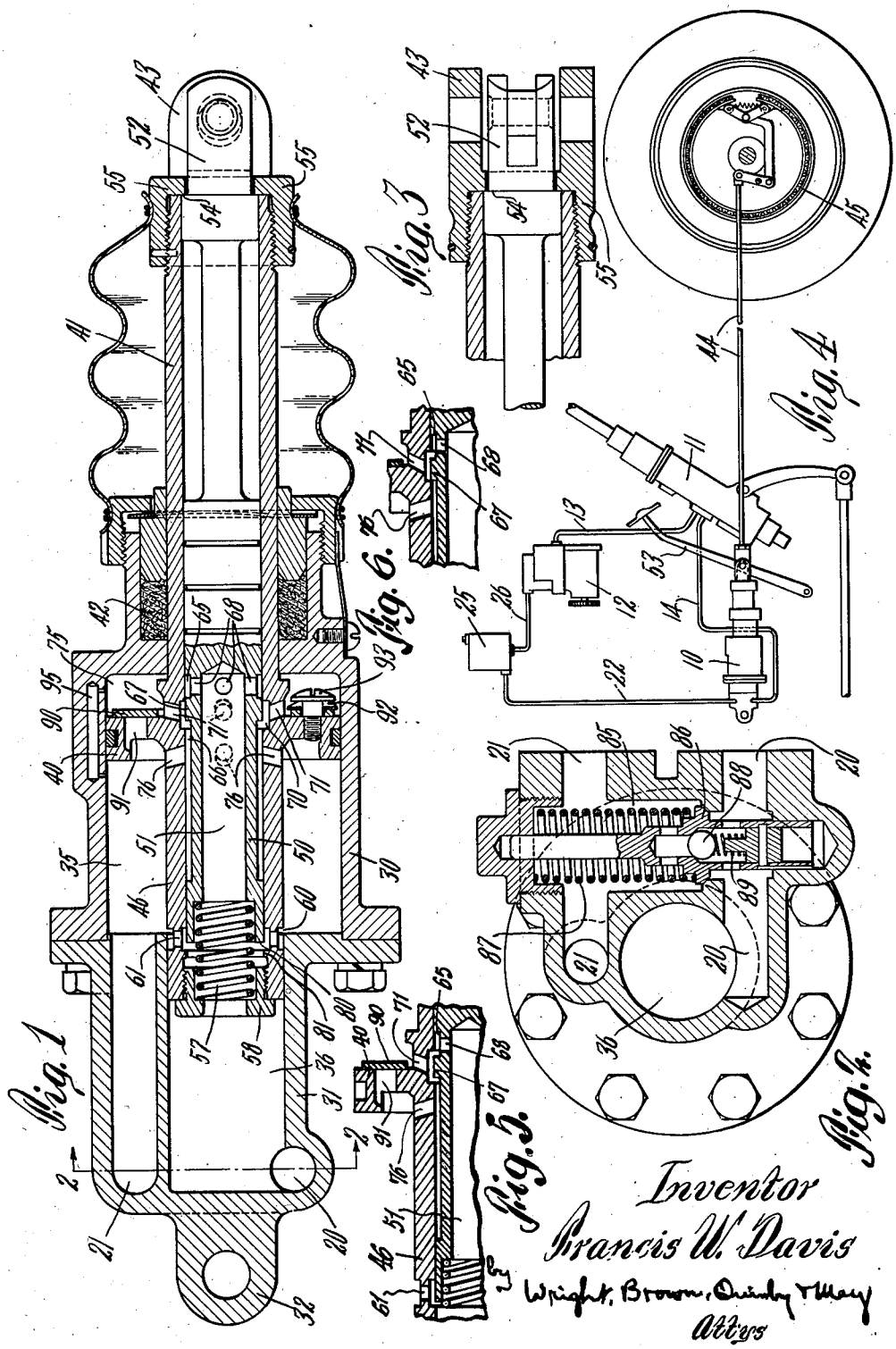
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DOUBLE ACTING SERVOMOTOR

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DOUBLE ACTING SERVOMOTOR

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6 Claims. (Cl. 121—41)

