Dec. 10, 1940. C. J. COBERLY 2,224,216

FLUID FLOW GOVERNOR

Original Filed April 11, 1934 2 Sheets-Sheet 1

Fig. 1.

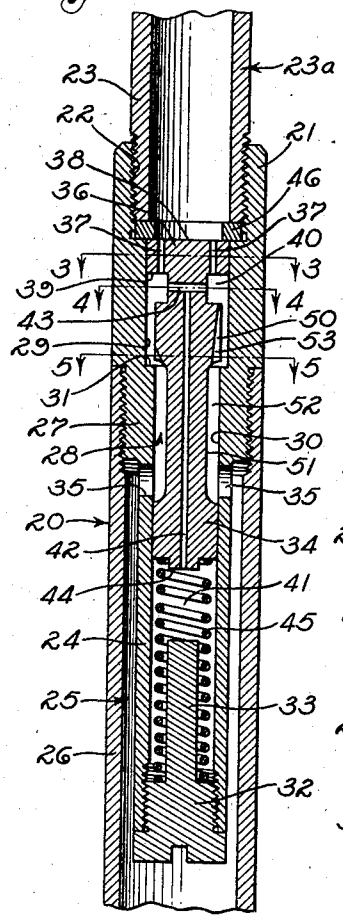


Fig. 2.

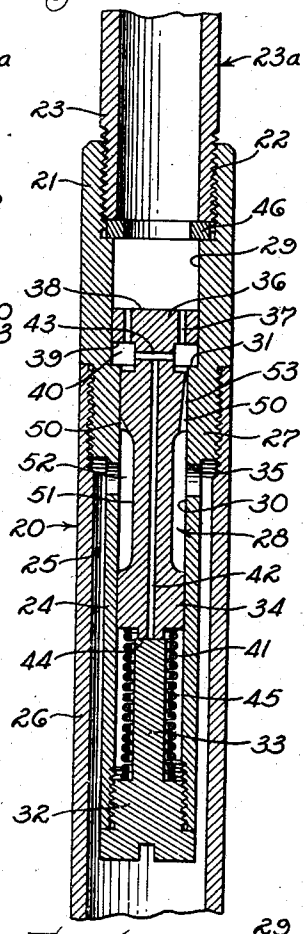


Fig. 6.

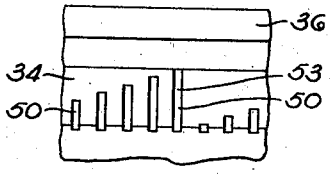


Fig. 9.

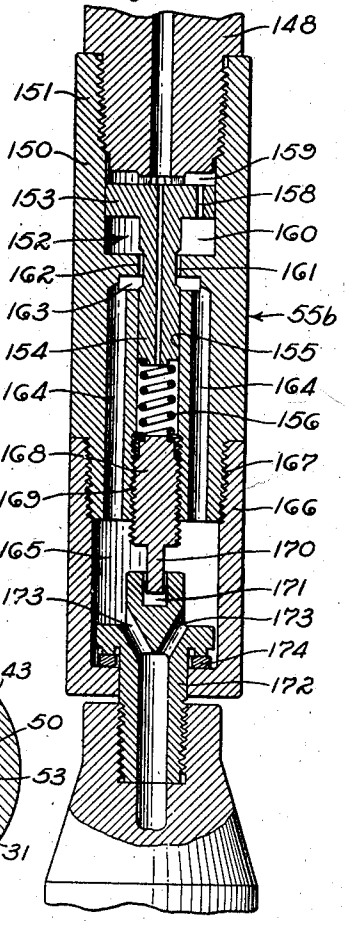


Fig. 3.

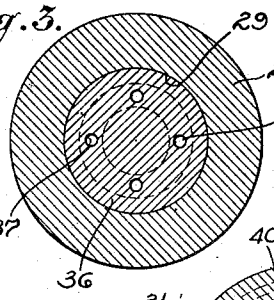


Fig. 4.

