No. 680,701. Patented Aug. 20, 1901.

F. C. CURTIS.

SPEED REGULATOR.

(Application filed Jan. 16, 1901.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 2.

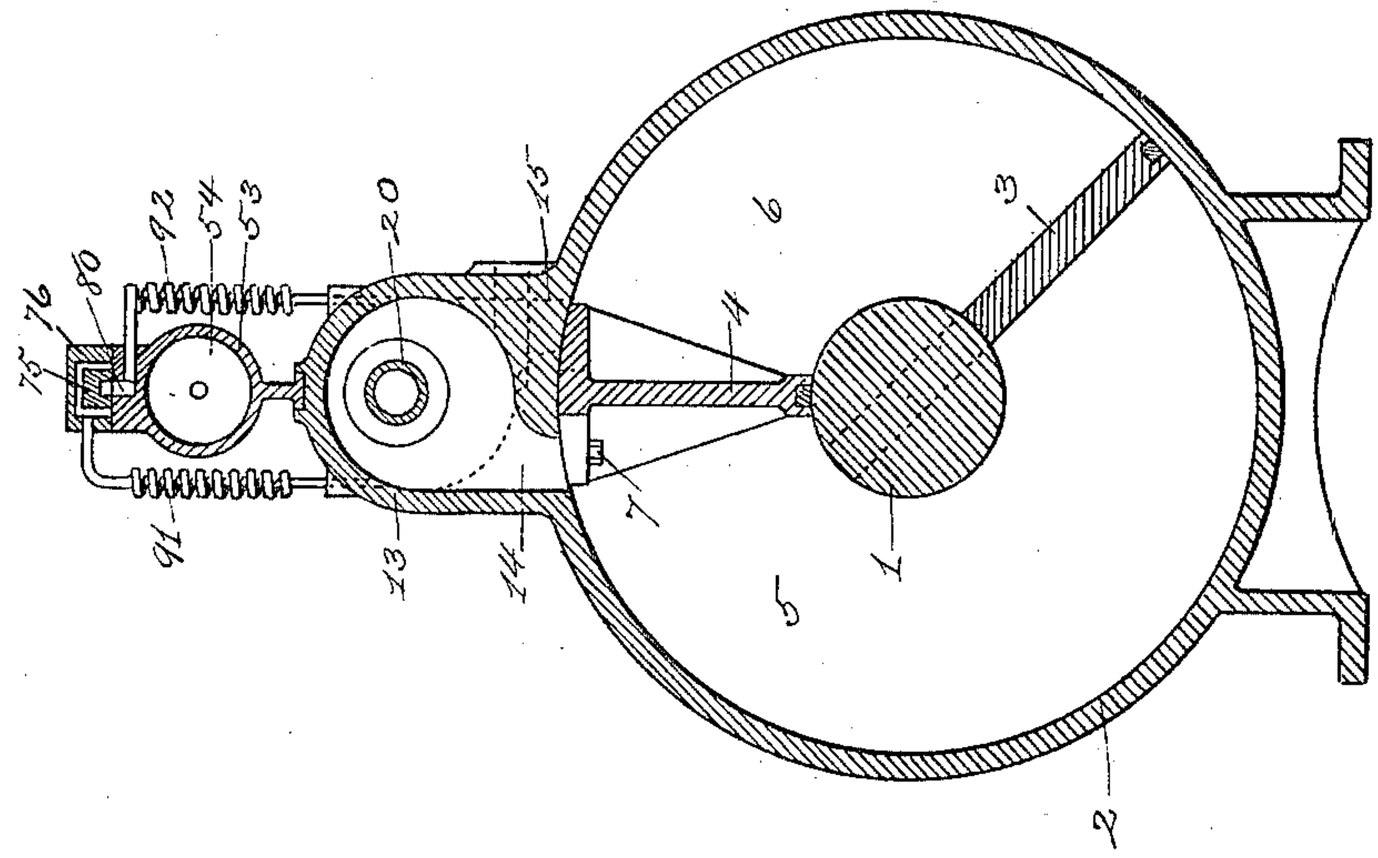

Fig. 1.

