No. 805,505. PATENTED NOV. 28, 1905.

M. WADDELL.

AUTOMATIC REGULATOR FOR ELECTRIC CIRCUITS.

APPLICATION FILED JUNE 28, 1904.

3 SHEETS—SHEET 1.

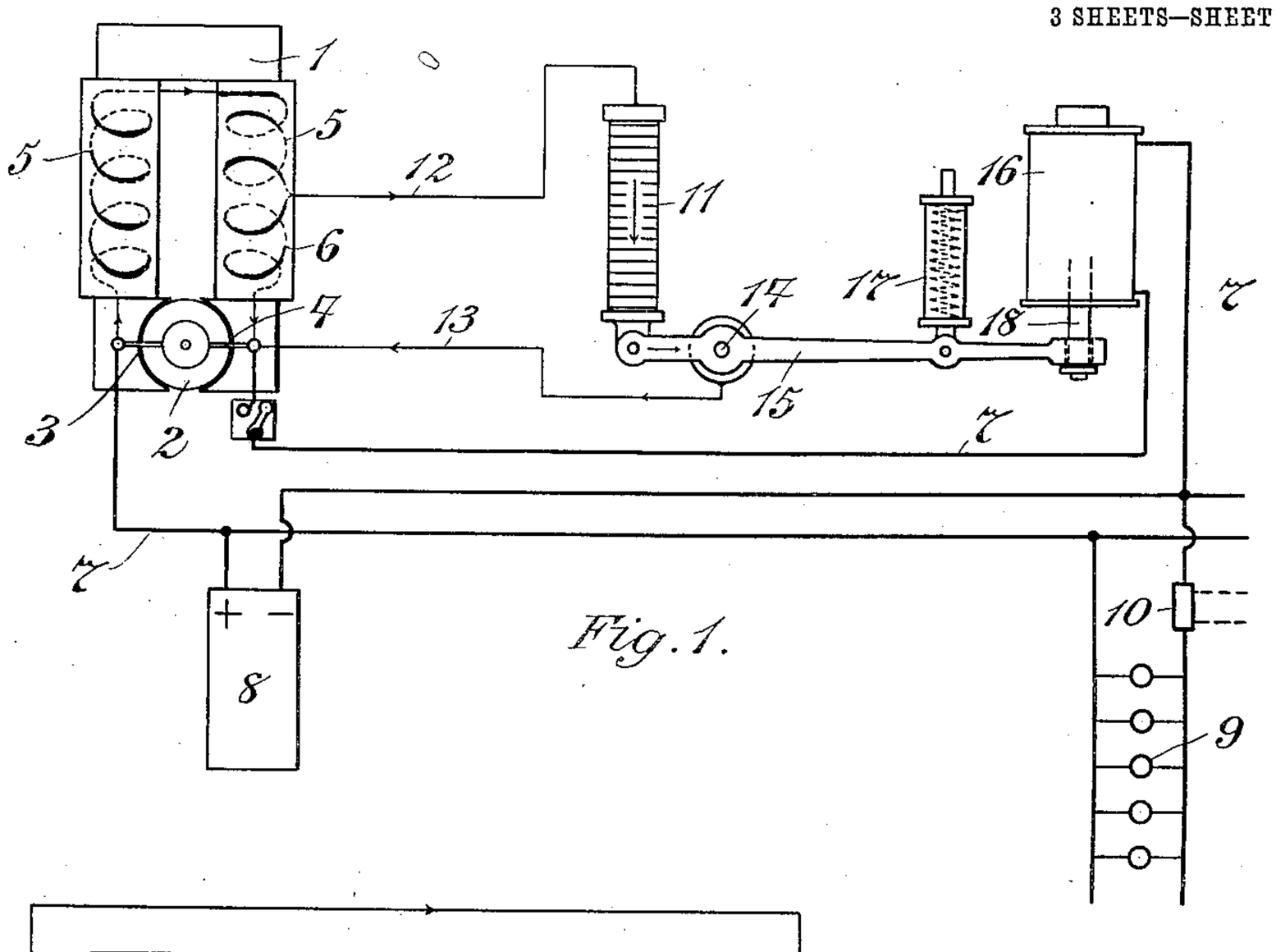


Fig. 1.

