

1,234,882.

W. A. DOBLE.
SPEED GOVERNOR.
APPLICATION FILED JUNE 2, 1913.

Patented July 31, 1917.
3 SHEETS—SHEET 1.

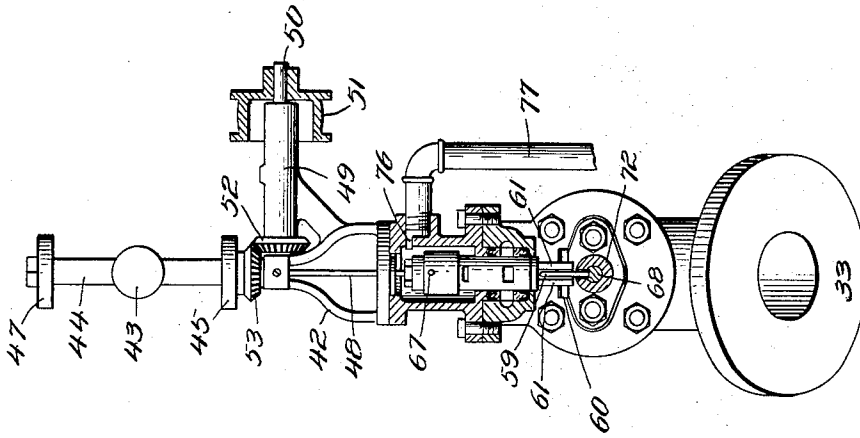


Fig. 2.

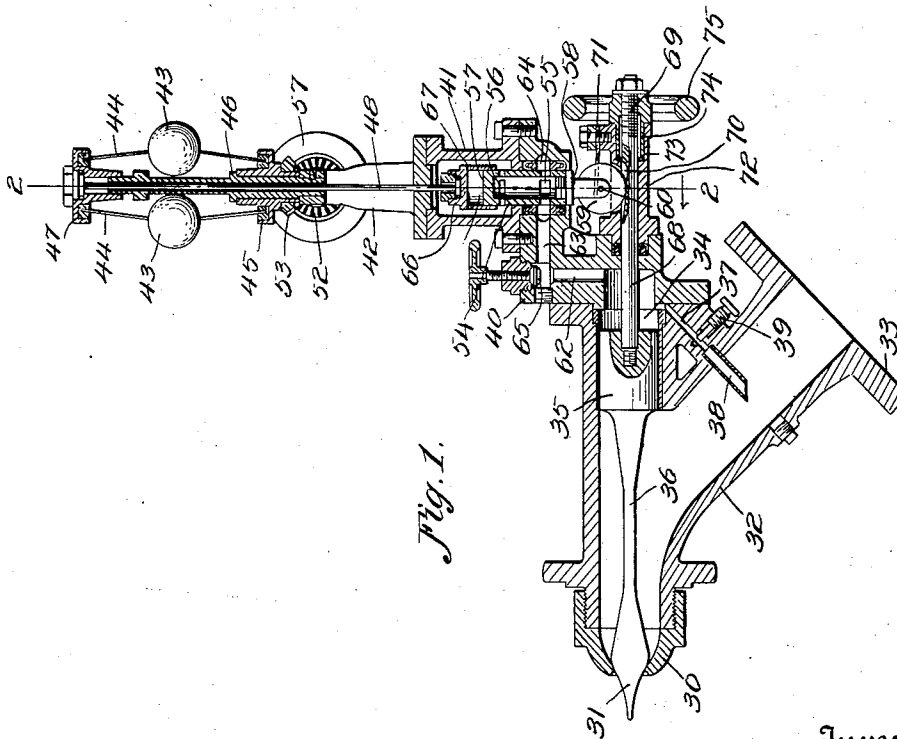


Fig. 1.

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3 SHEETS—SHEET 2.

Fig. 3.

