of operation that the portion 110 on the control valve member 64 becomes important. At this point, it may be noted that the control valve member 64, for purposes of efficiency in production, is symmetrical about its principal axis. As suggested above, the portion 110 may be considered superfluous in the operation of the control valve assembly in Figure 1. Therefore, if desired, the control valve member may be asymmetrical in this respect. However, this is immaterial from the inventive standpoint and it is considered that the principles of the invention are applicable in either instance.

As shown in Figure 2, the control valve member 64 is angularly positioned so that it occupies a second status, wherein the detent-receiving notch 130 is disposed upwardly, as indicated by the indicating pin 132. In so far as concerns the neutral position of the control valve member 64, the same conditions obtain that obtain in the neutral position as shown in Figure 1.

When the control valve member 64 is in its neutral position, the position-retaining means is disengaged, since the detent-receiving notch 130 will be axially spaced from the detent ball 128. Likewise, when the control valve member 64 is shifted to the right or in the direction of the arrow A, the position-retaining means is ineffective. The active position resulting from shifting of the control valve member 64 in the direction A in Figure 2 is the same as that in Figure 1. That is, the inlet 12 is disconnected from the exhaust passage 14 and is connected to the second motor port 28 via the valve member portion 108. The first check valve 38 is positively opened by means of the valve member portion 106 and first check valve plunger 60. The first motor port is connected to the first exhaust port 22 via the valve member portion 110.

At this point, the second important feature of the invention should be considered. This is the opening of the by-pass passage 112 by the control valve 116—120, which is accomplished manually. Therefore, the motor port 26 is connected directly to the exhaust passage 14 via the passage 112 when the main control valve member 64 is in its neutral position or in its active position when moved in the direction A. Hence, the control valve assembly now functions as a one-way control, delivering fluid under pressure only through the motor port 28 and line 50 to one end of the cylinder 46, return fluid from the cylinder 46 being carried via the line 44, first motor port 26 and either the first exhaust port 22 or by-pass passage 112.

The most important function of the control valve assembly when utilized in the status shown in Figure 2 is its ability to permit floating of the motor elements, such as the piston 52 in the cylinder 46 or the piston in a one-way motor if used. This result follows from the positive opening of both check valves respectively by the control valve member portions 110 and 108, which provides for free circulation of fluid between the cylinder 46 and valve bore 16. Since the left-hand portion 136 establishes communication between the second motor port 28 and second exhaust port 24, the result will be no different from that that obtains when the control valve member 64 is shifted to the left in Figure 1. However, without the by-pass passage 112 and positive opening of the check valve 38, there could be no free circulation of fluid at the right-hand end of the casing. As shown in Figure 2, the passage 112 directly communicates the motor port 26 to the reservoir or exhaust passage 14.

Of further importance is the operation now of the position-retaining means. When the control valve member is shifted to the position as shown in Figure 2, the spring-loaded detent ball 128 seats in the notch or recess 130, thus holding the control valve member 64 in position against the action of the loaded spring 76.

Summary

Briefly described, and for the purposes of facilitating an understanding of the invention as defined in the appended claims, the control valve assembly may be considered as having dual capacity, which results from the selective angular positioning of the control valve member 64 in either a first status (Figure 1) or a second status (Figure 2). In its first status, the control valve member 64 is effective to positively open the first check valve 38 when shifted to a first active position in the direction of the arrow A. This disconnects the inlet from the exhaust passage, disconnects the first motor port 26 from the inlet and connects said first motor port to the first exhaust port; and the second motor port is connected to the inlet and disconnected from the second exhaust port. When the control valve member 64 is shifted to its second active position (in the direction B), the aforesaid conditions are reversed. As mentioned above, it is not fundamentally necessary that the first check valve 38 be positively opened when the control valve member 64 is shifted to the left. Nevertheless, because of the symmetrical construction of the control valve member 64 this result follows. The by-pass means 112—114 is closed and hence establishes no communication between the first motor port 26 and exhaust passage 14. It will be noted that this passage by-passes the disconnection at 84 between the first motor port 26 and first exhaust port 2; although it could readily be otherwise connected to accomplish the same result. However, in the first status of the control valve assembly, the by-pass is closed and has no effect on the operation of the system.

On the other hand, when the control valve member 64 is angularly positioned to its second status (Figure 2) the positive opening of the first check valve 38 and the opening of the by-pass passage 112—114 is important, as previously described.