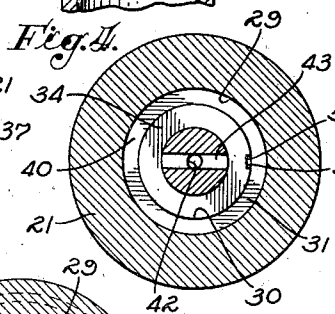
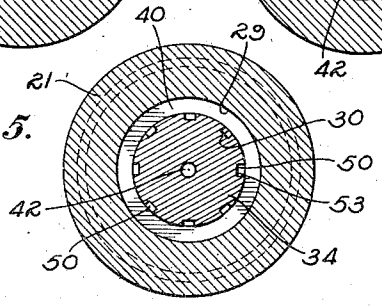


Fig. 5.



INVENTOR
CLARENCE J. COBERLY
BY HARRIS, KIECH, FOSTER & HARRIS
FOR THE FIRM
ATTORNEYS.

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Fig. 8.

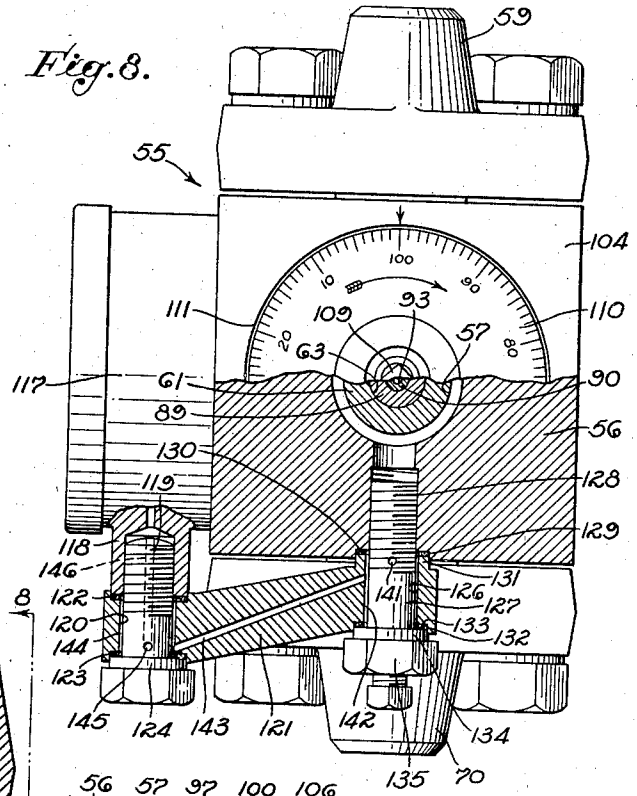
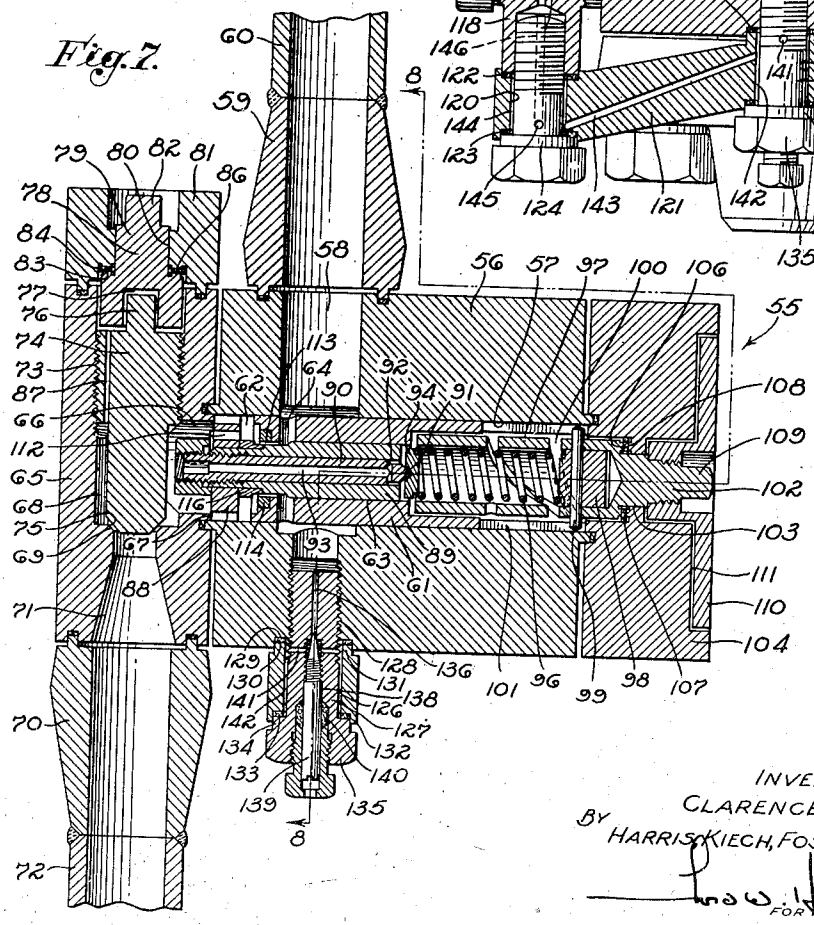