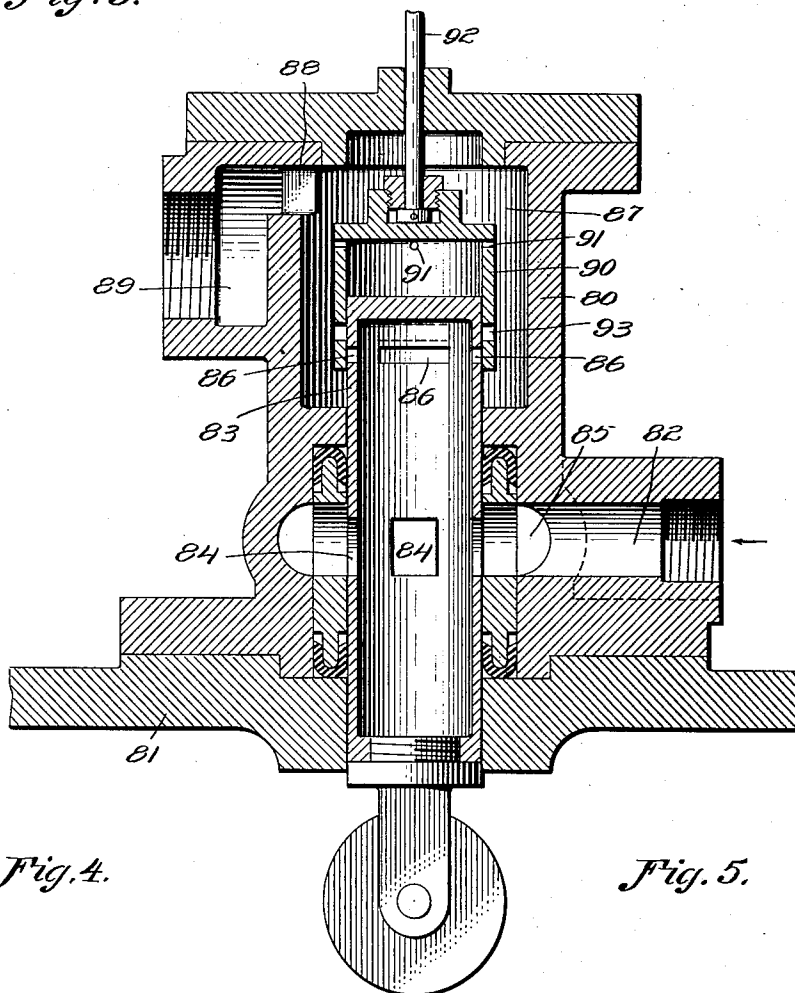


Fig. 4.

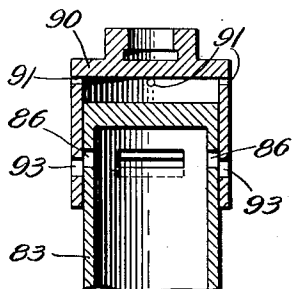
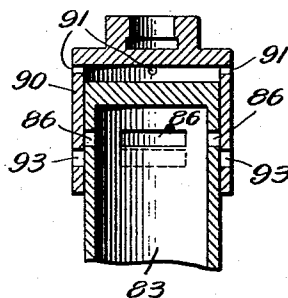


Fig. 5.



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3 SHEETS—SHEET 3.

