No. 652,390. Patented June 26, 1900.

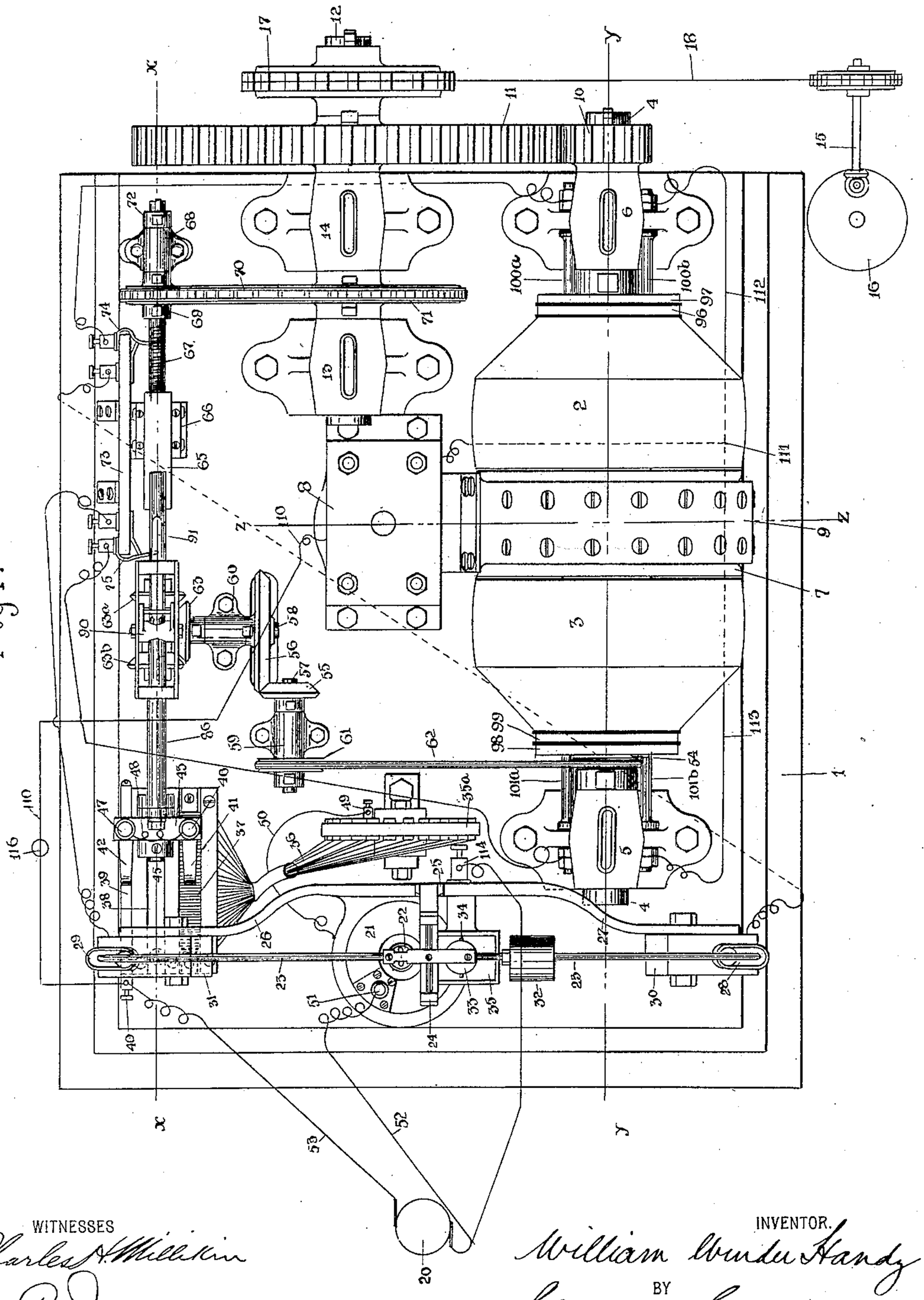
W. W. HANDY.

ELECTRIC GOVERNOR.

(Application filed Mar. 9, 1899.)

(No Model.) 4 Sheets—Sheet 1.

Fig 1.