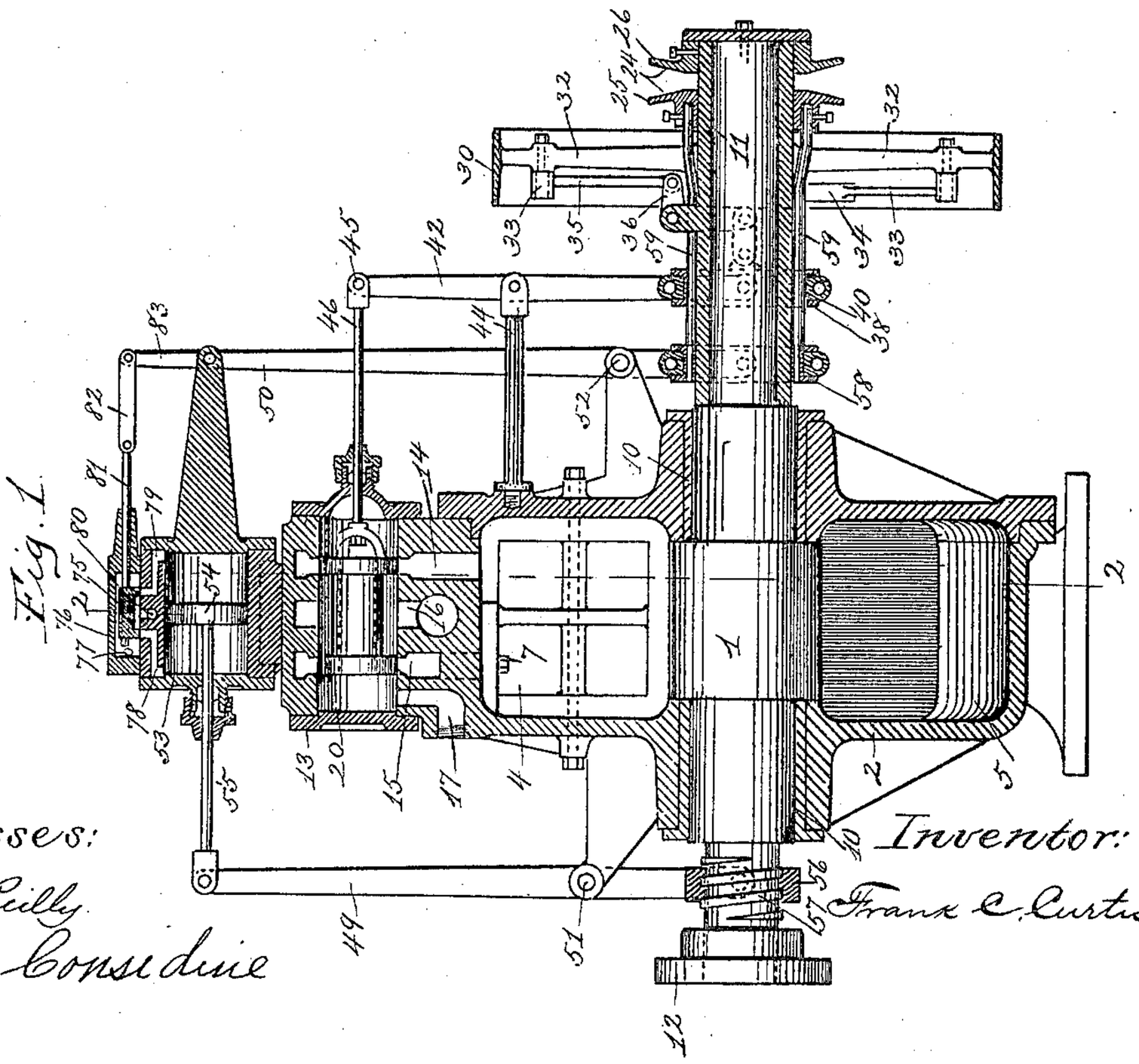

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Fig. 3.

