CONTROL DEVICES FOR HYDRAULIC MOTORS

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This invention relates to improvements in control devices for hydraulic motors and while generally applicable has a special sphere of utility in connection with hydraulic servo-motors as used on tipping wagons or the like for working appliances attached to tractors, in which a pump is connected to a control member and the latter to a working cylinder by means of two valve controlled working pipes. These valves are used for the purpose of closing the working pipe when the pump is not operating, in order to avoid unintended use and thus damage, to the appliances and to avoid accidents occurring. It is also intended to prevent the appliance such as a tip-body from falling down owing to its own weight until the operator desires it to do so.

It is known to arrange valves for these purposes in the manner of check valves, the opening stroke of which is directed in the same direction as the liquid flowing from the pump. These close automatically when fluid approaches them from the working cylinder with too great pressure or at too great a velocity. However, it is difficult to open such a valve with the aid of the pressure fluid coming from the pump when it is under the loading of the appliance. Special constructional measures are therefore necessary to render this possible. In addition, there is the danger that the pipes leading to the working cylinder, usually in the form of flexible pipes may burst or become leaky owing to suddenly occurring pressure within them.

An object of this invention is to avoid such disadvantages.

According to this invention the opening stroke of the closing member of the valves acts in the same direction as the direction of flow of the fluid returning from the working cylinder. From the function of these valves it automatically follows that they are so proportioned that they cannot be opened by the return pressure of the liquid in the working cylinder, at least as long as this pressure remains within predetermined limits.

Such a construction of the valves enables the stop members to be constructed favourable to streamline flow so that foaming is avoided, in particular foaming of the liquid returning to the pump.

Various arrangements in accordance with the present invention are illustrated in the drawings, by way of example.

In the drawings:

Fig. 1 shows one form of construction in the position of rest.

Fig. 2 the same in the operative position.

Fig. 3 shows a second form of construction.

Fig. 4 shows a third form of construction.

A pump 1 or another source of pressure and suction supplies pressure fluid to a pressure pipe 2 and sucks fluid through a container from a suction pipe 4. The pressure and suction conduits 2, 4 lead to a cock 5. From the latter, working pipes 6 and 7 lead to a working cylinder 8 in which is disposed a piston 9. This piston displaces, by its piston rod 10, a working appliance such as a tip wagon body and the latter sinks back when the piston 9 rises in the cylinder 8.

The cock 5 contains a transverse channel 11 and two lateral channels 12 and 13. The latter is connected with the transverse channel 11 by a small bore 14. A valve 15 is inserted in the working pipe 6. It contains a valve chamber 16 which forms part of the working pipe 6. This chamber encloses a closing member 17, the upper end of which carries a piston 18, and a cylinder 19, in which the piston 8 slides being pressed downwardly by a spring 20. The lower end of the closing member 17 is constructed as a cone 21 of an angle of about 90°. The shaft 22 connected to this cone has a diameter which is considerably greater than the seat 23 against which the closing member 17 is disposed in the closing position. The lower end of the cylinder 19 is connected by a control pipe 24 with the part of the working pipe 7 coming from the cock 5.

A valve 25 is inserted in the working pipe 7, which is constructed similarly to the valve 15. It contains a valve chamber 26, closing member 27 with piston 28, cylinder 29 and spring 30. The cone 31 on its shaft 32 cooperates with a valve seat 33. The lower end of the cylinder 29 is connected by a control pipe 34 with the part of the working pipe 6 coming from the cock 5.

The cross section of the valve seats 23 and 33 and the tension of the springs 20 and 30 are arranged so that when the valves are closed, the pressure in the parts 35 and 36 of the working pipes 6 and 7 bounded by the working cylinder 8 is not able to raise the closing members until it has attained a predetermined degree as would for instance endanger the installation.

When the pump is operated and the cock 5 is moved to the position shown in Fig. 1, the pressure fluid flows through the pressure pipe 2, the transverse channel 11 and the suction pipe 4 back to the pump 1 without pressure. The valves 15 and 25 remain closed. The working pipe 7 is connected through the bore 14 with a suction pipe 4 so that when a predetermined pressure in the pipe member 35 is exceeded, fluid may raise the closing member 27 and flow away. If the working appliance such as a tip-wagon body is to be lowered, the cock 5 is placed in the position shown in Fig. 2. Then pressure fluid flows from the pressure pipe 2 through the lateral channel 12 and the working pipe 6 into the valve chamber 19, presses on the cone 21, raises the closing member 17 and passes into the lower part of the working cylinder 8. At the same time it places the lower part of the cylinder 29 under pressure by reason of connection with the control pipe 34 and thereby raises the closing member 27. The fluid from the upper part of the working cylinder 8 therefore escapes through the valve chamber 26, working pipe 7, lateral channel 13 and suction pipe 4 into the tank 3. The working piston 9 rises and lowers the attached appliance.

