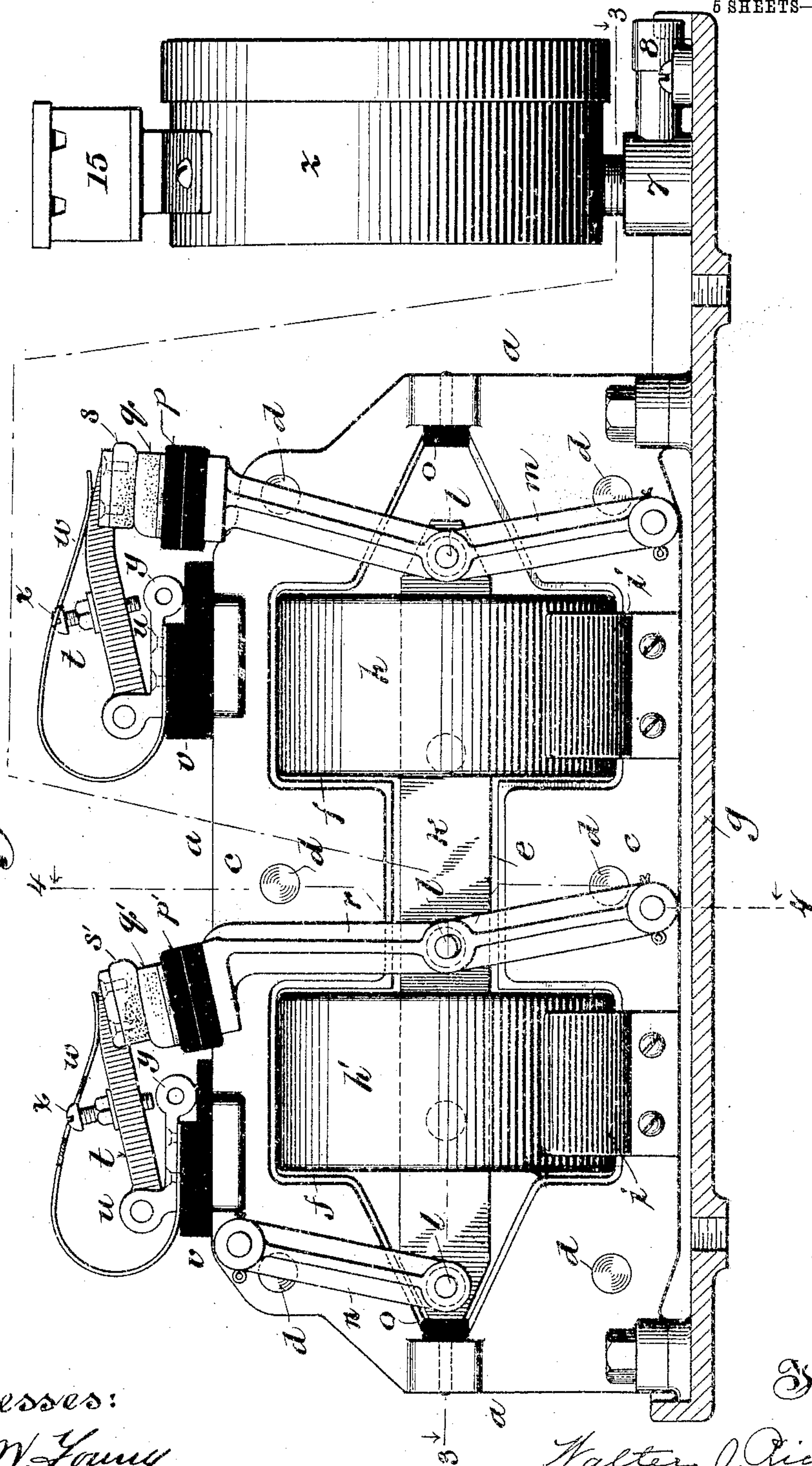


W. J. RICHARDS.  
ELECTRIC CURRENT GOVERNOR.

APPLICATION FILED APR. 11, 1903.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:  
Geo. W. Young,  
Chas. L. Goss.