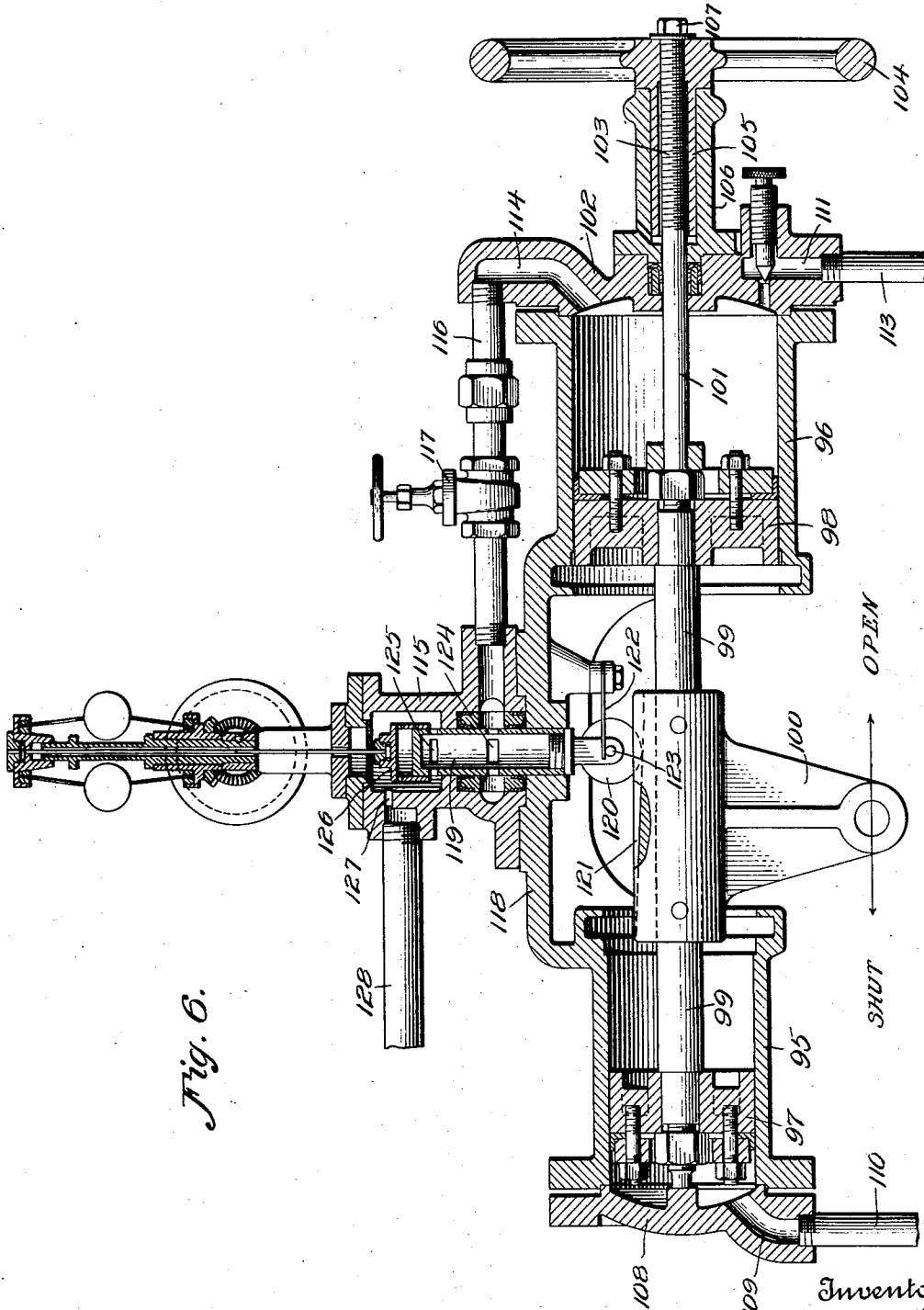


Fig. 6.

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UNITED STATES PATENT OFFICE.

WILLIAM A. DOBLE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO THE PELTON WATER WHEEL COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

SPEED-GOVERNOR.

1,234,882.

Specification of Letters Patent.

Patented July 31, 1917.

Application filed June 2, 1913. Serial No. 771,308.

To all whom it may concern:

Be it known that I, WILLIAM A. DOBLE, a citizen of the United States, residing at San Francisco, county of San Francisco, State of California, have invented certain new and useful Improvements in Speed-Governors, of which the following is a specification.

This invention relates to improvements in speed controlling apparatus for motors and more particularly to that class of speed controlling apparatus which is adapted for use in connection with water wheels used for driving electric generators.

The invention belongs to that type of speed controlling apparatus in which the speed responsive or governing element controls the gate, or other device for regulating the supply of motive energy, by means of a relay mechanism.

One of the objects of the invention is to provide a mechanism of this class in which the gate or analogous device is moved by fluid pressure means and the controlling or pilot valve for the fluid pressure means is moved in definite relation to the gate so that for every position of the gate there is a corresponding position for the pilot valve.

Another object is to provide an improved form of pilot valve provided with means for limiting the rapidity of the movements of the pilot valve so as to avoid sudden changes in the position of the gate.

Another object of the invention is to provide an improved form of pilot valve which is arranged to automatically close the gate whenever the belt by which the governor is driven breaks or slips off the pulley.

Another object is to provide, in connection with the automatically operating apparatus, means whereby the gate may be operated manually.

Another object is to provide a speed controlling apparatus having an "anti-racing" device which is so constructed that the movement of the gate, due to a given change in the speed of the motor, varies according to the load on the motor or the gate opening. In speed controlling apparatus as heretofore constructed anti-racing devices have

been provided which have been of the "uniformly-acting" type in which the change in the position of the gate depends entirely upon the change in speed regardless of the load on the motor. With such devices the motor will "race" because the speed is affected more by the same gate change when the motor is working under small load than under full load. The quantity of water flowing through the gate of a water wheel controlled by an apparatus of this type has been heretofore made to change proportionally to the speed of the water wheel at all loads, and to suit full load conditions. If the water wheel runs under small load, then the gate changes caused by the governor by speed variations will be too large and a racing of the water wheel will occur. In my invention the apparatus is so constructed that the gate change is smaller for a small load than for a full load.

Another object of the invention is to provide an improved means for connecting the gate and the pilot valve, whereby movements of the gate are transmitted to the pilot valve. It has been found difficult in most cases, where speed controlling apparatus is used to place the speed responsive element close to the part from which it is operated and at the same time have the servo-motor in the proper position to operate the gate. In order to obtain the best results it is therefore necessary to separate the speed responsive element from the servo-motor and provide suitable connecting means between the two. By this arrangement the speed responsive element may be placed close to the shaft from which it is driven and the servo-motor may be located in the proper position to operate in which large power units, must necessarily be had a considerable distance from the speed responsive element. In connecting the servo-motor with the speed responsive device cranks and long shafts are undesirable to use on account of possible lost motion which would be detrimental to the correct action of the apparatus. Long belts are also undesirable because of the pulsations which they produce due to the flapping of the belts

and in the case of an inertia governor belts could not be used at all. In carrying out my invention the servo-motor is connected with the pilot valve, which is operated by the speed responsive element in such a manner that the movements of the gate are transmitted to the valve by means of balls which are arranged in a tube, the balls acting in substantially the same manner as would a liquid under similar circumstances with the exception that by the use of the balls the disadvantages which would arise from leakage of a liquid are avoided.

Other objects and the various features of novelty will be apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a longitudinal section through a water wheel nozzle and the apparatus for controlling the flow through the nozzle.

Fig. 2 is an end elevation of Fig. 1 with certain parts shown in section on the line 2—2 of Fig. 1.

Fig. 3 is a longitudinal section through a modified form of pilot valve.

Figs. 4 and 5 are fragmentary sectional views showing the pilot valve in different positions from that shown in Fig. 3.

