(No Model.) 2 Sheets—Sheet 1.

# C. E. DOOLITTLE.

## APPARATUS FOR REGULATING SPEED OF WATER WHEELS.

No. 549,848. Patented Nov. 12, 1895.

Fig. 2.

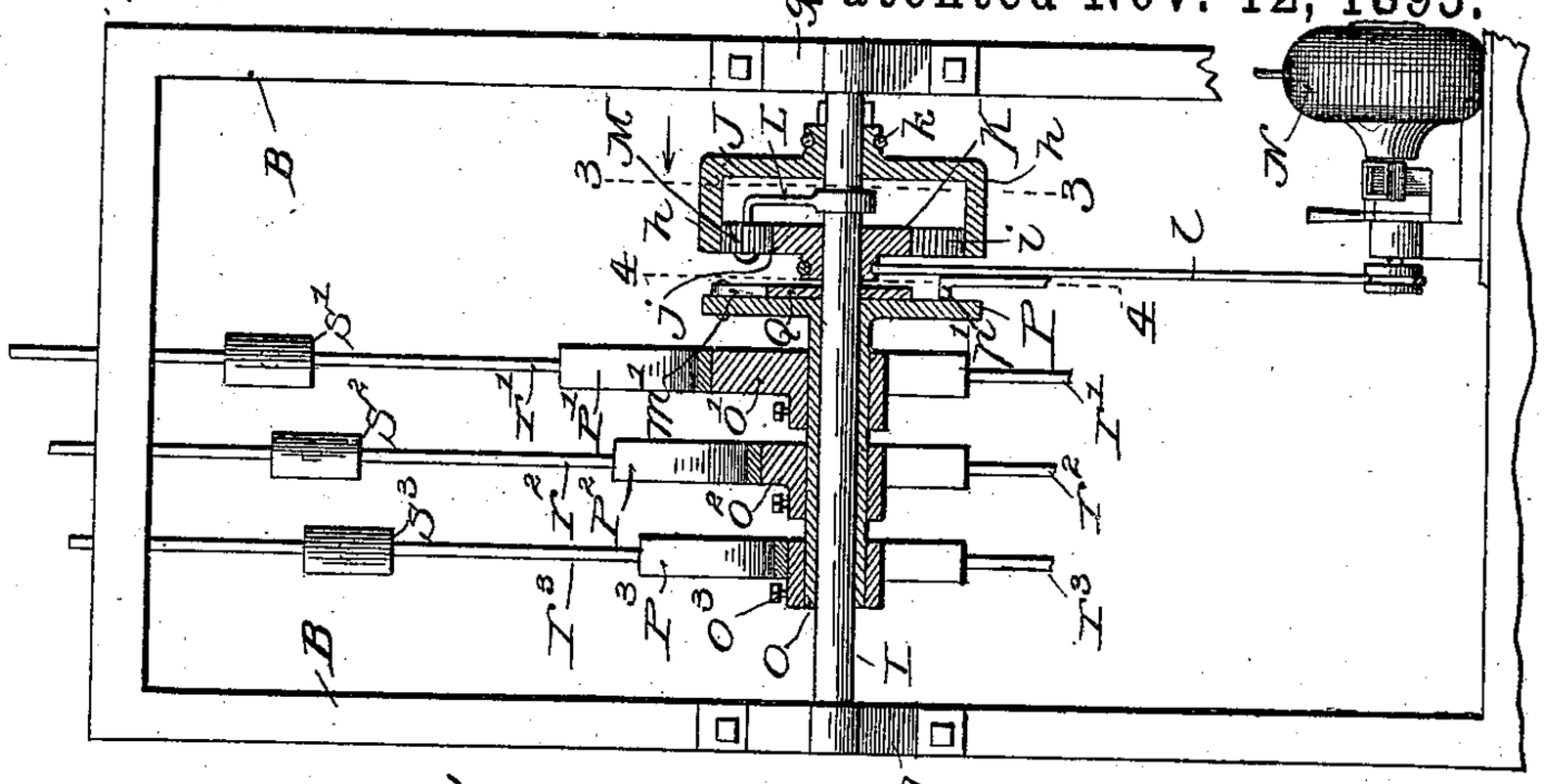
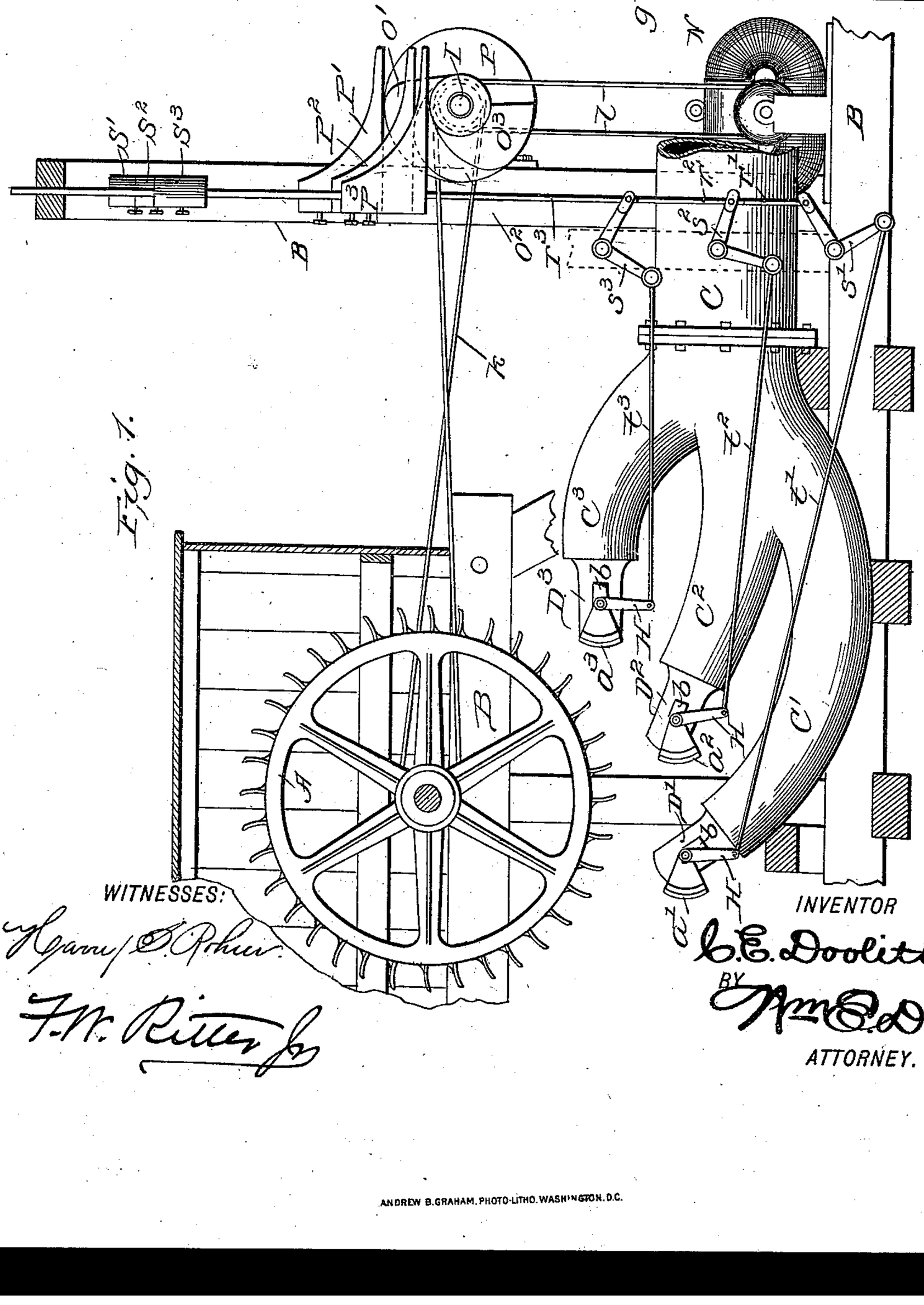