WITNESSES

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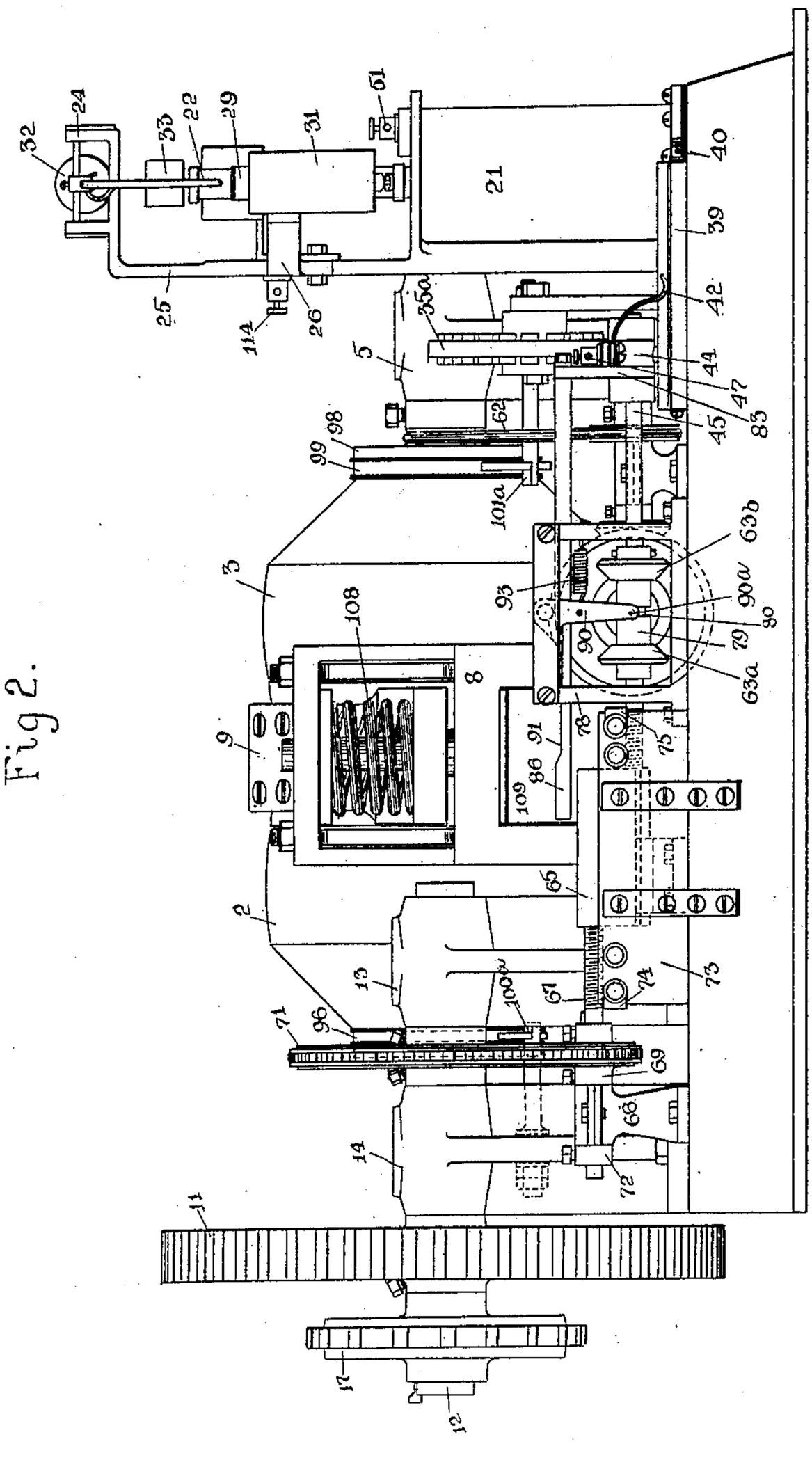
Fig 2.



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ELECTRIC GOVERNOR.

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(No Model.) 4 Sheets—Sheet 3.

Fig 3.