Fig. 6 is a longitudinal section through another form of speed controlling apparatus.

Referring to Fig. 1 the numeral 30 indicates the nozzle of a water wheel which is controlled by a needle valve or gate 31. The nozzle may be supplied with water by means of the nozzle body 32 which may be connected with a suitable conduit by means of the flange 33. Rearwardly of the nozzle 30 the nozzle body 32 is provided with a chamber 34 in which is arranged a piston or plunger 35 which is connected with the needle valve 31 by means of the stem 36. A port 37 connects the water passage in the nozzle body 32 with the chamber 34 at the rear of the plunger 35. An entrance tube 38 is arranged in the water passage in the nozzle body 32 and supplies the port 37. This entrance tube has its outer end arranged preferably at the center passage through the nozzle body where the water contains less grit and other impurities and is cut off at an angle and has its open side faced upstream or away from the nozzle to facilitate the flow of water to the chamber 34 and to make use of the velocity of the inflowing water for pressure in the tube. A suitable valve 39 controls the flow of water through the port 37.

Secured to the nozzle body at the rear of the chamber 34 is a casting 40 on which is mounted the valve casing 41. Supported on the casing 41 is a suitable bracket 42 which carries the governor. The governor may be of any suitable construction but

preferably comprises a pair of centrifugal weights 43 secured to suitable springs 44. The lower ends of the springs 44 may be secured to the member 45 which is rotatably mounted on a sleeve 46 carried by the bracket 42. The upper ends of the springs 44 may be secured to a member 47 which is rotatably and slidably mounted on the sleeve 46. A rod 48 is arranged within the sleeve 46 and has its upper end connected with the member 47 in such a way that this member may rotate with respect to the rod, but will move the rod up and down in the sleeve 46.

The bracket 42 is provided with a bearing 49, in which is arranged a shaft 50. This shaft carries a pulley 51 which may be driven from the shaft of the motor by means of a belt. The shaft 50 also carries a bevel gear 52 which meshes with a corresponding gear 53 rigidly connected with the member 45.

Arranged in a suitable chamber in the casting 40 is a valve 54 having the ports 55 and 56. The valve 54 is hollow and has its upper end closed by a suitable wall 57 and has at its lower end a head 58 which carries a cam wheel 59, the latter being supported by means of a pin 60 which is mounted in ears 61 on the head.

The casting 40 is provided with the ports 62 and 63, these ports connecting the chamber 34 with a passage 64 surrounding the valve 54 adjacent the ports 55. A valve 65 is provided for the purpose of closing the port 62 and preventing water from flowing from the chamber 34 to the passage 64.

A pilot valve 66 is arranged in the casing 41 and surrounds the upper end of the valve 54. The pilot valve is in the form of a cylindrical cup which closely fits the upper end of the valve 54 and is connected with the rod 48. The pilot valve 66 is provided with restricted openings 67 through its side wall which permit water to pass to and from the interior of the valve and thus provide a dash pot device for preventing sudden movements of the valve. The valve 66 is moved by the governor to open and close the ports 56 in the valve 54.

A stem 68 is secured to the plunger 35 and extends through a suitable stuffing box in the casting 40, and has its outer end screw threaded, as indicated at 69. In the upper side of the rod 68 is an inclined groove 70, in which is arranged the lower edge of the wheel 59. Springs 71 are secured to a bracket 72 carried by the casting 40 and bear on the upper side of the pin 60 and press the wheel 59 into the groove 70. The outer end of the bracket 72 is recessed as indicated at 73 to receive the extension 74 on the hub of the hand wheel 75. The hand wheel 75 has screw threaded engagement

with the outer end of the rod 68, whereby the needle valve 31 may be moved by turning the hand wheel.

The operation is as follows:

5 The wheel 51 being driven from the motor shaft will revolve at a speed directly proportionable to said shaft and the rotation of the wheel will be transmitted to the member 45, the centrifugal weights 43 and the member 47. The centrifugal force on the weights 10 43 will cause them to move outwardly and draw the member 47 downward and since the pilot valve 66 is directly connected with the member 47 by means of the rod 48 the 15 pivot valve will move up and down in unison with the member 47.

Assuming that the needle valve and the valve 65 are closed and the valve 39 open it will be seen that pressure on the opposite 20 sides of the plunger 35 will be substantially equal and the pressure on the needle will hold the latter in closed position. If the valve 65 is now opened water from the chamber 34 will pass through the ports 62 and 63 25 and the chamber 64 in the casting 40 and through the ports 55 and 56 of the valve 54 into the interior of the casing 41. From the latter the water will be discharged through a suitable port 76 and a waste pipe 77. If 30 the water flowing through the port 37 is so throttled by the valve 39 that it will not supply the chamber 34 as rapidly as water is flowing from the latter, the pressure in the chamber 34 will be reduced and if the difference 35 in the pressure on the two sides of the plunger 35 is greater than the force with which the needle 31 is pressed to its seat the valve 31 will be moved to the right and water will be permitted to flow through 40 the nozzle against the wheel. This will start the wheel and as it increases in speed the centrifugal weights 43 will move outwardly and slide the pilot valve 66 downwardly. As the needle 31 moves toward the 45 right the piston valve 54 is lifted by the inclined groove 70. The pilot valve 66 and the valve 54 are thus moved toward each other, and the ports 56 in the piston valve are gradually covered by the pivot valve. As 50 the ports 56 are covered the flow there-through is restricted and the pressure in the chamber 34 is increased to a point where the loads on the opposite sides of the plunger 35 equalize and the needle valve comes to rest. 55 The parts will remain in this position so long as the speed of the motor remains constant, the flow of water from the chamber 34 through the ports 56 in the valve 54 being just sufficient to maintain the proper pressure in the chamber 34 to counterbalance the 60 pressure on the opposite side of the plunger. If the motor increases in speed for any reason the centrifugal weights 43 will move the pilot valve 66 downwardly and further re-