Fig. 1.



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(No Model.)

2 Sheets—Sheet 2.

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## APPARATUS FOR REGULATING SPEED OF WATER WHEELS.

No. 549,848. Patented Nov. 12, 1895.

Fig. 3.

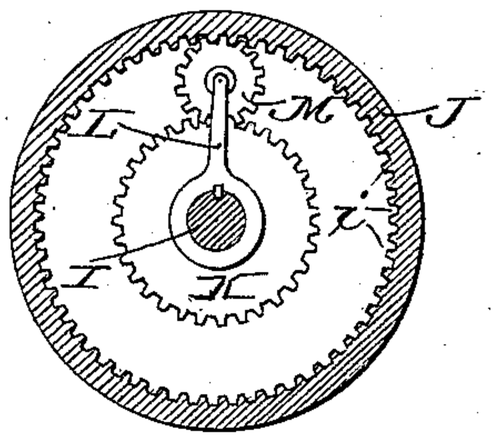



Fig. 4.

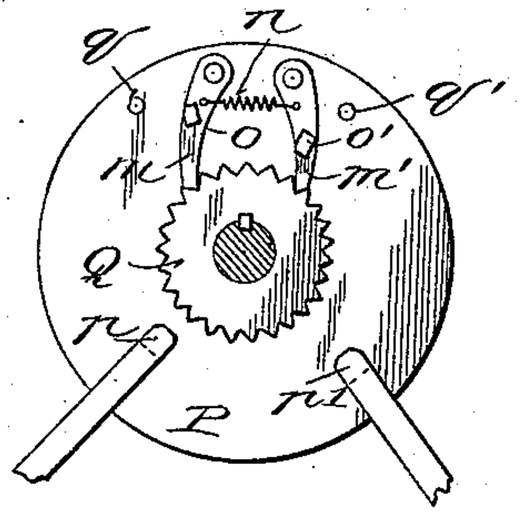



Fig. 5.

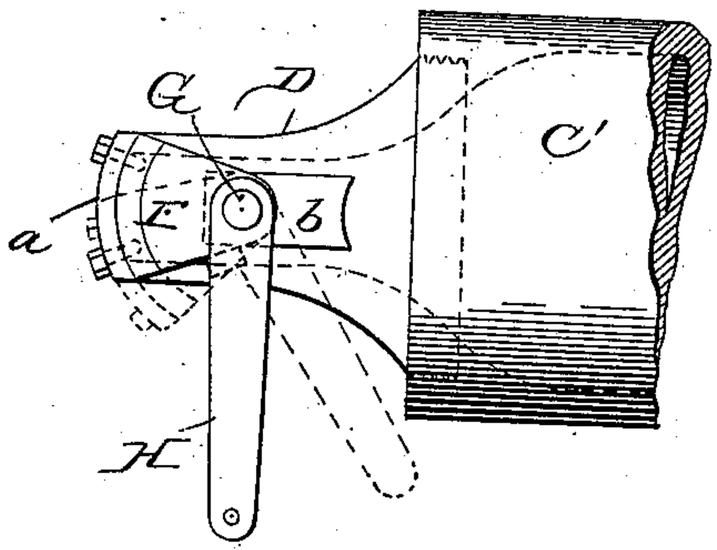



Fig. 6.

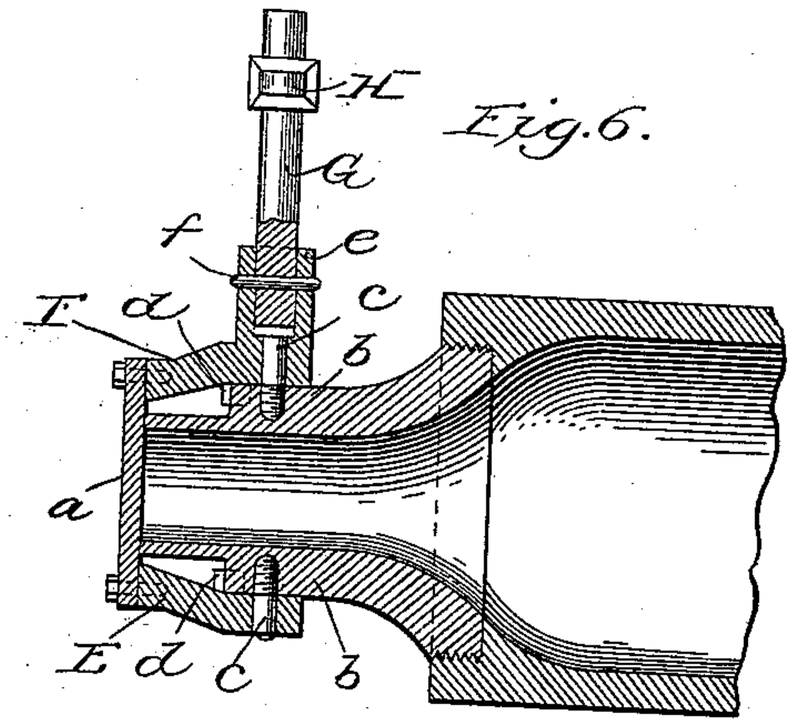
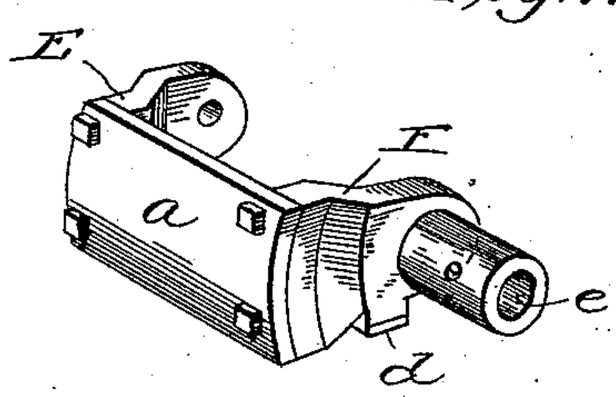



