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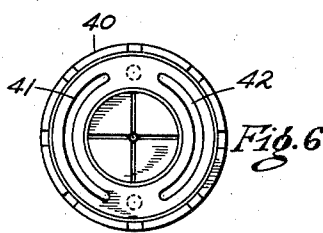
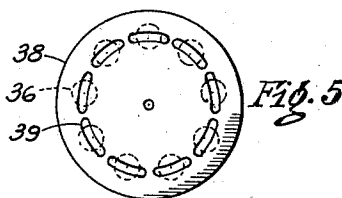
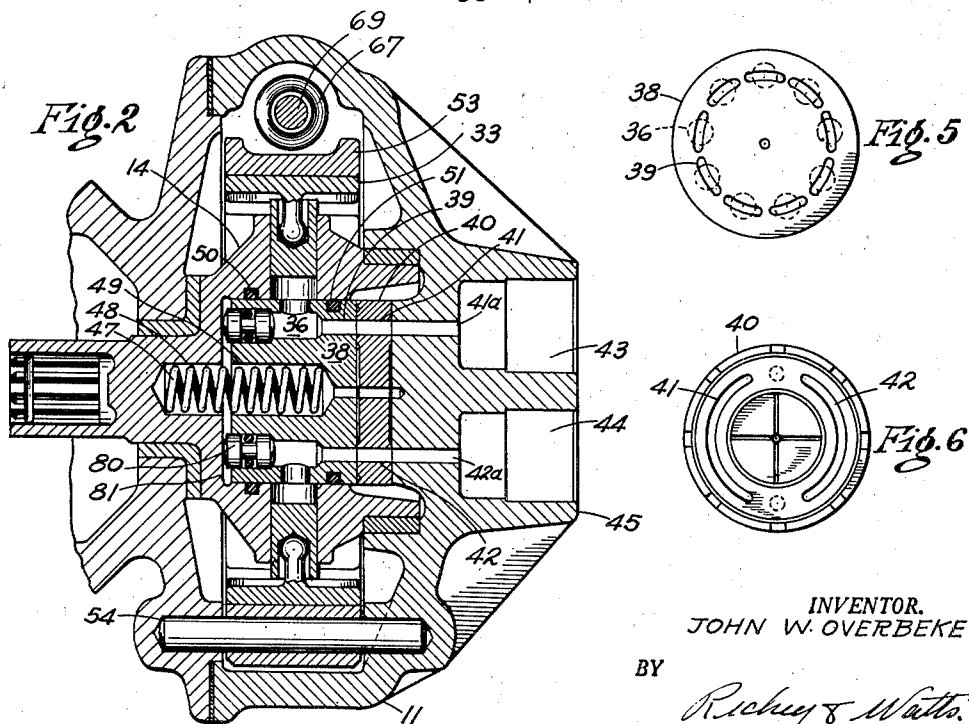
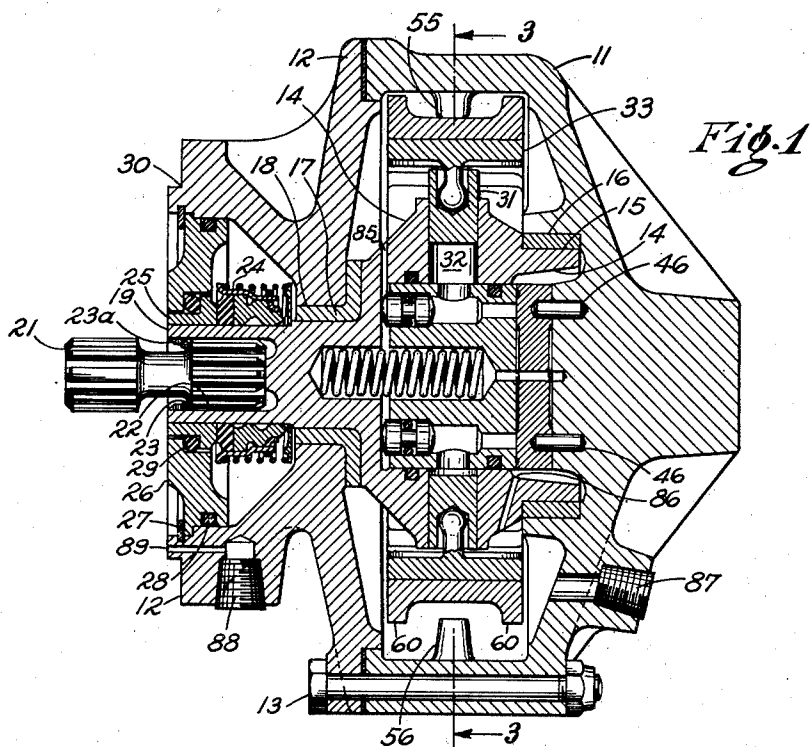
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2,552,449