strict the flow through the ports 56. This 65 will cause an increase in pressure in the chamber 34 and move the needle valve 31 toward the closed position until the flow through the nozzle is just sufficient to maintain the normal speed. As the needle valve 70 moves the valve 54 will be lowered until the flow through the ports 56 is sufficient to again reduce the pressure to a point where the loads on the opposite sides of the plunger 35 are equalized. The needle valve 31 will 75 then come to rest.

It will thus be seen that, for every position of the pilot valve, there is a definite position of the needle valve. If, by a change of 80 speed, the centrifugal weights change their position and move the pilot valve the needle valve will follow to its corresponding position accordingly.

To close the needle valve 31 and stop the wheel the valve 65 is closed. This will cause 85 the pressures on the opposite sides of the chamber to equalize and permit the pressure on the needle valve to close the latter.

From Fig. 2 it will be observed that the port 76 is above the ports 67 in the pilot 90 valve and therefore the level of the water in the casing 41 will always be above the port 67, and therefore maintain the chamber within the pilot valve full of water so that 95 the movements of the pilot valve will be dampened and regulated by the flow through the ports 67.

To operate the needle valve by hand, in case the governor is out of order, the hand 100 wheel 75 is used. In turning the hand wheel in one direction, the needle valve can be pulled from its seat and when the hand wheel is turned in the opposite direction the water pressure in the nozzle will move the 105 needle toward the seat in accordance with the movements of the hand wheel.

The extension 74 of the hand wheel hub is of greater length than the stroke of the 110 needle valve 31. This elongated hub is arranged to slide freely in the recess 73, so that when the hand wheel is placed in the position shown in the drawings at the extreme end of its travel where it abuts the nut at the outer end of the rod 68, any movement 115 of the needle valve causes the hand wheel to travel back and forth with the rod 68 and as long as the hand wheel is maintained in the position shown with respect to the rod 68 it has no influence whatsoever on the position 120 of the needle valve. When the hand wheel is rotated, however, it screws forward on the rod 68 and prevents the needle valve from completely closing, and in this way the needle valve can be opened and held open independent of the action of the governor. 125

In Figs. 3, 4 and 5 I have shown a modified form of pilot valve which may be used in place of the valve shown in Figs. 1 and 2.

In addition to the functions performed by the pilot valve shown in Figs. 1 and 2 the valve shown in Figs. 3, 4 and 5 acts as a safety device for stopping the motor in case the governor belt breaks or slips off one of its pulleys. This valve is arranged in a casing 80 which may be secured to any convenient support 81. The casing is provided with an inlet port 82 having the same function as the port 63 in Fig. 1. Arranged in the casing 80 is a piston valve 83 which may be identical in construction with the valve 54 of Fig. 1. The valve 83 is provided with the inlet ports 84 adjacent the annular passage 85 in the casing 80, this passage being in communication with the port 82 and being similar to the passage 64 shown in Fig. 1. The valve 83 is also provided with the outlet ports 86 through which the water passes from the interior of the valve into the chamber 87. This chamber is provided with an outlet port 88 which communicates with an outlet passage 89, this construction being identical with that shown in Fig. 2. The pilot valve 90 is arranged to slide on the upper part of the piston valve in the same manner as the pilot valve 66 shown in Fig. 1 and is provided with the ports 91 which permit water to flow to and from the interior of the pilot valve and thus acting as a dash pot to retard the movements of the valve. The valve 90 is connected with a suitable actuating rod 92 which corresponds to the rod 48. The valve 90 differs from the valve 66 in that it is provided with the ports 93 which are arranged a short distance above the lower edge of the valve and which are adapted to register with the ports 86 to permit water to flow from the interior of the valve 83 into the chamber 87. As shown in Fig. 3 the position of the pilot valve with respect to the piston valve 83 is such that the ports 86 are closed, this being the normal position of the valves when the governor is not in operation. When the governor is rotated the rod 92 and the valve 90 will be moved downwardly and the ports 93 brought into registration with the ports 86, as shown in Fig. 4, this being the normal running position of the valve. In case the motor speeds up the pilot valve will be moved to a lower position and further restrict or shut off entirely the flow through the ports 86, as shown in Fig. 5. This will effect a rise in pressure in the chamber 34 and move the needle valve 31 toward the closed position, which will thereby reduce the speed of the motor and permit the valves to assume the position shown in Fig. 4. If the belt which drives the governor pulley 51 should break or slip off the governor would stop rotating and the pilot valve would be drawn upwardly to the position shown in Fig. 3 in

which position the ports 86 are completely closed. This would cause the pressure in the chamber 34 to rise and move the valve 31 to the closed position and thereby stop the motor.