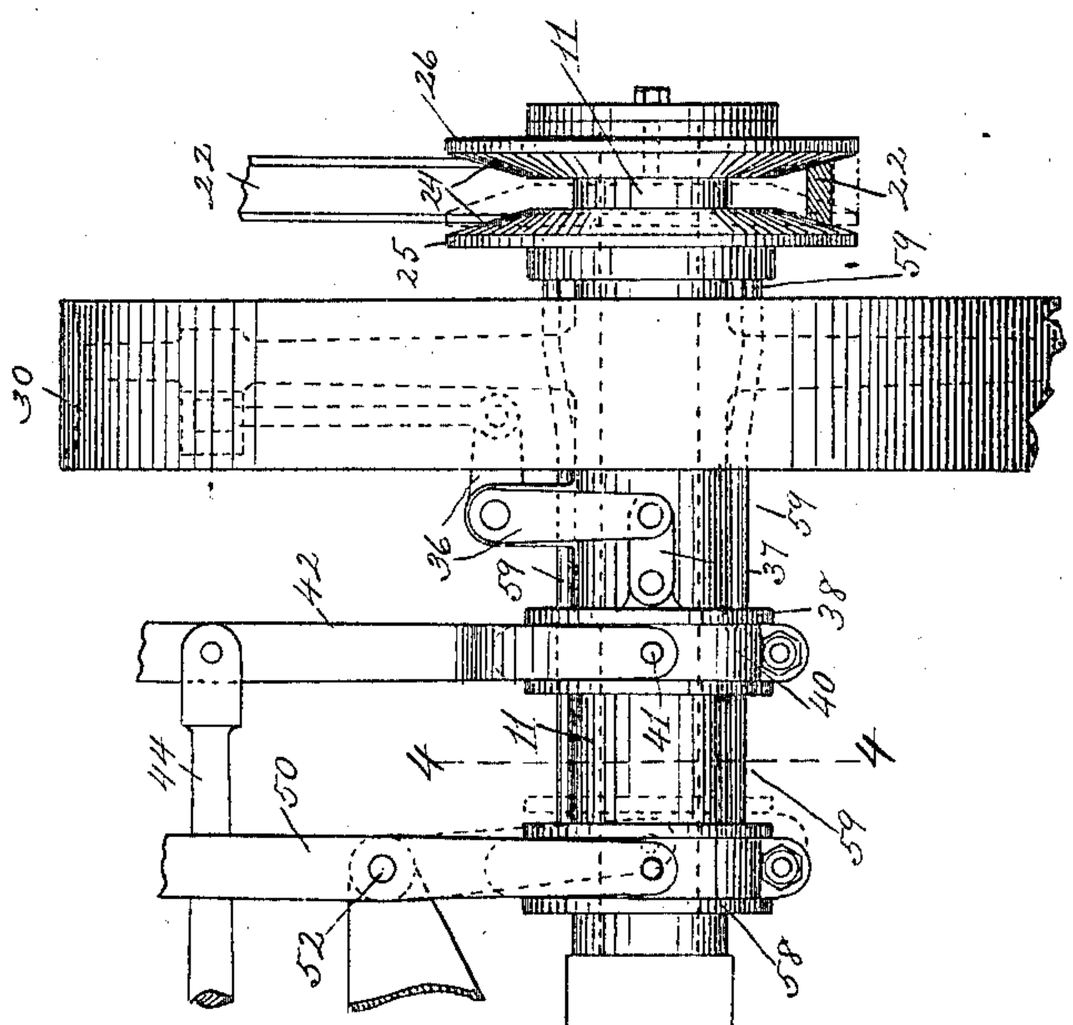


Fig. 5.

