No. 707,052. Patented Aug. 12, 1902.

J. L. CREVELING.

REGULATION OF ELECTRIC LIGHTING SYSTEMS.

(Application filed July 17, 1901.)

(No Model.)

3 Sheets—Sheet 1.

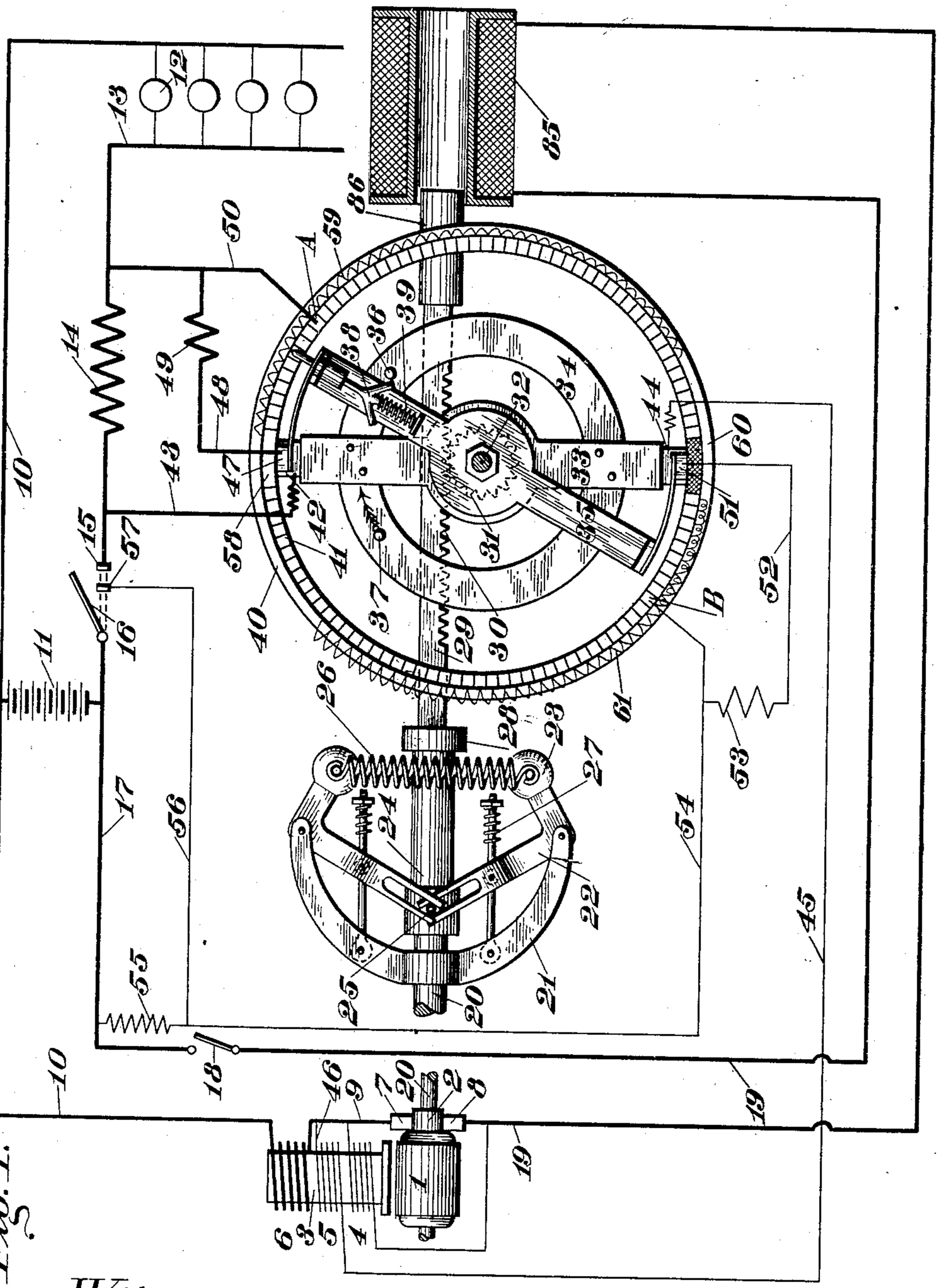

Fig. 1.

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Fig. IV.

