Nov. 6, 1928. 1,690,484

E. G. GARTIN

MOTOR

Filed Jan. 30, 1920 2 Sheets-Sheet 1

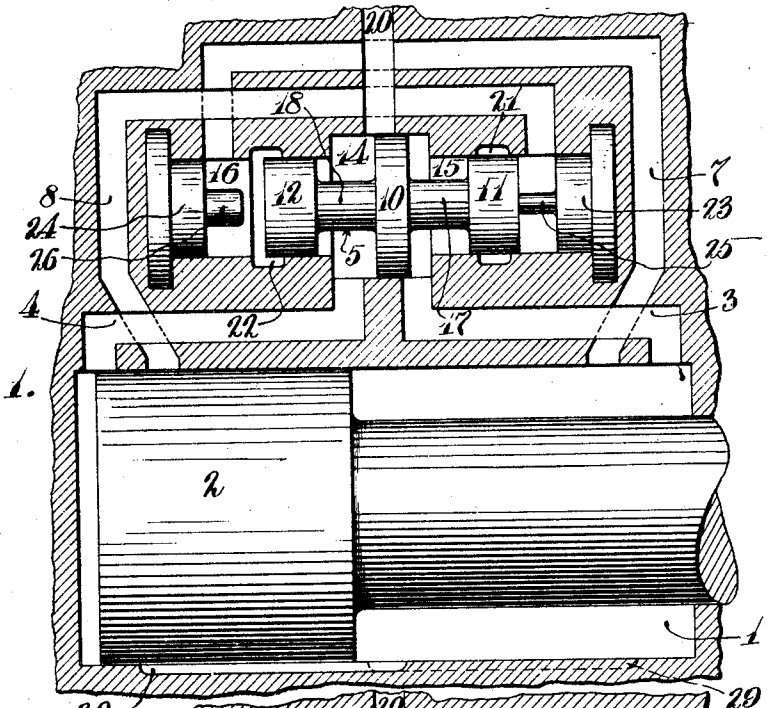


Fig. 1.

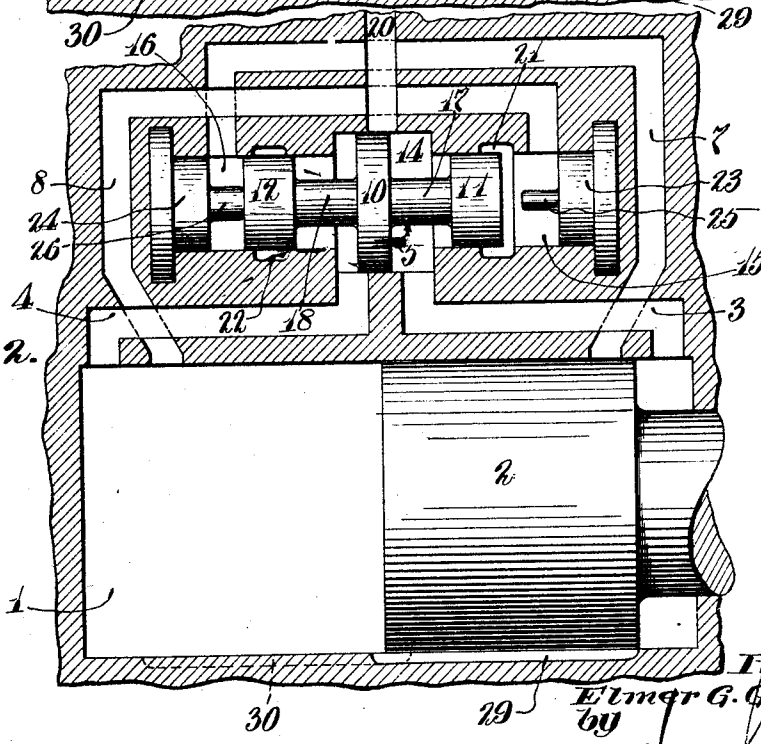


Fig. 2.

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Fig. 3.

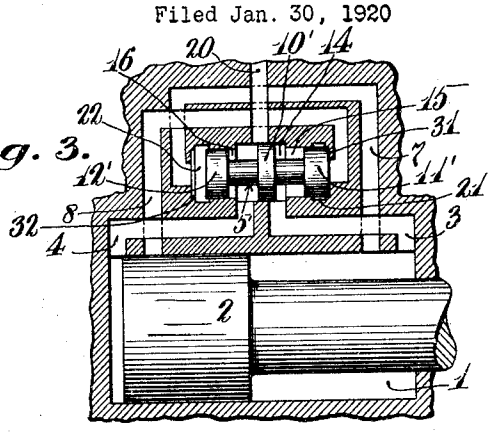


Fig. 4.