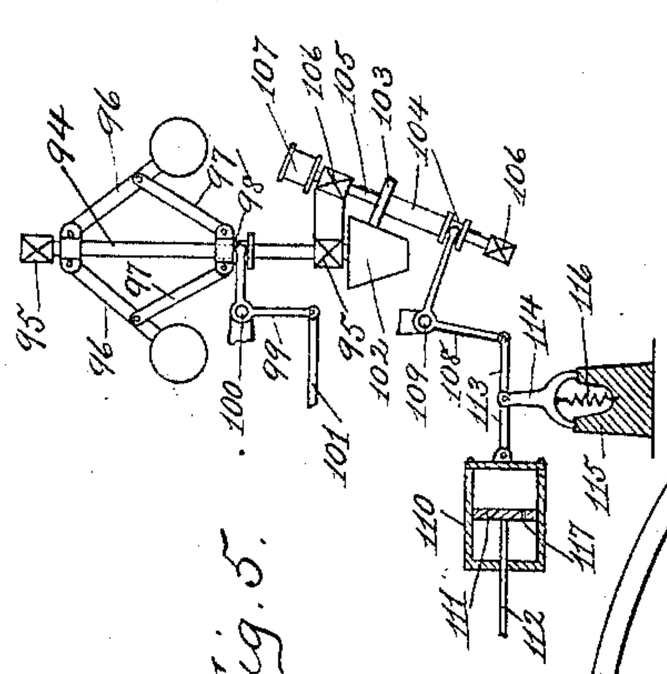
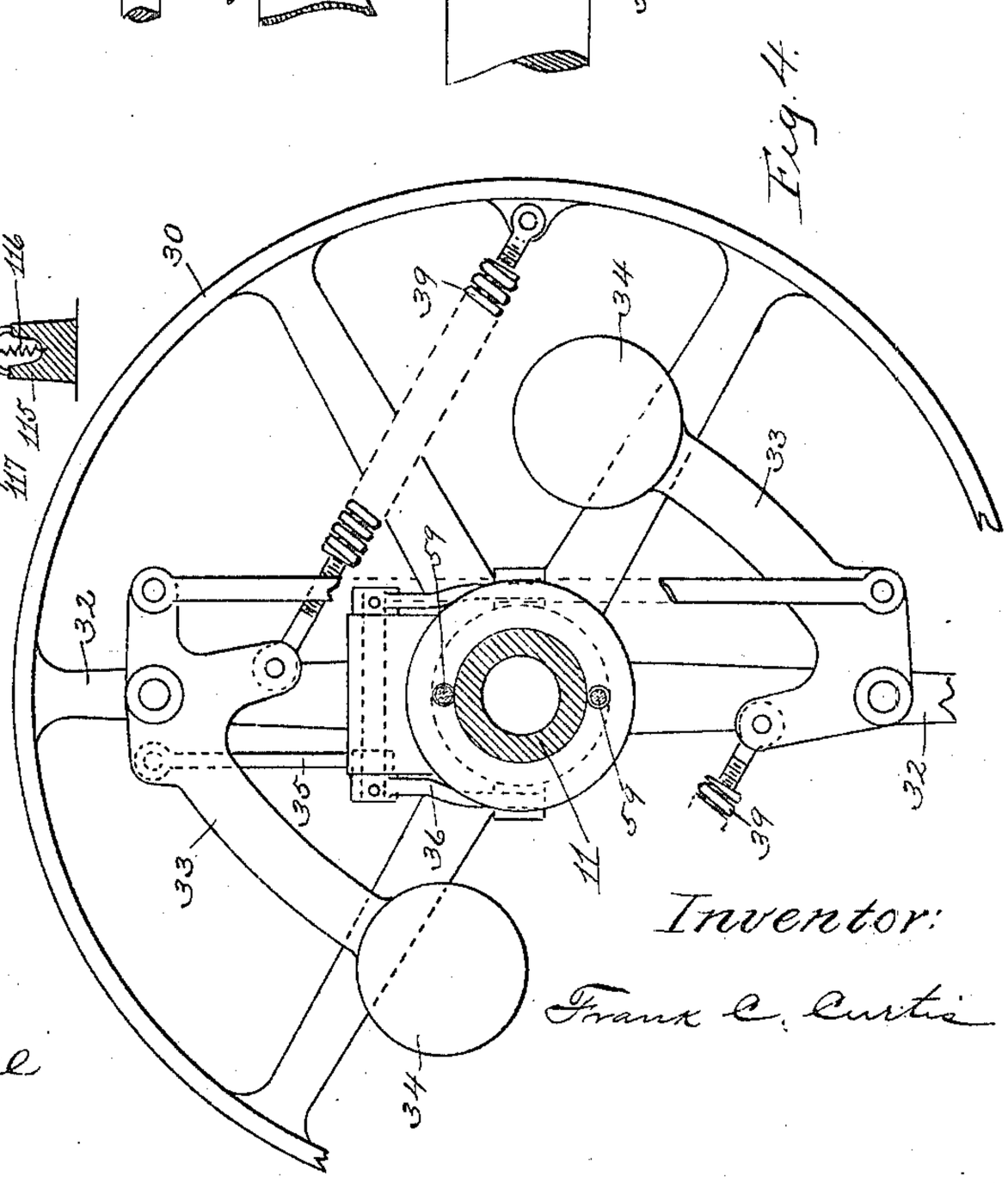


Fig. 4.



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UNITED STATES PATENT OFFICE.

FRANK C. CURTIS, OF TROY, NEW YORK, ASSIGNOR TO THE STURGESS GOVERNOR ENGINEERING COMPANY, OF SAME PLACE.

SPEED-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 680,701, dated August 20, 1901.

Application filed January 16, 1901. Serial No. 43,465. (No model.)