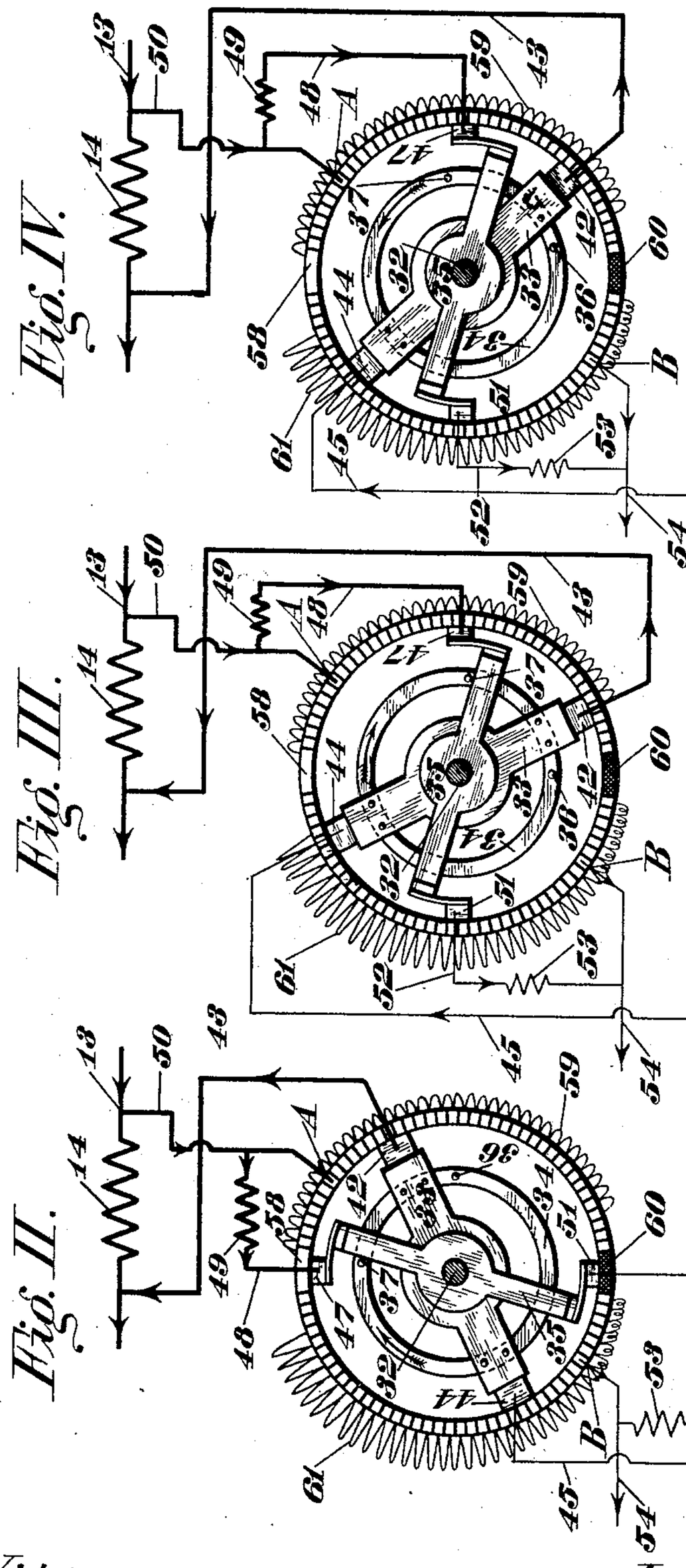

Fig. III.

Fig. II.

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(No Model.) 3 Sheets—Sheet 3.

Fig. VI.