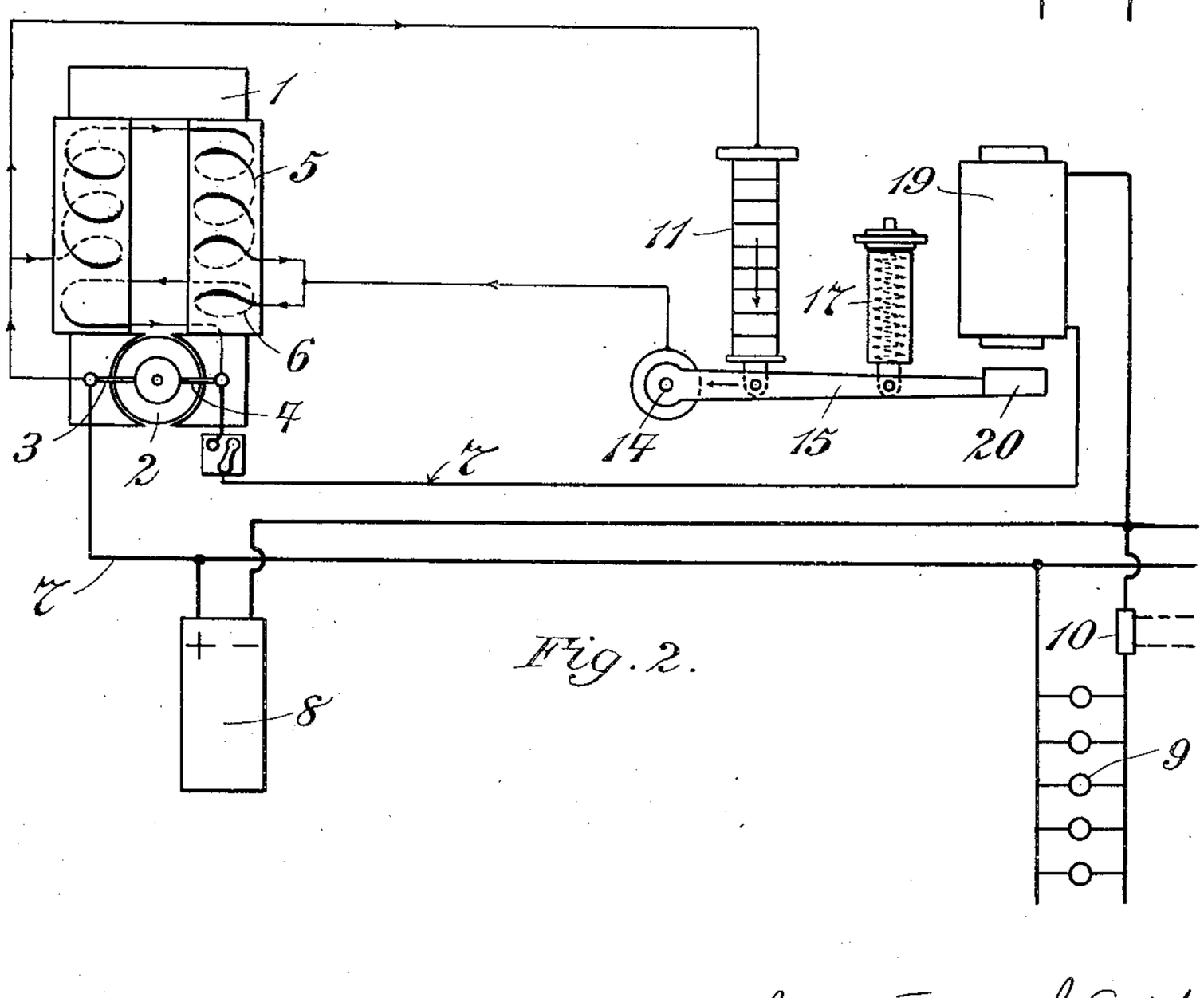


Fig. 2.

Witnesses
Florence Pick
Marie M Hovey

Montgomery Waddell
Inventor

By his Attorney Hmackaye

No. 805,505. PATENTED NOV. 28, 1905.

M. WADDELL.

AUTOMATIC REGULATOR FOR ELECTRIC CIRCUITS.

APPLICATION FILED JUNE 28, 1904.