From the above it will be seen that the pilot valve shown in Fig. 3 will normally operate in exactly the same manner as the valve shown in Figs. 1 and 2 and in addition provides an extremely simple and effective means for shutting down the motor whenever the governor belt breaks or slips off one of its pulleys.

In starting the motor when the pilot valve shown in Fig. 3 is used, it is necessary, after the valve 65 is opened, to use the hand wheel 75 to open the needle valve 31 to a point where the motor has assumed sufficient speed to cause the pilot valve 90 to uncover the ports 86. When the ports 86 are uncovered the reduction in pressure in the chamber 34 will cause the valve 31 to be further opened and permit the governor thereafter to fully control the movements of the valve.

In Fig. 6 I have illustrated a speed controlling mechanism of the general type shown in Figs. 1 and 2, which is suitable for controlling the speed of any kind of motor. In the mechanism shown in Figs. 1 and 2 the pressure of the water in the nozzle is used for moving the valve in one direction, the pressure in the chamber 34 being used to move the valve in the other direction. In the mechanism shown in Fig. 6 I have provided a double-acting hydraulically operated servo-motor which may utilize as operating fluid any suitable liquid under pressure.

In this mechanism I have provided two cylinders 95 and 96, the cylinder 96 being considerably larger than the cylinder 95. The cylinder 95 is provided with a suitable piston 97 and the cylinder 96 is provided with a piston 98, these pistons being connected by a rod 99 having secured thereto a suitable bracket or cross head 100 which may be connected with the device for controlling the supply of motive energy to the motor controlled. The rod 99 has an extension 101 which projects through the head 102 of the cylinder 96 and is provided with the screw-threaded portion 103 exteriorly of the head. A hand wheel 104 engages the threaded portion 103 of the rod 101 and has its hub provided with an extension 105 which is arranged in a guide 106 secured to the head 102. The outer end of the rod 101 is provided with a suitable nut or abutment 107 which limits the outward movement of the hand wheel 104. The cylinders 95 and 96 are of the single-acting type and are preferably arranged in axial alinement. The cylinder 95 is provided with a head 108 and

a suitable supply port 109 communicates with the space between the head 108 and the piston 97. The supply port 109 may be conveniently arranged in the head 108 and communicates with a suitable supply pipe 110. A supply port 111 controlled by a valve 112 communicates with the space between the head 102 and the piston 98 of the cylinder 96. The port 111 may be conveniently arranged in the head 102 and has connected therewith a supply pipe 113. A port 114 preferably arranged in the head 102 communicates with the interior of the pilot valve casing 115 by means of a suitable pipe 116 in which may be arranged a stop valve 117 of any preferred construction.

The cylinders 95 and 96 may have integrally formed therewith a connecting table or bracket 118 on which the pilot valve casing 115 may be mounted. The pilot valve is preferably of the type shown in Figs. 1 and 2 and is controlled by a governor in the manner shown in Figs. 1 and 2. Whenever desired the valve construction shown in Fig. 3 may be used. The piston valve 119 carries a cam roller 120 which may be arranged in an inclined groove 121 in the cross head 100. The table 18 may have secured thereto springs 122 similar to the springs 71 shown in Fig. 1, these springs bearing on the pin 123 on which the roller 120 is mounted, and tending to hold the roller 120 against the inclined surface of the groove 121. The valve 119 is provided with the ports 124 and 125 and a pilot valve 126, this arrangement being identical with that shown in Fig. 1. The chamber 115 is provided with a discharge port 127 which communicates with a waste pipe 128.

In operation the pipes 110 and 113 are connected with a common source of liquid under pressure. The pressure always acts on the piston 97 and tends to move the piston and the parts connected therewith in the direction of the arrow marked "open." The pressure also acts on the piston 98, and since this piston is of much larger area than the piston 97 the load on the former will overbalance the load on the latter and move the pistons with the cross head 100 in the direction of the arrow marked "shut" and shut off the supply of motive energy to the motor controlled. When the valve 117 is open the liquid will flow from the cylinder 96 through the port 114, pipe 116 and the ports in the valve 119 to the waste pipe 128. By means of the valve 112 the supply of liquid to the cylinder 96 may be restricted so that, on account of the discharge of the liquid from the cylinder 96, the pressure in this cylinder will be reduced to a point where the force acting on the piston 98 is equal to or lower than the force acting on the piston 97. If the two forces are equal the parts will re-

main stationary, but if the force acting on the piston 98 is less than that acting on the piston 97 the pistons will be moved toward the right in Fig. 6 and open the device which supplies the motive energy to the motor. This will cause the motor to start and since the governor which controls the pilot valve 126 will be driven by the motor the pilot valve will be lowered as the motor increases in speed and the discharge through the ports 125 gradually restricted and thus cause the pressure in the cylinder 96 to increase to a point where the force acting on the piston 98 exactly counterbalances the force acting on the piston 97. This will bring the pistons to rest with the supply device for the motor in open position and if this position is suitable for maintaining the motor at normal speed the parts will remain in this position. When the motor changes in speed for any reason the pilot valve will be raised or lowered and open or close the controlling device for the motor, as may be necessary, in the manner fully described in connection with the mechanism shown in Fig. 1.