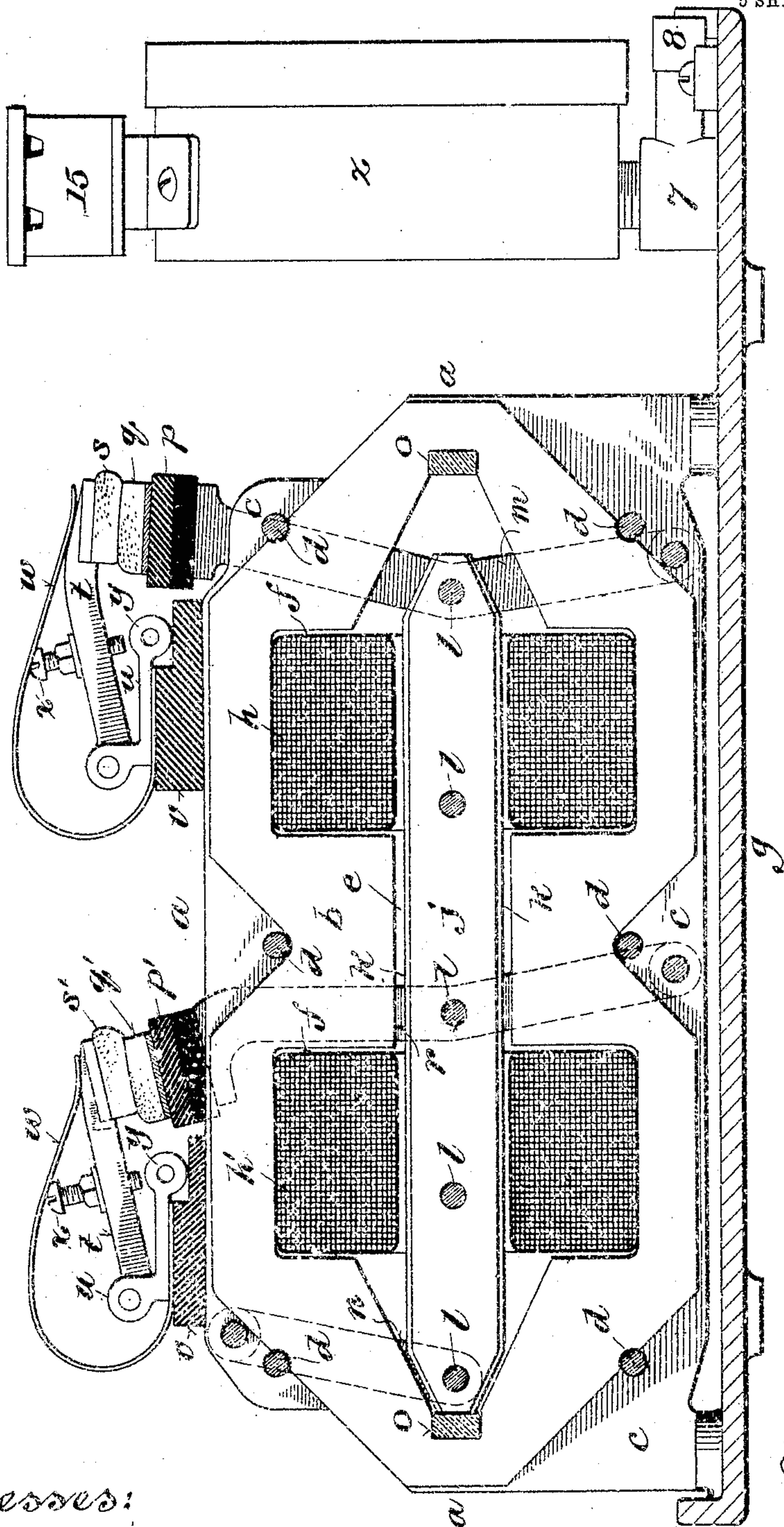
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APPLICATION FILED APR. 11, 1903.

5 SHEETS—SHEET 2.

Fig. 2.