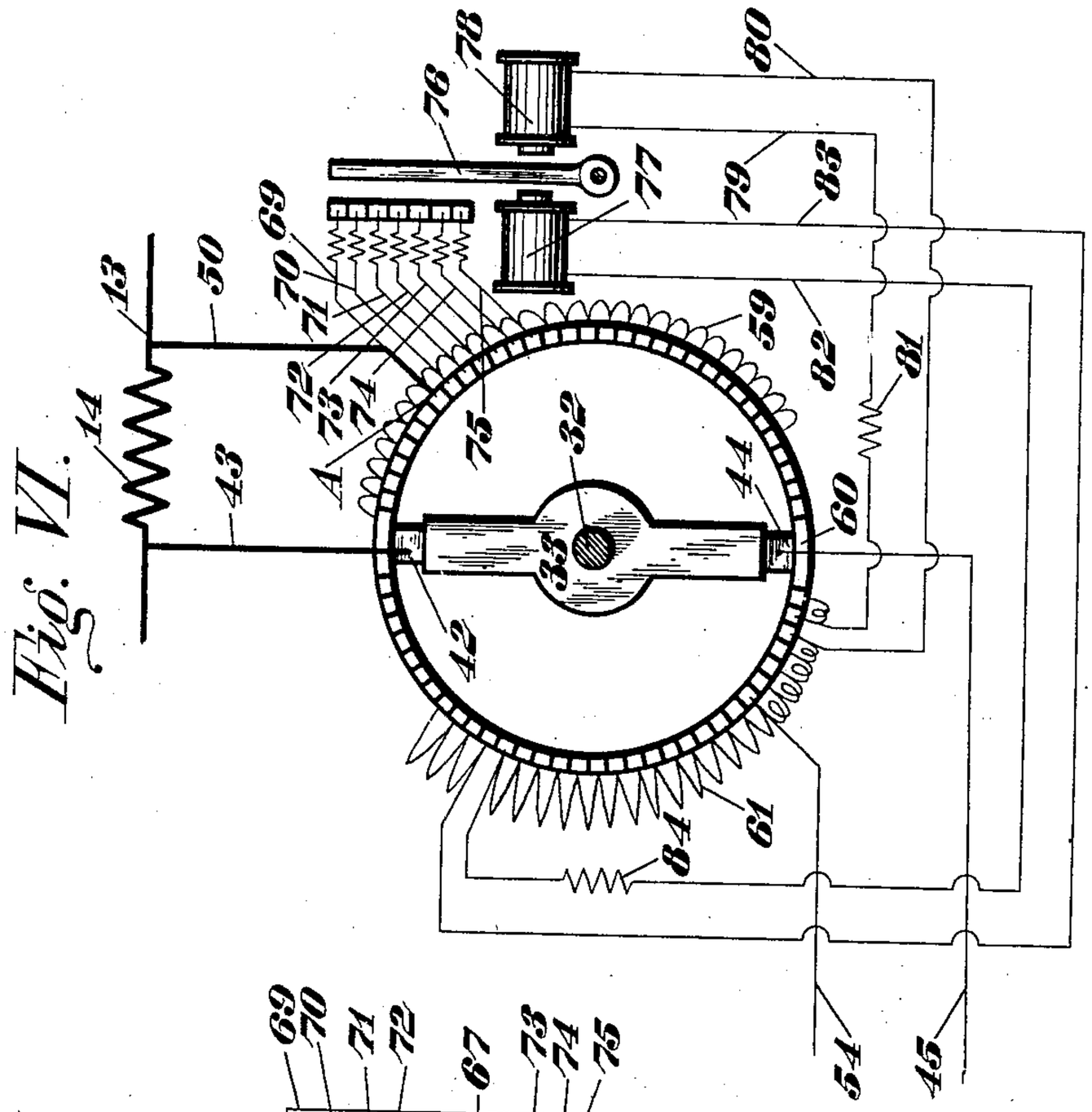