3 SHEETS—SHEET 2.

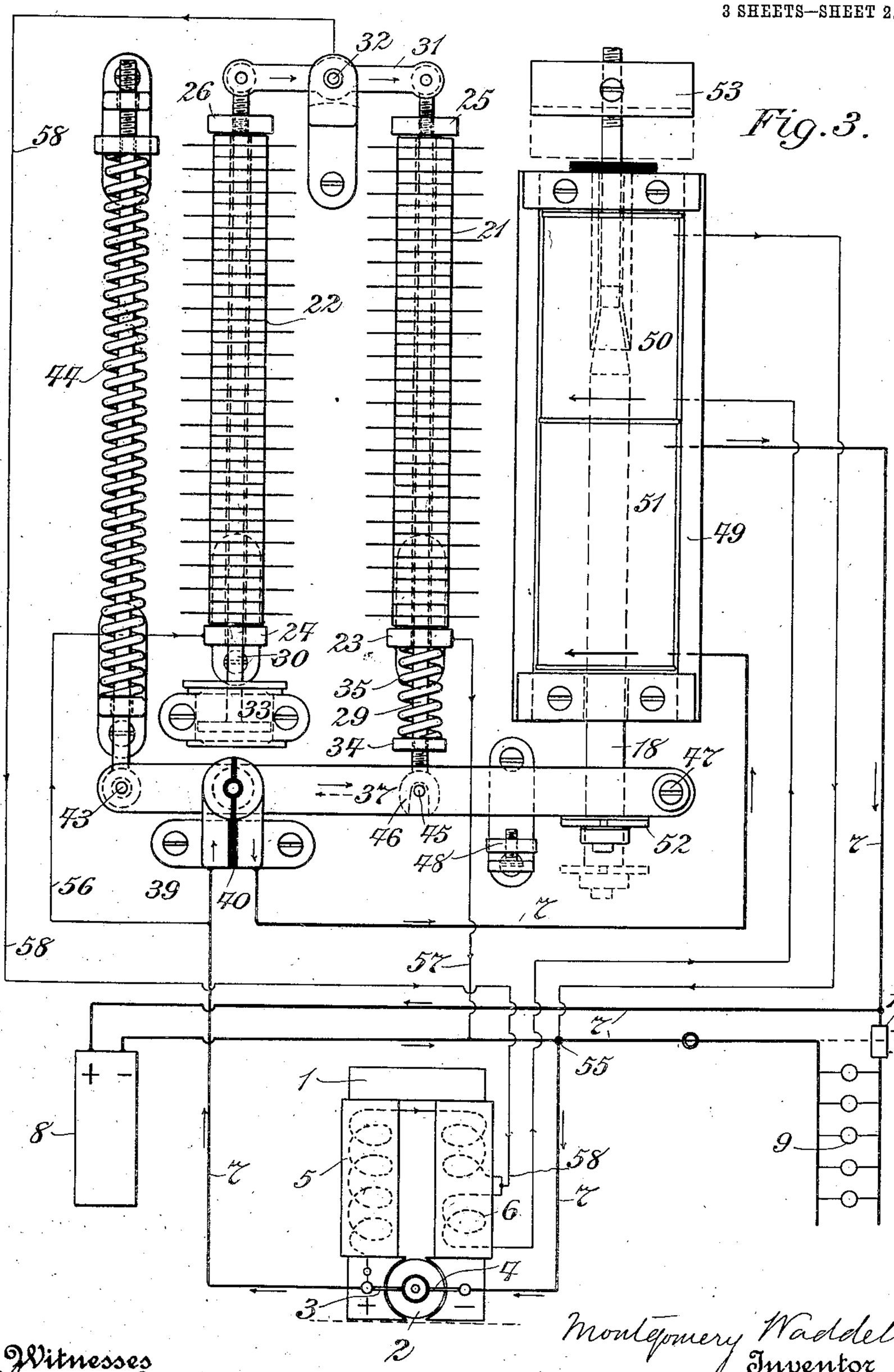


Fig. 3.

Witnesses
Florence Pick
Marie M. Hovey

Montgomery Waddell
Inventor

By his Attorney Howard Kage

No. 805,505. PATENTED NOV. 28, 1905.

M. WADDELL.

AUTOMATIC REGULATOR FOR ELECTRIC CIRCUITS.

APPLICATION FILED JUNE 28, 1904.