Witnesses:  
Geo. H. Young.  
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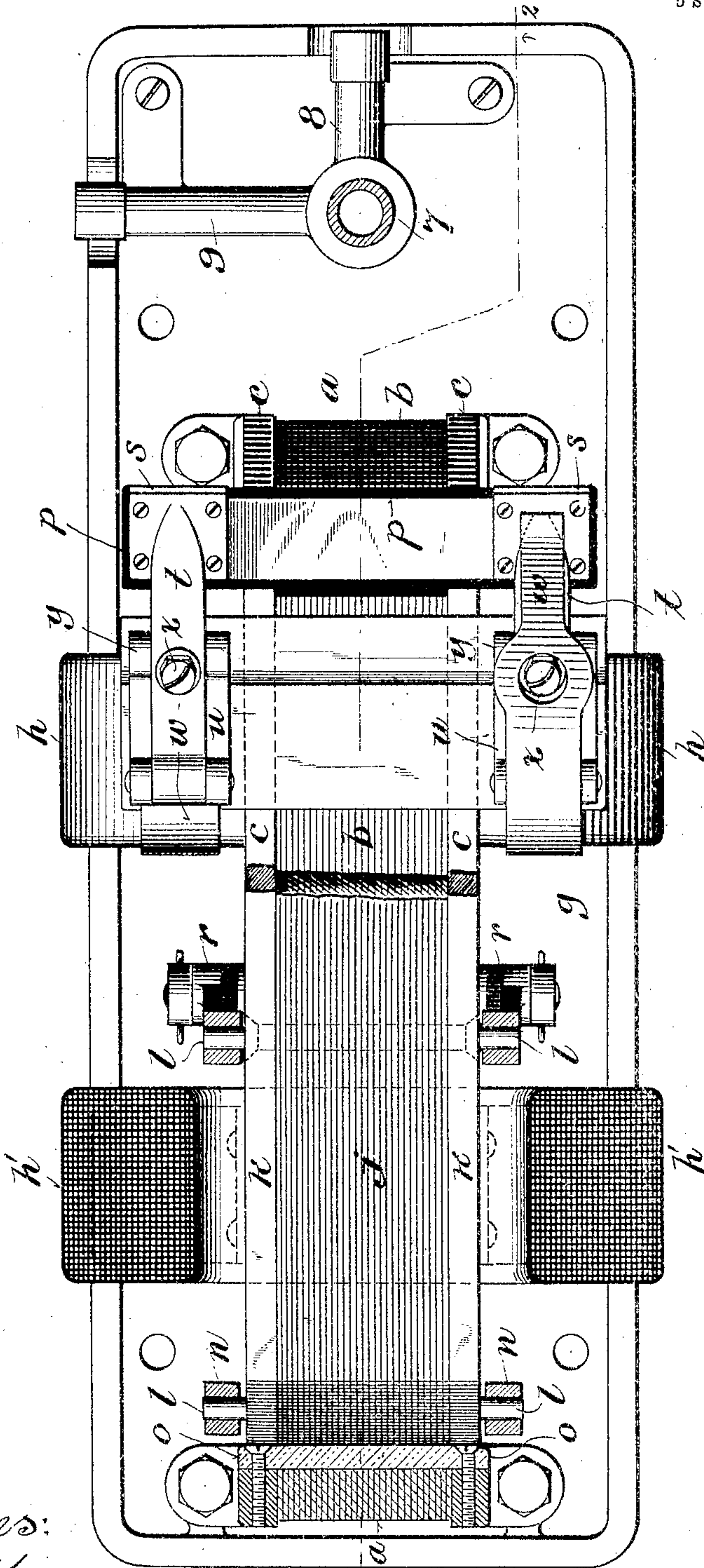
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ELECTRIC CURRENT GOVERNOR.  
APPLICATION FILED APR. 11, 1903.

5 SHEETS—SHEET 3.

*Fig. 3.*



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6 SHEETS—SHEET 4.