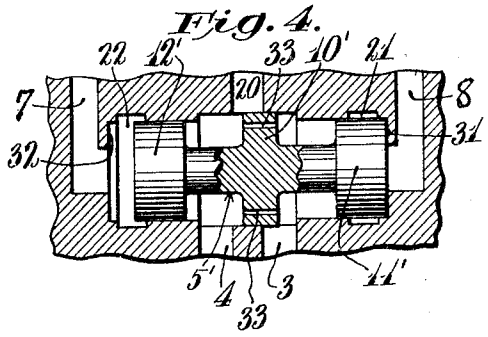


Fig. 5.

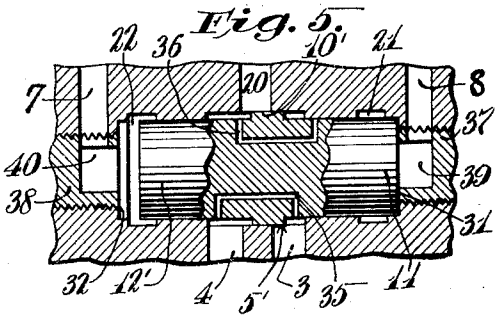


Fig. 6.

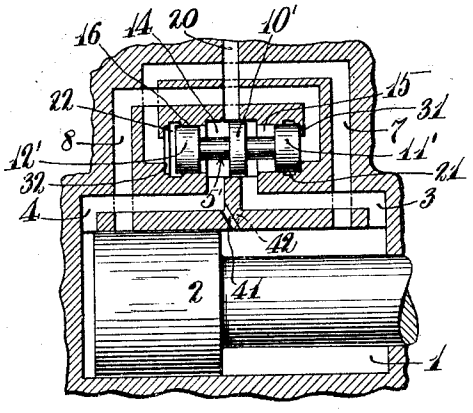
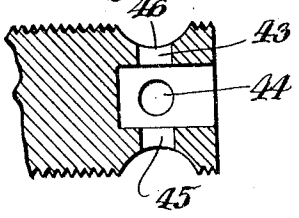


Fig. 7.



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Patented Nov. 6, 1928. 1,690,484

UNITED STATES PATENT OFFICE.

ELMER G. GARTIN, OF CLAREMONT, NEW HAMPSHIRE, ASSIGNOR TO SULLIVAN MACHINERY COMPANY, A CORPORATION OF MASSACHUSETTS.

MOTOR.

Application filed January 30, 1920. Serial No. 355 149.

My invention relates to motors.

Its object is to provide an improved fluid pressure motor. Another object is to provide an improved fluid pressure motor in which extremely prompt valve actuation may be obtained. A further object of my invention is to provide an improved fluid pressure motor in which the degree of cushion at each end of the motor may be adjusted at the time of the motor's construction to precisely the desired amount and thereafter varied at will should this be desired. A further object of my invention is to provide an improved motor in which the length of stroke may be adjusted by varying the port relation to promote extreme speed in operation. Various other objects of my invention will be brought out in connection with the description thereof.

In the accompanying drawings I have shown, for purposes of illustration, certain forms which my invention may assume in practice.

In these drawings,—

Fig. 1 is a diagrammatic view of a motor embodying my improved construction with the distribution ports, the valve chamber, and the valve throwing ports shown in developed relationship.

Fig. 2 is a similar view showing the piston and valve in a different position.

Fig. 3 is a similar view showing a different type of valve and a motor varied accordingly.

Fig. 4 is a detail section showing the valve chest of Fig. 3 on an enlarged scale and with portions of the valve broken away.

Fig. 5 is a similar view of a valve of somewhat different construction.

Fig. 6 is a developed sectional view showing a different arrangement of the valve throwing ports.

Fig. 7 is a detail sectional view through a modified form of one of the plugs shown in Fig. 5.

In Figs. 1 and 2 I have shown one illustrative form of my improved construction embodied in a fluid pressure motor of the valved type which is provided with the usual cylinder 1 in which reciprocates a piston 2 under the action of fluid distributed to the cylinder by means of my improved valve mechanism.