To all whom it may concern:

Be it known that I, FRANK C. CURTIS, a citizen of the United States, residing at Troy, county of Rensselaer, and State of New York, have invented certain new and useful Improvements in Speed-Regulators, of which the following is a specification.

The invention relates to such improvements; and it consists of the novel construction and combination of parts hereinafter described and subsequently claimed.

Reference may be had to the accompanying drawings, and the reference characters marked thereon, which form a part of this specification.

Similar characters refer to similar parts in the several figures.

My invention is applicable to various kinds of fluid-operated motors or prime movers, and is more particularly adapted to hydraulic motors, such as water-wheels, the supply to which is regulated by a gate or the like. Such motors do not respond promptly to variations in their fluid-supply on account of the inertia of the fluid and the moving parts, so that in regulating the speed of such a motor the motor itself cannot be relied upon to induce by its return to normal speed inaction of the gate-operating mechanism after action of the same has been induced by a departure of the motor from normal speed, because before said inertia could be overcome and the normal speed of the motor restored an excessive movement would have been imparted to the gate which would cause such a variation in the fluid-supply as to impart to the motor abnormal speed as soon as said inertia was overcome, causing almost continuous excessive fluctuation of the apparatus.

The object of my invention is to induce inaction of the gate-operating mechanism by varying the rotary speed of the centrifugal governor relatively to that of the motor after the governor in its normal speed relation to the motor and in response to an abnormal rate of speed of the motor has induced action of said mechanism.

A further object of my invention is to gradually restore the normal speed relation of the governor and motor after inaction of the gate-operating mechanism has been so induced without thereby affecting the speed of the governor.

Referring to the drawings, Figure 1 is a view in central vertical longitudinal section of a speed-regulator embodying my invention. Fig. 2 is a vertical cross-section of the same, taken on the broken line 2 2 in Fig. 1. Fig. 3 is a view in elevation, on an enlarged scale, of the parts shown at the right-hand end of Fig. 1. Fig. 4 is a view in cross-section taken on the broken line 4 4 in Fig. 3, showing the centrifugal governor in elevation, partly broken away. Fig. 5 is a view, partly in section and partly in elevation, of a modified form of mechanism.

I have shown as a preferred form of gate-operating mechanism a gate-controller comprising a rock-shaft 1, contained in a cylindrical inclosure 2, having its axial line coincident with the axial line of the cylindrical inclosure and provided with a radial leaf-piston 3, fixed thereon and extending from the shaft to the cylindrical wall of the inclosure. The inclosure is also provided with a fixed partition 4, radial to the shaft and extending from the shaft to the cylindrical wall of the inclosure, so that such partition, together with the leaf-piston and shaft, divides the inclosure into two chambers 5 and 6. The fixed partition is secured to the wall of the inclosure by means of the bolts 7. The shaft is provided with suitable bearings 10 in the end walls of the inclosure. One end of the shaft projects through the end wall beyond its bearings and is provided with a flange 12 for connecting the shaft with the gate of the water-wheel (not shown) in the usual well-known manner.

Mounted upon the cylinder 2 is a cylindrical inclosure 13 for a hollow distributing-valve 20, the valve-inclosure being connected with chamber 5 through port 14 and with chamber 6 through a similar port 15, (indicated by dotted lines in Fig. 2,) and with an inlet-port 16, leading from a fluid-pressure supply (not shown) and extending around the valve 20, also with an exhaust-port 17. When fluid under pressure is admitted through port 14 into chamber 5, the fluid-pressure upon the piston 3 causes the piston and rock-shaft to oscillate, the piston traveling in a direction

toward the right hand, as seen in Fig. 2, the fluid contained in chamber 6 being forced from such chamber through the other port 15 into the valve-inclosure and from thence through the exhaust-port 17 outside of the inclosure, and when fluid under pressure is admitted through port 15 into chamber 6 the piston is caused to oscillate and travel in the opposite direction, the fluid in chamber 5 being forced back through port 14 into the valve-chamber and out through the hollow valve and the exhaust-port 17, thereby causing the piston to act as a rock-lever on the rock-shaft to impart to the shaft an oscillatory motion adapted to move the gate of a water-wheel or the like in either of two opposite directions to open or close the same, and thereby increase or diminish the water-supply to the water-wheel. The fluid under pressure can be supplied to the chambers 5 and 6 alternately by operating said valve in the usual manner. The valve is automatically operated by a centrifugal governor 30, which may be of any known form and connected with the prime mover (not shown) or machinery operated thereby.