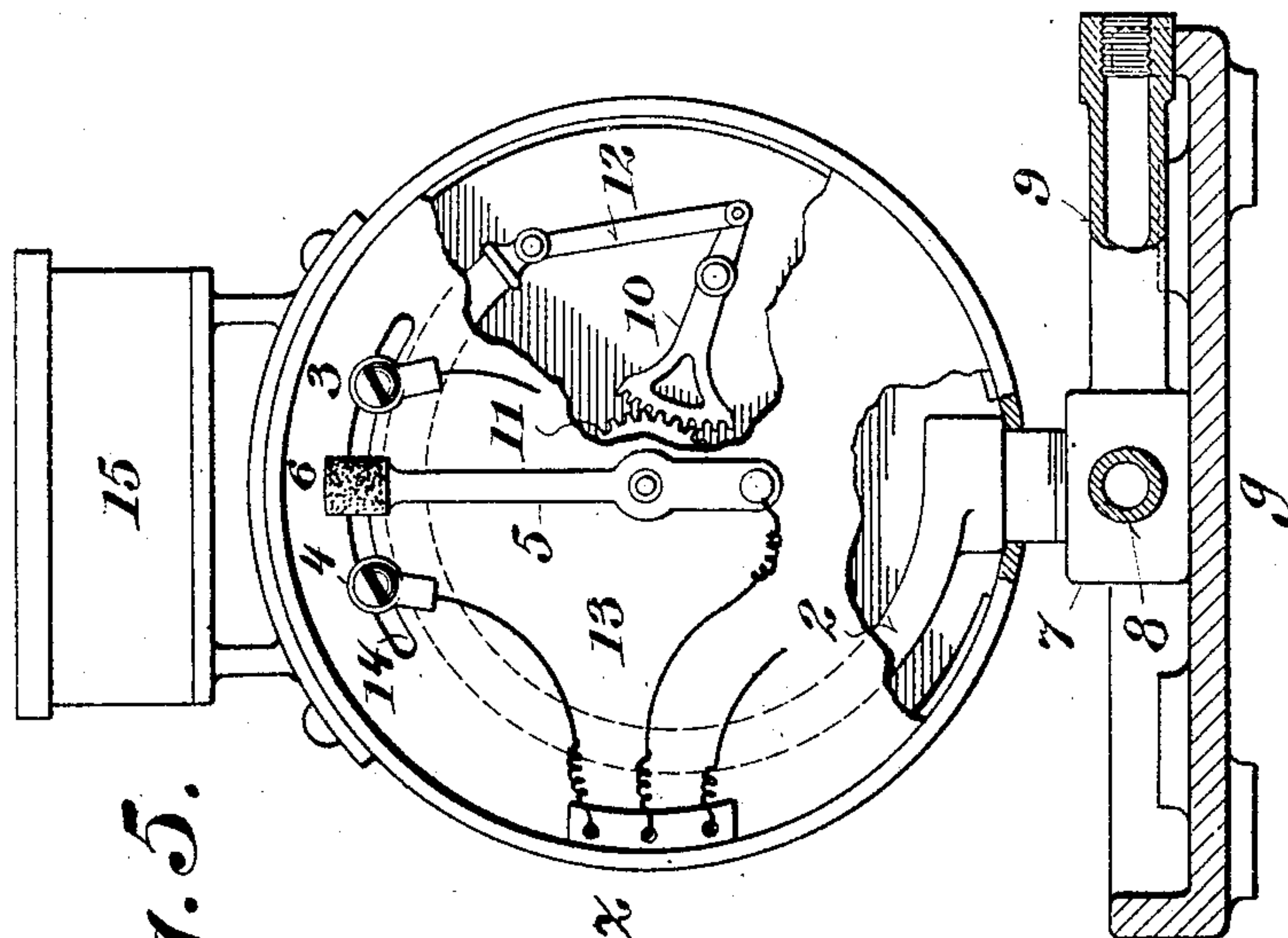


Fig. 5.

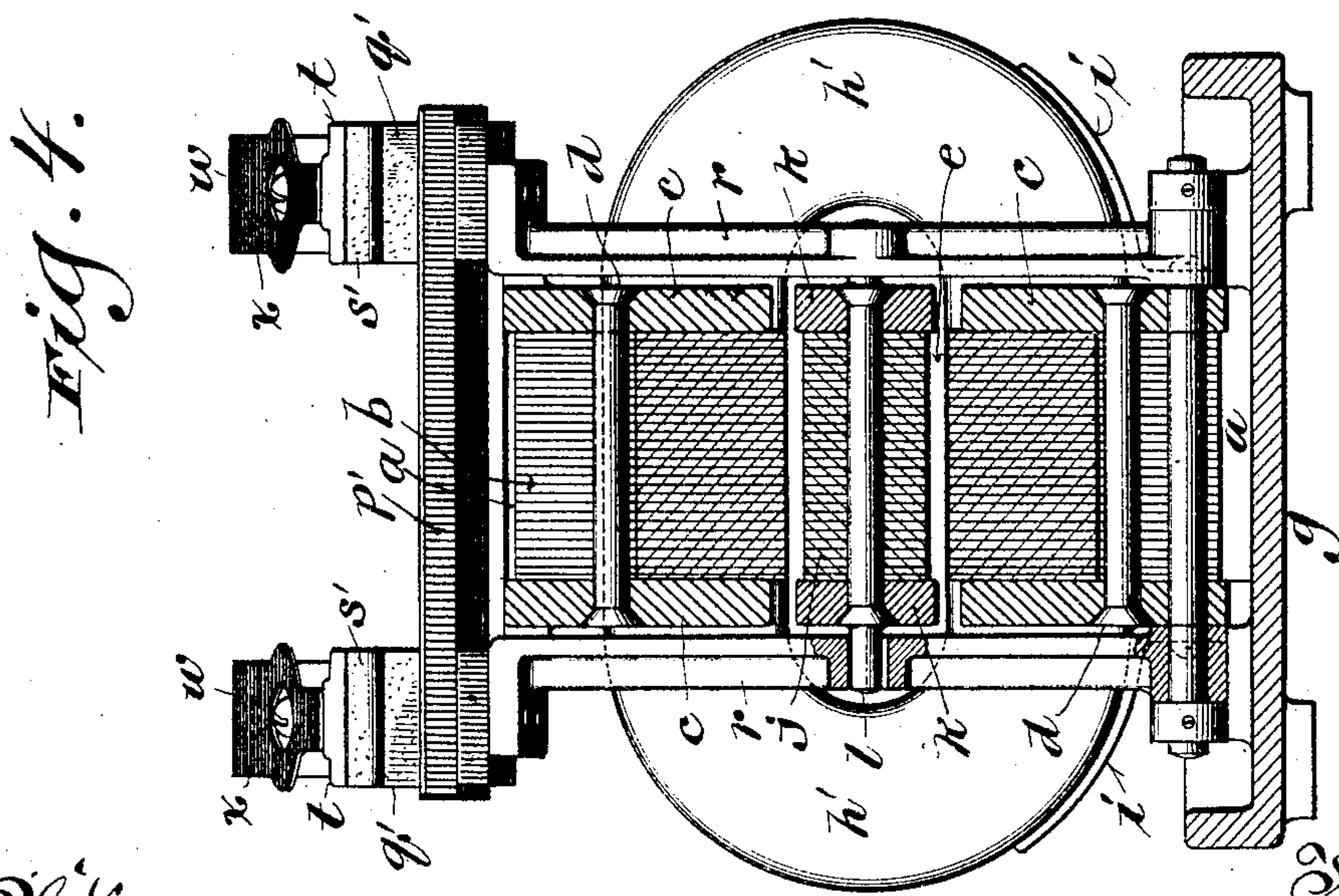


Fig. 4.