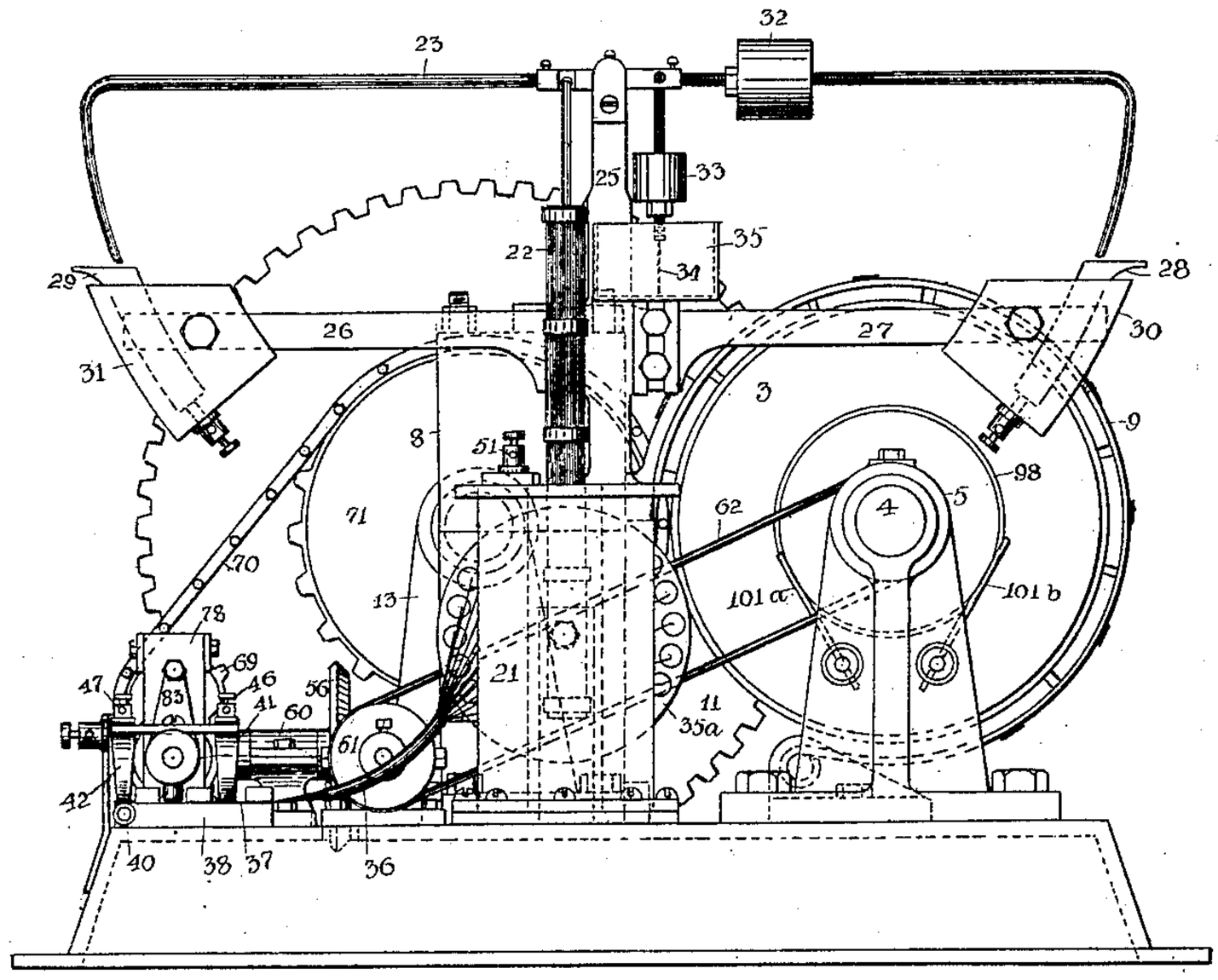

Fig 6.

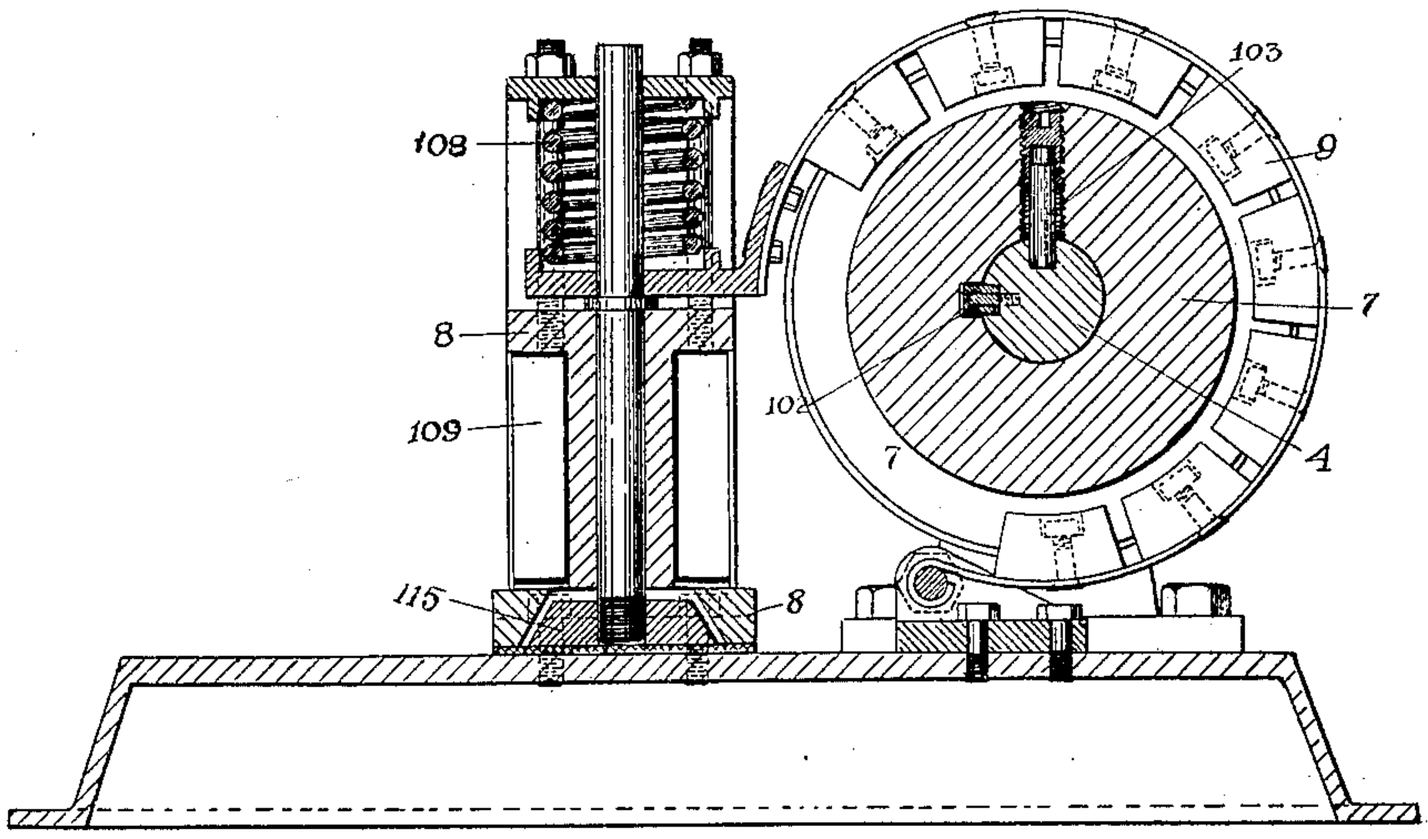

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Fig 5.