To distribute fluid to the opposite ends of the cylinder, I have provided passages 3 and 4, the distribution of fluid to which is controlled by means of a valve generally indicated by 5. To conduct away exhaust fluid from the cylinder, I have arranged exhaust passages 7 and 8 also controlled by the valve 5. The valve 5 is of what is generally known as the three-spool type, being formed with a large central spool 10 and end spools of smaller diameter 11 and 12, the valve chest being provided with bores 14, 15, and 16 in which the several spools of the valve respectively have a sliding fit. The spools 11 and 12 are of equal diameter and are connected to the middle spool 10 by the reduced portions 17 and 18. Live pressure fluid is conducted to the central chamber 14 through an inlet passage 20. Suitable exhaust passages lead from the annular exhaust grooves 21 and 22 communicating with the bores 15 and 16 adjacent the ends of the valve travel therein.

To limit the motion of the valve in the valve chest, I have shown plugs 23 and 24 projecting into the ends of the bores 15 and 16 and extending from the inside faces of these plugs are pins 25 and 26 against which the spools 11 and 12 strike at the ends of the valve travel. It will be ovbious that the size of these pins can be readily changed by changing to plugs having pins of different size, and that in view of the fact that the portion of the end surface of the valve contacting with the pin may be made greater or less as may be desired by changing plugs, a difference in the throwing of the valve can be readily accomplished. For example, in the present disclosure I have shown the pin 25 of slightly smaller area than the pin 26 for a purpose hereafter described.

Cooperating with the piston 2 and of slightly greater length than the head thereof are a pair of ports 29 and 30 arranged in the wall of the cylinder and so located as to interconnect the chambers at the opposite sides of the piston at the instant when the ports 7 and 8 are overrun by the piston. The function of these passages will be hereafter described. In the construction of the valve illustrated the area of the annulus subjected to unbalanced pressure on the spool 10 is somewhat greater than the annulus surrounding the pins 25 and 26 and exposed to pressure at the ends of heads 11 and 12 when pressure is transmitted through the passages 7 and 8. This is necessary for reasons which will be obvious as the operation of the motor is described and the

ratio of these areas may be varied to effect any desired operation of the motor.

The operation of this form of my improved motor is as follows: Starting with the parts in the position shown in Fig. 1, live fluid passing through the port 20 will enter the chamber 14 and act on the unbalanced annulus of the spool 10 to hold the valve in the position shown. It will likewise pass by way of the port 4 to the left hand end of the piston 2 and force the piston to the right. As soon as the left hand end of the piston has overrun the port 8, live fluid from the left hand end of the cylinder will be transmitted through the port to the annulus exposed to pressure on the end of the spool 11. This pressure in part counter-balances the pressure acting on the annulus of the spool 10. It will be obvious that the area exposed to pressure on spool 11 must not equal the unbalanced area of the spool 10 because some unbalanced pressure is necessary to hold the valve in its proper position and prevent vibration thereof. It will be readily apparent, however, that, by inter-changing plugs 23 for other plugs with different sized pins 25, any desired area ratio can be realized, especially if the proportions of the several spools are simultaneously varied. As the piston moves further to the right and overruns port 7, there will be, at the instant of closure of this port, a communication opened between the opposite ends of the cylinder through the port 29 for a slight time interval in such manner that a puff of high pressure fluid from the left hand end will pass around to the closed space in the right hand end of the cylinder. This fluid will be further compressed during further movement of the piston 2 and driven up through port 3 where it will act on the unbalanced area of the valve spool 10. When the pressure acting on this unbalanced area is sufficient when cooperating with the pressure acting on the end of spool 11 to overcome the live pressure acting on the unbalanced portion on the left hand face of spool 10, the valve will be thrown to the left hand end of its chest, as shown in Fig. 2, and admission will occur to the right hand end of the cylinder. The cycle of operations will then be reversed.

By making the size of pin 25 smaller than that of pin 26, it will be clear that the valve will be thrown when a less pressure has been built up in the forward end of the cylinder than will be necessary in the back end thereof. This will produce a more nearly uncushioned blow on the forward end during the striking movement of the piston as the steel may be arranged to be struck the instant after the necessary throwing pressure is reached and positiveness will be assured due to the additional compression due to penetration.