Witnesses:  
Geo. W. Young,  
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Walter J. Richards,  
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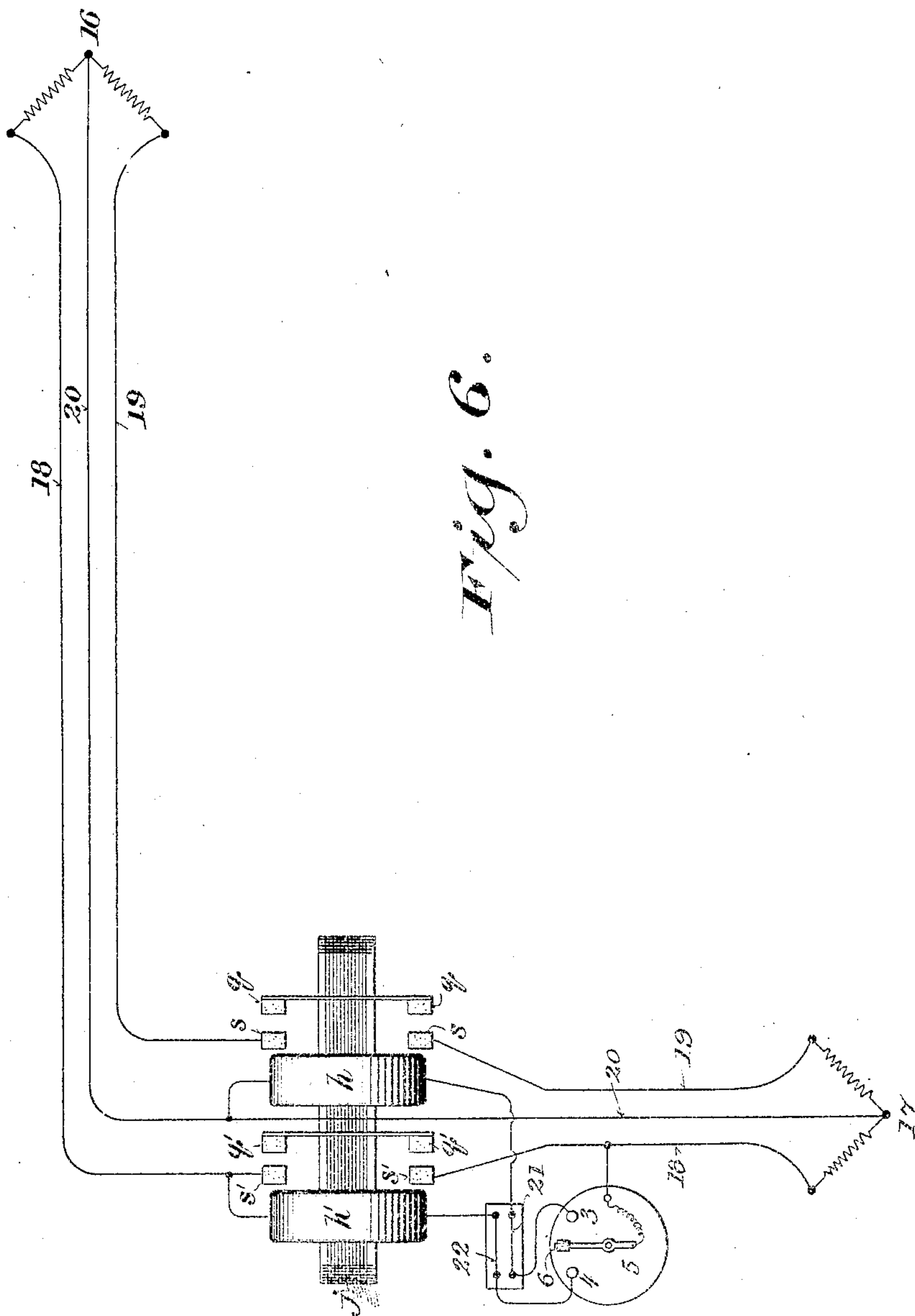
No. 778,333.

PATENTED DEC. 27, 1904.

W. J. RICHARDS.  
ELECTRIC CURRENT GOVERNOR.

APPLICATION FILED APR. 11, 1903.

5 SHEETS—SHEET 5.



Witnesses:  
Geo. W. Young,  
Chas. L. Goss.

Inventor:  
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# UNITED STATES PATENT OFFICE.

WALTER J. RICHARDS, OF MILWAUKEE, WISCONSIN.

## ELECTRIC-CURRENT GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 778,333, dated December 27, 1904.

Application filed April 11, 1903. Serial No. 152,165.

*To all whom it may concern:*

Be it known that I, WALTER J. RICHARDS, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Electric-Current Governors, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

The main objects of this invention are to automatically open and close alternating-current circuits according to predetermined variations in certain conditions—as, for example, variations in fluid-pressure produced by an alternating-current motor—and generally to improve the construction and operation of apparatus for this purpose.