HYDRAULIC FLUID MECHANISM

Filed April 12, 1946

2 Sheets-Sheet 1



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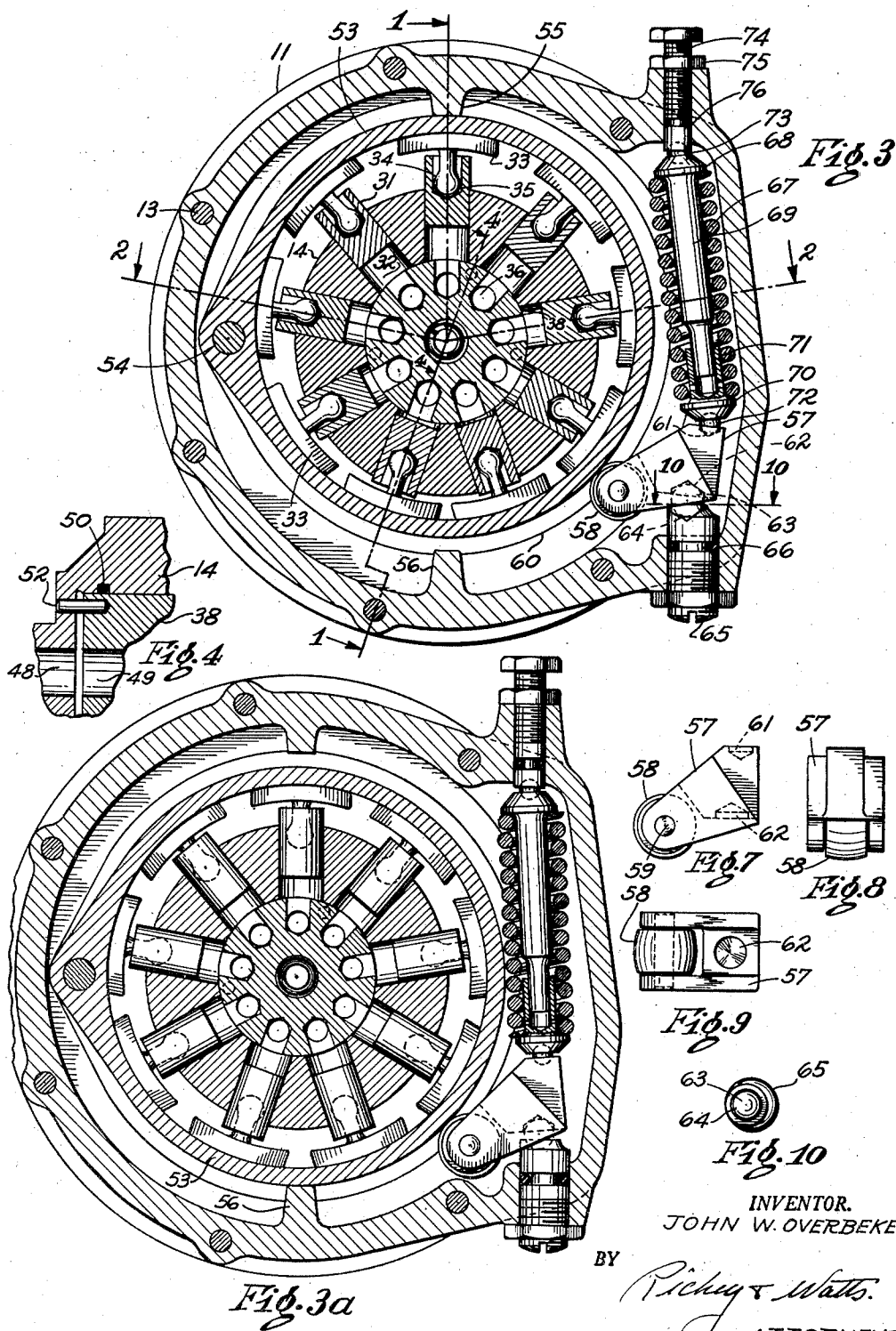
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,552,449