Fig. 7.



INVENTOR
CLARENCE J. COBERLY
BY HARRIS, KIECH, FOSTER & HARRIS
FOR THE FIRM
ATTORNEYS.

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UNITED STATES PATENT OFFICE

2,224,216

FLUID FLOW GOVERNOR

Clarence J. Coberly, Los Angeles, Calif., assignor to Roko Corporation, Reno, Nev., a corporation of Nevada

Original applications April 11, 1934, Serial No. 720,059, now Patent No. 2,119,736, dated June 7, 1938, and December 16, 1935, Serial No. 54,557, now Patent No. 2,119,737, dated June 7, 1938. Divided and this application May 6, 1938, Serial No. 206,426

4 Claims. (Cl. 137—152)

This is a division of my copending applications, Serial No. 720,059, filed April 11, 1934, now Patent No. 2,119,736, granted June 7, 1938, for Governed fluid operated pump, and Serial No. 54,557, filed December 16, 1935, now Patent No. 2,119,737, granted June 7, 1938, for System of operating fluid-operated pumps.

Fluid operated pump mechanisms for use in deep wells ordinarily include a fluid motor with a pump unit connected to the moving part of the fluid motor and being adapted to pump oil from the well up through a tube leading to the top of the well. For operating the mechanism fluid, such as oil, is pumped under relatively high pressure through a tube which connects to the motor of the mechanism. As long as the device is pumping oil from the oil formation in the well, it will operate at a normal speed, but it often occurs that gas forms in or enters the pump unit so that instead of a liquid being pumped, the pumping mechanism is operating against a compressible gas, the result being that a material portion of the pumping load is removed and the pump then races or operates at high speed until the gas is removed from the pumping unit. Fluid operated deep well pumps, due to space limitations, are customarily of cylinder-piston type, both the fluid motor and the pump unit of the pumping mechanism having cylinders and pistons respectively. When a pump of this character is allowed to race, very great liability of injury is present. For example, the pistons will strike the ends of the cylinders in which they operate, battering the same and upsetting the ends of the pistons, and in some instances breakage of parts may occur.

It is a primary object of the invention to provide a simple form of governor for controlling the flow of a fluid under pressure, which governor operates in response to changes in the load against which the fluid pressure is working.

It is a further object of the invention to provide a governing device adapted to be placed in a pressure fluid delivery line ahead of the mechanism to which the fluid is being delivered, such governor having a moving body with one face thereof exposed to the pressure of fluid in the delivery tube and the other face thereof exposed to a pressure which varies in accordance with the pressures existing in the mechanism which receives or is operated by the pressure fluid.

Further objects and advantages of the invention will be made evident throughout the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a vertically sectioned view showing the governor of the mechanism with the parts thereof in one operating position.