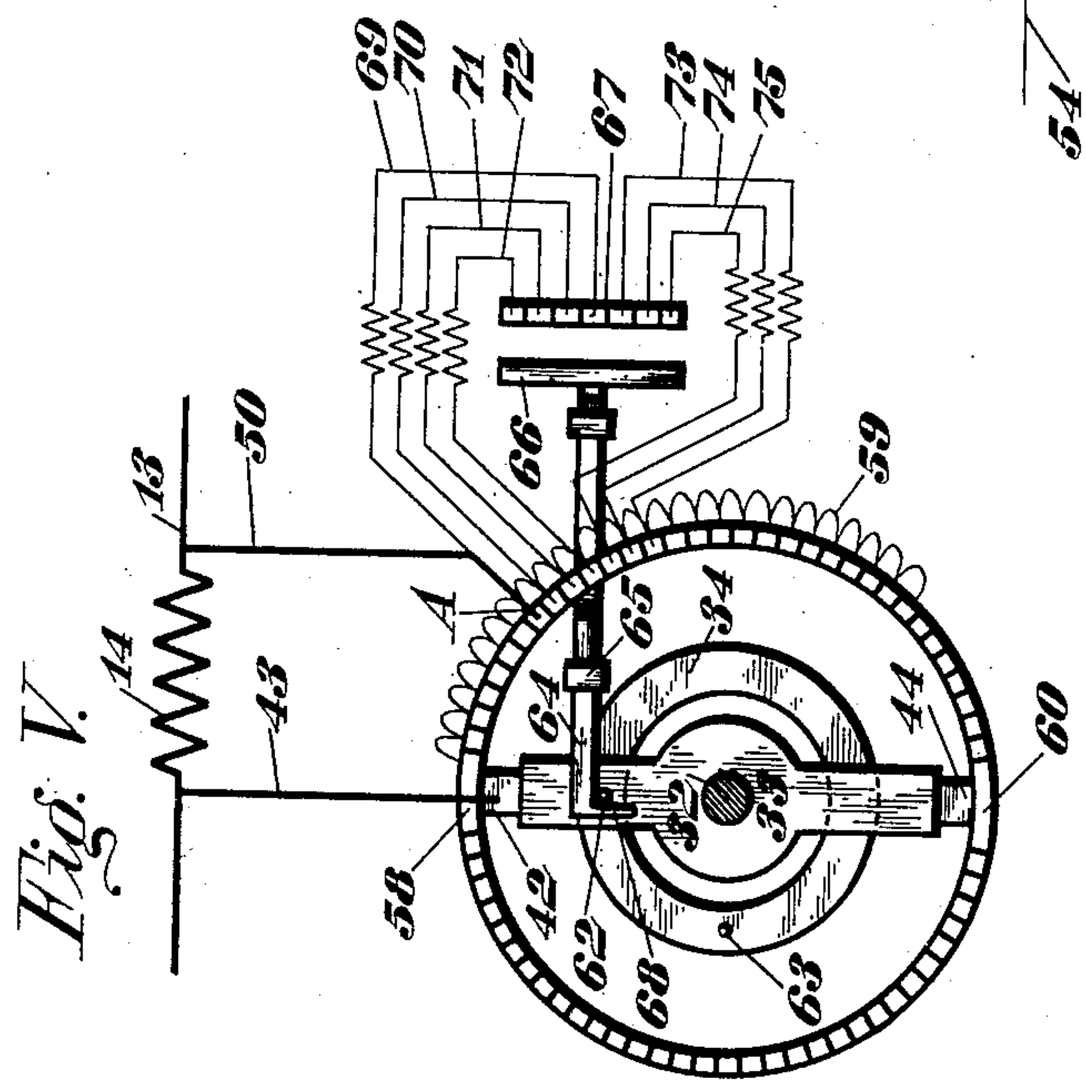