In the form of governor shown in Figs. 1, 3, and 4 inside the rim of the governor and pivoted to the spokes 32 are levers 33, provided with weights 34 on one arm and links 35 on the other arm, connected, respectively, with one arm of the bell-crank lever 36, and the other arms of the bell-crank lever being connected by link 37 with the sleeve 38 rotary with the governor. The outward throw of the weights 34 may be controlled by means of coiled springs 39. The sleeve 38 is provided with an annular channel adapted to receive a ring 40, having on its opposite sides pivot-studs 41, upon which is pivoted the bifurcate end of lever 42. The other end of lever 42 is pivotally connected at 45 with the valve-stem 46, and the lever is fulcrumed upon the stud 44. The centrifugal governor being connected so that the rotary movements of the motor will be transmitted thereto and the parts being so adjusted that when the governor is rotated at a predetermined normal speed corresponding with the desired normal speed of the motor a closed position of the valve 20 will be thereby induced. It will be apparent that any deviation of the governor from its normal speed will cause a movement of said valve which will admit fluid under pressure to one side or the other of the piston 3 to operate in the proper direction the gate-shaft and gate which controls the supply to the motor. Any variation in the speed of the motor due to a variation in load will thus induce through the governor action of the gate-operating mechanism and gate to affect the supply, which would eventually cause the motor and governor to return to normal speed; but the abnormality of speed is not immediately corrected on account of inertia, as above stated. It is necessary, therefore, to provide some means other than the motor for closing the distributing-valve before the controller has acted upon the gate a sufficient length of time to open or close it fully or more than was necessary to restore the normal speed of the motor. The mechanism for accomplishing this result comprises the principal feature of my invention and consists of means for varying the rotary speed of the governor in advance of and in accordance with a governor-induced variation in speed of the motor. This I accomplish by interposing between the motor and governor a variable-gear connection and connecting an adjustable member thereof with the gate-operating mechanism.

As a preferred form of variable gear, I have shown a pair of disks 25 and 26, mounted upon the sleeve 11, which supports the centrifugal governor, said disks having their adjacent sides beveled and adapted to receive between them a motor-driven belt 22, having its edges similarly beveled. One of the disks 25 is capable of movement toward and from the other upon the sleeve 26 and may be connected in any known manner with the gate-operating mechanism to cause the movements of the gate-operating mechanism to induce movements of said disk 25 toward and from the disk 26. Such movements of the disk 25 will cause the belt 22 to engage portions of the beveled disks of differing diameters and vary the speed relation of the governor relatively to the motor. As a means for connecting the variable gear with the gate-operating mechanism I have shown a pair of levers 49 and 50, fulcrumed, respectively, at 51 and 52 upon fixed supports and connected at their upper ends by a link comprising the members 53 54 55, the lever 49 being connected at its lower end with a nut 56, fitting a screw-threaded portion 57 of the gate-shaft, and the lever 50 being connected at its lower end with the sleeve 58, free to slide longitudinally of the sleeve 11 and connected by links 59, passing through the sleeve 38 and between the spokes of the centrifugal wheel, with the movable disk 25. The link comprising the members 53 54 55 being considered as a rigid element, it will be seen that a rocking movement of the gate-shaft in one direction will cause the belt-receiving space between the beveled disks to be widened, and an opposite movement of the gate-shaft will cause the space between said disks to be contracted, causing the speed of the governor relatively to that of the motor to be increased or diminished accordingly and this in advance of the variation in speed induced in the motor by such movement of the gate-operating mechanism and gate. The speed of the governor is thus restored to normal and caused to induce inaction of the gate-operating mechanism by closing the valve 20 in advance of the restoration of the motor to normal speed as a result of the governor-induced action of such mechanism. This link connecting the levers 49 and 50 comprises,

