

No. 639,450

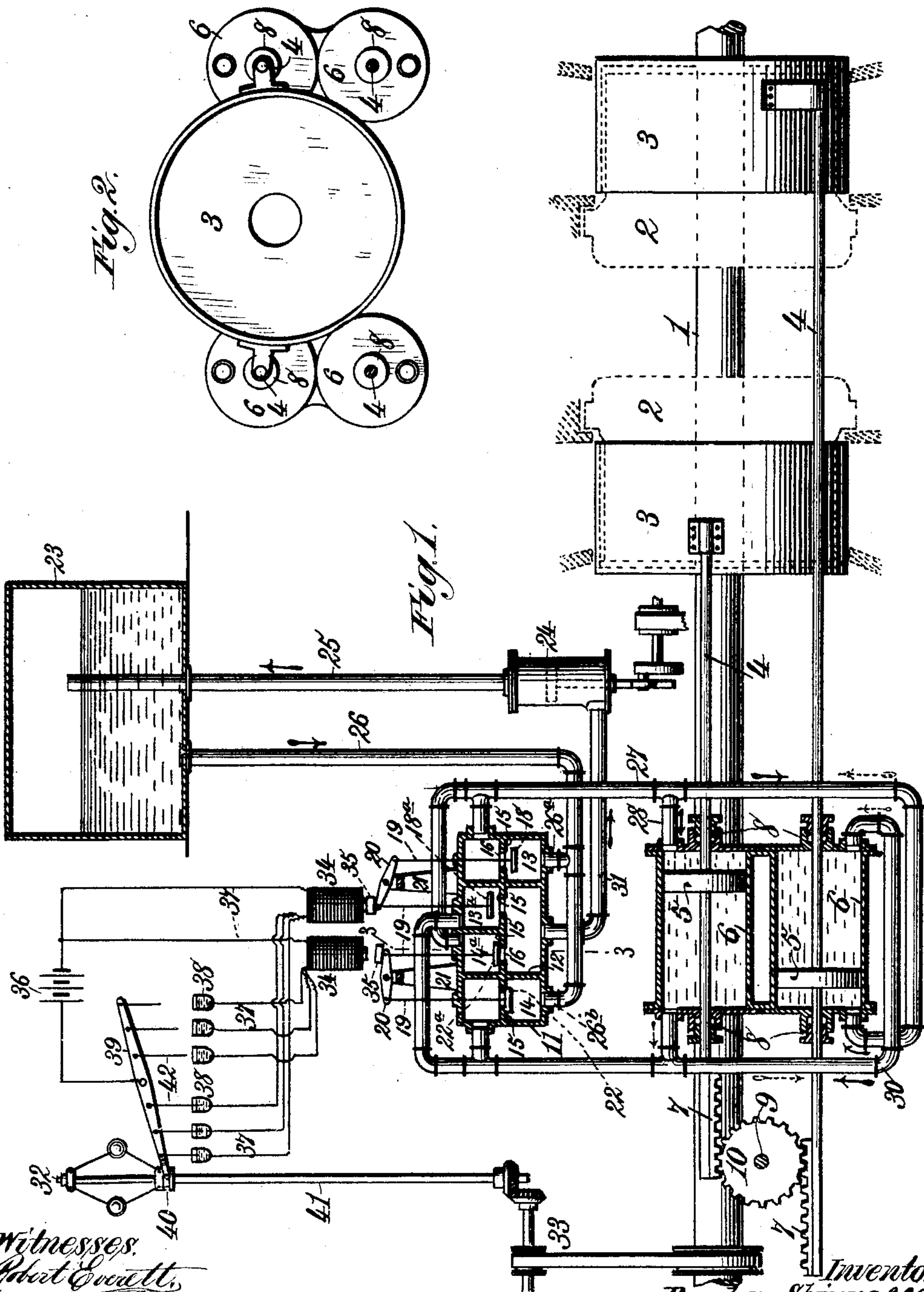
Patented Dec. 19, 1899.

R. SHIRREFFS.  
GOVERNOR MECHANISM.

(Application filed June 20, 1899.)

(No Model.)