Fig. 2 is a sectional view similar to Fig. 1, showing the parts in another extreme position of operation.

Fig. 3 is an enlarged cross section on a plane represented by the line 3—3 of Fig. 1.

Fig. 4 is an enlarged cross section on a plane represented by the line 4—4 of Fig. 1.

Fig. 5 is an enlarged cross section on a plane represented by the line 5—5 of Fig. 1.

Fig. 6 is a projection of the upper portion of the movable valve member of the device shown in Fig. 1, showing the relative lengths of the flow controlling channels or orifices therein.

Fig. 7 is a cross section showing details of construction of an alternative form of differential-pressure control means forming a part of the invention.

Fig. 8 is a section on a plane indicated by the line 8—8 of Fig. 7.

Fig. 9 is a sectional view of an alternative form of my invention.

My pumping mechanism constitutes a direct improvement over the prior art in the provision of a means for maintaining the delivery of pressure fluid to the motor element so as to maintain a substantially constant motor speed even when the working load on the pumping mechanism is decreased, thereby preventing the pumping mechanism from racing in such a manner that injury to the pump structure may occur. The means which I employ for this purpose consists of a governor of the character of the governor 20, details of which are shown in Figs. 1 to 6 inclusive. Such governor comprises a tubular shell 21 having a threaded counterbore 22 at its upper end for connection to the lower end 23 of a pressure fluid delivery pipe 23a. The lower portion 24 of the shell 21 is of externally reduced diameter so as to provide a fluid space 25 within the upper end of a discharge tube 26, the upper end of the tube 26 being threaded onto an intermediate portion 27 of the shell 21. The shell has a bore or axial opening 28 consisting of an upper major bore 29 and a lower smaller minor bore 30, the bores 29 and 30 being separated by a radial shoulder 31. Threaded into the lower end of the minor bore 30 is a plug 32 having a central extension 33 projecting upwardly therefrom to serve as a stop for the downward movement of a member 34 which is movable in the bores 29 and

30. Below the shoulder 31 the minor bore 30 is provided with lateral ports or openings 35 communicating with the space 25 of the discharge tube 26. Slidable within the major bore 29 is a body or piston 36 which in the present form of the invention is directly connected to and forms the upper extremity of the member 34. This body 36 has metering orifices 37 extending from an upper face 38 thereof to a lower face 39 thereof for the purpose of transmitting pressure fluid from the pipe 23a to the space 40 within the major bore 29 below the piston or body 36. The space 40 is connected by passage means to the lower space 41 below the member 34 in the minor bore 30. Such passage means may be conveniently formed from an axial passage 42 extending upwardly from the lower end of the member 34, and a lateral passage 43 connecting the upper end of the passage 42 with the space 40. The pressure of the fluid in the pipe 23a is applied directly to the upper face 38 of the body 36, tending to move this body downwardly in the major bore 29. Reacting against this downward pressure is the pressure of fluid against the face 39 of the body 36, the pressure of fluid against the lower end face 44 of the member 34, and upward pressure of a spring 45 which extends within the lower chamber 41 and between the plug 32 and the member 34. Under normal conditions of operation, that is, with the reciprocating parts of the pump moving at a slow normal rate of speed, the upward pressure against the member 34, which is connected to or includes the piston 36, is slightly in excess of the downward pressure exerted by the pressure fluid in the pipe 23a so that the member 34 may be held in raised position, as shown in Fig. 1, against a shoulder provided by an inserted ring 46. Should the pressure of fluid upwardly against the member 34 be decreased, as, for instance, by racing of the pump mechanism, the member 34 will move downwardly. The invention provides flow restricting means, or, in other words, velocity and pressure reducing means operating in consequence of the downward movement of the member 34 so that the flow of pressure fluid from the pipe 23a to the delivery pipe 26 will be restricted in volume.