Fig. 7.

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# UNITED STATES PATENT OFFICE.

CLARENCE E. DOOLITTLE, OF ASPEN, COLORADO.

## APPARATUS FOR REGULATING SPEED OF WATER-WHEELS.

SPECIFICATION forming part of Letters Patent No. 549,848, dated November 12, 1895.

Application filed February 13, 1895. Serial No. 538,260. (No model.)

*To all whom it may concern:*

Be it known that I, CLARENCE E. DOOLITTLE, a citizen of the United States, residing at Aspen, in the county of Pitkin and State of Colorado, have invented certain new and useful Improvements in Apparatus for Regulating the Speed of Water-Wheels; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention relates to jet or reaction water-wheels and special apparatus for regulating the supply of water thereto under varying loads.

More particularly stated, the invention relates to a differential or other controlling governor, one or more oscillating valves guarding the discharge-nozzles, and mechanism interposed between said governor and valves, whereby the latter are operated dissimultaneously by action of the governor to bring more or less water into play upon the wheel as occasion requires. Heretofore much difficulty and loss of power have been experienced in the operation of governors for this class of machinery, and particularly was this so prior to the invention of a differential governor, forming the subject-matter of Letters Patent No. 502,557, granted to me on the 1st day of August, 1893, and operating upon a like principle. It is a well-known fact also that valves used in connection with the discharge nozzle or nozzles of water-motors have heretofore been operated with difficulty owing to their mechanical construction and their position within or back of the nozzles, and that such valves have been attended by much leakage and consequent waste of power. To overcome these objections, mainly, the present system has been devised, wherein are insured prompt and accurate response of the governor to the slightest variation in speed of the governed motor and leakage at the valves is reduced to a minimum, while the power required to open or close said valves is one-fourth only that required by the ordinary butterfly-valve located within the valve-chambers of the discharge-pipes.

The invention will be hereinafter particularly described, and pointed out in the claims following.

In the accompanying drawings, which form part of this specification, and in which like letters indicate like parts wherever employed, Figure 1 illustrates a side elevation of my invention, comprising a water-wheel, multiple-discharge nozzles, valves therefor of peculiar construction, a speed-governor, valve-operating mechanism, and a motor running at constant speed for operating upon the governor. Fig. 2 represents a vertical central section of the speed-governor and adjacent mechanism in connection with an end view of a constant-speed motor. Fig. 3 is a transverse vertical section on line 3 3, Fig. 2, looking in direction of the arrow. Fig. 4 is a similar view on line 4 4, Fig. 2. Fig. 5 is an enlarged side elevation of one nozzle with my improved valve applied thereto. Fig. 6 is a horizontal central section of said nozzle with valve, and Fig. 7 a perspective view of the valve detached.

Reference being had to the drawings and letters thereon, A indicates a water wheel or motor of any preferred construction; B, a suitable frame upon which it is mounted.

C indicates a main water-supply pipe, C′ $C^2$ $C^3$ communicating laterals, and D′ $D^2$ $D^3$ discharge-nozzles, through which water may be applied in as many streams to the wheel A, the amount of water discharged from said nozzles being controlled by oscillating valves $a'$ $a^2$ $a^3$, guarding the ends thereof, said valves in turn being operated by mechanism interposed between them and a speed-governor, as will later appear.