2 Sheets—Sheet 1.



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2 Sheets—Sheet 2.

Fig. 3.

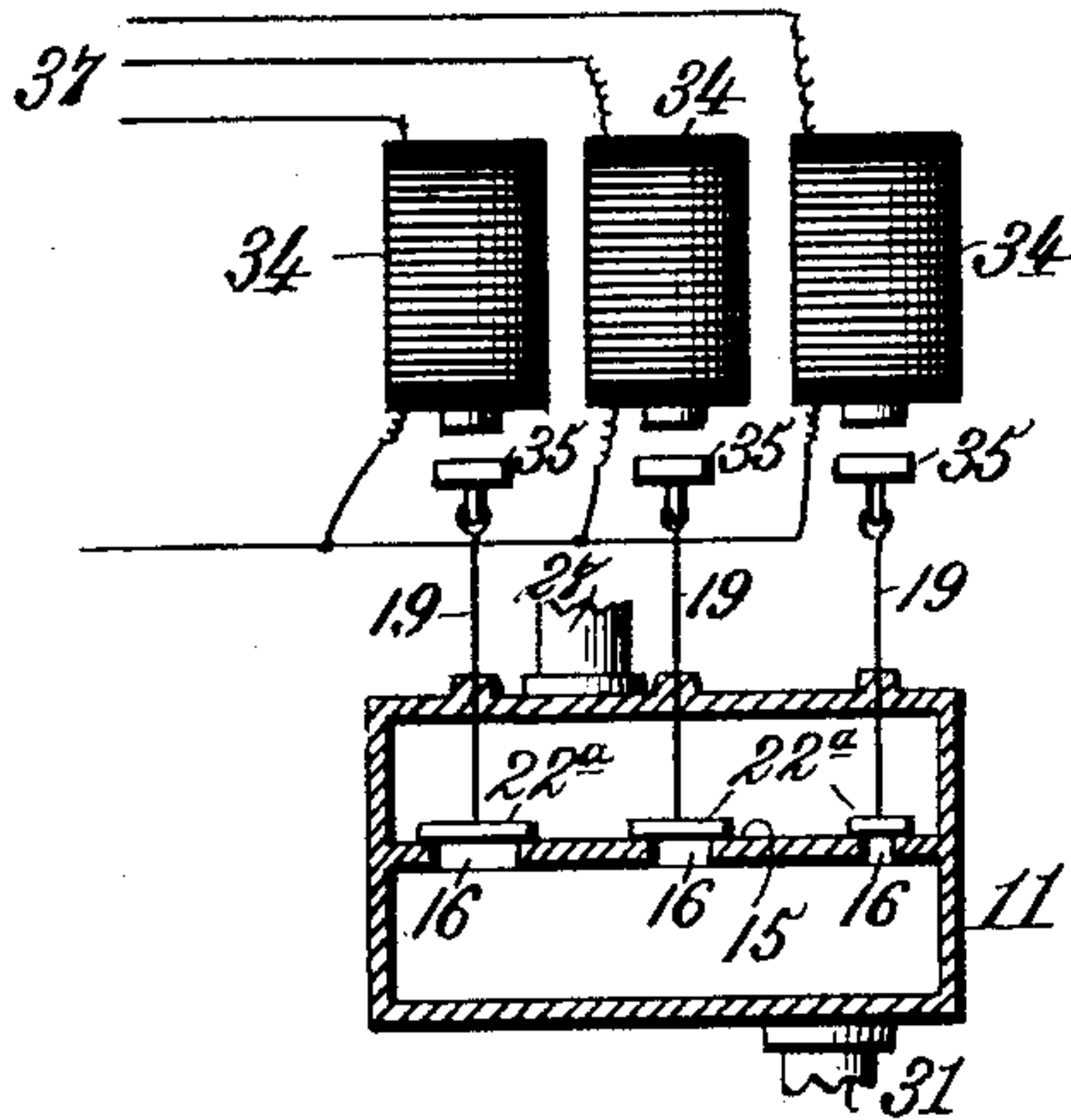
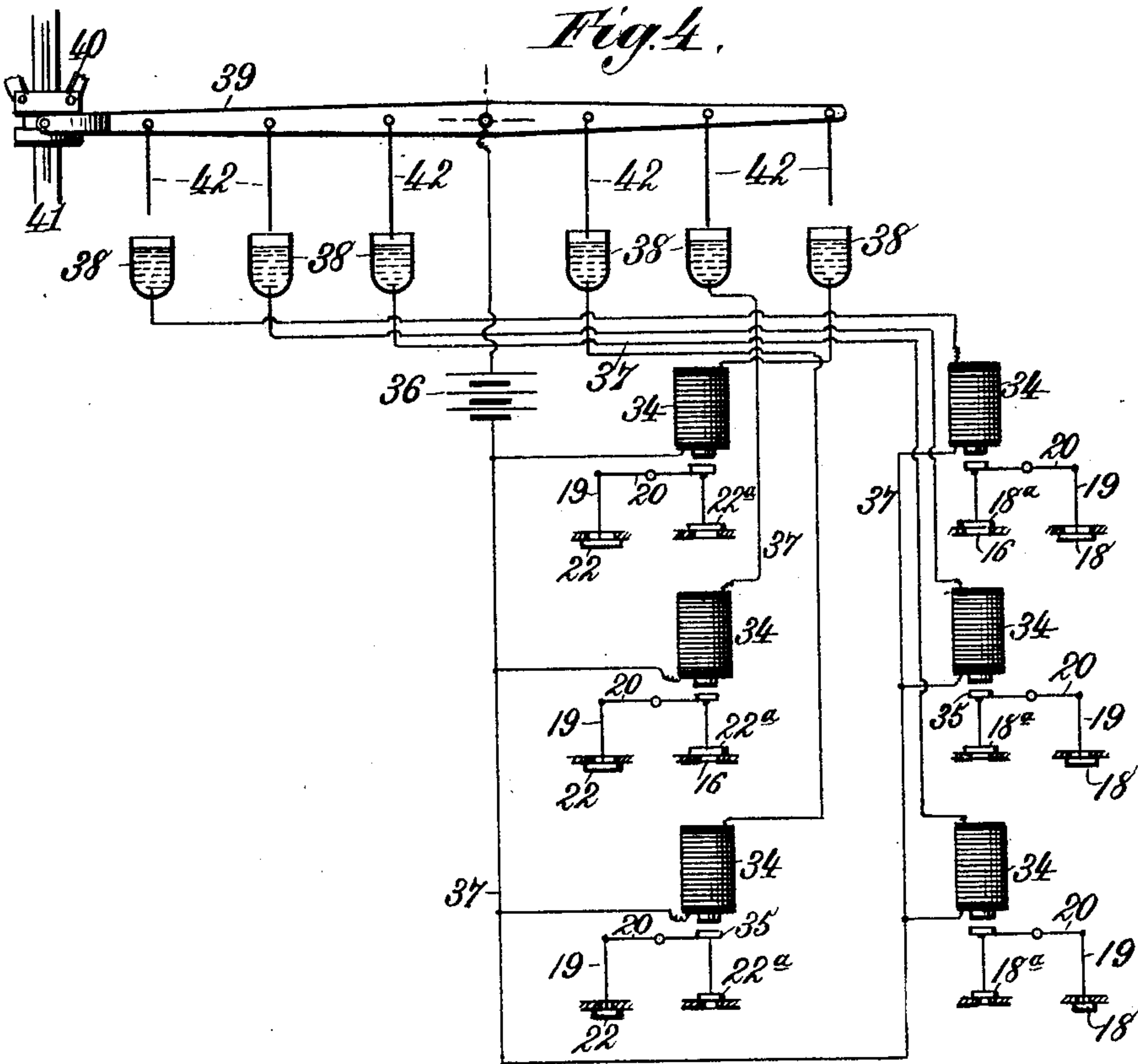