HYDRAULIC FLUID MECHANISM

John W. Overbeke, Cleveland, Ohio

Application April 12, 1946, Serial No. 661,716

17 Claims. (Cl. 103—161)

1

This invention relates broadly to fluid motors and pumps of the positive displacement type, and more specifically to mechanism for the pressure control thereof. In systems in which incompressible fluids are used in positive displacement pumps and motors it has been necessary to provide a relay valve and by-pass circuit in order to safeguard the mechanism from undue wear, fracture or failure of operation during periods of excessive pressure. Although the relief valve has been found expedient in certain environs, there are many installations in which such design is impractical; for example, pumps and motors in which the factor of weight and size inhibit the use of relief or return conduits, applications in which the possibility of clogging of the by-pass lines would be too great a hazard, and applications in which failure of the relief valve spring would be fatal, not only to the hydraulic unit but also to the machine with which it is associated.

One solution to this problem, which has been disclosed, resides in the provision of a radial cylinder pump or motor incorporating a device to render the pistons inoperative in case of too high back pressure in the discharge line, where the device is used as a pump, or too great external load where it is used as a motor.

An object of the invention is to provide a fluid pump or motor having an improved regulating device for reducing the piston stroke to zero in case of overload.

Another object of the invention is to provide a device for reducing the piston stroke of a motor or pump in case of overload, which is capable of rapid and automatic operation, and which will restore the pump or motor to its normal condition upon the termination of the overload.

A further object of the invention to provide a device of the character defined above which is readily adjustable both with respect to the overload pressure at which the initial operation takes place, and with respect to the reduced pressure where the return operation occurs.

Further objects of the invention reside in the provision of a mechanism which is simple in construction, durable of structure, and reliable of operation.

Other objects and advantages more or less ancillary to the foregoing and the manner in which all the various objects are realized will appear in the following description, which, considered in connection with the accompanying drawings, sets forth the preferred embodiment of the invention.

2

In the interest of clarity, the embodiment shown herein will be referred to as a pump; however, as is well known to those skilled in the art, radial cylinder motors and pumps of the type described herein are identical, the difference being merely one of application of the apparatus.

Referring to the drawings:

Fig. 1 is a vertical section through a pump embodying the invention, the section being taken on the plane indicated by line 1—1 in Fig. 3.

Fig. 2 is a horizontal section taken on the plane 2—2 in Fig. 3.

Fig. 3 is a vertical section taken on the plane indicated by the line 3—3 in Fig. 1, illustrating the improved regulating device, and showing the pump in its operative condition.

Fig. 3a is a view similar to Fig. 3, showing the pump in inoperative condition.

Fig. 4 is a sectional view taken on the plane indicated by the line 4—4 in Fig. 3.

Fig. 5 is an end view of one of the valve parts.

Fig. 6 is an end view of another of the valve parts.

Figs. 7, 8, and 9 are views of a bell crank lever employed in the regulating device; and

Fig. 10 is a sectional view taken on the plane of the line 10—10 in Fig. 3, and illustrating a detail of the regulating device.

The improved regulating device which comprehends the subject of this application is shown herein, for purposes of illustration, in combination with a pump of the type disclosed in my co-pending application No. 637,699, for Hydraulic Fluid Mechanism, filed December 28, 1945. The construction of the pump as briefly described herein constitutes a preamble to the description of the novel regulating device.

The pump embodies a casing 11 having a cover plate 12 secured thereon by bolts 13. A cylinder block 14 is mounted for rotation within the casing, upon a hub 15 within a bushing 16 in the end wall of the casing and upon a thrust and journal bearing 17, in a bore 18 in the cover plate 12. The cylinder block is formed with a trunnion or shaft 19 disposed in axial alignment with the hub 15 and mounted for rotation within the journal bearing 17. A coupling member 21, splined on both ends, is received in a broached socket 22 in the end of the shaft 19, and is retained therein by a snap ring 23 seated in a groove in the coupling member and engaged with a shoulder 23a in the socket 22.