Nozzles D are screwed into the ends of laterals C, as shown by Fig. 6, and to facilitate their attachment or removal have formed upon their opposite sides raised lugs *b* with squared surfaces for the reception of a wrench. Into these lugs are screwed two pins *c c*, on which the valve turns. The valve *a*, having a cylindrical surface with a radius equal to the distance from *a* to the center line of the pins *c c*, is fastened by four cap-screws to the side arms E F, which turn loosely on the pins *c*. Arms E F also are each formed with a small projecting lug *d d* on the under side,

adapted to engage the under side of lugs *b b* with an upward movement of the valve at the instant it is wholly closed, thus limiting its movement to that extent. Side arm F differs from E only in socket *e*, projecting from the side thereof for reception of the valve-stem G, the latter being firmly secured therein by a pin *f* passing therethrough. To the valve-stem G is keyed or otherwise secured a lever H for use in rocking the stem G and through it oscillating the valve-plate *a* across the curved end of nozzle D by means of valve-rod connections and a governor now to be described.

At suitable points on frame B are bracketed journal-bearings *g g*, in which is journaled a main rock-shaft I, and upon said shaft are mounted two loose pulleys J and K. Pulley J is formed with an enlarged annular flange *h*, bearing an internal gear *i*, while the pulley K has formed thereon a spur-gear *j*. Between the pulleys J and K is an angular arm L, keyed rigidly to the shaft I and having journaled upon its outer end a small pinion M intermediate of and meshing with the gears *i j*. Pulley J takes its power in one direction from a belt or rope *k*, driven by the motor to be governed, as A, and the pulley K acquires a reverse motion through the medium of belt or rope *l*, driven from a small dynamo N or other source of constant speed, as shown by Fig. 1. The diameters and rates of revolution of pulleys J and K are so proportioned that when they are running at normal speed the velocity of a point on the pitch-line of J is equal to and in opposite direction to that of a point on the pitch-line of K, and the intermediate pinion M revolves upon its own axis without changing its position with reference to the shaft I. On main shaft I is also loosely mounted a sleeve O, bearing at one end a disk P, while adjacent to said disk is a ratchet-wheel Q, keyed to and moving with the main shaft. Pivoted upon disk P is a pair of dogs *m m'*, connected by a light spring *n* and bearing upon their surface projecting lugs *o o'*, respectively, arranged at unequal distances from the center of shaft I, each being thereby adapted to engage its stop *p p'* at intervals, said stops being projected from frame B into the paths of lugs *o o'*, as shown most clearly by Fig. 4. These dogs *m m'* stand normally in engagement with the ratchet-wheel Q, being held in such position by operation of spring *n*, and are limited in their upward movement under influence of stops *p p'* by small pins *q q'*, located in the face of disk P.

Upon sleeve O are adjustably secured cams $O'$ $O^2$ $O^3$, upon the upper surface of which ride toes or tappets $P'$ $P^2$ $P^3$, the latter being vertically adjustable upon rods $r'$ $r^2$ $r^3$. These rods, which are supported in frame B, are provided, respectively, with weights $S'$ $S^2$ $S^3$ at their upper ends to facilitate a downward movement thereof, while at the lower end of rods $r'$ $r^2$ $r^3$ are located fixed bell-crank levers $s'$ $s^2$ $s^3$, connected to said rods as shown. At the opposite end of levers $s'$ $s^2$ $s^3$ are pivoted links $t'$ $t^2$ $t^3$, the same being in turn connected to the end of their respective valve-levers H for the purpose of opening or closing the valves.