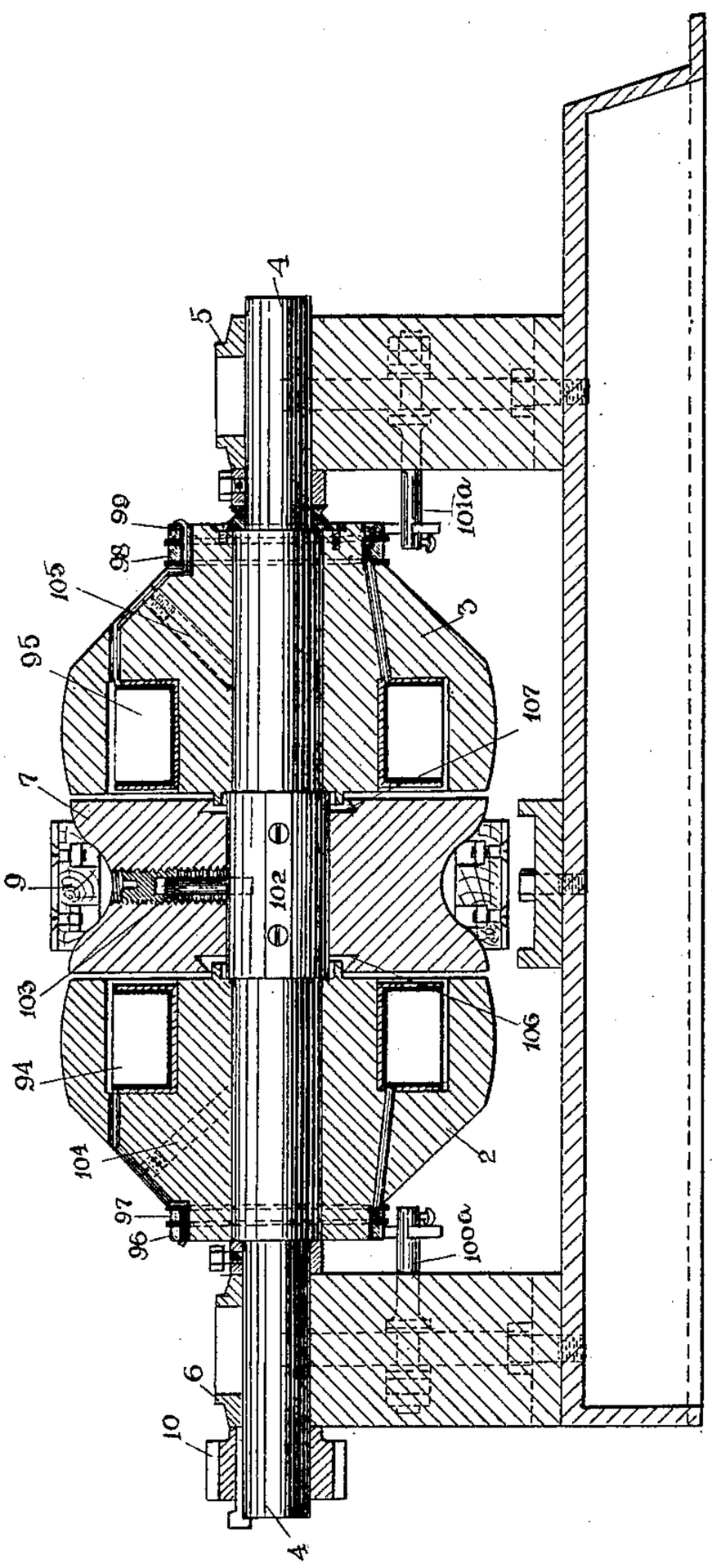
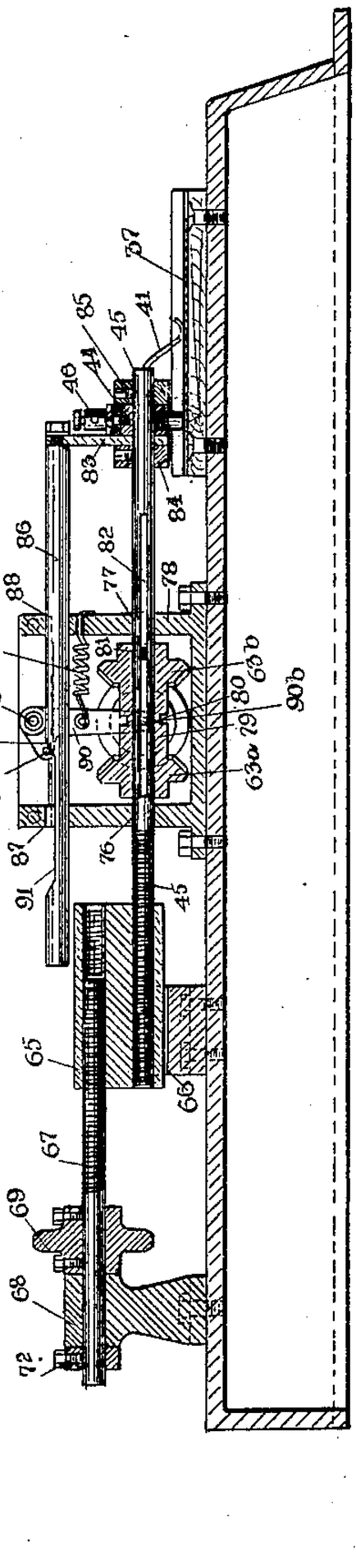