3 SHEETS—SHEET 3.

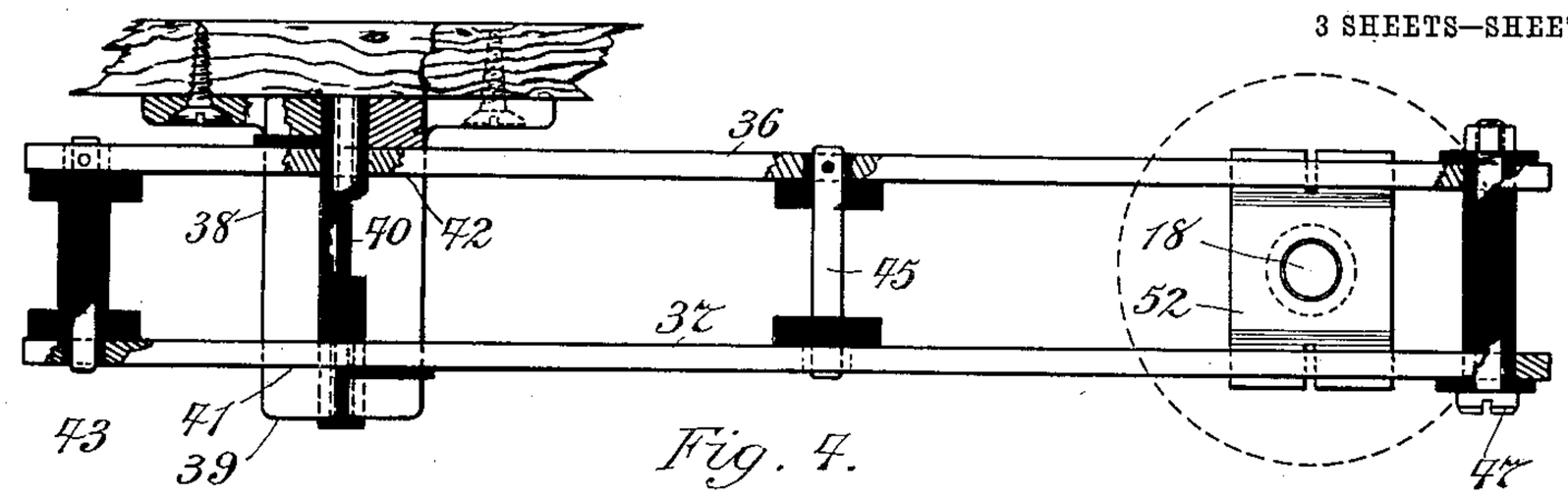


Fig. 4.

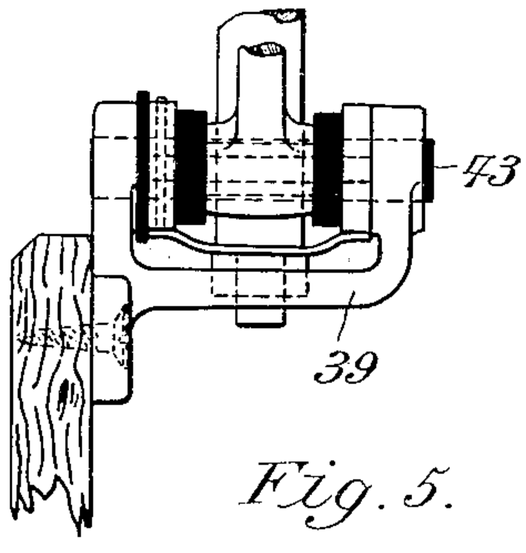
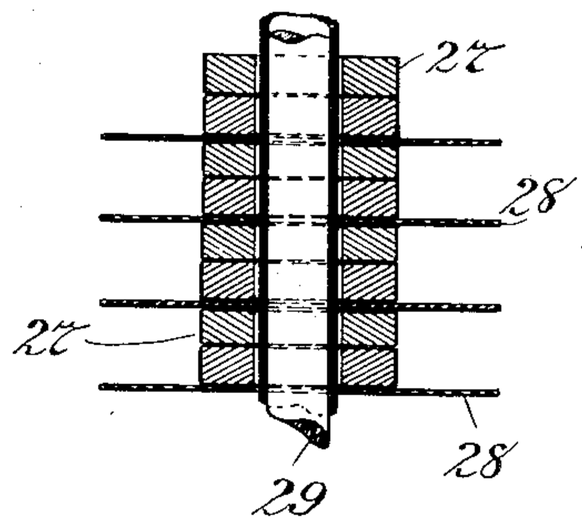


Fig. 5.

Fig. 6.



Witnesses
Florence Pick
Marie M. Hovey

Montgomery Waddell
Inventor
By his Attorney H. MacKaye

UNITED STATES PATENT OFFICE.

MONTGOMERY WADDELL, OF NEW YORK, N. Y.

AUTOMATIC REGULATOR FOR ELECTRIC CIRCUITS.

No. 805,505. Specification of Letters Patent. Patented Nov. 28, 1905.

Application filed June 28, 1904. Serial No. 214,468.

To all whom it may concern:

Be it known that I, MONTGOMERY WADDELL, a subject of the King of Great Britain, residing in the city, county, and State of New York, have invented a certain new and useful Improvement in Automatic Regulators for Electric Circuits, of which the following is a specification.

My present invention relates to an improved means for the regulation of electric circuits for the maintenance of constant current or of constant potential, or of both, in different parts of a system supplied by one or more generators.

The invention is particularly useful in connection with dynamos used with auxiliary secondary batteries—for instance, for lighting purposes, particularly where (as in car-lighting) the dynamo is most conveniently driven at a varying rate of speed.

This invention may be readily combined with certain features of the apparatus described in my United States Letters Patent No. 760,091, dated May 17, 1904, and when so combined the advantages incident to both inventions are successfully united.

Certain preferred forms of this present invention are shown in the accompanying drawings, wherein—

Figure 1 is a diagram of circuits as used in one embodiment of my general invention. Fig. 2 is a similar illustration of a modified arrangement. Fig. 3 is a combined side elevation and diagram showing the rheostat and governor so arranged as to combine the two forms shown in Figs. 1 and 2 while uniting with them certain features of my aforesaid prior patent. Fig. 4 is a top view of a preferred form of rheostat-bar. Fig. 5 is an end view of the same, showing one mode of attachment therefor; and Fig. 6 is a sectional view of one rheostat-column preferably used by me.