This invention relates to a servo-motor having an element movable in one direction for a power stroke and in the opposite direction for a return stroke. A motor of this type is particularly adapted and intended for use in applying brakes on a vehicle, but it is evident that it is capable of other equivalent uses especially where a strong pull in one direction only is desired. The particular embodiment of the invention hereinafter shown and described is particularly adapted for use on automobiles and for operation by means of a liquid such as oil or a glycerine-water mixture, supplied under pressure by a suitable pump. Most liquids undergo an increase in viscosity at lower temperatures, this being true of most oils. Hence, when oil is employed in the operation of a servo-motor such as is described in my Patent No. 1,846,089 the thickness and viscosity of the oil when it is cold may prevent a sufficiently rapid return of the brake pedal when the brake springs are relied upon to return the mechanism to its normal position after the brakes have been applied. This difficulty is overcome according to the present invention by utilizing the power fluid not only to apply the brake, but also to relieve the brake pressure and assist in the return of the power-actuated member of the motor so that the brake pedal will follow the foot of the operator.

For a more complete understanding of this invention reference may be had to the description thereof which follows and to the drawing of which

Figure 1 is a longitudinal sectional view of a servo-motor embodying the invention.

Figure 2 is a sectional view of the forward end of the motor, taken on the line 2—2 of Figure 1.

Figure 3 is a fragmentary sectional view of the rear end of the apparatus shown in Figure 1.

Figure 4 is a diagrammatic representation of several parts of an automobile, showing how the invention may be employed.

Figures 5 and 6 are fragmentary portions of Figure 1, showing the parts in different relative positions of operation.

Referring to Figure 4, the motor 10 for applying the brakes may be conveniently used in conjunction with a power-actuated steering mechanism 11. This mechanism is preferably of a type wherein the valve members are so arranged that there is a free flow of power fluid through the mechanism when the power is not being employed for the actuation of the steered part of the automobile. Within the casing which houses the steering gear 11 there may also be a spring-pressed relief valve, such as is illustrated in Figure 2, so that if the resistance of the power-actuated member in the gear becomes excessive, the power fluid will be by-passed when the pressure reaches a predetermined value. A power pump is conveniently indicated at 12, the discharge line 13 from the pump 12 leading to the inlet of the steering gear 11. A pipe 14 leads from the outlet of the steering gear to the inlet 20 of the servo-motor for the brakes. The discharge outlet 21 of this motor is connected as by a return pipe 22 to a reservoir 25 from which the inlet of the pump 12 is supplied as by a pipe 26. While any suitable fluid, preferably a liquid, may be employed in the operation of the present invention, oil is a convenient liquid for use in an automobile or the like. For convenience, the power fluid is hereinafter referred to as oil. The invention, as shown, is embodied in a casing 30 having a forwardly projecting extension 31 of reduced diameter, terminating in an ear 32 by which the motor may be secured to the automobile frame or other suitable support. The casing 30 encloses a main chamber 35 having a forward extension 36 within the reduced portion 31 of the casing. Reciprocable in the casing 30 is a piston 40 having a rearwardly extending piston rod 41 projecting through the rear end of the casing and suitably packed as at 42. At the rear end of the rod 41 is a yoke 43 to which may be secured a brake rod 44 adapted to apply one or more brakes 45 by a tension on the rod 44. The piston rod 41 is extended forwardly of the piston 40 in the form of a stem 46 which is adapted to telescope with the casing extension 31, being slidably fitted therein. The piston rod 41 and stem 46 constitute a continuous hollow tube within which is slidably fitted a valve member 50. The forward portion of the valve member is hollow as at 51, the rear end of the valve member projecting from the rear end of the piston rod 41 and terminating in a yoke 52 which is connected to the brake pedal lever 53 of the automobile. Rearward movement of the valve member 50 is limited by engagement of a shoulder 54 with a cap 55 mounted on the rear end of the piston rod 41, the yoke 43 of the piston rod being shown as integral with the cap 55. The valve member 50 is normally held in its extreme rearward position as by a suitable spring 57, which is compressed between a shoulder in the forward end of the valve member 50 and a shoulder within a thimble 58 screwed into the open end of the stem 46. The stem 46 is provided with an annular groove 60 communicating with