Other objects and features of the invention not specifically enumerated herein will undoubtedly

occur to those versed in the art, as likewise will various modifications and alterations in the preferred embodiment of the invention disclosed, all of which may be achieved without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A fluid-pressure control valve assembly, comprising: a casing having a valve bore, a fluid inlet leading to the bore, first and second motor ports leading from the bore, an exhaust passage, and first and second exhaust ports leading from the bore to the exhaust passage; first and second check valves respectively in the motor ports and normally closed against return fluid; a control valve member in the valve bore having a neutral position in which the check valves are closed and the inlet is led to the exhaust passage; said member being shiftable in one direction from said neutral position to a first active position in which the inlet is disconnected from the exhaust passage, the first motor port is disconnected from the inlet and connected to the first exhaust port, and the second motor port is connected to the inlet and disconnected from the second exhaust port; said member being selectively shiftable in the opposite direction from said neutral position to a second active position in which the aforesaid conditions are reversed; means connected to said member and effective when the member is shifted to its first active position to positively open the first check valve; means connected to said member and effective when the member is shifted to its second active position to positively open both check valves; means in the casing providing a passage communicating between the exhaust passage and the first motor port and by-passing the fluid disconnection between the first motor port and first exhaust port when the control valve member is in its second active position; and means movably carried by the casing for selectively opening or closing said by-pass passage.

2. The invention defined in claim 1, further characterized in that: means is provided for optionally retaining the control valve member in its second active position, wherein both check valves are positively held open, so that when said by-pass means is opened both motor ports lead to the exhaust passage.

3. The invention defined in claim 1, further characterized in that: a portion of said control valve member has a position-retaining element thereon; the casing is provided with a position-retaining element cooperatively engageable with the position-retaining element of the control valve member when said member is shifted to its second active position; and said control valve member portion is selectively angularly positionable relative to the position-retaining element of the casing to condition said elements for non-engagement when said member is shifted to its second active position.

4. The invention defined in claim 3, further characterized in that: said position-retaining elements are enclosed by the casing; and means is connected to the control valve member portion and projects exteriorly of the casing, including a member indicating the angular position of the position-retaining element on the control valve member portion.

5. The invention defined in claim 1, further characterized in that: the control valve member is selectively angularly positionable in the valve bore to occupy either a first or second control status; said control valve member is symmetrically formed so that in either status it functions as aforesaid to control the motor and exhaust ports and the inlet and exhaust passage; detent means is provided in the casing, including a detent member projecting into the valve bore; and the control valve member is provided with a detent-receiving recess arranged to receive said detent member when the control valve member is in its second position in but one status.

6. A fluid-pressure control valve assembly, comprising: first and second motor port means, respectively having check valves normally biased to closed position against return fluid flow; fluid inlet means; fluid exhaust means; valve means for selectively establishing a neutral condition, in which the inlet means is connected to the exhaust means, or either of first or second active conditions, in the first of which the first motor port is disconnected from the inlet means and connected to the exhaust means and the second motor port is connected to the inlet means and disconnected from the exhaust means, and in the second of which the connections and disconnections are reversed, so that fluid pressure is selectively directed through one motor port while returning through the other; means connected to the valve means for positively opening the first check valve incident to the establishment of said first active condition; means connected to the valve means for positively opening both check valves incident to the establishment of said second active condition; means providing a passage between the exhaust means and the first motor port and by-passing the fluid disconnection between said first motor port and the exhaust means when said second active condition obtains; and means for selectively opening or closing said passage means.

7. A fluid-pressure control valve assembly, comprising: first and second motor port means, respectively, having check valves normally biased to closed position against return fluid flow; fluid inlet means; fluid exhaust means; valve means for selectively establishing a neutral condition, in which the inlet means is connected to the exhaust means, or either of first or second active conditions, in the first of which the first motor port is disconnected from the inlet means and connected to the exhaust means and the second motor port is connected to the inlet means and disconnected from the exhaust means, and in the second of which the connections and disconnections are reversed, so that fluid pressure is selectively directed through one motor port while returning through the other; means for positively opening the first check valve during the establishment of said first active condition; means for positively opening both check valves during the establishment of said second active condition; means providing a passage between the exhaust means and the first motor port and by-passing the fluid disconnection between said first motor port and the exhaust means when said second active condition obtains; and means for selectively opening or closing said passage means.

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