preferably, a movable fluid-filled cylinder 53, containing a piston 54, fixed upon the piston-rod 55, the cylinder being pivotally connected with one of said levers and the piston-rod with the other. The cylinder being filled with a comparatively non-compressible fluid, as water, the piston remains immovable therein so long as the contained fluid cannot pass from one side of the piston to the other, in which case the several parts act as a rigid connection between said levers for the purposes above stated. The mechanism shown, however, permits of the expansion and contraction of said link by fluid-pressure applied to one side or the other of said piston. In Figs. 1 and 2 I have shown means for expanding and contracting such link consisting of a cut-off valve 75, reciprocatory in the chamber 76, which is connected, as by inlet 77 and coiled pipe 91, with the pressure-supply port 16 of the main valve-cylinder 13. The case of the cylinder 53 is provided with fluid-passages 78 and 79, leading from the pressure-chamber 76 to the piston-chamber on opposite sides of the piston. The chamber 76 is provided with an exhaust-port 80, which may be connected by a coiled pipe 92 with the exhaust-port 17 of the main cylinder. The cut-off valve 75 is connected by stem 81 and link 82 with a projection 83 of the lever 50. It will be seen that any movement of the connected parts which changes the position of the lever 50 from that shown in Fig. 1 will cause a movement of said valve 75, which will admit fluid under pressure to one side or the other of said piston and at the same time open the exhaust to the opposite side of the piston and that the pressure so applied to the piston will cause contraction or expansion of said link in a direction to restore the lever 50 to its normal position and at the same time to gradually restore the valve 75 to a closed position. This expansion or contraction of said link is contemporaneous with the gradual return of the motor to normal speed as the inertia is overcome and the expansion or contraction of the link causes the beveled disk 25 to be so moved as to neutralize the function of the motor to vary the speed of the governor as the speed of the motor is gradually restored to its normal relation to that of the governor. Action of the gate-operating mechanism having been induced by abnormal speed of the governor caused by abnormal speed of the motor and the governor having been restored to normal speed and thereby having induced inaction of said mechanism before the motor has been restored to normal speed it will be seen that the subsequent variation in speed of the motor in returning to its normal speed will have no effect to vary the speed of the governor or to change the position of the valve 20, so that when the speed of the motor has been restored to its normal relation to that of the governor the several parts will maintain their normal relations until again disturbed by an abnormal demand upon the motor.

The gate-operating mechanism of my improved regulator is always under the direct control of the centrifugal governor, and the position of the valve controlling such mechanism has a definite and fixed relation to the rotary speed of the centrifugal mechanism at all times.

I do not wish to be limited to any specific form of variable-gear mechanism for transmitting motion from the motor to the governor, nor to any specific mechanism for causing the movements of the gate-operating mechanism to actuate the adjustable member of the variable gear.

The expansible and contractible link connection may be of any known form movable as a rigid element in response to the movements of the gate-operating mechanism and contractible and expansible to restore the adjustable member of the variable gear to its normal position.

In Fig. 5 of the drawings I have shown a modified form of the centrifugal governor, variable gear, and expansible and contractible link. The governor-shaft 94 is rotary in fixed bearings 95 and carries the weighted levers 96, connected by links 97 with a sliding sleeve 98. The angle-lever 99 is fulcrumed at 100 upon a fixed support and has one arm connected with said sleeve, and its other arm may be connected with the valve of the gate-operating mechanism in any known manner, as by the link 101. (Shown broken away in part.) The governor-shaft is provided with a conical friction-pulley 102, adapted to be engaged by the friction driving-pulley 103, fixed upon the sleeve 104, feathered upon the shaft 105 and free to slide thereon, said shaft being rotary in fixed bearings 106 and provided with a belt-pulley 107, adapted to receive a motor-driven belt. (Not shown.) An angle-lever 108, fulcrumed at 109 upon a fixed support, has one end engageable with said sleeve 104 and its other end connected with the expansible and contractible link mechanism adapted to connect said lever with the gate-operating mechanism. The expansible and contractible link comprises the fluid-filled cylinder 110 and the inclosed piston 111 with its piston-rod 112, the piston-rod being connected with the angle-lever 108 by the link 113, fixed upon the tilting post 114, which rests upon a fixed support 115, with which it is connected by the controlling-spring 116, which tends to maintain such post in a vertical position thereupon. The piston is provided with a small aperture 117, adapted to permit the fluid contained in the cylinder to pass therethrough from one side of the piston to the other. The cylinder being connected with the gate-operating mechanism it will be seen that the movement of such mechanism will cause the movements of the piston, cylinder, and rod as a substantially rigid element to cause the movements of the adjustable member 103 of the variable gear and at the same time tilt

the post 114 to an inclined position against the force of the spring 116, which tends to restore the post to vertical position, such restoration being permitted by the gradual escape of the inclosed fluid through the aperture 117 from one side of the piston to the other.