In Fig. 3 I have shown a motor similar to that shown in Figs. 1 and 2 with the exception that passages 29 and 30 are omitted and the valve and chest construction changed accordingly; and the construction of the valve and chest is shown on a larger scale in Fig. 4. In this case, instead of having a valve provided with relatively large differential areas on the central spool 10, I have shown a valve 5′ having spools 10′, 11′, and 12′, and the spools 11′ and 12′ cooperate with their seats 31 and 32 against which they seat snugly so that pressure entering through the passages 7 and 8 acts on a much reduced area of the spools 11′ and 12′, thereby making it possible to employ a much smaller throwing annulus on the head 10′, which makes it possible to bring the several spools of the piston to more nearly uniform size. In this case, in order to bring about a throwing of the valve, a series of leakage passages 33 are formed through the spool of the valve and when the valve is in the position shown in Figs. 3 and 4, live fluid leaks through the passages 33 into the space between the heads 10′ and 11′ from which, however, it passes freely to the exhaust by passages 3 and 7. When, however, the port 7 has been overrun by the piston, this pressure no longer escapes and pressure passing through ports 33 and acting on the right hand differential area of the spool 10′, where it cooperates with pressure acting on the right hand end of the valve spool 11′, throws the valve to its other position. It will be obvious that as the pressure more nearly equalizes on the opposite sides of the spool 10′, the pressure acting on the end of the head 11′ will cause the valve to be thrown.

In Fig. 5 I have shown a valve which is identical in proportion of unbalanced areas with that shown in Fig. 4, but in this case, I have shown the passages 35 and 36 so arranged that when the valve is in the position shown, the passage 35 inter-connects the ports 3 and 4, the operation, however, being the same as in Figs. 3 and 4. In this figure, I have shown the seats against which the valve spools 11′ and 12′ rest when at the ends of their travel, as formed on interchangeable plugs 37, 38 having bores 39 and 40 therein, and in different plugs these bores may be formed of different size so as to vary the area of the surface on which fluid pressure acts, thereby varying the operation of the motor. With the construction shown in Figs. 3, 4 and 5, it is accordingly possible to omit the throwing passages 29 and 30.

In Fig. 6 I have shown a still further method of throwing the valve. All the details of the construction are precisely the same as in Fig. 3 with the exception of the fact that the ports 33 are omitted and other throwing means is added. In this case, a puff of live fluid is admitted through passages 41 or 42 at the moment when the piston reaches approximately the end of its stroke, this fluid

serving to cause throwing of the valve by acting on the unbalanced area of head 10′ and permitting the pressure acting on the head 11′ or 12′ to shift the valve. These passages are not opened until the piston has overrun the ports 7 or 8.

In the illustration of the plugs 37 and 38 in Fig. 5, I have shown them in their simplest form, but it will be understood that in practice, in order to render adjustment possible they will be provided with a series of radial passages as indicated at 43, 44, and 45 in Fig. 7, and that these passages may if desired communicate with an annular groove 46 into which ports 7 and 8 will open. This will permit the plugs to be screwed in or out as desired to vary the valve throw, without interference with communication of bores 39 and 40 with passages 7 and 8 respectively.

While I have in this application specifically described several forms which my invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be modified and embodied in other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three-spool valve therein having an enlarged central spool and end spools of equal diameters, live fluid distribution passages leading to the ends of the cylinder controlled by said central spool, fluid exhaust passages leading to the cylinder at points separated from the ends thereof controlled by said end spools, means for substantially balancing the unbalanced force produced by the action of live fluid upon said middle spool prior to the moment when throwing pressure is transmitted to the valve, and means for entirely overcoming said unbalanced force for throwing the valve.

2. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three-spool valve therein having an enlarged central spool and end spools of equal diameters, live fluid distribution passages leading to the ends of the cylinder controlled by said central spool, fluid exhaust passages leading to the cylinder at points separated from the ends thereof controlled by said end spools, means for counterbalancing the unbalanced force due to live fluid acting on the large spool of said valve by live pressure transmitted through the exhaust passage leading to the end of the cylinder filled with live pressure, and additional means for cooperating with said counterbalancing force for shifting the position of said valve.

3. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three-spool valve therein having an enlarged central spool and end spools of equal diameters, fluid distribution passages leading to the ends of the cylinder controlled by said central spool, fluid exhaust passages leading to the cylinder at points separated from the ends thereof controlled by said end spools, means for substantially balancing the unbalanced force due to live fluid acting on the large spool of said valve by live pressure transmitted through the exhaust port leading to the end of the cylinder filled with live pressure, and means for transmitting a throwing pressure to the opposite side of said large spool after the closure of the active exhaust passage by the piston, said means including by-pass passages in the walls of the cylinder and inter-connecting the two ends thereof for a very short interval of time immediately after the exhaust port is closed.

4. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three-spool valve therein having an enlarged central spool and end spools of equal diameters, fluid distribution passages leading to the ends of the cylinder controlled by said central spool, fluid exhaust passages leading to the cylinder at points separated from the ends thereof controlled by said end spools, means for substantially balancing the unbalanced force due to live fluid acting on the large spool of said valve by live pressure transmitted through the exhaust port leading to the end of the cylinder filled with live pressure, and means for transmitting a throwing pressure to the opposite side of said large spool after the closure of the active exhaust passage by the piston, said means including piston controlled by-pass passages in the walls of the cylinder and inter-connecting the two ends thereof for a very short interval of time immediately after the exhaust port is closed.

5. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three-spool valve therein having an enlarged central spool and end spools of equal diameters, fluid distribution passages leading to the ends of the cylinder controlled by said central spool, fluid exhaust passages leading to the cylinder at points separated from the ends thereof controlled by said end spools, means for substantially balancing the unbalanced pressure due to live fluid acting on the large spool of said valve by live pressure transmitted through the exhaust port leading to the end of the cylinder filled with live pressure, and means for transmitting a throwing pressure to the opposite side of said large spool after the closure of the other exhaust passage by the piston, said means

including passages opened for a slight time by the piston immediately upon the closure of the exhaust port and conducting live pressure to the opposite side of said large spool.

6. A fluid pressure motor comprising a cylinder, a piston therein, fluid supply passages leading to the ends of said cylinder, fluid exhaust passages leading to said cylinder at points separated from the ends thereof, a three-spool valve controlling said ports, the middle spool of said valve being larger than the end spools and controlling the supply passages while the end spools control the exhaust passages, means to substantially balance the unbalanced pressure due to the live fluid acting on one face of said large spool comprising an area subject to cylinder pressure on one of said small spools, means for varying said area comprising interchangeable plugs contacting with the ends of said spools and having different areas of contact, and means to actuate said valve for controlling fluid flow through said passages.

7. A fluid pressure precussive motor comprising a cylinder, a piston reciprocating therein, a valve controlling the supply and exhaust of fluid to and from said cylinder, means comprising a differential area on said valve to create a pressure to hold it in one position, means comprising an opposing pressure surface adapted to substantially balance said first pressure surface, means to vary the extent to which balancing is effected comprising interchangeable plugs contacting with said last mentioned surface to different extents, and means to actuate said valve for controlling fluid flow through said passages.

8. A fluid pressure percussive motor comprising a cylinder, a piston reciprocable therein, a valve controlling the supply and exhaust of fluid to and from said cylinder, fluid pressure means operative to hold said valve in opposite extreme positions, means for throwing said valve by sudden application of live pressure fluid and compression of the same, and fluid pressure means governed by movement of the piston for substantially neutralizing the holding action of said first mentioned means prior to the time of the initial action of the throwing fluid on said valve, whereby the latter is sharply thrown.

9. A fluid pressure percussive motor comprising a cylinder, a piston reciprocating therein, a fluid thrown valve controlling the supply and exhaust of fluid to and from said cylinder, fluid pressure means operative to hold said valve in opposite extreme positions, means to substantially balance said first mentioned means prior to the action of the throwing agent on said valve, means comprising members having different areas of contact with said valve to vary the extent to which balancing takes place, and means for overbalancing said holding means to throw the valve.

10. A fluid pressure percussive motor comprising a cylinder, a piston therein, a valve chest having differential bores, a three spool valve therein having an enlarged central spool and end spools of equal diameters, fluid distribution passages leading to the ends of the cylinder, fluid exhaust passages controlled by the end spools and opening into said cylinder at points separated from the ends thereof, means for admitting live fluid pressure for a short interval of time to the fluid distribution passages immediately after the adjacent exhaust passages are closed, and means for actuating said valve to control fluid flow in said passages.

11. A fluid pressure percussive motor comprising a cylinder, a piston reciprocable therein and fluid control means including a valve controlling the supply and exhaust of fluid to and from said cylinder and comprising fluid pressure means operative to hold said valve in opposite extreme positions, means to substantially balance said first mentioned means prior to the action of the throwing agent on the valve, means for suddenly applying live fluid pressure to said valve, and means for increasing the pressure thereof by compression to throw the valve.