In Figs. 1 and 2 the dynamo to be regulated, which is shown as shunt-wound, is shown at 1, the armature 2 feeding current to the brushes 3 and 4, and the field-magnets being provided with two sets of coils 5 and 6 in series. The main circuit-wires are shown at 7, and in the form shown these supply current to a secondary battery 8 and to lights 9. At 10 there is indicated any desired form of local regulator for the lights. The two sections of field-magnet winding 5 and 6 are reversely wound with respect to each other, and the longer section 5, which may be termed the "principal" coil, always prevails. At any moment the actual field-magnet excitation is the result of the difference between the effects of the two coils. The reverse winding of the field-magnet coils is conventionally indicated in the drawings by making those portions of the field-magnet coils which are convex toward the observer in unbroken curves, while the portions of the coils behind the field-magnets are shown dotted.

The description thus far given applies to Figs. 1 and 2 alike; but these figures show somewhat different modes of treatment of these elements. In Fig. 1 a rheostat 11 is shown preferably composed of one or more columns of resisting-bodies whose total resistance is variable by changes in pressure, which column is placed in series with the principal coils 5 and in shunt with the reverse-coils 6. In the form shown this is accomplished by connecting the top of the column 11 by the wire 12 to the end of the principal coil 5, while the wire 13 connects the armature-brush 4 to the pivot 14 of the regulator-arm 15, one end of which bears upon the lower end of the column 11. A variety of means may be employed for control of the regulator-arm 15, and these will differ in construction and in arrangement with reference to the electrical system according to the nature of the regulation required. In the form shown on Fig. 1 this control is accomplished by the solenoid 16 and reaction-spring 17. The solenoid 16 is placed in series with the main circuit 7, and its core 18 is so attached to the end of the arm 15 that the normal effort of the solenoid tends to compress the spring 17 or equivalent reactive means and to diminish the pressure on the column 11.

The operation of the apparatus shown in Fig. 1 is as follows: Assuming the system to be in operation and that for any reason there is a tendency to an increase of current in the main wires 7, the first momentary rise in current will cause an increased effort in the solenoid 16, which by decreasing the pressure of the spring 17, transmitted through the lever 15 to the resisting-column 11, will instantly cause an increase in the total resistance of said column. This will cause a corresponding decrease in the total current passing through the principal field-magnet coils 5, while at the same time producing an increased flow in the reverse-coils 6. There will thus be caused a double weakening of the field-magnet of the dynamo 1 and undue rise in the main current will be prevented.

By combining the regulator with the two reversely-wound field-magnet sections, substantially as shown, relatively small changes in current will instantly produce important changes in the field-magnet.

In Fig. 2 is illustrated a modified arrangement of parts equally within the scope of my invention. Here the column 11 is placed in series with the reverse-coil 6, which is diagrammatically shown wound on both legs of the magnet. This position of the field-magnet coil is also appropriate to the arrangement in Fig. 1. The resisting-column 11, which is in shunt with the principal exciting-coil 5, is so placed in this form of my invention that the reactive spring 17 tends to oppose compression upon the column 11. The solenoid 16 and core 18 are replaced in this figure by an equivalent combination of magnet 19 and armature 20, the normal effect of which is to oppose the spring 17 and to exert pressure upon the column 11.

The operation of the arrangement shown in Fig. 2 is as follows: An incipient increase of current in the main circuit acts through the magnet 19 to increase the pressure upon the column 11, thus lessening its total resistance. This causes diversion of current from the principal or exciting-coil 5 of the field-magnet and increases the flow through the reverse-coil, whereby again the field-magnet is weakened and the desired regulation is accomplished.

While I have shown my regulator applied to a shunt-wound generator, my invention is not limited to this combination.