the interior of the stem through a series of holes 61. The groove 60 opens into the chamber 35 when the piston is in its extreme rearward position as shown in Figure 1. Thus oil entering the inlet 20 normally flows through the chamber 36 into the interior of the stem 46, through the holes 61 and the groove 60 into the main chamber 35, and thence outwardly through the outlet 21. Since these passages offer a relatively unrestricted flow for the oil through the casing, there is but little oil pressure ordinarily in the casing. It may be noted that such pressure as there may be at times in the chamber 36 acts against the valve member 50, tending to assist the spring 57 in pressing the valve member rearwardly. Oil pressure in the chamber 36 also acts against the forward end of the stem 46, the effective area of pressure being equal to the annular area of cross section of this stem. For the operation of the motor, the valve element 50 is provided with a pair of external annular grooves 65 and 66, these grooves being separated by an annular rib 67. The groove 65 is in constant communication with the interior hollow 51 by a series of holes 68 through the wall of the valve member 50. Opposite this rib 67 is an annular groove 70 in the inner wall of the piston rod 41 and stem 46, the groove 70 communicating through a series of holes 71 with a pressure chamber 75 in the casing 30, rearward of the piston 40. The groove 66 communicates with the chamber 35 forward of the piston as by a number of holes 76. As shown in Figure 1, the groove 65 in the valve is normally cut off from communication with the groove 70 but can be moved into communication therewith by forward movement of the valve member 50 relative to the piston 40, that is, by taking up a portion of the lost-motion between these members. The rib 67 is not as wide as the groove 70 so that when a portion of the lost-motion between the valve member and piston has been taken up, the groove 65, and hence the hollow 51, is connected not only with the chamber 75 rearward of the piston, but also through the groove 66 and the holes 76 with the chamber 35 forward of the piston. Hence, oil entering the inlet 20 and flowing into the hollow 51 when the piston is in fully retracted position as shown in Figure 1 but the valve member 50 is partly advanced as shown in Figure 5, flows partly through the openings 61 directly into the chamber 35, partly into the chamber 75 through the holes 70, and partly through the grooves 66 and the holes 76 into the chamber 35. Thus more or less pressure is built up in the chamber 75 according to the relative size of the clearance on either side of the rib 67. As soon as there is any forward movement on the part of the piston 40, the groove 60 is closed by the wall of the casing extension 31 so that direct communication between the inlet and outlet through this groove is thereafter cut off until the piston has resumed its normal, fully retracted position. When the groove 60 has been closed by a small forward movement of the piston, or by sufficient relative movement by the valve member 50 to take up all the lost-motion between the valve member and the piston, whereby the forward end face 80 of the valve member 50 engages an annular rib 81 within the stem 46, all the oil entering the chamber 36 must flow through the holes 71 and 76 if only a portion of the lost-motion has been taken up, or through the holes 71 alone if all of the lost-motion has been taken up. Thus forward movement of the valve member 50 sufficient to take up all the lost-motion between it and the piston 40 directs the entire flow of the oil entering the inlet 20 into the pressure chamber 75 where the pressure acts against the rear face of the piston 40, this rear face having an area of considerable magnitude compared with the end area of the stem 46 and the cross-sectional area of the valve 50 against which the oil presses in the opposite direction. As long as the lost motion between the valve member 50 and the piston 40 is completely taken up, the full pressure of the oil is exerted against the rear face of the piston, thus maintaining a maximum forward drag on the brake rod 44. When pressure on the brake pedal lever 53 is removed, the spring 57 together with oil pressure acting rearwardly against the valve 50, pushes the valve member 50 rearwardly so that further flow through the holes 68 and the groove 65 is completely cut off. The oil pressure in the chamber 75 is relieved thorugh the holes 71, the groove 66, and the holes 76, into the chamber 35 and out through the discharge outlet 21. Maximum oil pressure however, is still present in the chamber 36 and is exerted against the forward end of the stem 46 and against the valve member 50, this pressure tending to move both members rearwardly. Thus there is a positive rapid return movement of the brake pedal when the pedal has been released by the operator, this return movement being caused by pressure in the chamber 36. As the cross sectional area of this chamber is small compared to the pressure area on the piston 40, the return movement is more rapid than the working movement for a given rate of flow of oil. As soon as the piston 40 and valve member 50 have reached their extreme retracted positions, the grooves 60 opens into the chamber 35 and again provides for a direct flow from the inlet 20 to the outlet 21. In order to limit the maximum braking force to be applied by means of the motor, a suitable by-pass 85 is provided between the inlet 20 and the outlet 21, a spring loaded relief valve 86 being connected in this by-pass to relieve any excess pressures above a predetermined maximum which may occur in the inlet 20. The valve 86, as shown, is pressed against its seat as by a spring 87, the physical characteristics of which determine the maximum pressure. A ball check 88 may be provided within the valve 86, this check being held on its seat as by a light spring 89. Thus, if pressure in the discharge 21 should exceed pressure in the inlet 20, as when the brakes are applied when no power fluid is being supplied, this excess in the discharge 21 is at once relieved past the check valve 88.