Fig. V.



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UNITED STATES PATENT OFFICE.

JOHN L. CREVELING, OF NEW YORK, N. Y.

REGULATION OF ELECTRIC-LIGHTING SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 707,052, dated August 12, 1902.

Application filed July 17, 1901. Serial No. 68,650. (No model.)

To all whom it may concern:

Be it known that I, JOHN L. CREVELING, a citizen of the United States, residing at the borough of Manhattan, city, county, and State of New York, have invented a certain new and useful Improvement in the Regulation of Electric-Lighting Systems, of which the following is a specification.

My invention relates to the regulation of electric-lighting systems and will be described with reference to a car-lighting system, to which the invention is primarily applicable.

In the accompanying drawings I have shown sufficient elements of a car-lighting system to illustrate my invention.

The object of my invention is to produce a means of overcoming the ill effects which would naturally be caused by the lagging tendency of a centrifugal governor used to regulate the field resistance and also the resistance of the lamp-circuit in an electric-lighting system. In systems of this character the regulation by means of a centrifugal governor is not as exact as might be desired, for the reason that the increments or decrements of the effect produced by the centrifugal governor do not keep pace with the increment or decrement of the effect imparted to the circuit by the electric controller.

In the accompanying drawings, Figure I represents a diagrammatic view of the apparatus as at present preferred by me, all parts being shown as in a normal position when at rest. Fig. II shows a portion of the apparatus in a position caused by the revolution of the armature and, for example, may be considered as at about one-half speed. Fig. III represents the position assumed by the parts of the regulator when the speed has increased until at or near the limit. Fig. IV represents the same parts after the speed has suffered a decrease; and it is thought that these views will aid in following up the operation of the device, as shown in Fig. I. Fig. V shows a portion of the apparatus in a modified form, the portions not shown taken substantially the same as in Fig. I. Fig. VI shows a still further modification, the omitted portions being considered the same also as in Fig. I.

Throughout all the sketches like characters are used to indicate like parts.

In Fig. I, 1 indicates the armature, 2 the commutator, and 3 the field-magnet, of any suitable type of dynamo or generator, in this case taken as provided with field-coil 4, in shunt across the brushes, battery field-coil 5, and differential series coil 6. The generator is assumed to have its armature revolve in one direction only, inasmuch as several means have been shown for accomplishing this irrespective of the direction of the train, and also various styles of pole-changers are well known which would serve to properly make the connections for reversal in direction of rotation. 7 is therefor taken as the positive and 8 as the negative brush. From 7 the lead 9 is carried to one end of the differential coil 6, the other end of which is connected with the main 10, which leads to the positive pole of the storage battery 11 and, continuing therefrom, communicates with one terminal of the lamps or translating devices 12, the other terminal of which is in communication with the main 13, which is led to the resistance 14 and thence to the switch-contact 15. From the other side of this switch (indicated at 16) the main 17 is led to the negative pole of the storage battery and thence to the switch 18, from which wire 19 is carried to the negative brush 8.

The switch 15 16 may be of any suitable type—as, for instance, a hand-switch—used merely to turn the lights on or off, as desired. The switch 18 may be of any of the well-known types adapted to connect the generator with the battery when the same shall have reached proper electromotive force.

20 represents the armature-shaft and is provided with a yoke 21, carrying members 22, at one extremity of which are placed the balls or weights 23. The members 22 are operatively connected with the sleeve 24, which is free to slide along the shaft 20, as by means of pins 25, while the spring 26 tends to draw the balls together and cause the sleeve 24 to assume the position shown in the drawings. 27 is another set of springs which come into play only after the sleeve 24 shall have had a certain predetermined displacement. The sleeve or collar 28 unites the sleeve 24 with the member 29 in such manner that 24 is free to revolve without revolving 29; but 29 is subject to any lateral displacement given to

the member 24. 29 is provided with a rack, as indicated at 30, engaging a pinion 31, as shown in dotted lines. The rack 29 is provided with a core 86 of a solenoid 85 in the dynamo main circuit. This solenoid is shown as placed in series with the generator-main, so that the energizing of the solenoid tends to aid centrifugal force in moving the various parts. By this means both the variation in speed and the output of the generator are utilized. The pinion 31 is mounted upon a shaft 32, to which is fixed the member 33, carrying a circular disk or annulus 34. The member 35 is placed loosely upon the shaft 32 and is free to revolve about the same in a manner as will hereinafter be described.

36 and 37 represent pins attached to the disk 34 and adapted to impart motion to the member 35.

38 is a locking device normally held outward, as by the spring 39, against the flange 40 and is so arranged that the pins 36 and 37 when brought against its beveled sides will cause the lock to disengage and allow the member 35 to be revolved, together with the member 33, so long as the pins press against the member 38 with sufficient force. When the pins 36 and 37 travel away from the member 38, this lock serves to hold 35 in a fixed position, so that vibration will not cause it to move from one pin toward the other. The member 40 also serves to unite the various bars of the commutator 41 mechanically, while each bar is of course insulated from 40 and also from its neighbors.

42 represents a brush carried at one extremity of the member 33 and properly insulated therefrom in any desirable manner. A wire 43 connects this brush with the main terminating in contact 15. 44 represents a brush carried at the opposite extremity of the member 33, from which the wire 45 leads to one end of the battery field-coil 5, the other end of which is connected with the main 9, as by the wire 46.