12. A fluid pressure percussive motor comprising a cylinder, a piston reciprocable therein, a valve controlling the supply and exhaust of fluid to and from said cylinder and having a plurality of opposed surfaces adapted to be subjected to pressure to throw said valve and to hold it in opposite positions, certain of said areas being operative when subjected to live fluid pressure to effect said last mentioned function, means for conducting piston moving pressure to other of said areas to substantially oppose the force of said live fluid pressure prior to the action of throwing pressure on the valve, and means including passages controlled by movements of said piston for suddenly conducting live pressure fluid to the front end of the cylinder where it is compressed by the piston, and means for conducting said compressed fluid to said valve for throwing the same.

13. A fluid pressure percussive motor comprising a cylinder, a piston reciprocable therein, said piston compressing fluid at one end of said stroke to a relatively high pressure, a valve chest, a three spool valve therein, live motive fluid distribution passages controlled by the central spool of said valve, and means for throwing the valve including means for transmitting the fluid compressed by the piston through one of said live fluid distribution passages to said central spool.

14. A fluid pressure percussive motor comprising a cylinder, a piston therein, said piston compressing fluid at one end of its stroke to a relatively high pressure, a valve chest, a three spool valve therein, live motive fluid distribution passages controlled by the cen-

tral spool of said valve, means for throwing said valve including means for transmitting the fluid compressed by the piston to said central spool, and exhaust passages controlled by the end spools of said valve.

15. In a fluid pressure motor, a cylinder, a piston reciprocable therein, said piston compressing fluid at one end of its stroke to a relatively high pressure, a valve chest, a valve reciprocable therein having an enlarged annular central spool, means controlled by said spool for distributing live piston actuating fluid to said cylinder, and means for throwing said valve including means for transmitting the fluid compressed by said piston to the total area on one side of said enlarged annular portion of said central spool.

16. A fluid pressure percussive motor comprising a cylinder, a piston reciprocating therein, a valve controlling the supply and exhaust of fluid to and from said cylinder, fluid pressure means operative to hold said valve in opposite extreme positions, means opened by movement of said piston for conveying live fluid to said valve for substantially balancing said holding means, means later opened by a movement of said piston for conveying live fluid to the front end of said cylinder where it is compressed, and means for conveying compressed fluid to said valve to overbalance the holding means and thereby throw said valve.

17. A fluid pressure motor having a cylinder and piston, a fluid distributing valve therefor, adapted to be operated by the pressure serving to cushion the piston at the ends of its stroke, and means normally cooperating with said valve for determining the degree of cushioning pressure for said piston at each end of its opposite stroke necessary for operating the valve, said means being adapted to be exchanged for other means for effecting variation in the degree of cushioning pressure necessary to operate the valve.

18. A fluid pressure motor having a cylinder and piston, a fluid distributing valve therefor, adapted to be operated by the pressure serving to cushion the piston at the ends of its stroke, and mechanical means normally engageable with said valve for determining the degree of cushioning pressure for said piston at each end of its opposite structure necessary for operating the valve, said means being adapted to be exchanged for other means for effecting variation in the degree of cushioning pressure necessary to operate the valve.

19. A fluid pressure motor having a cylinder and piston, a valve chamber, a fluid distributing valve in said chamber to control the supply and exhaust of fluid from said cylinder, fluid pressure means for holding said valve in one of its extreme positions, other fluid pressure means adapted to act on certain surfaces of said valve, tending to balance said holding means, means in said chamber contacting with said surfaces to limit the area therefor exposed to the balancing pressure, said means adapted to be exchanged for other means, allowing a different area to be exposed to balancing pressure, whereby the balancing action can be arranged to regulate operation of the valve, and means for throwing said valve.

20. A fluid pressure motor having a cylinder and piston, a valve chamber, a three spool valve in said chamber for regulating supply and exhaust of fluid from said cylinder, having an enlarged central spool and end spools, fluid pressure means acting on said central spool for holding said valve in one of its extreme positions, live fluid pressure means acting on the end surfaces of said end spools, removable plugs secured in said ends of the valve chamber for contacting with said end surfaces to limit the exposed area thereof, said valve chamber adapted to receive plugs of different sizes so that the balancing action on said valve is determined by the size of the plug used, and means controlled by movement of said piston for overcoming the unbalanced pressure and throwing the valve.

In testimony whereof I affix my signature.

ELMER. G. GARTIN.