The piston 40 is also provided with a check valve in the form of an annular plate 90 closing a circular series of holes 91 of suitable size sufficient to permit a relatively large flow of oil from the chamber 35 into the chamber 75 when the piston is moved forwardly. The plate 90 is resiliently held in place as by a number of spring washers 92 on screws 93. Thus if the pump 12 is being driven slowly so that there is insufficient flow of oil to fill the chamber 75 as rapidly as it expands with a quick forward movement of the piston 40, suction in the chamber 75 which might result from such rapid forward movement of the piston is easily relieved by flow of oil through the openings 91 from the chamber 93.

In the upper portion of the casing 30 is an air relief passage 95 opening into the chamber 75 and 35 when the piston is in its fully retracted position. Thus when oil under pressure is first di-

rected into the chamber 75 any bubble which may have formed at the uppermost end thereof is quickly discharged through the vent 95 and is swept into the discharge 21, the vent 95 soon thereafter being closed by forward movement of the piston.

From the foregoing description of certain embodiments of this invention, it should be evident to those skilled in the art that various changes and modifications might be made therein without departing from its spirit or scope as defined by the appended claims.

I claim:

1. Mechanism of the class described, comprising a casing having a main chamber with a reduced extension at the forward end thereof, a piston reciprocable in said main chamber forwardly on a working stroke and rearwardly on a return stroke, said piston having a hollow stem extending forwardly and slidably fitted in said chamber extension, a manually operable valve element within said stem with a lost-motion connection thereto, a fluid supply inlet at the forward end of said chamber extension, and a fluid discharge outlet at the forward end of said main chamber, said piston and element having valve openings cooperating to afford free passage of power fluid from the inlet to the outlet only when the piston and element are both at their extreme rearward position, and to direct power fluid against the rear face of the piston when said lost-motion is taken up.

2. Mechanism of the class described, comprising a casing having a main chamber with a reduced extension at its forward end, a piston slidable in said main chamber and having a hollow stem slidably fitted in said extension, and a manually operable element slidably fitted within said stem, said piston and element normally being in their extreme rearward position, a fluid inlet at the forward end of said extension, a fluid outlet at the forward end of said main chamber, said stem having openings through its wall normally providing direct passage for fluid from said extension to the forward portion of said main chamber, said piston and element also having openings cooperating upon take-up of said lost-motion to direct fluid against the rear face of said piston.

3. Mechanism of the class described, comprising a power-actuated member having a forward working stroke from a normal position of rest and a rearward return stroke, said member having front and rear opposed faces of substantially equal area and an additional front face of lesser area, all said faces being adapted to be pressed by power fluid employed for the actuation of the mechanism, means including a manually operable control element having a lost-motion connection with said member for balancing fluid pressure against said opposed faces when said element is in normal position relative to said member and the member is in its normal position and for directing power fluid against the additional front face only when the element is in its normal position relative to said member but the member is in a forward position.

4. Mechanism of the class described, comprising a casing with an inlet and an outlet, a reciprocable fluid power actuable member slidable in said casing from and to a normal position of rest, a control element having a lost-motion connection with said member and cooperating therewith to direct power fluid against surfaces of said member to produce follow-up movement, said member having a passage connecting said inlet and outlet when the member is in its normal position and adapted to be closed by said casing whenever said member is displaced from its normal position.

5. Mechanism of the class described, comprising a casing having a main chamber therein and a forward chamber of lesser diameter opening into said main chamber, an inlet duct opening into the forward end of said forward chamber, an outlet duct opening into the forward end of said main chamber, a piston slidably fitted in said main chamber and provided with an extension slidably fitted in said forward chamber, and a control element movable with said piston and capable of limited movement relative thereto to direct power fluid entering said inlet against the rear face of said piston.

6. Mechanism of the class described, comprising a casing having a main chamber and a forward chamber of lesser diameter opening thereinto, an inlet duct opening into the forward end of said forward chamber, an outlet duct opening into the forward end of said main chamber, a piston slidably fitted in said main chamber, said piston having a hollow open-ended extension slidably fitted in said forward chamber, said extension having a passage through its wall opening into said main chamber when the piston is in its rearmost position and cut off from the main chamber when the piston and extension move forwardly, and a valve element having a lost-motion connection with said piston and adapted to cooperate therewith to direct power fluid from said inlet duct against the rear face of said piston.

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