Fig. 4.



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# UNITED STATES PATENT OFFICE.

REUBEN SHIRREFFS, OF RICHMOND, VIRGINIA.

## GOVERNOR MECHANISM.

SPECIFICATION forming part of Letters Patent No. 639,450, dated December 19, 1899.

Application filed June 20, 1899. Serial No. 721,254. (No model.)

*To all whom it may concern:*

Be it known that I, REUBEN SHIRREFFS, a citizen of the United States of America, residing at Richmond, in the county of Henrico and State of Virginia, have invented certain new and useful Improvements in Governor Mechanism, of which the following is a specification.

My invention relates to improvements in governor mechanism chiefly intended for governors for water-wheels, and particularly, though not exclusively, adapted for side-supply turbine water-wheels. My improved governor is also adapted for use in connection with steam-engines for controlling the valves thereof.

The object of the invention in connection with water-wheels is to provide governor mechanism of novel construction and mode of operation capable of delicate operation to correct the slightest deviation of the wheel from normal speed and exerting progressively-increased force according to the degree of the deviation from the normal speed, and for this purpose operating to open and close the gates of the water-wheel smoothly and without shock or jar and with great accuracy opening or closing the gates to just the degree required to correct the evil. When employed in connection with steam-engines, the governor will perform the usual functions in a novel and improved manner.

To these ends the invention consists in the novel construction, combination, arrangement, and mode of operation of parts, as hereinafter described, and pointed out in the appended clauses of the claim, reference being made to the accompanying drawings, wherein—

Figure 1 is a view, partly in elevation and partly in central section, illustrating mechanism embodying my invention. Fig. 2 is a view looking at the face of the water-gates and showing the manner of their connection with the rods for opening and closing them. Fig. 3 is a cross-sectional view of the valve-chest on the line 3 3 of Fig. 1, illustrating the electromagnets for operating the valves. Fig. 4 is a diagrammatic view showing the electromagnets, the circuits thereof, and the contact-lever for making and breaking the circuits.

In the drawings I have illustrated and will

now describe the best embodiment now known to me of my invention, and in which the governor mechanism is arranged in connection with a two-turbine-water-wheel installation wherein the wheels are arranged on a horizontal shaft; but I desire it understood that the essence of my invention may be embodied in arrangements adapted for use with water-wheels of other construction or in connection with a single side-supply turbine wheel or wheels arranged on a vertical shaft to have a horizontal rotation. The governor is adapted, furthermore, for application to steam-engines.

I do not confine myself to the particular details of construction and arrangement hereinafter described otherwise than as specifically set forth in the claims.

In the said drawings the reference-numeral 1 indicates the shaft of the water-wheels, 2 the water-wheels, which are conventionally illustrated in dotted lines, and 3 the gates of the water-wheels. As these parts in themselves constitute no part of my invention, they need not be more fully shown or referred to. The said gates 3 are capable of movement longitudinally of the shaft to regulate the admission of water to the turbine wheels, increasing or diminishing the supply automatically, according to the increase or decrease of the speed of the water-wheels as compared with the normal speed thereof. The gates are so moved through the medium of rods 4, connected thereto, as shown, and provided with piston-heads 5, located in and adapted to traverse the piston-cylinders 6. The piston-rods extend out of the cylinders and have their free ends provided with racks 7, and said rods pass through stuffing-boxes 8, carried by the cylinder-heads, to afford fluid-tight packings. Mounted upon a counter-shaft 9 are gear-wheels 10, only one of which is shown, which mesh with the racks 7 of the piston-rods to cause said rods and the water-gates connected therewith to move in precision and equally.

The numeral 11 indicates a single valve-chest divided in the example shown by partitional walls 12 into four valve-chambers 13 13<sup>a</sup> and 14 14<sup>a</sup>, the valve-seats being indicated by the numeral 15, three valve-seats being arranged in each valve-chamber in alinement



and graded in area to form graded ports 16, as illustrated in Fig. 3 of the drawings.

As will hereinafter fully appear, the valves arranged in the two right-hand valve-chambers 13 13<sup>a</sup> operate to admit the motive fluid to throw the pistons to open the gates and increase the supply of water thereto and to exhaust from the opposite sides of said pistons, and those valves 22 22<sup>a</sup> arranged in the two left-hand chambers operate to admit the fluid to the pistons in the reverse direction to close the gates and decrease the supply of water to the wheel and to exhaust from the opposite sides of said pistons.