The preferred form of my device (shown in Figs. 3 to 6) employs a combination of two rheostat-columns with the principal and reverse coils on the field-magnet. This may be used in a variety of ways, according to the kind of regulation desired, and I prefer to use it so that during a portion of the period of its operation at least it combines the two systems above described with reference to Figs. 1 and 2. Fig. 3 furthermore shows an improved form of regulator-arm to be applied in combination with the other parts of the regulator in such a manner that it forms part of an automatic means for closing the main circuit and bringing the regulator itself into operation. This feature, as well as the means for employing two resisting-columns differentially, is capable of application to a variety of regulating devices, and I do not limit myself in my claims to its use in combination with the other features of my invention, which are illustrated with it in Fig. 3. It is to be further understood that I am not limited to use of my regulator in combination with a shunt-wound generator, as it is applicable to use with either a series-wound or a separately-wound generator. In said figure there are shown two resisting-columns, as 21 and 22, resting upon fixed conducting-abutments 23 and 24 and subjected to compression between these abutments and two compression members or nuts 25 and 26 at their opposite ends. As shown in Fig. 6, the resisting-columns in question are preferably composed of superimposed carbon buttons 27, separated at regular intervals by metal plates 28, the whole being perforated from end to end to permit the passage of an insulated rod 29 30 in each column. The rod 29 is threaded at its upper end to receive the pressure-nut 25, and the nut 26 is similarly applied to the rod 30. This arrangement permits of adjustments to suit various conditions. A conducting cross-lever 31 is pivoted at 32 between the two columns, and its two ends are pivotally attached to the upper ends of the rods 29 and 30. The lower end of the rod 30 is preferably provided with a dash-pot 33, adapted to prevent sudden movements. At the lower end of the rod 29 a nut 34 is screwed in place and a short strong regulating-spring 35 is so placed between the abutment 23 and the nut 24 as to tend to exert a constant pressure upon the column 21, while at the same time opposing exertion of pressure upon the second column 22. The regulator-bar takes the form of a frame comprising the two conducting side pieces 36 and 37, pivoted upon an insulated pin 38. (See Fig. 4.) The pin 38 is borne at its two ends in a bracket 39, made of two conducting halves separated by insulation 40. The side piece 36 is connected to one half of 39 and the side piece 37 to the other half by contact between the respective parts, as shown in Fig. 4 at 41 and 42. The side pieces are connected at three points by cross-pins insulated from said side pieces. The first of these (shown at 43) provides a pivotal connection for the long regulating-spring 44. The second pin 45 is placed between the solenoid and the pivot 38, and upon this pin there bears a saddle 46, fixed at the lower end of the rod 29. The short spring 35 pushes the saddle 46 down upon the pin 45. The third pin 47 serves to unite the side pieces at their outer extremity. In Fig. 3 a stop 48 is shown, which serves to limit downward movement of the regulator-frame. The regulating-solenoid 49 is preferably supplied with coils 50 and 51, and its core 18 carries at its lower end a circuit-closing cross-piece 52, preferably composed of one or more springs, as shown in plan view in Fig. 4. This bridge-piece 52 extends transversely under the pivoted regulator, (see Fig. 4,) so as to make electrical contact with both side pieces and lift one end of the frame when the core 18 is raised. A small rod extends upward through the top of the solenoid, being fixed to the end of the core, and an appropriate weight 53 is carried by said rod. This weight is preferably screwed upon the rod which carries it to facilitate adjustment in position, and thereby regulate the distance to which the bridging-piece 52 falls when circuit is broken. (See Figs. 3 in dotted lines.)

The apparatus shown in Fig. 3 is connected to the dynamo-circuit for operation as follows: One part of the bracket 39 is connected directly to one brush 3 of the armature, and the main current, leaving from the other part of said bracket and passing through the coarse-wire coil 51 on the solenoid 49, goes to the translating devices. Two shunt-circuits lead from the main circuit between the armature and the bracket 39. The first of these leads through the principal field-magnet coil, the reverse-coil, and the solenoid-coil 50, back to the main line at 55. The second shunt goes by the wire 56 up through the resisting-column 22, across the lever 31, down the column 21, and back to the line by the wire 57. In addition to these connections a compensating wire 58 connects the lever 31 between the two columns 21 and 22, with a point between the two sections of the field-magnet coils. As indicated by the opposed arrows on the wire 58, the current will flow in one direction or the other on this wire, according to the conditions existing in the system. Under certain possible conditions of equilibrium no current at all will flow here. Assuming now that the dynamo is ready to start from a state of rest to supply current to a previously-idle main circuit, the solenoid-core is depressed and the bridging-piece 52 occupies the position shown in dotted lines in Fig. 3. After the dynamo starts and as soon as sufficient potential exists at the brushes 3 and 4 the core 18 will be raised by the action of the coil 50, and the bridging-piece 52 will be lifted into contact with the two side pieces 36 37, thus closing the main circuit and putting pressure against the pivoted frame. The main circuit will then proceed, as indicated by the arrows, from brush 3 to one insulated section of the bracket 39, to the side piece 37, across the bridging-piece 52 to the other side piece 36, thence to the other side of the bracket 39, to the coil 51 on the solenoid, and finally through the translating devices back to brush 4. Before closure of circuit at 52 the resistance of the column 22 is near its highest point and that of the column 21 is near its minimum, owing to the action of the spring 35. The result is that very little current is diverted from the principal field-magnet coil 5, and the column 21 diverts a large part of the current from the reverse-coil 6, but leaving sufficient to enable the coil 50 to operate the main-circuit switch. This condition of course favors rapid building up of the field magnetism. As soon as the lifting action of the solenoid is felt there is at first a rapid rise of resistance in the column 21 and a corresponding fall of resistance in the column 22, which checks the rise of field magnetism by diverting more current from the coils 5 and progressively less from the coils 6. At the same time the current passing through the coil 50 is increased, and this coil acts through the solenoid to still further compress the column 22 while relieving the column 21 of pressure. The desired balance is determined in advance by the tension and dimensions of the springs 35 and 44 and the characteristics of the solenoid and dynamo. The short and long springs herein shown and described have their functions fully set forth in my application for Letters Patent, Serial No. 182,576, filed November 15, 1903.