The flow restricting means which I employ is of simple character and consists essentially of channels or orifices 50 in the member 34 near the upper end thereof but spaced below the body or piston 36. These grooves or orifices 50 lead upwardly from a vertically elongated annular channel 51 in the member 34 and increase in length progressively so that as the member 34 moves downwardly from the position in which it is shown in Fig. 1, the entering of the passages 50 into the upper end of the minor bore 30 will cause a gradual reduction in the communication between the space 40 above the shoulder 31 and the space 52 formed by the channel 51 of the member 34 in the minor bore 30. When the member 34 is in its extreme lowered position, against the stop 33, the communication between the space 40 and the space 52 will be restricted to the groove or orifice indicated at 53 in Figs. 1, 2, and 6, which is the only one of the grooves 50 which extends entirely to the shoulder 31 which is formed near the upper end of the member 34 in a position confronting the space 40. As shown in Fig. 1, when the pumping mechanism is operating at normal speed, so that the pressure in the delivery tube 26 is high, the raised position of the member 34 provides a free communication from the space 40, through the channel 51 and the ports 35, with the space 25 of the discharge tube 26.

An especial feature of my invention is the provision of a structure wherein the control member 34 moves downwardly in proportion to the difference in pressures existing in the inlet and outlet portions of the governor valve. It will be perceived that as the member 34 moves downwardly, the movement of the orifices 50 into the upper end of the minor bore 30 proportionately restricts the escape of fluid from the space 40, and that as the restriction of the escape of fluid increases, the pressure in the spaces 40 and 41 is increased until such time as the fluid pressures acting upwardly against the member 34 balance the fluid pressure acting downwardly thereon. Accordingly, therefore, the reduction in the pressure of fluid in the outlet space 25 of the governor 20 causes a movement of the member 34 downwardly into a flow restricting position controlled by the relative differences in pressure in the pipe 23a and in the discharge tube 26. Any increase in pressure in the discharge tube 26 will be transmitted through the ports 35 and the space 52 to the lower ends of the orifices 50 where the pressure will cooperate with the frictional head produced by the orifices 50 to increase the pressure in the space 40, the result being that the member 34 moves upwardly until a balanced condition of operation is again attained.

An alternative embodiment of my invention is shown in Figs. 7 and 8, and is of such character that it controls the volume of pressure fluid passing therethrough, and comprises a control device or governor 55.

The control device 55 includes a body 56 having a central bore 57 from which a lateral outlet passage 58 extends. A flange connector 59 is secured in alignment with the opening 58 so as to connect an outlet pipe 60 therewith. Inserted in the bore 57 is a tubular member 61 which is of such length that a chamber 62 is left in the forward or leftward end of the bore. The leftward end of the tubular member 61 is provided with a primary bore 63 and with lateral openings 64 communicating with the discharge passage 58. A head 65 closes the leftward end of the bore 57, this head 65 being bolted in place and having an opening 66 in alignment with the bore 57 but being of smaller diameter than the bore to provide a shoulder 67. In crossing relation to the opening 66, the head 65 is provided with an opening 68, in one end of which a valve seat 69 is formed leading through an inlet passage 71 to a flange fitting 70 which is adapted to be bolted to the head 65 for the purpose of connecting an operating fluid header 72 to the inlet passage 71 of the control device 55. The upper or opposite end of the opening 68 is threaded at 73 to receive a valve member 74 having the lower end 75 thereof tapered for engagement with the valve seat 69. For moving the valve member 74 relative to the seat 69, a squared stem 76 is provided thereon, which stem 76 extends into a socket 77 formed in a member 78 having a stem 79 which projects within an opening 80 in a cap member 81 bolted on the upper end of the head 65. The stem 79 is provided with a projection 82 prepared to receive a wrench. The member 78 is provided with an outwardly faced shoulder 83 which bears against a packing ring 84 carried in an annular recess 86 formed at the inner end of the opening 80 of

the cap 81. To transmit fluid pressure to the inner face of the member 78, an opening 87 is formed longitudinally through the side portion of the member 74.