Fig 4.



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UNITED STATES PATENT OFFICE.

WILLIAM WINDER HANDY, OF BALTIMORE, MARYLAND.

ELECTRIC GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 652,390, dated June 26, 1900.

Application filed March 9, 1899. Serial No. 708,428. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM WINDER HANDY, a citizen of the United States of America, and a resident of the city of Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Electric Governors, of which the following is a specification.

The object of my invention is to provide a governor for turbine or other types of water-wheels which will rapidly operate the gates or valves for supplying water to the wheels and effectively prevent overgoverning.

In the drawings, Figure 1 is a plan view of the governor. Fig. 2 is a side elevation. Fig. 3 is an end elevation. Fig. 4 is a vertical longitudinal section through the relay device on line *x x*, Fig. 1. Fig. 5 is a vertical longitudinal sectional view through the friction-clutches on line *y y*, Fig. 1. Fig. 6 is a transverse sectional view through the brake on line *z z*, Fig. 1, showing the brake and armature.

My invention consists in the application of revolving electromagnetic friction-clutches for operating the gates or valves of a water-wheel and in a relay device for preventing excessive movement of the gates or valves in either direction, thereby preventing racing due to overgoverning.

My invention may be applied to types of prime movers other than water-wheels or may be employed for regulating the voltage of dynamos driven by prime movers which run at variable speeds.

Referring to Figs. 1 and 2, 1 is the base-plate of the governor, and 2 and 3 oppositely-revolving magnetic friction-clutches loosely mounted on the shaft 4, which is supported in the bearings 5 and 6 and driven by belts which run on the exterior of said clutches. 7 is an armature between the magnetic clutches 2 and 3, said armature being mounted on shaft 4 and connected thereto by means of a feather, so as to permit the armature to move longitudinally on the shaft in either direction as it is attracted by one or the other of the magnets 2 or 3. 8 is a magnetic brake, and 9 a brake-band surrounding the armature 7, said band clamping the armature and holding it in a fixed position at the instant that it is liberated from either of the magnetic clutches 2 or 3. Keyed to the shaft 4 is a pinion 10, which meshes with a gear 11, secured to the shaft 12 and supported in the bearings 13 and 14. Shaft 12 is designed to be connected to the gate-shaft 15 of the water-wheel 16 by means of the sprocket-wheel 17 and chain 18. 20 is a dynamo driven by the water-wheel 16. 21 is a solenoid connected to the dynamo, which as the voltage of the dynamo rises or falls, due to a change of speed of the water-wheel, exerts a variable force on a plunger 22, which is suspended from a lever 23, pivoted at 24 on the supporting-stand 25. This peculiar application of a solenoid to water-wheel governing has been described in two previous patents issued to me, No. 542,640, of July 16, 1895, and No. 571,363, of November 17, 1896.

Referring to Fig. 3, the solenoid and mechanism operated thereby are more clearly shown. The stand 25 has two arms 26 and 27, on which are supported metallic cups 28 and 29, which are insulated from the arms 26 and 27 by means of the blocks of insulating material 30 and 31. The cups 28 and 29 are filled with mercury and connected, by means of wires, with other parts of the governor. 32 is a weight for balancing the pull of the solenoid 21 and is adjustably mounted on the lever 23 by means of a screw-thread, as shown. 33 is a weight similarly mounted on the lever 23 for regulating the extent of movement of the plunger 22 due to any change of pull exerted by the solenoid 21. Suspended from the lever is a damping-vane 34, which moves in an oil-filled reservoir 35, said vane preventing undue vibration of the lever 23. Assuming that the normal speed of the water-wheel 16 and dynamo 20 is one hundred per minute and that at this speed the dynamo develops one hundred volts, the weight 32 is so placed on the lever 23 that the pull exerted by the solenoid 21 holds the lever 23 balanced in a central position, as shown, with both ends of the lever out of contact with the cups 28 and 29. The weight 33 is then so adjusted that a change of speed, and consequently voltage, within the governing limit of, say, two per cent. will cause the lever 23 to make contact with one or the other of the cups 28 or 29, due to the change of pull exerted by the solenoid 21 on the plunger 22.