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

1. In a speed-regulator, the combination with a governor for controlling the supply to a fluid-operated motor; of a variable-gear connection between said motor and governor; and means for automatically varying said gear at certain times to vary the rotary speed of the governor in accordance with, and in advance of, a governor-induced variation in speed of said motor.

2. In a speed-regulator, the combination with a governor for controlling the supply to a fluid-operated motor; of a variable-gear connection between said motor and governor; means for automatically varying said gear at certain times to vary the rotary speed of the governor in accordance with, and in advance of, a governor-induced variation in speed of said motor; and means for afterward automatically varying said gear to vary the speed of the governor simultaneously with, and in opposition to, the variation so induced in the speed of said motor.

3. In a speed-regulator, the combination with a centrifugal governor for controlling the supply to a fluid-operated motor which operates said governor; of means for automatically varying the rotary speed of said governor in advance of and in accordance with a variation in speed of said motor induced by said governor; and means to automatically counteract the function of said motor to afterward vary the speed of said governor in accordance with the variation so induced in the speed of said motor.

4. In a speed-regulator, the combination with a centrifugal governor for controlling the supply to a fluid-operated motor which operates said governor; of means for automatically imparting to said governor at certain times a variation in its rotary speed in accordance with, and in advance of, a governor-induced variation in the speed of said motor; and means for afterward neutralizing the function of said motor to vary the speed of said governor as the speed of said motor is gradually restored to its normal relation to that of said governor.

5. In a speed-regulator, the combination with a gate or the like controlling the supply to a fluid-operated motor; of a centrifugal governor; a variable-gear connection between said motor and governor; gate-operating mechanism controlled by said governor; an expansible and contractible link connecting said gate-operating mechanism with a movable member of said variable gear; and means for automatically contracting and expanding said link at certain times.

6. In a speed-regulator, the combination with a centrifugal governor for controlling the supply to a fluid-operated motor; of a variable cone-gear for transmitting motion from said motor to said governor; and means for automatically varying said cone-gear to vary the rotary speed of the governor in accordance with, and in advance of, a governor-induced variation in speed of said motor.

7. In a speed-regulator, the combination with a centrifugal governor for controlling the supply to a fluid-operated motor; of a variable cone-gear for transmitting motion from said motor to said governor; means for automatically varying said cone-gear to vary the rotary speed of the governor in accordance with, and in advance of, a governor-induced variation in speed of said motor; and means for afterward automatically varying said cone-gear simultaneously with, and in opposition to, the variation so induced in the speed of said motor.

8. In a speed-regulator, the combination with gate or the like for controlling the supply to a fluid-operated motor; of a centrifugal governor; a variable-gear connection between said motor and governor; gate-operating mechanism controlled by said governor; an expansible and contractible link connection between an adjustable member of said variable gear and the gate-operating mechanism; and means for expanding and contracting said link at certain times.

9. In a speed-regulator, the combination with a gate or the like controlling the supply to a fluid-operated motor; of a centrifugal governor; a variable-gear connection between said motor and governor; gate-operating mechanism controlled by said governor; an expansible and contractible link connection between an adjustable member of said variable gear and the gate-operating mechanism, and comprising a fluid-filled cylinder, piston and rod movable as a rigid element in response to the movements of the gate-operating mechanism, and contractible and expansible to restore the adjustable member of the variable gear to its normal position; and means for positively expanding and contracting said link by fluid under pressure.

10. In a speed-regulator, the combination with a gate or the like controlling the supply to a fluid-operated motor; a fluid-operated gate-controller, and a valve for regulating the fluid-supply to said controller; of a centrifugal governor connected with said valve, a variable-gear connection between said motor and governor; an expansible and contractible link connection between an adjustable member of said variable gear and said gate-controller; and means for automatically expanding and contracting said link at certain times.

11. In a speed-regulator, the combination with a gate or the like controlling the supply to a fluid-operated motor; a fluid-oper-

ated gate-controller; and a valve for regulating the fluid-supply to said controller; of a centrifugal governor connected with said valve; a variable-gear connection between said motor and governor; a fluid-filled cylinder and piston connected one with the gate-controller and the other with an adjustable member of said variable gear; and means for supplying fluid under pressure at certain times to the several sides of said piston.

In testimony whereof I have hereunto set my hand this 14th day of January, 1901.

FRANK C. CURTIS.

Witnesses:
E. M. O'REILLY,
JAMES CONSIDINE,