Slidable in the leftward end of the bore 57 is a piston member 88 which is secured to the leftward end of a tubular stem 89 having a pin 90 therein provided with a pointed and diametrally reduced rightward end 91 with radial openings 92 communicating with an axial opening 93 extending to the leftward end of the stem. The openings 92 and 93 provide a passage through which fluid may flow from the space 66 into the rightward end of the bore to balance the fluid pressure applied to the opposite ends of the tubular stem 89. The end 91 of the pin 90 engages a plate 94 which rests against the leftward end of an adjustment spring 96 which passes through a rotatable sleeve 97 to a block 98 having a laterally extending pin 99 therein. The ends of the pin 99 project through spiral grooves 100 in the sleeve 97 and into longitudinal slots 101 in the rightward end of the tubular member 61 to prevent rotation of the pin 99 and the block 98 but permit movement thereof in the direction of the axis of the bore 57. The sleeve 97 is rotatable for the purpose of moving the block 98 in axial direction as the result of the spiral grooves 100 moving with relation to the end portions of the pin 99. The sleeve 97 is closed at its rightward end and is provided with an outwardly projecting stem or extension 102 which passes through an opening 103 in a cover plate 104 on the rightward end of the body 56. At a point within the opening 103 the stem 102 is provided with a shoulder 106 which bears against a packing ring 107 which rests against an inwardly faced shoulder 108 provided by the cover plate 104. The outer end of the stem has a projection 109 prepared for engagement with a wrench adapted to turn the sleeve 97, and a dial plate 110 may be secured to the stem 102, this dial plate 110 being set in a recess 111 formed in the outer portion of the cover plate 104 and being calibrated to indicate various settings of the control device. Such calibrations may be in terms of barrels per day of operating fluid delivered through the outlet pipe 60.

The piston member 88 is provided with openings 112 forming metering orifices so that as the fluid delivered to the device through the inlet passage 71 passes from the opening 66 of the head 65 through the orifices 112 into the chamber 62, there will be a drop in pressure to form a pressure differential on the inner and outer sides of the piston member 88 tending to move the piston member and the stem 89 rightwardly against the leftward pressure of the spring 96. From the chamber 62 the operating fluid passes through an annular space 113 in the leftward end of the tubular member 61 to the radial passages 64 and finally through the outlet passage 58 to the discharge pipe 60. A wear ring 114 is provided in an inset recess in the leftward end of the tubular member 61, and the stem 89 and a valve sleeve member 116 carried thereon have a close sliding fit in the wear ring. The pressure differential between the pressure in the opening 66 and the pressure in the chamber 62 plus the force exerted by the spring 96 determine the position of the piston 88, the stem 89, and the valve sleeve 116. Accordingly, the pressure tending to move the piston 88 to the left, as seen in Fig. 7, may be adjusted by rotating the sleeve 97 having the spiral grooves 100 therein to give the desired compression to the spring 96. Any increase in fluid pressure in the pipe 72 will be transmitted to the fluid in the opening 66 to increase the force tending to move the piston 88 to the right, and if this force exceeds the leftward counter forces exerted by the fluid pressure in the chamber 62 and by the spring 96, the piston 88 will move to the right. Rightward movement of the piston 88, however, causes the valve sleeve 116 to also move to the right towards a close fit with the wear ring 114 which tends to close the annular space 113 normally between the valve sleeve and the wear ring. Partial closure of the space 113 restricts the flow of fluid from the opening 66 to the radial passages 64, so as to maintain the discharge through the outlet 58 at a substantially constant rate of flow. When the fluid pressure in the opening 66 drops below the leftward pressure exerted by the fluid in the chamber 62 and by the spring 96, the piston 88 will move to the left so as to open the annular space 113 to permit an increased flow of fluid therethrough.

Likewise, should there be a reduction in fluid pressure in the pipe 60 and the opening 58, a momentary drop in pressure in the chamber 62 would result, thereby increasing the pressure differential on the leftward and rightward faces of the piston 88 to cause a similar rightward movement of the piston 88 and the valve sleeve 116.