Referring again to Figs. 1 and 2, 35^a is a rheostat connected, by means of the wires 36,

with a series of contacts 37, insulated from each other and supported on a block of insulating material 38. Mounted on the block 38 is a contact-strip 39, which is provided with a binding-post 40. 41 and 42 are contact-brushes, one of which, 42, engages with the strip 39 and the other, 41, with one of the insulated contacts 37, depending upon its position with respect thereto. The brushes 41 and 42 are mounted on a supporting-piece 43 and insulated therefrom, said piece 43 being mounted on a collar 44, loosely mounted on a shaft 45. The brushes 41 and 42 are provided with binding-posts 46 and 47 and electrically connected by means of the wire 48. One terminal 49 of the rheostat 35^a is connected, by means of the wire 50, with one terminal of solenoid 21, the other terminal 51 of the solenoid being connected by the wire 52 with one terminal of the dynamo 20. The terminal 40 of the contact-strip 39 is connected by the wire 53 with the other terminal of the dynamo. In other words, the circuit is as follows: from one terminal of the dynamo through the solenoid 21, rheostat 35^a, one of the wires 36 and contacts 37, brush 41, wire 48, brush 42, strip 39, and binding-post 40 to the other terminal of the dynamo. 54 is a sheave-wheel rigidly connected to the magnetic clutch 3 and revolving with it. 55 and 56 are a pair of bevel-gears mounted on the shafts 57 and 58 and supported in the bearings 59 and 60, respectively. Mounted on the shaft 57 is a sheave-wheel 61, which receives motion from the magnetic clutch 3 by means of the belt 62. Mounted on the shaft 58 is a bevel-gear 63, which normally is constantly revolving between two bevel-gears 63^a and 63^b, mounted on the shaft 45. 65 is a sliding block supported in the slide 66. The block 65 has two screw-threaded holes through it, the upper hole inclosing the threaded shaft 67, supported in the bearing 68. Mounted on the shaft 67 is a sprocket-wheel 69, which is connected by the chain 70 and sprocket-wheel 71 with the shaft 12, which receives motion from the magnetic friction-clutches 2 and 3 through the pinion 10 and gear 11. The shaft 67 is held laterally fixed in the bearing 68 by means of the sprocket-wheel 69 and collar 72, but is free to rotate when the wheel 69 is revolved. As the shaft 67 revolves in either direction the sliding block 65 is moved forward or backward in the guide 66 by means of the screw-thread on said shaft. 73 is a block of insulating material upon which are mounted the switches 74 and 75, which are normally in contact, as shown in Fig. 1; but when the block 65 has been moved far enough in either direction by the screw-threaded shaft 67 it comes in contact with one of the switches and opens it.

Referring to Fig. 4, the construction of the relay device is more clearly shown. The shaft 45 is supported in bearings 76 and 77 in the stand 78. Mounted on the shaft between the bearings are the bevel-gears 63^a and 63^b, rigidly connected together by means of the sleeve 79, in which is cut a circumferential groove 80. Extending through the hub of one of the gears is a pin 81, which passes through a slot 82, cut in the shaft 45, as shown. The rear end of the shaft 45 is screw-threaded and entered in the lower hole of the sliding block 65, and upon the forward end is mounted the collar 44, which supports the brushes 41 and 42. Next to the collar 44 is loosely mounted a piece 83, both the collar and the piece 83 being held in a fixed position by means of the set-screwed collars 84 and 85. The piece 83 connects the shaft 45 with a second shaft 86, as shown, which is supported in the bearings 87 and 88 in the stand 78. Pivoted at 89 are a pair of bell-crank levers 90, the upper arms of which are connected by a pin 90^c, which rests on the upper surface of the shaft 86, and the lower arms engage with the groove 80 in the sleeve 79 by means of the inwardly-projecting pins 90^a and 90^b. The upper surface of the shaft 86 has a depression 91 in it for part of its length, as shown, the depression rising to the level of the upper surface by means of the inclined surface 92. Normally the pin 90^c rests midway on the inclined surface 92, being held in this position by the spring 93. When the sliding block 65 is moved in either direction, due to the rotation of the shaft 67, longitudinal movement is transmitted to the two shafts 45 and 86. When the shaft 86 moves to the right, the upper end of the bell-crank lever 90 drops to the level of the depression in the shaft 86, due to the tension of the spring 93. This causes the lower arms of the lever 90 to move the gears 63^a and 63^b to the right, which throws gear 63^a into contact with the constantly-revolving gear 63, and the shaft 45 is revolved through the medium of the pin 81 and in such a direction that the shaft 45 is screwed farther into the block 65, and the two shafts 45 and 86 and the parts connected thereto are returned to their normal positions, with the upper arm of lever 90 resting midway on the inclined surface 92, in which position the gear 63^a is out of contact with the gear 63 and the shaft 45 stationary as far as rotation is concerned. When the sliding block 65 is moved in the opposite direction, the upper arm of lever 90 is raised to the highest level on the shaft 86 and gear 63^b thrown into contact with gear 63, which causes the shaft 45 to rotate in the opposite direction and unscrew from the block 65, thereby returning the shafts 45 and 86 and the parts connected thereto to their normal positions, with the upper arm of lever 90 resting midway on the inclined surface 92 and the gear 63^b out of contact with gear 63. With the parts in their normal positions (shown in Fig. 4) the brush 41 rests midway on the contacts 37, in which position a certain amount of the resistance of rheostat 35^a is in series with the solenoid 21. If, however, the brush 41 is moved longitudinally, due to a longitudinal movement of the shaft