The numerals 18 18<sup>a</sup> designate the valves disposed in the two valve-chambers 13 13<sup>a</sup> at the right of Fig. 1, 18 being the inlet-valve for the motive fluid and 18<sup>a</sup> the exhaust-valve. The valves are arranged in pairs—inlet and exhaust—pivotally connected by stems 19 to the opposite ends of tilting arms 20, carried by posts or pedestals 21 on the valve-chest, and in the example illustrated are disposed in series of three pairs, the valves being in alinement and graded in size to correspond with the areas of the ports 16, as clearly shown in Fig. 3. The numerals 22 22<sup>a</sup> indicate a similar series of valves arranged in the valve-chambers 14 14<sup>a</sup> at the left of the valve-chest in Fig. 1, the numeral 22 indicating the fluid-inlet valve and the numeral 22<sup>a</sup> the exhaust-valve. These valves are mounted in pairs in like manner to the valves 18 18<sup>a</sup> and are graded in size to cover the graded ports also in like manner to said valves 18 18<sup>a</sup>.

The numeral 23 indicates a closed tank or reservoir for the storage of the motive fluid, which may be water, oil, or air or other fluid under pressure. The pressure is maintained by a suitable pump 24, conventionally shown in the drawings. This tank 23 is an elevated one, and it is possible under some conditions, where water or oil is the motive fluid employed, that there will be sufficient head or drop to perform the operation required thereof, the pump serving to supply the tank with water or oil, as will be apparent. I prefer, however, a closed tank and to have the motive fluid under pressure. The conduit from the pump to the tank is indicated by the numeral 25. A pipe or conduit 26 leads from the tank or reservoir to conduct the motive fluid to the valve-chest and thence to pass to actuate the pistons and the gates carried thereby when required by the operation of the governor. The pipe or conduit opens into the valve-chest at the outside chambers 13 and 14, as shown at 26<sup>a</sup> and 26<sup>b</sup>.

By arranging or grouping the valves in a single valve-chest, as described, I am enabled to simplify the construction and operation, since, as shown, it is necessary to employ but two pipes for conducting the motive fluid to the pistons for operation thereof and also to exhaust. The piston-cylinders are, even when the water-wheel is moving at normal

speed, kept full of the motive fluid, and this results in a cushioning, as it were, of the pistons, whereby they are steadied or supported on both their sides. This is accomplished by connecting together the inlet and exhaust valves, as shown. The course pursued by the motive fluid when the valves 18 18<sup>a</sup> are opened, as shown at the right hand of Fig. 1, to actuate the pistons to open the water-gates when the speed of the wheel is below normal, and thus increase the supply of water to raise the speed to normal, is indicated by the full-line arrows, the course being from pressure-tank 23 through conduit 26, past the valve 18, and through pipe 27, one part going through the mouth 28 of said pipe and entering in front of one piston 5, forcing the same to the left and opening the gate connected therewith. Another part of the motive fluid continues through the pipe 27 and enters behind the other piston 5, forcing it to the right and opening the gate to which its rod is connected. The course of exhaust from a supposed previous and opposite movement of the pistons is also indicated by the full-line arrows, the same being from the piston-cylinders into the pipe 30, past the valve 18<sup>a</sup>, and to the pump through the pipe 31, whence it is again forced into the tank for future use. Should the speed of the water-wheel be too great, the governor, operating as hereinafter described, will close the valves 18 18<sup>a</sup> and open the valves 22 22<sup>a</sup>, when the travel of the motive fluid will be in the reverse direction to that described, and consequently operating the pistons in the reverse direction to close the gates, the then course being indicated by the dotted-line arrows and the exhaust being also indicated by arrows in dotted lines. When the motive fluid enters at one side of the pistons, it will be observed that the exhaust from the opposite side is a forced one, or, in other words, the exhaust fluid is forced or driven by the piston through the exhaust-port in the valve-chest, which is arranged above the piston-cylinder. The valves are controlled for the function thus ascribed to them by a novel mechanism operated by the governor, as will be now referred to.