It consists in certain novel features of construction and in a novel arrangement and combinations of parts, as hereinafter particularly described, and pointed out in the claims.

In the accompanying drawings like characters designate the same parts in the several figures.

Figure 1 is a side elevation of the working parts of a governor embodying my invention, the base being shown in longitudinal section. Fig. 2 is a central longitudinal section on the line 2 2, Fig. 3. Fig. 3 is a plan view and horizontal section on the line 3 3, Fig. 1. Fig. 4 is a vertical cross-section on the line 4 4, Fig. 1. Fig. 5 is a face view of the primary switch, parts of the dial or face-plate being broken away to disclose underlying parts; and Fig. 6 is a diagram illustrating one of various ways of connecting the governor with the circuits of an alternator and motor.

For the purpose of illustration I have shown a governor designed to be brought into action by variations in fluid-pressure—as, for example, in air-pressure produced by an alternating-current-motor compressor; but it may be adapted to be brought into action by variations in other forces—such, for example, as an electric current—and it may be applied to various uses.

Referring to the drawings, *a* designates a magnetic circuit or field built up, as shown in Figs. 2 and 4, of thin plates or laminæ *b*, of steel or iron, which are clamped and held

together by side plates *c* and bolts or rivets *d* passing transversely through them. These laminæ and side plates are formed with corresponding openings, which when they are assembled form a longitudinal recess or opening *e*, intersected by transverse openings *f* in the field. The longitudinal recess *e* is enlarged outside of the transverse recesses *f*, and its opposing walls converge toward the ends of the governor. The laminated field is secured by bolts or screws passing through feet on the side plates *c* to a base-plate *g*. Coils *h h'*, suitably insulated and protected, are arranged in the transverse recesses *f* of the field coaxial with the longitudinal recess *e* and are supported in place by saddles or brackets *i*, attached to the side plates *c*.

A laminated armature or plunger composed of thin plates or laminæ *j*, of steel or iron, clamped between correspondingly-shaped side plates *k* by transverse bolts or rivets *l*, is arranged within the longitudinal recess *e* of the field and movable axially through the coils *h h'*. It is supported and guided by links *m n*, pivoted thereto near its ends and to the side plates *c* of the field, said links at one end of the governor being pivoted to the field below and at the other end above the armature, so that the center of the armature in its longitudinal movement will describe a nearly straight line. The ends of the armature are beveled to correspond with the converging walls of the recess *e* at the ends of the governor, whereby for a given movement of the plunger the air-gaps between its ends and the field are reduced. The field is provided at the ends of the recess *e* with stops *o*, of fiber or other non-magnetic material, to limit the endwise movement of the armature and prevent it from sticking to the field. The links *m* are extended upwardly beyond their pivot connections with the armature and are connected at their upper ends by an insulating cross-bar *p*, on which are mounted copper or other suitable contact-pieces *q*, which are connected with each other by a metal strip or conductor. Correspondingly-connected contact-pieces *q'* are in like manner mounted on an insulating cross-bar *p'*, connecting the upper ends of levers *r*, which are fulcrumed at their



lower ends to the field or other fixed part of the governor and are pivotally connected with the armature at or near its center. These levers are substantially parallel with the links *m* and their upward extensions. In the paths of the several movable contact-pieces *q* and *q'* are yielding mounted the relatively fixed contact-pieces *s s'*. The contact-pieces *s* and *s'* may be attached to the free ends of arms *t*, which are pivoted, as shown in Figs. 1 and 2, to metallic blocks *u*, mounted upon and insulated from each other by cross-bars *v*, of fiber or other insulating material, which are attached at their ends to the side plates *c* of the field. The arms *t* are yieldingly pressed toward the paths of the movable contact-pieces *q* and *q'* by springs *w* and are limited in their movement in that direction by stop-screws *x*. The pivot-blocks *u* are formed with eyes *y* for the attachment of the wires of the outside circuits. The contact-pieces *q q'* and *s s'* and the parts immediately associated therewith constitute what may be conveniently called the "main" switch of the governor. To control the supply of current to the coils *h* and *h'* and the operation of the main switch, the governor is provided with what may be conveniently called a "primary" switch *z*.

For use in connection with a motor-compressor, the circuit of which it is desirable to open and close automatically according to variations in air-pressure produced by the compressor, the primary switch may be conveniently mounted on the same base *g* with other parts of the governor hereinbefore described and may consist, as shown in Fig. 5, of a Bourdon or curved expansion tube 2, like or similar to those used in pressure-gages, maximum and minimum pressure contact-pieces 3 and 4, and a hand 5, provided with a contact-piece 6, arranged to engage when moved in opposite directions with the contact-pieces 3 and 4. The tube 2 is rigidly attached at one end to a head 7, having tubular branches 8 and 9 for convenience in connecting it with a pipe leading from the compressor or compressed-air reservoir, the branch which is not used being closed with a plug. The hand 5 is operatively connected with the free end of the tube 2 by means of a segment-gear 10, which meshes with a pinion 11 on the spindle of the hand and is connected by a link 12 with said tube. The tube 2 and the mechanism connecting it with the hand are inclosed in a suitable case provided with a face-plate 13, and the contact-pieces 3 and 4 are adjustably secured in a curved slot 14, which is concentric with the spindle of the hand on opposite sides of the movable contact-piece 6, so as to vary the limits of pressure at which the governor will act to open or close the motor-circuit.