In order to prevent leakage of the fluid about the shaft 19, the outer end of the cover plate 12 is provided with a sealing device which com-

3

prises, in brief, a collar 24 disposed in abutting engagement with a stationary sleeve 25 mounted in a plate 26, which is retained within the cover plate by a snap ring 27. A fluid sealing device, such as an O-ring seal 28, is interposed between the plate 26 and the cover plate, and a second O-ring 29 is mounted in the plate for engagement with the sleeve 25. The outer face of the cover plate 12 is preferably machined with a pilot bearing 30 to accommodate the alignment thereof with the prime mover with which it is associated.

The pump structure proper comprises a plurality of pistons 31 mounted for reciprocation in radial cylinders 32 in the cylinder block 14, (Figs. 1 and 3). The movement of the pistons within the cylinders is effected through the engagement of shoes 33 with the inner surface of track 53, which is mounted for eccentric adjustment relative to the axis of rotation of the cylinder block 14. The shoes 33 are formed with shanks terminating with spheroidal heads 34 which are received in sockets 35 in the outer ends of the pistons. The fluid flow to and from each cylinder is effected through an opening 36 (Figs. 2 and 3) in a cylindrical valve block 38 which is mounted in the center of the cylinder block 14 for rotation therewith. The openings 36 communicate with elongated ports 39 (Figs. 2 and 5) formed in the face of the valve block 38. The co-operating part of the valve mechanism comprises a valve plate 40 (Figs. 2 and 6) provided with elongated arcuate openings 41 and 42 disposed in radial alignment with the ports 39. The openings 41 and 42 constitute continuations of passages 41a and 42a in the casing 11 which communicate respectively with the intake opening 43 and the discharge opening 44 formed in a boss 45 of the casing 12. It will be understood that either opening may be used as the intake and that the cylinder block may be rotated in either direction. Assuming counter-clockwise rotation of the cylinder block, the opening 43 as shown in Fig. 2 will be considered as the intake port. During the outward movement of each piston, the corresponding port 39 therefore will overlie the opening 41 in the valve plate 40, and during the discharge stroke of each piston, the complementary port 39 will communicate with the exhaust opening 42.

The valve plate 40 is restrained from rotation by dowel pins 46 (Fig. 1) inserted into the valve plate and into the casing 11. In order to maintain the valve block 38 in seated engagement with the valve plate 40, a compression spring 47 (Fig. 2) is mounted in a bore 48 in the cylinder block and an axially aligned opening 49 in the valve block. A fluid seal between the cylinder block and the valve block is effected through the provision of O-rings 50 and 51. As will be seen in Fig. 4, dowels 52 inserted in openings in the cylinder and valve blocks constrain the parts from rotation relative to each other.

Considering now the regulating device and the adaptation thereof to a pump or motor of the type heretofore described, the track ring 53 (Fig. 3) is mounted for pivotal movement upon a shaft 54 anchored in the casing 11 in a plane common to the axis of rotation of the cylinder block 14. The pivotal movement of the ring is limited by a stop 55 in the upper portion of the casing and a stop 56 in the lower portion thereof. In normal operation the ring is eccentric to the center of rotation of the cylinder 14 and the outer face thereof is engaged with the upper stop 55

4

(Fig. 3). When, however, the ring is moved into engagement with the lower stop (Fig. 3a), the center of the ring will coincide with the center of the cylinder block and the pistons will become stationary.