By appropriate proportions in the coils and resistance-columns the current can be diverted from the exciting-fields to such an extent that under appropriate predetermined conditions an actual fall in both potential and current volume in the main circuit can be made to follow an excessive increase in the generator speed.

It will be seen that the arrangement shown in Fig. 3 and above described provides a very delicate and instantaneous regulating means, since the two differential columns 21 22 are so arranged as to produce contrary and simultaneous effects on the two oppositely-wound sections of field-magnet windings, and thus coöperate for the production of a large effect answering to relatively small casual changes in current. Moreover, the coil 50, acting as it does to increase its own effect until balanced by the changes in the main circuit and the coil 51, coöperates with the differential columns to promote promptitude and delicacy of regulation.

Many modifications may be made in the various parts of this invention without departing from the scope thereof, and I am not to be understood as limiting myself to the details herein shown and described.

What I claim is—

1. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other, one end of each section being electrically connected to one armature-brush and the remaining ends of the two sections being electrically connected to each other between said brushes; in combination with a rheostat connected in shunt with one of the sections of said coils and means for varying the resistance in said rheostat, substantially as described.

2. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other, one end of each section being electrically connected to one armature-brush and the remaining ends of the two sections being electrically connected to each other between said brushes; in combination with a rheostat connected in shunt with one of said coils and electromagnetic means in circuit with said dynamo for varying the resistance in said rheostat, substantially as described.

3. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other,

one end of each section being electrically connected to one armature-brush and the remaining ends of the two sections being electrically connected to each other between said brushes, in combination with a regulator comprising a variable-resistance device in shunt with the principal field-magnet coil, substantially as described.

4. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other, one end of each section being electrically connected to one armature-brush and the remaining ends of the two sections being electrically connected to each other between said brushes; in combination with a regulator comprising a variable-resistance device in shunt with the reverse field-magnet coil substantially as described.

5. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other, one end of each section being electrically connected to one armature-brush and the remaining ends of the two sections being electrically connected to each other between said brushes; in combination with a rheostat in shunt with each coil and electromagnetic means in circuit with said dynamo for simultaneously varying the resistance in both of said rheostats, substantially as described.

6. In a device of the class described, a dynamo having a principal field-magnet coil and a magnetically-opposing field-magnet coil in shunt with the armature and in series with each other, two separate rheostats in shunt with said armature and with the first-named shunt but in series with each other, a compensating wire connecting a point between said rheostats with a point between said field-magnet coils and means for simultaneously operating both of said rheostats, substantially as described.

7. In a device of the class described, a dynamo comprising two sections of field-magnet coils wound so as to magnetically oppose each other and a regulator comprising two separate rheostats electrically connected to said coils and means adapted to operate said rheostats simultaneously so as to increase the current in one of said coils while decreasing the current in the other, substantially as described.

8. In a device of the class described, a dynamo comprising two sections of field-magnet coils wound so as to magnetically oppose each other, an electromagnetic regulator in circuit therewith, two separate rheostats also connected to said coils and means operated by said electromagnetic regulator and adapted to operate said rheostats simultaneously so as to increase the current in one of said coils while decreasing the current in the other coil, substantially as described.

9. In a device of the class described, a dynamo having a principal winding and a reverse winding on the field-magnet thereof, two rheostats in series with each other and individually in shunt with said two field-magnet windings respectively and means for setting up simultaneous and opposite resistance changes in said two rheostats, substantially as described.

10. In a device of the class described, a dynamo having a principal field-magnet winding and a reverse field-magnet winding in shunt with the armature and in series with each other, two independent rheostats in series with each other and in shunt with said windings, a compensating wire connecting a point between said rheostats with a point between said field-magnet coils and means for setting up simultaneous and opposite resistance changes in said two rheostats, substantially as described.

11. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other; in combination with a separate rheostat in shunt with each of said field-magnet coils and means for varying the resistance of each of said rheostats substantially as described.

12. In a device of the class described, a dynamo having two sections of field-magnet coils wound so as to magnetically oppose each other; in combination with a separate rheostat in shunt with each of said field-magnet windings and means for setting up simultaneous and opposite resistance changes in said two rheostats, substantially as described.

13. In a device of the class described, a dynamo having a principal exciting field-magnet coil and a reverse-wound coil magnetically opposed thereto; in combination with a separate column of resisting-bodies in shunt with each of said field-magnet coils and means for setting up simultaneous and opposite changes in the pressures existing on said two columns, substantially as described.