If the appliance tries to move faster than corresponds to the feed pressure fluid, the pressure in the working pipe 6 is lowered and, therefore, the pressure also falls in the control pipe 34, so that the closing members of the valves close. The effective surface of the piston 28 is as great as, or greater than, the effective surface of the cone 21 so that the valve 25 closes at the same time as the valve 15 or somewhat before it, when the pressure in the pipe 6 falls. The working piston 9 is retarded in its movement and therefore, the fluid flowing from the United States Patent Office

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pump again increases the pressure so that the valves open and the lowering of the appliance is continued. The fluid flowing away with slight pressure incurs the risk of foaming particularly if it has been through narrow passages. This foaming adversely affects to a considerable extent the action of the pump. It has now become apparent that the cone 31 and the shaft 32 in the form illustrated very much reduce this risk of foaming as compared with other forms of valve.

For raising the appliance, the position of the cock 5 is reversed so that the pressure pipe 2 is connected with the working pipe 7, and the working pipe 6 with the suction pipe 4. The operations now proceed similar to those described above, the closing member 27 being raised by the pressure on the cone 31, and the closing member 17 by the pressure in the cylinder 19 supplied through the control pipe 24. As when lowering, the valves immediately open, independently of the load exerted on the piston 9 by the working appliances such as a tip-waggon body.

If the pump remains stationary for any reason, then the pipe pressure falls, the valves close and the working appliance is maintained in its position.

Another form of the valve control element is illustrated in the arrangement shown in Fig. 3. Compared with the arrangement in Fig. 2, the control pipes 24 and 34 are replaced by a connecting pipe 37 between the cylinders 19 and 29 and a control pipe 38 which connects the latter with the suction pipe 4. The other parts of the installation are the same as in the previous example.

If the cock 5 is in the illustrated position, the fluid flows without pressure through the transverse channel 11; the control pipe 38 is, therefore, likewise without pressure and the valves 15 and 25 remain closed. If the cock is reversed to effect a lowering or a raising of the working appliance, then the pressure pipe 2 is connected with one of the working pipes 6 or 7, and the pressure in the pressure pipe 2 immediately rises also, as in the control pipe 38 and the cylinders 19 and 29; the valves 15 and 25 are, therefore, raised by the force exerted on the pistons 18 and 28. Then the fluid moves the working piston 9 in the direction selected. If the working piston tries to move more quickly in doing this than corresponds with the quantity of the fluid fed, then the pressure in the pipe 2 and 38 is lowered. The valves therefore close. In this case, the effective surface of the piston 28 is arranged to be equal to or somewhat smaller than the corresponding surface of the piston 18 so that, particularly in lowering, the valve 25 is simultaneously closed with or before the valve 15.

In the form of construction according to Fig. 4, the control pipe 38 is replaced by a control pipe 39, which leads to a cock 40. The latter is connected by a pipe 41 with the pressure pipe 2. From this pressure pipe, a pipe 42 in addition, leads through a cock 43 having a bore 48, and a throttle valve 44 to the suction pipe 4. The pressure side of the throttle valve is connected by a pipe 45, and the suction side by a pipe 46, with the cock 40. This cock contains a T-shaped channel 47.

In the operational position, the cock 43 closes the pipe 42. The cock 40 is so adjusted that it connects the control pipe 39 with the pipe 41 and with the pressure pipe 2. If the cock 5 is set to the position shown in Fig. 4, the working pipe 6 is subjected to pressure, also the control pipe 39; the closing members 17 and 27 are raised and the working piston 9 is displaced. This operation proceeds similarly as in the form of construction shown in Fig. 3; the same applies to the reversed working direction.

If the working appliance is intended to be kept fixed in one place, then the cock 40 is turned so that the control pipe 39 is connected with the pipe 46. The pressure in the control pipe thereby sinks, and the valves are closed. At the same time, the cock 43 must be reversed, so that the fluid coming from the pump through the pipe and the bore 48 can flow away.

In many cases, it is desirable to allow the working appliance to move freely up and down. For this purpose the cock 5 is so adjusted that the two working pipes 6 and 7 are connected together by the transverse channel 11, and the cock 40 is set to a lowering of the control pipe 39 with the pipe 45. The pipe 42 is also open. The pressure fluid flowing through the portion of pipe 6 located on the left of throttle valve 44 is kept at a definite pressure by the throttle valve 44. This pressure is sufficient to open the valves 15 and 25 through the pipe 48 and the control pipe 39. The fluid in the working cylinder can now circulate freely through the working pipes and the cock 5, and the piston 9 follows the movements of the attached appliance.

The principles explained in the foregoing example for the proportioning of the valves apply in this case also. If the pressure in the working pipes is lowered, the valves close, whilst according to its dimension the valve 25 will move more or less at a higher speed than the valve 15. With the pump stationary, the valves are closed and only open when an inadmissibly higher pressure occurs in the working cylinder.