45, it changes its position on the contacts 37, thereby increasing or decreasing the resistance in series with the solenoid 21, according to the direction in which it is moved. This change of resistance increases or decreases the pull on the plunger 22, thereby causing it to rise or fall, respectively, as the resistance is increased or decreased.

Referring to Figs. 1, 2, and 3, the governor parts are so assembled and connected to the gate-stem 15 that when the load on the wheel 16 is increased and the governor admits more water to the wheel the brushes 41 and 42 are moved in such a direction as to decrease the resistance in series with the solenoid 21, thereby increasing its pull on the plunger 22 and causing the governor to cease operating before the speed has returned to normal. In case the load is decreased the brushes are moved in the opposite direction, decreasing the pull exerted by the solenoid and stopping the governor before the speed has returned to normal. This checking of the governor prevents it from operating the gate-shaft too far, thereby preventing overgoverning. After the governor has stopped a certain interval of time is required for the speed of the water-wheel 16 and dynamo 20 to return to normal. During this interval the gear 63, through the medium of the gears 63^a or 63^b and shaft 45, is returning the brushes 41 and 42 to their normal position, and the speed of the gear 63 should be so adjusted that at the instant the normal speed of the water-wheel is attained the parts of the relay mechanism should be in the position shown in the figures, with the brush 41 midway on the contacts 37 and the solenoid 21 exerting its normal pull on the plunger 22.

Referring to Figs. 5 and 6, which are respectively sectional views through the magnetic friction-clutches and armature and the magnetic brake and armature, 94 and 95 are coils wound internally on the magnetic clutches 2 and 3, the terminals of said coils being connected to collector-rings 96 and 97 and 98 and 99 on the exterior of the magnetic clutches. Current is supplied to the coils by means of the pairs of brushes and brush-holders 100^a and 100^b and 101^a and 101^b. (More clearly shown in Fig. 1.) The armature 7 is mounted on the shaft 4, between the magnetic clutches 2 and 3, and secured to said shaft by means of the feather-key 102. Normally the armature rests in the position shown, midway between the magnetic clutches and out of contact with them, being held in this position by means of a spring-pin 103. 104 and 105 are oil-holes, and 106 and 107 recesses in the armature to prevent oil being thrown out between the armature and the magnetic clutches. The brake-band 9 normally rests in contact with the surface of the armature 7, being clamped in this position by means of the spring 108, supported on the top of the brake-magnet 8. 109 is the coil of the brake-magnet, said coil being connected in series with the coils 94 and 95 of the magnetic clutches 2 and 3. The electrical connections are more clearly shown in Fig. 1. One terminal of the brake-coil 109 is connected by the wire 110 to one terminal of the dynamo 20, the other terminal of said coil being connected at point 111 to the wires 112 and 113, which lead to the coils 94 and 95 of the magnetic clutches through the brushes 100^b and 101^b, the other terminals of the magnetic clutch-coils 94 and 95 being connected to the mercury-cups 28 and 29 through the limit-switches 74 and 75, as shown. The other terminal of the dynamo is connected to the stand 25, and consequently to the lever 23, at the binding-post 114. When the lever 23 makes contact with the mercury in cup 28, a current flows through the coil 94 of the magnetic clutch 2 and coil 109 of the brake-magnet 8 by way of the limit-switch 74. The magnetic clutch 2 attracts the armature 7 and clamps it against its surface with great force, thereby transmitting motion to the armature and causing it and shaft 4 to revolve. In the meantime the armature 115 of the brake-magnet 8 has been raised against the spring 108 and the brake-band 9 raised from the surface of the armature 7, thereby permitting it to turn freely. When contact is broken between the lever 23 and cup 28, the spring-pin 103 returns the armature 7 to its normal position, and the spring 108 of the brake-magnet forces the armature 115 down and clamps the armature 7 within the brake-band 9, thereby instantly stopping any further rotation of said armature 7 and shaft 4. If the lever 23 makes contact with the cup 29, a current flows through coils 95 of the magnetic clutch 3 and coil 109 of brake-magnet 8 by way of the limit-switch 75. The brake-band 9 is again raised from the armature 7 and said armature attracted by the magnetic clutch 3 and clamped against its surface, thereby causing the shaft 4 to revolve in the opposite direction. To prevent undue sparking between the lever 23 and the cups 28 and 29, a non-inductive resistance 116 is placed in series with the brake-magnet 8 and magnetic clutches 2 and 3, as shown in Fig. 1.