An ordinary ball or similar governor is conventionally shown and indicated by the numeral 32, its specific construction not being important to this invention, and any suitable centrifugal governor may be employed. The governor is driven from the shaft of the water-wheel in any convenient manner, such as a belt-and-gear connection 33. Electromagnets 34 are arranged in two series in coöperative relation to the valves, each series comprising in the present example three electromagnets, the armatures 35 of which are carried by the tilting valve-arms 20, so that when energized the attraction of the armatures by the magnets will operate to open the corresponding pair of valves, and when the magnets are de-energized the weight of the armatures, which are carried at one end of the tilting arms, will



operate to close said valves. When the governor is moving at normal speed, all the valves are of course in closed position against their seats and by reason of the manner of their coupling in pairs are practically balanced, so that their operation is much facilitated.

The numeral 36 indicates a battery which I prefer to employ, though I do not restrict myself thereto, as other source of electrical energy may be adopted within the scope of my invention. To this battery are connected one terminal of the windings 37 of each electromagnet employed, the other terminals being connected to mercury-cups 38. Suitably pivoted on a support (not shown) is a contact-lever 39, one end of which is connected with a ring 40, freely movable up and down upon the governor-staff 41, according to the speed of the governor, and this connection operates to tilt the contact-lever in one or the other direction. The lever is in electrical connection with the battery and carries two series of contact-wires 42, arranged on opposite sides of its fulcrum-point and adapted, according to the direction and degree of tilt of the lever, to make and break contact with one or more of the corresponding series of mercury-cups, and thus make and break the energizing-current through the magnet-windings whose terminals are connected to said mercury-cups. As shown, these contact-wires are of different lengths, in order that they may successively make contact with the mercury-cups, whereby the valves of either series 18 18<sup>a</sup> or 22 22<sup>a</sup> may be opened in succession, according to the demand made for piston-actuating motive fluid by the speed of the governor, which, as stated, receives its movement from the water-wheel shaft.

As hereinbefore stated, the valve-ports and the valves in each set or series are graded in size in order to admit passage of a greater or less quantity of the motive fluid, and it is designed, as illustrated, that contact shall first be made with the mercury-cup in circuit with that magnet which controls the valve closing the port of least area, and this is desirable, first, because the supply of motive fluid afforded by a port of least area may be sufficient to correct the speed of the water-wheel, and, secondly, in cases where it is not sufficient such supply will serve at all events to start the movement of the piston, whereupon it will be promptly assisted by an increased flow of the motive fluid through the valves which are opened in succession by the making of contact with the other mercury-cups in the series, and thus all shock which would otherwise occur by the sudden forceful movement of the pistons is avoided. The arrangement is also advantageous in that when the speed of the water-wheel has been approximately brought to normal the breaking of contact will first occur in the circuit which controls the valve closing the port of greatest area and the other ports successively, thus

obviating the danger of opening or closing the gates to a greater degree than required and instead of correcting the speed of the wheel creating an evil on the other side by causing it to move too slow or too fast, as the case may be. Such a defective operation would result in an almost constant deviation of the speed of the wheel from normal, and therefore an almost constant movement of the pistons and gates. For instance, if the fault which is sought to be corrected is that the wheel is moving too rapidly, then when the gates have moved to approximately the closed position desired and that circuit is broken which is necessary to permit the port of greatest area to close, the motive fluid supplied by the other ports of smaller area until closed is sufficient to move the gates to precisely that degree of closing which is essential under the circumstances without too greatly closing them, which, as will be obvious, would cause the evil of the wheels moving too slowly, and this having to be corrected the result would be an almost constant deviation of the speed of the wheel and movement of the pistons and gates.

The arrangement shown of the tilting lever and the mercury-cup connection for making and breaking the circuits of the electromagnets is a very satisfactory one and is specifically claimed by me; but in the broader aspect of my invention I do not confine myself to this arrangement, as other suitable means for making and breaking the circuits of the magnets to be operated by the governor may be employed.