The ring 53 is normally maintained in engagement with the upper stop 55 by the lever 57, the structure of which is shown with greater clarity in the several views of Figures 7, 8 and 9. A roller 58 mounted on a shaft 59 secured in a clevis of the lever 57 bears against the outer surface of the ring, where it is guided by the flanges 60 (Figs. 1 and 3). The forces that maintain the ring in its eccentric position are exerted on the lever 57 at points defined by a socket 61 and a second socket 62 disposed in offset relation thereto. A ball 63 constituting the fulcrum for the lever 57 (Fig. 3), is interposed between the socket 62 and a recess 64 in the upper end of a screw 65 threaded into the lower portion of the casing. The screw 65 is locked in its adjusted position by a jam nut, and an O-ring 66 is seated in a recessed portion of the body thereof to prevent the escape of fluid through the threaded portion thereof. The regulating force bearing on the lever 57 is exerted by a compression spring 67 retained between a shoulder 68 formed on a rod 69, and a shoulder 70 formed on a cap 71 mounted in telescoping relation with the rod 69. A ball 72 seated in the socket 61 and retained by a socket in the head of the cap 71 transmits the force to the outer end of the lever 57. The reaction of the spring 67 is transmitted from rod 68 through a ball 73 to a cap screw 74 threaded into a boss in the upper portion of the casing. The screw 74 is locked by a jam nut 75, and an O-ring 76 prevents leakage of fluid along the screw.

The lever 57 forms in effect a bell crank for the transmission of the thrust of the spring 67 to the ring 53. When the ring is in its upper or operative position, the effective moment of the spring is much greater than when the ring is in its lower position. Therefore, the force tending to maintain the ring 53 against the upper stop 55 is considerably greater than the force tending to effect its return after it has been displaced from that position. When the pump is in operation, the back pressure from the exhaust line acting on the pistons 31 creates a force which tends to rotate the ring from its operative position to the inoperative position shown in Fig. 3a. As the back pressure increases, this force will ultimately become sufficient to outweigh the thrust of spring 67, whereupon the ring will drop to its lower position and pumping will cease. The thrust of the spring continually tends to restore the ring to its upper position, but since the effective length of the lever arm is reduced, this action will not occur until the outlet pressure has been substantially decreased.

The operating points of the regulating mechanism may be varied in either of two ways. First, by adjusting the cap screw 74 to regulate the compressive force of the spring 67, and second, by adjusting the screw 65 so that movement of the eccentric socket 64 (Fig. 10), will vary the ratio of the effective lengths of the arms of the lever 57.

Since the effective length of the lever arm decreases rapidly as the ring 53 moves away from its upper stop 55, the ring will snap rapidly from its operative to its inoperative position, and for the same reason it will move quickly from its inoperative to its operative position as soon as the back pressure is sufficiently decreased.

As will be seen in Figs. 1 and 2, floating pistons

5

80, mounted in bores communicating with the openings 36 in the valve block 38 provide, under the action of the confined fluid, a force against the surface 81 of the cylinder block 14 which maintains the valve block in intimate engagement with the valve plate 40. The channels 85 and 86 (Fig. 1) permit such fluid as may escape around the valve to be thrown outward centrifugally into the casing where it serves to lubricate the movement of the shoes 33 around the track 53.

A drain plug 87 is provided for the purpose of maintaining a fluid level within the casing sufficient for lubrication, and to avoid flooding from an accumulation of leakage.

A drain plug 88 is provided to draw off, through the bore 89, excess lubricating oil issuing from the driving face of the prime mover, and to prevent intermixture of pump fluid and prime mover lubricant.

The expression "force-multiplying means" in the claims is employed to define a means which multiplies a force by a quantity which may be either greater than or less than unity.

I claim:

1. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force and force-multiplying means comprising a lever for applying the force to the control means so constructed that the force delivered is less the nearer the control means approaches its cutoff position.

2. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force and force-multiplying means for applying the force to the control means so constructed that the force delivered is less the nearer the control means approaches its cutoff position, the force-multiplying means comprising a lever with arms disposed at an angle to each other.

3. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising a resilient means, means for adjusting the compression of the resilient means, and lever means for applying the compression force to the control means so con-

6

structed that the force delivered is less the nearer the control means approaches its cutoff position.

4. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force, force-multiplying lever means for applying the force to the control means so constructed that the force delivered is less the nearer the control means approaches its cutoff position, and means for adjusting the moment arms and thereby the force-multiplying ratio of the lever means.

5. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force, force-multiplying lever means for applying the force to the control means so constructed that the force delivered is less the nearer the control means approaches its cutoff position, and means for varying the fulcrum point of the lever means to vary the ratio between the force delivered in full-stroke position and the force delivered in cutoff position.

6. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force and means for applying the force to the control means comprising a bell crank so positioned that the effective lever arm of the force-delivering means decreases as the control means moves toward its cutoff position.

7. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force and means for applying the force to the control means com-

prising a bell crank and means for varying the position of the fulcrum of the bell crank.

8. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinder, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force and means for applying the force to the control means comprising a bell crank so positioned that the effective lever arm of the force-delivering means decreases as the control means moves toward its cutoff position, and means for adjusting the fulcrum of the bell crank to vary the said lever arm.

9. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cut off position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cut off position, and a regulating means urging the control means toward its full-stroke position comprising a yieldable member, an abutment therefor adjustable to vary the stress of the yieldable member, a lever connecting the yieldable member and the control means, and means for varying the fulcrum point of the lever to vary the mechanical advantage of the yieldable member.

10. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising a fixed supporting member, a yieldable member, and a bell crank, one arm of which exerts force on the control means, and the other arm of which is biased by the yieldable member, the fulcrum of the bell crank being a sphere received in a socket in the bell crank and in a socket in the supporting member.

11. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising a fixed supporting member, a yieldable member, and a bell crank, one arm of which exerts force on the control means, and the other arm of which is biased by the yieldable member, the fulcrum of the bell

crank being a sphere received in a socket in the bell crank and in a socket in the supporting member, the supporting member being rotatable and the socket being eccentric therein.

12. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising a compressible member, a bell crank, one arm of which is coupled with the compressible member and the other arm of which is coupled with the control means, a supporting member forming a fulcrum for the bell crank, and an abutment for the compressible member, the articulations between the abutment, compressible member, bell crank, and fulcrum being formed by spheres received in recesses therein.

13. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for delivering a substantially constant force, means for applying the force to the control means, and means for adjusting the operating points of the regulating means.

14. A fluid displacement machine with fluid inlet and outlet connections and comprising a rotatable cylinder block formed with radial cylinders, pistons in the cylinders, a track ring for effecting reciprocation of the pistons, the track ring being movable about a pivot eccentric to the cylinder block between an eccentric position with respect to the cylinder block and a concentric position, and being urged to the concentric position, by piston reaction, a compression spring adjacent the ring at the side remote from the pivot, and a lever coupling the spring and the ring, the arms of the lever being angularly disposed so that the effective force arm of the spring decreases as the ring approaches concentricity with the cylinder block, the spring urging the track ring to an eccentric position.

15. A fluid displacement machine with fluid inlet and outlet connections and comprising a rotatable cylinder block formed with radial cylinders, pistons in the cylinders, a track ring for effecting reciprocation of the pistons, the track ring being movable between an eccentric position with respect to the cylinder block and a concentric position, and being urged to the concentric position by piston reaction, a compression spring adjacent the ring, and a lever coupling the spring and the ring, the arms of the lever being angularly disposed so that the effective force arm of the spring decreases as the ring approaches concentricity with the cylinder block, the spring urging the track ring to an eccentric position.

16. A fluid displacement machine with fluid inlet and outlet connections and comprising a rotatable cylinder block formed with cylinders,

9

pistons in the cylinders, a means for effecting reciprocation of the pistons, the said means being movable with respect to the cylinder block to vary the stroke of the pistons, and being urged to minimum-stroke position by piston reaction, means urging the first-named means toward maximum-stroke position, and a lever coupling the two said means, the arms of the lever being angularly disposed so that the effective force arm of the urging means decreases as the first-named means approaches concentricity with the cylinder block.

17. In combination, a fluid displacement machine having cylinders, pistons therein, fluid inlet and outlet connections, and control means for effecting reciprocation of the pistons, the control means being movable from a position in which the pistons operate through a full stroke to a cutoff position in which the pistons are stationary with respect to the cylinders, the reactions of the pistons on the control means urging

10

it toward its cutoff position, and a regulating means urging the control means toward its full-stroke position comprising means for constantly exerting force, and a linkage coupling the last named means to the control means, the linkage comprising a lever so constructed that the ratio of the force supplied to the control means to the force supplied by the force exerting means decreases as the control means approaches its cutoff position.

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