To show the pressure of fluid being delivered into the pipe 60, the control device may be provided with a pressure gauge 117. The gauge 117 has an inlet 118 into which a screw 119 is threaded. This screw 119 passes through an opening 120 in a connector ring or link 121. The ends of the opening 120 are counterbored to receive gasket rings 122 and 123 which respectively engage the lower end of the inlet 118 and a shoulder 124 formed on the upper part of the head of the screw 119. The link 121 has another opening 126 spaced from the opening 120, and a screw 127 passes through the opening 126 into threaded engagement with an opening 128 formed in the body 56 so as to communicate with the passage 58 thereof. The lower end of the opening 128 is formed with a counterbore 129 to receive a packing ring 130, and an axial flange 131 is provided on the link 121 to extend into the counterbore 129 and bear against the packing ring 130. The lower end of the opening 126 is formed with a counterbore 132 into which a packing ring 133 is compressed by a shoulder 134 formed on the upper part of the head 135 of the screw 127. By the use of the gasket or packing rings shown, both ends of each opening are sealed against escape of fluid under pressure.

The screw 127 has an axial opening 136 leading downwardly from the upper end thereof and connecting with an opening 138 of larger diameter which leads upwardly from the lower end of the screw 127. The opening 138 has a valve needle 139 threaded therein so as to enter the lower end of the opening 136, this needle 139 being provided with packing means 140 to prevent leakage therearound. Radial holes 141 lead outwardly from the upper part of the opening 138 to carry fluid under pressure into the space 142 in the opening 126 around the body of the screw 127. From the annular space 142 the fluid is carried through a hole 143, diagonally drilled in the link 121, to the annular space 144 formed in the opening 120 around the body of the screw 119. A radial hole 145 in the screw 119 communicates with an axial opening 146 leading up-

wardly to the upper end of the screw 119 to the mechanism of the pressure gauge 117, not shown, but which may be of conventional design.

Another alternative form of flow governor 55b is shown in Fig. 9. This control member 55b is provided with a body 150 of tubular form internally threaded at its upper end 151 for connection to the lower end of an inlet pipe 148 which carries the operating fluid to the governor 55b. Employing the same principles of construction as the device shown in the preceding figures, the body 150 has an interior space 152 in which a piston 153 is vertically movable. This piston 153 has a tube 154 extending downwardly therefrom into the diametrally reduced bore 155 of the body 150. A spring 156, bearing against the lower end of the tube 154, tends to move the tube and piston 153 upwardly. A pressure differential to move the piston downwardly is produced by metering orifices 158 in the piston through which the operating fluid must pass from the chamber 159 above the piston 153 to the chamber 160 formed below the piston 153. An increase in pressure above the piston 153, or a decrease in pressure below the piston, will increase the pressure differential and move the piston downwardly against the action of the adjustment spring 156, causing valve openings 161 in the wall of the tube 154 to move downwardly relative to the upper end 162 of the bore 155, thereby restricting at this point the area of passage for the fluid which passes through the openings 161 and then through radial passages 163 and down through longitudinal passages 164 which extend to the lower end of the body 150 and connect with a chamber 165 in a tubular part 166 threaded at 167 to the lower end of the body 150.