In a two-wheel installation four cylinders are employed, one pair being arranged above the other, as more clearly shown in Fig. 2 of the drawings. When the invention is embodied in connection with a one-wheel installation, the two upper cylinders are omitted. But one cylinder and piston is necessary when the governor is applied to steam-engines, and the piston-rod will be connected to the throttle-valve or other valve to be controlled in any usual manner known to those skilled in the art. Except in that the piston-rod will be connected to a throttle or other valve instead of a gate-valve of a water-wheel the governor mechanism is constructed, arranged, and operates in the manner hereinbefore set forth.

Having thus described my invention, what I claim is—

1. In governor mechanism, the combination with a piston-cylinder and piston, of a valve-chest, pipes communicating with the valve-chest and with the piston-cylinder at opposite sides of the piston, each of said pipes serving as supply and also as exhaust pipes for the piston-cylinder, tilting arms carried by said valve-chest and provided with an armature, valves hung at opposite ends of said tilting arm, electromagnets arranged in operative relation to said tilting arm, means for making



and breaking the circuit of said magnets, and a fluid-pressure supply for operating the piston, substantially as described.

2. In governor mechanism, the combination with a piston-cylinder and piston, a valve-chest, and means for supplying fluid under pressure to the piston-cylinder through the valve-chest, of a tilting arm carried by said valve-chest, inlet and exhaust valves hung at opposite ends of said arm, and electromagnetic mechanism for tilting said arm to operate said valves, substantially as described.

3. In governor mechanism, the combination with a piston-cylinder and piston, of a tank for supplying fluid under pressure to operate said piston, a valve-chest provided with valves and interposed between said tank and said piston-cylinder, means for operating the valves, pipes communicating with said valve-chest and said piston-cylinder for conducting the motive fluid to the piston-cylinder and exhausting therefrom, a pipe conveying the motive fluid from the tank to the valve-chest and a pipe for conducting the exhaust from the valve-chest back to the tank, and a fluid-circulating pump, substantially as described.

4. In governor mechanism, the combination with a piston-cylinder and piston, of means for supplying fluid under pressure to the piston-cylinder comprising a valve-chest in communication with the piston-cylinder, a plurality of inlet and a plurality of exhaust valves arranged in said chest, and means for controlling the valves, substantially as described.

5. In governor mechanism, the combination with a piston, of means for supplying fluid under pressure for operating said piston embodying inlet and exhaust valves hung together at opposite ends of a tilting arm, an armature carried by said arm, electromagnetic mechanism for controlling said valves, and means for making and breaking the circuit thereof, substantially as described.

6. In governor mechanism, the combination with a piston-cylinder and piston, and means for supplying fluid under pressure to the piston-cylinder comprising inlet and exhaust valves hung at opposite ends of a tilting arm, of electromagnets for controlling said valves, and a tilting lever connected to a speed-governor for making and breaking the circuits of the magnets, substantially as described.

7. In governor mechanism, the combination with a piston, and a cylinder in which said piston is arranged, means for supplying fluid under pressure to the cylinder embodying inlet and exhaust valves hung at opposite ends of a tilting arm, electromagnets for controlling said valves, a speed-governor, and a tilting lever connected therewith and carrying contact-wires for making and breaking the circuits of said magnets, substantially as described.

8. In governor mechanism, the combination with a piston-cylinder and piston, of means for supplying fluid under pressure to said cyl-

inder embodying valves graded in size, and means for controlling said valves, substantially as described.

9. In governor mechanism, the combination with a piston-cylinder and piston, of means for supplying fluid under pressure to said cylinder embodying valves graded in size, and electromagnetic mechanism for controlling said valves, substantially as described.

10. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising a plurality of series of valves graded in size, and means for controlling said valves, substantially as described.

11. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising a plurality of series of valves graded in size, a plurality of series of electromagnets operatively arranged with relation to said valves, a circuit making and breaking mechanism comprising a plurality of series of contacts for successively making and breaking the circuits of the magnets whereby the valves are successively opened and closed, substantially as described.

12. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising a single valve-chest, a plurality of inlet and a plurality of exhaust valves arranged in said chest, pipes leading from the valve-chest to the piston-cylinder, and means for controlling the valves, substantially as described.

13. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising a single valve-chest, a plurality of inlet and a plurality of exhaust valves arranged in said chest, pipes leading from the valve-chest to the piston-cylinder, and electromagnetic means for controlling the valves, substantially as described.

14. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder, comprising two sets of inlet and exhaust valves, each set containing a series of valves for admitting the motive fluid to opposite sides of the piston and exhausting from the reverse sides, and means for controlling said valves, substantially as described.

15. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder, comprising two sets of inlet and exhaust valves, each set containing a series of valves for admitting the fluid to opposite sides of the piston and exhausting from the reverse sides, and electromagnetic means for controlling said valves, substantially as described.

16. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising independent inlet and exhaust



valves graded in size, and means for individually or independently opening and closing said valves, substantially as described.

17. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising independent inlet and exhaust valves graded in size, and electromagnetic mechanism for opening and closing said valves, substantially as described.

18. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder embodying inlet and exhaust valves graded in size, electromagnets for controlling said valves, and contact mechanism for successively opening and successively closing said valves, substantially as described.

19. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder embodying inlet and exhaust valves graded in size and hung together in pairs on tilting arms, armatures carried by said arms, electromagnets, and means for successively energizing and deenergizing said magnets to open and close said valves, substantially as described.

20. In governor mechanism, the combination with a cylinder and piston, of means for supplying fluid under pressure to said cylinder comprising a single valve-chest, pipes leading from said valve-chest to the piston-cylinder, a plurality of series of inlet and exhaust valves graded in size and hung in pairs on tilting arms, armatures carried by said arms, electromagnets, and a lever connected to and operated by a speed-governor and contacts carried thereby to successively make and break the circuits of the electromagnets, whereby the graded valves are opened and closed in succession according to the direction and degree of the tilt of the contact-lever, substantially as described.

21. In mechanism for governing water-wheels, the combination of rods connected to the wheel-gate, cylinders through which said rods pass, pistons upon said rods within said cylinders, racks upon the ends of said rods, gear-wheels in mesh with said racks causing the rods to move in precision, a single valve-chest containing a plurality of inlet and exhaust valves, a pair of pipes leading from said valve-chest to the piston-cylinders, and electromagnetic means for opening and closing the valves, substantially as described.

22. In mechanism for governing water-wheels, the combination with rods connected

to the wheel-gate, cylinders through which said rods pass, pistons upon said rods within said cylinders, racks upon the ends of said rods, gear-wheels in mesh with said racks causing the rods to move in precision, a single valve-chest containing a plurality of series of valves graded in size, a pair of pipes leading from said valve-chest to the piston-cylinders, and electromagnetic means for opening and closing the valves in succession, substantially as described.

23. In mechanism for governing water-wheels, the combination with rods connected to the wheel-gate, piston-cylinders through which said rods pass, pistons on the rods within the cylinders, racks on the ends of said rods, gear-wheels in mesh with said racks, a single valve-chest, a plurality of inlet and exhaust valves arranged in said chest, electromagnetic means for opening and closing said valves, a pressure-tank communicating with said valve-chest, a pair of pipes leading from the valve-chest to the piston-cylinders, an exhaust-pipe leading from the valve-chest, and a pump for forcing the exhaust fluid into the pressure-tank, substantially as described.

24. In mechanism for governing a two-wheel water-wheel installation, the combination with rods connected with the gates of the wheels, piston-cylinders through which said rods pass, pistons on said rods, racks on the ends of said rods, gear-wheels in mesh with said racks, a valve-chest, a plurality of inlet and exhaust valves in said chest, pipes leading from the valve-chest to the piston-cylinders, a pressure-tank in communication with the valve-chest, a pump, an exhaust-pipe leading from the valve-chest to the pump, a conduit from the pump to the pressure-tank, and electromagnetic mechanism for opening and closing the valves, substantially as described.

25. In governor mechanism, the combination with a plurality of pairs of piston-cylinders, of pistons arranged therein the rods of which extend out of the cylinders and are provided with racks, gear-wheels mounted on a counter-shaft and meshing with the piston-rod racks to cause the pistons to move in precision and equally and means for operating the pistons, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

REUBEN SHIRREFFS.

Witnesses:

B. H. DAVIS,  
CARY SHEPPARD.