By means of the hand wheel 104 the motor may be manually controlled independent of the governor in the same manner as described in connection with the mechanism shown in Fig. 1.

From the above it will be seen that the mechanism shown in Fig. 6 operates in the same manner as the mechanism shown in Fig. 1 and it will be understood that the valves 112 and 117 are in all respects the equivalents of the valves 39 and 65 respectively.

Having thus described the invention what is claimed as new is:

1. In a speed controlling mechanism, the combination of a controlling element, fluid pressure means for actuating said element, speed responsive means, a pilot valve actuated by said speed responsive means, a member having a cam surface and arranged to be moved with said controlling element, and a valve actuated by said cam surface and co-operating with said pilot valve to control said fluid pressure means.

2. In a speed responsive mechanism, the combination of a controlling element, fluid pressure means for actuating said controlling element, speed responsive means, a pilot valve adapted to be actuated by said speed responsive means, a member having a cam surface and arranged to be actuated by said fluid pressure means, a valve coöperating with said pilot valve to control said fluid pressure means, means whereby said valve is moved in one direction by said cam surface, and spring means for moving said valve in the other direction.

3. In a speed controlling mechanism, the combination of a controlling valve, a piston

connected with said valve and adapted to actuate the same, means whereby a substantially uniform fluid pressure is maintained on one side of said piston, means for supplying fluid pressure to the opposite side of said piston, speed responsive means, means for discharging fluid from said opposite side of said piston, and valves controlled by said speed responsive means and the movements of said controlling valve whereby the pressure on said opposite side of said piston may be varied for the purpose of moving said controlling valve.

4. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with said valve and adapted to have one side thereof subjected to the pressure of the fluid passing through said valve, a chamber on the opposite side of said piston, means for supplying pressure fluid to said chamber, means for discharging pressure fluid from said chamber, a manually operable valve for controlling said means, a valve adapted to be moved with said controlling valve, speed responsive means, and a valve adapted to be actuated by said speed responsive means and cooperating with said second-mentioned valve for controlling the discharge of fluid from said chamber.

5. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with the controlling valve and adapted to have one side thereof subjected to the pressure of the fluid passing through said valve, a chamber on the opposite side of said piston, means for supplying fluid pressure to said chamber, a rod adapted to be moved with said controlling valve and having a cam surface thereon, a passage for discharging fluid from said chamber, a manually operable valve for controlling said passage, a valve in said passage and adapted to be actuated by said cam surface, speed responsive means and a pilot valve adapted to be actuated by said speed responsive means and cooperating with said last-mentioned valve to control the discharge of fluid from said chamber.

6. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with said valve and having one side thereof subjected to a substantially constant fluid pressure, a chamber at the other side of said piston, means for supplying fluid pressure to said chamber, a rod connected with said piston having a cam surface thereon, a passage for discharging fluid from said chamber, a manually operable valve for controlling said passage, a sleeve valve having the interior thereof in communication with said passage, means whereby said sleeve valve is moved by said cam surface in accordance with the movements of said controlling valve, speed responsive

means and a pilot valve actuated by said speed responsive means and cooperating with said sleeve valve to control the discharge of fluid through said passage.

7. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with said valve and having one side thereof subjected to a substantially constant fluid pressure, a chamber at the opposite side of said piston, means for supplying fluid pressure to said chamber, a rod connected with said piston and having a cam surface thereon, a passage for discharging fluid from said chamber, a sleeve valve arranged in said passage, means whereby said sleeve valve is actuated by said cam surface, speed responsive means, and a pilot valve slidable on the exterior of said sleeve valve and cooperating with the latter to control the discharge of fluid through said passage.

8. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with said valve and having one side thereof adapted to be subjected to a substantially constant fluid pressure, a chamber at the other side of said piston, means for supplying fluid pressure to said chamber, a passage for discharging fluid from said chamber, a sleeve valve having the interior thereof in communication with said passage and provided with a wall at one end thereof, means for moving said sleeve valve in accordance with the movements of said controlling valve, speed responsive means, and a pilot valve adapted to be actuated by said speed responsive means and cooperating with said sleeve valve to control the discharge of fluid through said passage and to retard the movements of said speed responsive means.