Upon the case of the primary switch is mounted a fuse-block 15 to carry fuses, through which the circuit connections are made with the contact-pieces 3 and 4.

To illustrate the circuit connections and operation of the governor, I have shown in Fig. 6 a diagram of the governor in connection with a three-wire system and a two-phase alternator or generator and a two-phase motor. In this diagram 16 designates the alternator, 17 the motor, and 18, 19, and 20 the three circuit mains or conductors, the main 20 being common to both phases of the alternator and the motor. The main 18 is connected with the fixed contact-pieces *s'* and the main 19 with the contact-pieces *s* of the governor. One terminal of the coil *h* is connected with the main 20 and the other terminal through a fuse 21 on the fuse-block 15 with the contact-piece 3 of the primary switch. One terminal of the coil *h'* is connected with the main 18 and the other terminal of this coil is connected through a fuse 22 with the contact-piece 4 of the primary switch. The hand or movable contact 6 of the primary switch is also connected with the main 18, so that the coil *h'* is in a shunt which taps the same main on opposite sides of the main switch or of the break between the two contact-pieces *s'*.

In a two-phase three-wire system, as illustrated by Fig. 6, the governor hereinbefore described operates as follows: The main switch being open and the movable contact-piece 6 of the primary switch between the contacts 3 and 4, as shown, when the pressure falls to the minimum limit for which the governor is adjusted the contact-piece 6 will engage with the contact-piece 4, closing the circuit through the coil *h'*. The armature or plunger will thereupon be shifted to the left, closing the breaks in the mains 18 and 19 between the contact-pieces *s'* and *s*. The circuits of both phases of the system being thus closed, the motor is started and the air-pressure gradually raised. As the pressure increases the hand 5 will be turned to the right and separate the contact-piece 6 from the contact-piece 4; but before this takes place a short circuit has been made around the contact-pieces 3 and 6 by the closing of the main switch, and consequently no arc will be produced by the separation of the contact-piece 6 from the contact-piece 4. When the pressure reaches the limit for which the governor is adjusted, the contact-piece 6 engages the contact-piece 3 and closes the circuit through the coil *h*. The armature or plunger is thereupon shifted by said coil back to the right, and the movable contact-pieces *q* and *q'* are separated from the contact-pieces *s s'*, thereby opening the mains 18 and 19 and stopping the motor. As the air-pressure falls the hand 5 will turn back to the left; but no arc will be formed by the separation of the contact-piece 6 from the contact-piece 3, because the circuits of both phases, including that with which the hand 5 is connected, have been opened by the main switch. When contact is again made between the contact-pieces 6 and 4, the circuit will be



again closed through the coil  $\mathcal{H}'$ , and the main switch will close the circuits of both phases, starting the motor.

In a three-phase three-wire system and in an independent two-phase four-wire system, as in the two-phase three-wire system herein shown, the governor is arranged to open one main of each phase, leaving the other main or mains closed. In a single-phase system the governor is arranged to make two breaks in the circuit in series in one main, or preferably one break in each main. For convenience and economy in construction the laminæ of the field extend unbroken from one end of the governor to the other end, embracing both coils; but they may be made in sections separated from each other between the coils, thus forming a separate and distinct magnetic circuit for each coil and preventing any lines of force induced by one coil from passing through the field around the other coil.

Various other changes in details of construction and arrangement of parts may be made within the spirit and intended scope of the invention.

I claim—

1. In an electric-current governor the combination of a switch, a laminated field provided with coils, a plunger or armature movable axially in said coils and connected with the movable part of the switch, and a primary switch controlling the supply of current to said coils, substantially as described.

2. In an electric-current governor the combination of a switch, separate field-coils, a laminated plunger or armature arranged to be moved in opposite directions by said coils and connected with the movable part of the switch, and means controlling the supply of current to said coils separately, substantially as described.

3. In an electric-current governor the combination of a switch, a field provided with coils, an armature movable axially in said coils and carried by links which are pivoted thereto and to fixed parts of the governor, the movable part of said switch being operatively connected with said armature, and means controlling the supply of current to said coils, substantially as described.

4. In an electric-current governor the combination of a switch, a magnetic field having a longitudinal recess and transverse recesses, magnet-coils inserted in said transverse recesses, an armature movable axially in said coils and the longitudinal recess in the field-circuit, the movable part of said switch being connected with said armature, and means actuated independently of said switch for controlling the supply of current to said coils, substantially as described.