The lower end of the spring 156 rests against an adjusting plug 168 which is screwed into threads 169 at the lower end of the bore 155. The plug 168 has a flattened tongue 170 which projects downwardly through a slot 171 formed in the upper end of a body 172 which is disposed within the tubular member 166, and which body 172 is threaded into the upper end of the motor which forms a part of the pump unit (not shown). The body 172 has passages 173 therein through which the operating fluid may flow from the chamber 165 into the other end of the fluid motor to operate the pump mechanism. The body 150 of the control valve and the member 166 thereof are rotatable relative to the body 172 which is secured in the upper end of the motor. The adjusting plug 168, being connected through the use of the tongue 170 with the body 172, remains stationary when the inlet pipe 148, and likewise the valve body 150, is turned, with the result that by rotation of the valve body 150, the adjusting plug 168 may be caused to screw upwardly or downwardly in the lower end of the bore 155 so as to change the compression of the spring 156 and thereby change the adjustment of the control valve. This form of the control valve is adjusted by turning the inlet pipe 148 until a desired flow of operating fluid is obtained therethrough. Packing means 174 are provided between the body 172 and the member 166 to prevent leakage of fluid from the space 165.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A governor of the character described, including: a tubular shell having an inlet end and an outlet end, there being a bore in said shell comprising a major bore portion facing the inlet end of said shell and a minor bore portion facing the outlet end of said shell and of less internal diameter than said major bore portion, the inner ends of said bore portions being in open communication; a movable member slidable in said bore, one end of said member making a sliding fit in said minor bore portion, said member having a valve head thereon adapted to cooperate with a shoulder formed by the junction of said major bore portion and said minor bore portion to throttle a flow of fluid through said bore, said member having a passage therein communicating between said major bore portion and said minor bore portion below the end of said member; a piston formed on the other end of said member and slidably disposed in said major bore portion, there being orifice means connecting the inlet end of said shell with said major bore portion below said piston; and a spring disposed in said minor bore portion below said member and adapted to normally urge said member toward said inlet end of said shell.

2. A governor of the character described, including: a tubular shell having an inlet end and an outlet end, there being a bore in said shell comprising a major bore portion facing the inlet end of said shell and a minor bore portion facing the outlet end of said shell and of less internal diameter than said major bore portion, the inner ends of said bore portions being in open communication; a movable member slidable in said bore, one end of said member making a sliding fit in said minor bore portion, said member having a valve head thereon adapted to cooperate with a shoulder formed by the junction of said major bore portion and said minor bore portion to throttle a flow of fluid through said bore, said member having a passage therein communicating between said major bore portion and said minor bore portion below the end of said member; a piston formed on the other end of said member and slidably disposed in said major bore portion, there being orifice means connecting the inlet end of said shell with said major bore portion below said piston; a spring disposed in said minor bore portion below said member and adapted to normally urge said member toward said inlet end of said shell; and means for varying the normal compression on said spring.

3. A governor of the character described, including: a tubular shell having an axial open bore therethrough; means for connecting an inlet pipe to an inlet end of said shell and in axial alignment therewith; means for connecting an outlet pipe with an outlet end of said shell and in axial alignment therewith, said inlet and outlet pipes being of substantially the same external diameter as said shell; a movable member slidably disposed in said bore, one end of said member making a sliding fit in one end of said bore, the other end of said member forming a piston making a sliding fluid-tight fit in the other end of said bore, said member having a valve element intermediate its ends adapted to throttle a flow of fluid through said bore; orifice means communicating between said inlet pipe end of said shell and said bore below said piston so as to be capable of impress-

ing a differential fluid pressure across said piston through said orifice means; port means for communicating between said bore below said valve element and an outlet pipe; a plug closing said outlet end of said bore; and resilient means for normally resiliently urging said movable member toward said inlet end.

4. A governor of the character described, including: a tubular shell having an axial open bore therethrough; means for connecting an inlet pipe to an inlet end of said shell and in axial alignment therewith; means for connecting an outlet pipe with an outlet end of said shell and in axial alignment therewith, said inlet and outlet pipes being of substantially the same external diameter as said shell; a movable member slidably disposed in said bore, one end of said member making a sliding fit in one end of said bore, the other end of said member forming a piston making a sliding fluid-tight fit in the other end of said bore, said member having a valve element intermediate its ends adapted to throttle a flow of fluid through said bore and a passage communicating with the space between said piston and said valve element and said outlet end of said bore; orifice means communicating between said inlet pipe end of said shell and said bore below said piston so as to be capable of impressing a differential fluid pressure across said piston through said orifice means; port means for communicating between said bore below said valve element and an outlet pipe; a plug closing said outlet end of said bore; and a compression spring in said bore between the outlet end of said movable member and said plug for normally resiliently urging said movable member toward said inlet end.

CLARENCE J. COBERLY.