47 represents a brush suitably attached to one extremity of the member 35 and electrically insulated therefrom. The wire 48 connects this brush with one side of the resistance 49, the other side of which is in connection with the wire 50, which serves to connect the main 13 with a bar of the commutator 41, as indicated at A, and the selection of which will hereinafter be explained. 51 represents a similar brush in mechanical connection with the opposite end of the member 35 and electrically connected with the resistance 53, as by means of wire 52, the other end of resistance 53 being connected with the wire 54, one end of which is led to a bar of the commutator 41, as indicated at B, the other end of 54 being in connection with the resistance 55, which is in turn connected with the main 17. The wire 56 is led from the wire 54, between the bar B and resistance 55, to the switch-contact 57.

58 represents a broad segment of the commutator or a number of segments joined together, upon which the brushes 42 and 47 normally rest when the armature of the generator is revolving very slowly or at rest.

59 represents a series of resistances used for connecting the various bars of the commutator upon the right-hand side of the center line with the broad bar 58.

60 represents a broad bar of the commutator, similar to 58, but made of insulating material. Upon this bar the brushes 44 and 51 normally rest when the machine is not in motion, and thus electrical connection between these brushes and the variable resistance is broken when the armature is standing still.

61 represents the variable resistance used for joining together the various bars of the commutator on the left-hand side of the center line in a manner which will hereinafter plainly appear.

In practice the mechanical governor may be so adjusted as to properly insert the various resistances in phase with the tendency of the electromotive force to rise, and if so arranged a decrease in the movement of the mechanical governor should cause a greater ratio of the variation of resistance to compensate for the lagging tendency due to friction and causes tending to throw the upward and outward movement of the governor out of phase with the speed variations, or vice versa.

The operation of this system is substantially as follows, starting with the generator at rest and the various parts of the apparatus in the positions as indicated in Fig. I: If it be desired that the lamps or other translating devices (indicated at 12) shall be in operation, it is merely necessary to close the switch, (indicated at 16,) and current will then flow from the battery 11 through the main 10, translating devices 12, main 13, and, dividing, part will flow through the resistance 14 and part through the wire 50, where it will again divide, a part going through resistance 49, wire 48, brush 47, bar 58, brush 42, wire 43. The other portion entering the variable resistance at A will flow through said resistance to bar 58 and thence through wire 43, uniting with the other two above-named circuits and leading to the contact 15, thence through switch 16 and main 17 to the negative pole of the battery 11. It will thus be seen that a small amount of resistance is inserted in the lamp or translating-circuit when the generator is at rest. No current will flow through the armature of the generator, owing to the action of the switch 18, and no current will be wasted by flowing through the battery field-coil, inasmuch as this circuit is broken, since both of the brushes 44 and 51 are resting upon a bar made of insulation. As soon as the generator shall have its armature revolved at any appreciable speed the balls or weights 23 will fly outward, causing the sleeve 24 to slide along the shaft, which in turn will cause the brushes carried by the member 33 to revolve in the direction as indicated by