5. In an electric-current governor the combination of a switch controlling the main circuit, a magnetic field provided with coils arranged transversely thereto, an armature mov-

able axially within said field and carried by links pivoted to fixed supports on opposite sides of its axis, the movable part of said switch being operatively connected with said armature, and means controlling the supply of current to said coils, substantially as described.

6. In an electric-current governor the combination of a switch, a magnetic field provided with two coaxial coils, a plunger or armature movable axially in said coils and connected with the movable part of the switch, links pivoted to said armature and extending therefrom in opposite directions at its opposite ends and pivoted to a suitable fixed support, and means controlling the supply of current to said coils, substantially as described.

7. In an electric-current governor the combination of a switch, a recessed laminated field provided with transverse magnet-coils, a laminated armature movable axially within said field through said coils, the movable part of the switch being connected with said armature, and means controlling the supply of current to said coils, substantially as described.

8. In an electric-current governor the combination of a main switch, a laminated field provided with two coils arranged coaxially therewith, a laminated armature movable axially in said coils and connected with the movable part of the switch, and an automatic primary switch connected with said coils and adapted to open and close the circuit of one or the other according to variations in the force actuating said primary switch, substantially as described.

9. In an electric-current governor the combination of a main switch, a laminated field provided with two coaxial coils, a laminated armature movable axially in said coils and connected with the movable part of said switch, and a primary switch having a fluid-actuating connection and contact-pieces connected with said coils whereby variations in fluid-pressure open and close the circuit connections of said coils and cause them to open and close the main switch, substantially as described.

10. In an electric-current governor the combination of a main switch, a laminated field provided with two coaxial coils, a laminated armature movable axially in said coils and connected with the movable part of said switch, and a primary switch having maximum and minimum pressure contact-pieces and a third contact-piece connected with said coils and a part of the circuit, and a fluid-pressure connection adapted to produce contact between either the maximum or minimum pressure contact-piece and the other contact-piece, whereby one or the other of said coils is energized and the main switch is opened or closed according to variations in the fluid-pressure, substantially as described.

11. In an electric-current governor the combination of a main switch, a longitudinally and



transversely recessed field consisting of laminæ held between side plates, coaxial magnet-coils inserted in the transverse recesses in said field, an armature movable axially in the longitudinal recess in said field through said coils and composed of laminæ held between side plates, said armature being connected with the movable part of said switch, and a primary switch controlling the supply of current to said coils, substantially as described.

12. In an electric-current governor the combination of a switch, a laminated magnetic field provided with coils, an armature arranged to be moved in opposite directions by said coils, and connected with the movable part of the switch, and means controlling the supply of current to said coils separately, substantially as described.

13. In an electric-current governor the combination of a switch, a magnetic field provided with two coaxially-arranged coils, a laminated armature movable axially in said coils and supported and guided by links connecting it with fixed parts of the governor on opposite sides of its axis, the movable part of said switch being connected with said armature, and a primary switch controlling the supply of current to said coils, substantially as described.

14. In an electric-current governor the combination of a main switch having relatively fixed and movable contact-pieces, a laminated magnetic field having transverse recesses intersecting a longitudinal recess, coils arranged in said transverse recesses coaxially with said longitudinal recess, a laminated armature movable axially within said longitudinal recess and through said coils and connected with the movable part of said switch, and a primary switch controlling the supply of current to said coils, substantially as described.

15. In an electric-current governor the combination of a main switch, a laminated magnetic field having a longitudinal recess terminating with converging walls, coils arranged coaxially with said recess, a laminated armature terminating in beveled ends and

movable axially in said recess through said coils, the movable part of said switch being connected with said armature, and a primary switch controlling the supply of current to said coils, substantially as described.

16. In an electric-current governor the combination of a main switch, a laminated magnetic field having transverse recesses intersecting a longitudinal recess which terminates with converging walls and non-magnetic stops, coils arranged in said transverse recesses coaxial with the longitudinal recess, a laminated armature movable endwise through said coils within said longitudinal recess and having its ends beveled to correspond with the converging walls of said recess, supporting and guiding links pivoted to said armature and on opposite sides thereof to fixed parts of the governor, the movable part of said switch being connected with said armature, and a primary switch controlling the supply of current to said coils, substantially as described.

17. In an electric-current governor the combination of a main switch, comprising relatively fixed and movable contact-pieces, a laminated longitudinally-recessed magnetic field, coils arranged coaxial with the recess in said field, a laminated armature movable longitudinally within said recess through said coils, supporting and guiding links pivoted to said armature near its ends and extending therefrom at its opposite ends in opposite directions and pivoted to fixed parts of the governor, the links at one end being extended and carrying contact-pieces of said switch, levers connected with said armature between its ends and carrying other contact-pieces of said switch, and a primary switch controlling the supply of current to said coils, substantially as described.

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

WALTER J. RICHARDS.

Witnesses:

JOHN H. HURLEY,  
CHAS. L. GOSS.