Instead of the cocks illustrated, differently constructed control members may be used, for example, slide or piston valves. Again alternative to the illustrated pipes, others may be arranged in order to return the leakage oil, more particularly from the upper parts of the cylinders 19 and 29.

We claim:

1. A servo-motor arrangement, comprising, in combination, servo-motor means including a cylinder member, and a piston member defining in said cylinder member two chambers, one of said members being reciprocable, said reciprocable member being adapted to be urged to move at a lower speed than said predetermined speed; a pair of said shut-off valves; a pair of cylinders, each housing one of said pistons; means urging said pistons in closing direction of associated shut-off valve; means connecting at one end thereof with both of said cylinders, and at the other end thereof with source of pressure fluid; and means communicating at one end thereof with said cylinder member, each of said means being adapted to be opened by source of pressure fluid passing to said servo-motor means at a predetermined pressure and adapted to close when said reciprocable member reduces the pressure in the respective conduit means by moving at a higher speed than said predetermined speed; a pair of shut-off valves; a pair of cylinder members, each connected to a source of pressure fluid for urging said cylinder members to move at a predetermined speed; a pair of said shut-off valves; and a pair of said shut-off valves being adapted to be opened by source of pressure fluid passing to said servo-motor means at a predetermined pressure and adapted to close when said reciprocable member reduces the pressure in the respective conduit means by moving at a higher speed than said predetermined speed; and means communicating at one end thereof with both of said cylinders, and at the other end thereof with source of pressure fluid for urging said pistons in opening direction of said shut-off valve.

2. A servo-motor arrangement, comprising, in combination, servo-motor means including a cylinder member, and a piston member defining in said cylinder member two chambers, one of said members being reciprocable, said reciprocable member being adapted to be urged to move by a load acting thereon; a pair of conduit means, each of said conduit means communicating at one end thereof with both of said cylinders, and at the other end thereof with source of pressure fluid for urging said pistons in opening direction of said shut-off valves; and a pair of conduit means; each of said conduit means communicating at one end thereof with both of said cylinders, and at the other end thereof with source of pressure fluid for urging said pistons in opening direction of said shut-off valves.
direction of the associated shut-off valve; a distribution conduit means communicating at one end thereof with both of said cylinders so that pressure fluid in said distribution conduit means urges said pistons to move in opening direction of the shut-off valves; and a control cock at the other end of said distribution conduit for connecting the same at will to a source of pressure fluid.

3. A servo-motor arrangement, comprising, in combination, servo-motor means including a cylinder member, and a piston member defining in said cylinder member two chambers, one of said members being reciprocable, said reciprocable member being adapted to be urged to move by a load acting thereon; a pair of conduit means, each of said conduit means communicating with one of said chambers in said cylinder member; cock means for alternately connecting said conduit means to a source of pressure fluid for urging said reciprocable member to move at a predetermined speed; a pair of shut-off valves, each shut-off valve arranged in one of said conduit means, said shut-off valves being adapted to be opened by pressure fluid passing to said servo-motor means at a predetermined pressure and adapted to close when said reciprocable member reduces the pressure in the respective conduit means by moving at a higher speed than said predetermined speed; a pair of pistons, each piston fixedly connected to one of said shut-off valves; a pair of cylinders, each housing one of said pistons; means urging said pistons in closing direction of the associated shut-off valve; a distribution conduit means communicating at one end thereof with both of said cylinders so that pressure fluid in said distribution conduit means urges said pistons to move in opening direction of the shut-off valves; pressure conduit means and suction conduit means adapted to be connected to a source of pressure and suction and connected to said cock means; a first by-pass conduit connecting said pressure and suction conduit means; a manually operated cock in said first by-pass conduit; a second by-pass conduit connecting said pressure and suction conduits; a control cock in said second by-pass conduit communicating with the other end of said distribution conduit means, and movable between one position connecting said distribution conduit means to said pressure conduit means and another position connecting said suction conduit means with said distribution conduit means.

4. An arrangement as claimed in claim 3 and including a throttle valve located in said first by-pass conduit; and a conduit connecting a point of said first by-pass conduit located between said manually operated cock and said throttle valve with said control cock, said control cock being movable to a third position in which said last mentioned conduit is connected with said other end of said distribution conduit.

5. An arrangement as claimed in claim 2 wherein each shut-off valve has a conical valve closing face and includes a valve seat having a smaller diameter than said conical valve closing face.

6. An arrangement as claimed in claim 1 wherein one of said pistons has a working face having a smaller area than the working face of the other piston so that said other piston opens the associated shut-off valve before said one piston.

7. An arrangement as claimed in claim 3 wherein one of said pistons has a working face having a smaller area than the working face of the other piston so that said other piston opens the associated shut-off valve before said one piston.

8. A servo-motor arrangement as claimed in claim 1 wherein said shut-off valve means include springs tending to close said shut-off valve means, said springs being so dimensioned as to permit opening of said shut-off valve means at a predetermined excess pressure in said conduit means produced by said servo-motor means when said cock means are closed.

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