This being substantially the construction of my present invenvion, its operation is as follows: Presuming that the parts are in the relative positions shown by Fig. 1 of the drawings, that the wheel A is working under an average load, that the dynamo N or other source of constant speed is driving loose pulley K in one direction, that the water-wheel A is driving loose pulley J with equal velocity at the pitch-line in the opposite direction, that valve $a'$ is wide open, valve $a^2$ one-half open, and valve $a^3$ closed. If now an additional load be imposed upon wheel A, with a consequent demand for more power, the result is that its speed is decreased, and in the same proportion the speed of loose pulley J is reduced, causing the pinion M to travel around the inner circumference of gear *i*, taking with it arm L, keyed to shaft I, which latter is thereby given a partial rotation. Ratchet-wheel Q, then moving with shaft I, operates through the agency of dog *m'* to drive disk P in a direction corresponding with the rotation of the shaft, whereupon sleeve O, integral with said disk, is rotated forward, taking with it cams $O'$ $O^2$ $O^3$, mounted thereon. The cam $O'$, Fig. 1, being at the height of its throw, has no further effect upon its connecting parts nor the valve $a'$ which it governs, shoe or tappet $P'$ merely riding upon the periphery of the cam. Cam $O^2$, however, operates to lift tappet $P^2$, elevating rod $r^2$, throwing its bell-crank $s^2$, and opening valve $a^2$ more fully through the intervening lever H and link $t^2$. Thus an additional amount of water will be automatically brought to bear upon the base-floats of wheel A to meet the requirement of more power; but should the power still be insufficient for the work required the cam $O^3$ will go into action upon the base of its tappet $P^3$ with a continued rotation of the sleeve O, whereupon said cam $O^3$ will operate to open its valve $a^3$ through intervention of tappet $P^3$, valve-rod $r^3$, crank $s^3$, link $t^3$, and its valve-lever H and an additional stream is brought to bear upon the floats of wheel A. If, on the other hand, the valves are in the position illustrated by Fig. 1, and a part of the load of wheel A is thrown off, my improved governor must then act to reduce the volume of water applied to the wheel. In this latter instance the accelerated speed of wheel A is communicated through belt *k* to pulley J, which, running faster than pulley K of constant speed, causes pinion M to travel around the inner circumference of gear *i*, turning with it shaft I, sleeve O, and cams $O'$ $O^2$ $O^3$ in a direction the reverse of that before described, with the effect of lowering said cams, and through the communicating mechanism

operate upon the valves $a'$ $a^2$ $a^3$ to automatically, successively, and independently close same in accordance with requirements of the load left upon the water-wheel. If after all the water has been turned on the load on wheel A is still so great that its speed is less than normal, the shaft I, sleeve O, and connecting parts may continue to turn without elevating the tappets P' P² P³ further until lug $o'$ on dog $m'$ comes in contact with the end of stop $p$, projecting in its path, whereupon said dog will be lifted out of engagement with ratchet-wheel Q, the disk P and sleeve O thus being brought to a standstill. This, however, does not prevent shaft I and ratchet-wheel Q from making further rotation under influence of the governor should it be required, in which event the dog $m$ simply slips on the teeth of ratchet-wheel Q as they pass from it, thus preventing injury to the governor. Similarly on a reverse movement of these parts, if after most of the water has been cut off the speed of the wheel A should be greater than the normal the parts last above mentioned may continue to turn until lug $o$ on dog $m$ is lifted out of engagement with ratchet-wheel Q by a stop $p'$, when, as before, if necessary, shaft I and ratchet-wheel Q may continue to revolve, dog $m'$ jumping the teeth of ratchet-wheel Q as they pass from it. In like manner the valves $a$ may be opened or closed dissimultaneously, according to requirements of the wheel, or a greater number of nozzles D may be employed, in which latter event the efficiency of the system will be correspondingly increased, and many minor changes of construction may be made in the governor, the stop, and the valve mechanisms without in the least departing from the spirit of my invention, which, having been thus described,

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

1. A speed governor for motors consisting of a rock shaft, a gear wheel running at constant speed, a second gear wheel driven in an opposite direction by the governed motor, an intermediate pinion rigidly connected to the rock shaft, and a cam controlled by the shaft for actuating suitable valve rods and valves, substantially as described.

2. A speed governor for motors consisting of a rock shaft, a loose gear upon the shaft running at constant speed, a second loose gear upon same shaft driven in the opposite direction by the governed motor, an intermediate pinion between said gears, an arm carrying said pinion rigidly connected to the rock-shaft, and a cam or cams controlled by the shaft for actuating suitable valve rods and valves, substantially as described.

3. The combination with a water-wheel of a speed governor, consisting of a rock-shaft, a loose gear upon the shaft driven at constant speed by an independent source of power, a second loose gear upon said shaft driven in the opposite direction by the water-wheel, a pinion between said gears, an arm carrying said pinion rigidly connected to the rock-shaft, a loose sleeve surrounding the shaft and connected thereto by a pawl and ratchet mechanism, and a cam or cams upon the sleeve for actuating suitable valve rods and valves, substantially as described.

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

CLARENCE E. DOOLITTLE.

Witnesses:
HARRY M. KOCH,
HARRY G. MCCULLOCH.