In operating the governor works as follows: Assuming that the water-wheel 16 and dynamo 20 are running at their normal speed and that an additional load is thrown on the water-wheel, the speed, and consequently voltage, of the dynamo 20 will decrease, the pull exerted by the solenoid 21 on the plunger 22 will decrease, and the weights 32 and 33 will raise the plunger slightly, thereby allowing the lever 23 to make contact with the cup 28. A current then flows from the dynamo 20 through the limit-switch 74 and coils 94 and 109 of the clutch 2 and brake 8. The brake-band 9 is raised, the armature 7 clamped against the surface of the clutch 2, and shaft 4, gears 10 and 11, and gate-stem 15 are revolved in such a direction as to admit more water to the water-wheel 16. In the mean-

time the shaft 67 is being revolved by the sprocket-wheels 69 and 71 and chain 70 in such a direction as to move the block 65 and the two shafts 45 and 86 toward the limit-switch 74. The brushes 41 and 42 are moved in the same direction, which decreases the resistance in series with the solenoid 21 and causes it to exert an increased pull on the plunger 22, thereby raising the lever 23 out of contact with the cup 28 and breaking the circuit through the brake 8 and clutch 2, the brake-band 9 again clamping the armature 7 and preventing further rotation. At the instant that the shafts 45 and 86 and brushes 41 and 42 were moved from their normal position the gear 63^b was thrown into contact with the constantly-revolving gear 63 and the shaft 45 revolved in such a direction as to screw out of the block 65, said shaft 45 in the meantime running at the proper speed to return the brushes 41 and 42 and the other parts of the relay device to their normal position by the time the speed of the water-wheel 16 has reached its normal value. If the load is increased to an extent greater than the capacity of the water-wheel 16, the block 65 is brought into contact with the limit-switch 74, which is opened and the circuit broken through the clutch 2, thereby preventing the gate-shaft 15 being turned past its limit. If the load on the water-wheel 16 is decreased, the speed, and consequently voltage, of the dynamo 20 will increase and the reverse of the actions explained above will take place. The solenoid will draw the plunger 22 down slightly, thereby allowing the lever 23 to make contact in the cup 29. A current then flows from the dynamo through the limit-switch 75 and coils 95 and 109 of the clutch 3 and brake 8. The brake-band 9 is raised, the armature 7 clamped against the clutch 3, and the gate-stem 15 revolved in the proper direction to decrease the amount of water admitted to the water-wheel 16. In the meantime the brushes 41 and 42 are moved in a direction opposite to that in which they were moved when the load on the water-wheel was increased. This increases the resistance in series with the solenoid 21 and causes a decreased pull on the plunger 22, thereby allowing the weights 32 and 33 to withdraw the lever from the cup 29. This breaks the circuit through clutch 3 and brake 8 and permits the brake-band 9 to clamp the armature 7. At the instant that the brushes 41 and 42 were moved from their normal position the gear 63^a was thrown into contact with gear 63 and the shaft 45 revolved, thereby returning the brushes 41 and 42 to their normal positions by the time the water-wheel 16 has reached its normal speed.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In combination with a governor, a dynamo, a relay device and brushes operated thereby, said brushes being adapted to move over a series of contact-points, a rheostat connected to the contacts, a solenoid in series with the rheostat, electrical connections between the dynamo and the above-named parts, and means for moving the brushes over the contacts, all arranged substantially as described and for the purposes set forth.

2. In combination with governor, a dynamo, a relay device consisting of two shafts, one of which may be moved laterally and the other both laterally and axially, contact-brushes connected to the shafts and adapted to move over a series of contact-points, a rheostat connected to the contacts, a solenoid in series with the rheostat and means substantially as described for moving the brushes over the contacts for the purposes set forth.

3. In combination with a governor, a dynamo, a solenoid connected thereto, a plunger and lever operated by the solenoid, contacts with which the ends of the lever engage, a rheostat and series of contact-points connected to the solenoid, a contact-brush adapted to move over the contacts, said brush being mounted on a shaft which is adapted to move both laterally and axially, a second shaft connected to the first and adapted to move with it laterally, a pair of gears mounted on the first shaft, said gears normally resting out of contact with a third gear which is constantly revolving between them, a lever operated by the second shaft when it is moved, said lever being adapted to throw the gears into contact with the constantly-revolving gear thereby transmitting axial motion to the first shaft, all arranged and constructed substantially as described and for the purposes set forth.

4. In a governor the combination of a dynamo, a solenoid connected thereto, a plunger and lever operated by the solenoid, contacts with which the ends of the lever engage, oppositely-revolving magnetic friction-clutches, an armature between the clutches and adapted to be operated thereby, a brake for clamping the armature when the governor is at rest, a rheostat and series of contact-points connected to the solenoid, a contact-brush adapted to move over the contacts, said brush receiving motion from a relay device which is operated in such a manner as to first cause the brush to move from its normal position over the contacts, and by a reverse motion to return to the said normal position, all arranged and constructed substantially as described and for the purposes set forth.

Signed by me at the city of Baltimore, in the State of Maryland, this 25th day of February, 1899.

WILLIAM WINDER HANDY.

Witnesses:
CHARLES H. MILLIKIN,
E. W. CODY.