9. In a speed controlling mechanism, the combination of a controlling valve, a piston connected with said valve and adapted to have one side thereof subjected to a substantially constant fluid pressure, a chamber at the other side of said piston, means for supplying fluid pressure to said chamber, a passage for discharging fluid from said chamber, a rod adapted to be moved with said controlling valve and having a cam surface thereon, a sleeve valve having the interior thereof in communication with said passage and provided with an end wall, means whereby said sleeve valve is moved by said cam surface, speed responsive means, a pilot valve adapted to be actuated by said speed responsive means and cooperating with said speed valve to control the discharge of fluid through said passage and to retard the movements of said speed responsive means, and manually operable valves adapted to control the flow of pressure fluid to and from said chamber.

10. In a speed controlling mechanism, the combination of a controlling valve, a piston

connected with said valve and adapted to have one side thereof subjected to a substantially constant fluid pressure, a chamber at the other side of said piston, means for supplying fluid pressure to said chamber, a passage for discharging fluid from said chamber, a rod adapted to be moved with said controlling valve and having a cam surface thereon, a sleeve valve having the interior thereof in communication with said passage and provided with an end wall, means whereby said sleeve valve is moved by said cam surface, speed responsive means, a pilot valve adapted to be actuated by said speed responsive means and cooperating with said sleeve valve to control the discharge of fluid through said passage and to retard the movements of said speed responsive means, manually operable valves adapted to control the flow of pressure fluid to and from said chamber, and a manually operable device connected with said rod and adapted to move said controlling valve.

11. In an apparatus of the class described, the combination of a controlling valve, fluid pressure means for moving said controlling valve, speed responsive means, and valve means for controlling said fluid pressure means, said valve means comprising a sleeve having ports therein whereby fluid may be discharged from said fluid pressure means through said sleeve, a pilot valve adapted to be actuated by said speed responsive means and slidable on the exterior of said sleeve, said pilot valve being provided with ports adapted to register with ports in said sleeve when said speed responsive means is in operation and being also provided with means adapted to close the ports in said sleeve when said speed responsive means ceases to operate.

12. In an apparatus of the class described, a controlling valve, fluid pressure means for actuating said controlling valve, speed responsive means, and valve means actuated by said speed responsive means and said fluid pressure means for controlling the latter and comprising a sleeve having axially spaced ports and a valve slidable on the exterior of said sleeve and adapted to control one of said ports, said valve having a port adapted to register with said sleeve port when said speed responsive means is in operation and being adapted to close said sleeve port when said speed responsive means is out of operation.

13. In an apparatus of the class described, the combination of a controlling valve, fluid pressure means for operating said valve, and means for controlling said fluid pressure means and comprising, a tubular valve having axially spaced ports extending through its wall and a tubular valve concentrically arranged with respect to said first-men-

tioned valve and provided with an opening through its wall and spaced from the ends thereof and adapted to cooperate with one of the ports of said first-mentioned tubular valve.

14. In an apparatus of the class described, the combination of a valve, fluid pressure means for operating said valve and valve means for controlling said fluid pressure means and comprising a tubular valve having a wall at one end thereof and axially spaced ports, and a second tubular valve slidable on the exterior of said first-mentioned valve and having an end wall adapted to cooperate with the end wall in said first-mentioned tubular valve to form a closed chamber, and a port extending through said second-mentioned tubular valve and adapted to establish communication between said chamber and the exterior of said second-mentioned valve.

15. In an apparatus of the class described, the combination of a controlling element, fluid pressure means for operating said controlling element, and valve means for controlling said fluid pressure means and comprising a tubular valve having a closed end and axially spaced ports, a cup-shaped valve concentrically arranged on the exterior of said first-mentioned valve and cooperating with the end wall of the latter to form a chamber, and a port extending through the wall of said cup-shaped valve and establishing communication between said chamber and the exterior of said valve.

16. In an apparatus of the class described, the combination of a controlling element, fluid pressure means for operating said element, and valve means for controlling said fluid pressure means and comprising a casing, a plurality of chambers in said casing, a tubular valve movable in said casing and having an end wall and ports establishing communication between the interior of said valve and said chambers, a cup-shaped valve in one of said chambers slidable on the exterior of said tubular valve and cooperating with the end wall of said tubular valve to form a dash pot, a port establishing communication between the interior of said dash pot and the chamber in which said cup-shaped valve is arranged, and an outlet port from said chamber arranged above said last-mentioned port whereby fluid will be maintained in said dash pot at all times.

17. In an apparatus of the class described, the combination of a controlling element, fluid pressure means for operating said controlling element, and valve means for controlling said fluid pressure means and comprising a casing having a plurality of chambers therein, a tubular valve having an end wall in one of said chambers and having ports establishing communication between

the interior of said valve and said chambers, a cup-shaped valve slidably arranged on the exterior of said tubular valve and cooperating with the end wall of the latter
5 to form a dash pot, a port through the wall of said cup-shaped valve establishing communication between said dash pot and the chamber in which said valve is arranged, and an outlet port from said chamber ar-

ranged above said last-mentioned port 10 whereby said dash pot will be supplied with fluid at all times.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM A. DOBLE.

Witnesses:

ARTHUR L. BRYANT,
JOHN M. COTT.