14. In a device of the class described, a dynamo having a principal field-magnet winding and a reverse field-magnet winding, in combination with a separate column of resisting-bodies in shunt with each of said field-magnet windings, a pivoted spring-pressed lever whose opposite ends bear on said two columns and means for changing the effective pressure exerted on said pivoted lever, substantially as described.

15. In a device of the class described, a dynamo having a principal exciting field-magnet coil and a reverse-wound field-magnet coil; in combination with a separate column of resisting-bodies in shunt with each of said field-magnet windings, a lever whose opposite ends bear on said two columns, means for exerting pressure to tilt said lever in one direction and means for exerting various degrees of force on said lever in opposition to said first-named means, substantially as described.

16. In a device of the class described, a dynamo having two reversely-wound sets of field-magnet coils in series with each other, two col-

umns of resisting-bodies, a solenoid having two coils, and mechanical means connecting said columns and said solenoid for producing differential pressure changes in said columns under the influence of current changes in said solenoid; in combination with an electric connection between one end of the field-magnet coils and one end of one of said resisting-columns, a connection between one end of the other column and the working circuit of the dynamo, a connection between the remaining ends of both said columns and the junction between the two sets of field-magnet coils and a connection from the remaining end of the entire field-magnet system, through one coil of said solenoid to the working circuit of the dynamo, substantially as described.

17. In a device of the class described, a dynamo having two oppositely-wound sections of field-magnet coils in series with each other and together in shunt with the armature, and a rheostat connected in shunt with one of the field-magnet sections, substantially as described.

18. In a device of the class described, a dynamo having two oppositely-wound sections of field-magnet coils in series with each other and together in shunt with the armature, a rheostat connected in shunt with one of the field-magnet sections and means for varying the resistance of said rheostat, substantially as described.

19. In a device of the class described, a dynamo having a principal and a reverse-wound section of field-magnet coils in series with each other and together in shunt with the armature and an automatic regulator comprising a variable-resistance device in shunt with the principal field-magnet coils, substantially as described.

20. In a device of the class described, a dynamo having a principal and a reverse-wound section of field-magnet coils in series with each other and together in shunt with the armature and an automatic regulator comprising a variable-resistance device in shunt with the reverse field-magnet coil, substantially as described.

21. In combination with a dynamo having an exciting-coil producing operative magnetization of its field-magnet, a rheostat in series with the entire exciting-coil, a second rheostat in shunt around said entire exciting-coil and means for simultaneously producing opposite resistance changes in said two rheostats, substantially as described.

22. In combination with a magneto-electric generator having a principal or exciting coil and a coil magnetically opposed thereto, two rheostats so connected to said field-magnet coils as to exert opposite tendencies upon the flow of current in said coils and means for producing simultaneous and opposite resistance changes in said rheostats, substantially as described.

23. In a device of the class described, a dynamo having a principal and a magnetically-opposing section of field-magnet winding, an electromagnetic regulator having primary and secondary coils, said secondary coil being in series with said magnetically-opposing field-magnet coil, and a rheostat controlled by said regulator and connected in shunt around said field-magnet coil, substantially as described.

24. In a device of the class described, a dynamo having a principal and a magnetically-opposing section of field-magnet winding, an electromagnetic regulator having a primary coil in series with the main circuit of said dynamo and a secondary coil in series with said magnetically-opposing field-magnet winding, and a rheostat controlled by said regulator and connected in shunt around said magnetically-opposing field-magnet coil and said secondary regulator-coil, substantially as described.

25. In a device of the class described, a dynamo having a principal and a magnetically-opposing section of field-magnet winding, an electromagnetic regulator having a primary coil and a secondary coil, said secondary coil being in series with said magnetically-opposing field-magnet winding, and two rheostats both controlled by said regulator, one of which is connected in shunt around said magnetically-opposing field-magnet winding and said secondary regulator-coil while the other rheostat is in series with said last-named winding and coil, substantially as described.

26. In a device of the class described, a dynamo having a principal and a reverse section of field-magnet winding, an electromagnetic regulator therefor comprising a coil connected to form with said two field-magnet sections a single electric series, two rheostats in series with each other and connected in shunt with the entire aforesaid electrical series of coils, an electric connection from a point between said rheostats directly to a point between said two field-magnet sections and means controlled by said regulator for changing the resistances of said rheostats, substantially as described.

27. In a device of the class described, a dynamo, a rheostat in shunt with the exciting-coil of said dynamo, and an electromagnetic regulator for said dynamo having a primary and a secondary coil, said primary coil being in series with the main circuit of the dynamo and said secondary coil being in series with said rheostat, substantially as described.

MONTGOMERY WADDELL.

Witnesses:
WILLIAM H. KETTRA,
JOSEPH V. O'DONNELL.