the arrow in Fig. I. At a speed which we will consider as a little below that necessary to bring the generator to the same voltage as the battery the balls are adapted to move outwardly until the springs 27 are brought into play. In this position we will consider the brushes 42 and 44 as brought around upon the contacts A and B, respectively. In this position the lamp resistance will be cut out, inasmuch as the wire 50 will then communicate directly with the wire 43, practically short-circuiting the resistance 14. As this brush travels over the resistance 59 the brush 44 travels over 61, first making contact and completing the battery-circuit through a very high resistance and gradually reducing the same until when in contact with B the battery field-circuit is as follows: Current flows from the battery 11 through the main 10, coil 6, wire 46, coil 5, wire 45, brush 44, bar B, wire 54, and, dividing, returns to the battery through resistance 55 and wire 56 and switch 15 16 57. It will thus be seen that when the switch controlling the lamp-circuit is closed the resistance 55 is practically short-circuited. This is done to enable the generator to supply more current when the lamp-circuit is closed, when it is obvious that the increase in current is desirable. The object of reducing the resistance of the lamp or translating-circuit, as above outlined, is to compensate for the drop upon the lamps which would otherwise be caused by the taking of current for the energizing of the field; but if the speed of the generator increase, the switch 18 will close and current will be supplied by the generator through the following circuit: from brush 7 through main 9, coil 6, main 10, and returning to the generator through main 17, switch 18, lead 19, and brush 8, part of the current from the generator branching and flowing through coil 4, tending to assist in magnetizing the field, as in any ordinary shunt-machine. Now if the speed of the generator increase the voltage will tend to rise and more current will tend to flow from the generator to the battery and translating devices. Within certain limits it is of course desirable that this increase should take place; but when the maximum is reached the current output should be held constant, and while the current is going from its minimum to its maximum it is necessary that some means be provided to keep the voltage impressed upon the translating devices practically constant. The increase in speed of course causes the member 33 to revolve and insert the resistance 61 into the field-circuit and the resistance 59 into the lamp-circuit and while passing from the point above mentioned—that is, from minimum to maximum activity—the steps of the field resistance are made very small, while the steps in the lamp resistance are made comparatively large, inasmuch as it is desirable to have practically full field throughout this interval, while of course the translating-circuit requires its greatest alteration in resistance during this time. Further increase in speed merely causes the member 33 to revolve and insert resistance in both circuits until it reaches the position indicated in Fig. II, in which position the pin 37 is shown in contact with the member 35, and any further movement of the member 33 will cause 35 to have a like travel. However, should the generator now slow down resistance would be withdrawn from the lamp-circuit and also from the field-circuit until 33 came in line with bars A B, when the generator should have full field and the lamp resistance would be reduced to a minimum in a well-known manner. However, should the speed increase until, say, at full speed, as indicated in Fig. III, the member 35 would travel along until in the position as shown in the figure. Under these conditions the position of the brushes 47 and 51 would also tend to determine the amount of resistance in the two circuits. The current, returning now from the lamps or other translating devices through the main 13, would pass partly through the resistance 14, as before; but the branch circuit 50 would carry current to the bar A of the commutator and thence through the multiple circuit composed in part by the portions of the variable resistance included between the bar A and the brush 47 and in part by the resistance 49, wire 48, which multiple circuit would be in series with the remaining portion of the variable resistance 59 included between the brush 47 and brush 42, from which the current would flow, as by the wire 43, to the main 13. The battery field-circuit would now be from wire 45 to brush 44, thence through the portion of the variable resistance included between the brush 44 and brush 51, and branching at 51 part of the current would flow through that portion of the variable resistance lying between 51 and the bar B, and part would flow through the wire 52, resistance 53, uniting and returning through the wire 54. Now should the speed of the generator decrease, so as to cause the member 33 to move in the direction indicated by the arrow in Fig. IV, the resistance included in the lamp-circuit between the brushes 42 and 47 and the resistance included in the field-circuit between the brush 44 and the brush 51 would be diminished until the two brushes were bought into contact with the same bars, or, better, until the pin 36 comes in contact with the member 35. Then these two sets of brushes will upon further decrease of speed return to their original position together in a manner which can clearly be followed in the figure. It will be noticed that the movement of the members from the positions shown in Fig. II to that in Fig. III may be accomplished with little variation, as desired, in the two resistances, owing to the displacement of both sets of brushes. However, as soon as a reverse movement is caused the brushes 47 and 51, standing still, will cause the ratio of decrease of resistance to be changed in any

desired manner by the approach of the brushes 42 and 44—that is, as much resistance as is desired may be introduced in each circuit by the moving of the various parts from the positions shown in Fig. I to the positions shown in Fig. II—and further revolution—as, for instance, the position shown in Fig. III—may be accomplished with as little or as great addition of resistance as may be desired. In fact, the parts may be placed as shown in Fig. III without any alteration of resistance whatever. However, as soon as the speed lessens the resistance may be materially decreased and may be practically all taken out, if so desired, at the speed of revolution which was necessary to place the parts in position as indicated in Fig. II. (This of course is an extreme case.)

In Fig. V the member 33 is shown as carrying the disk 34, which is provided with pins 62 and 63, adapted to engage the finger 68 of the sliding bar 64, supported in the bearings 65, carrying at its outer end the insulated contact-piece 66, adapted to connect the several insulated contacts, (indicated at 67.) The wire 69 leads from the bar A to one of the bars of 67, while 70 leads from the bar adjacent to A to one of the contacts of 67. 71 72 73 74 75 represent wires joining the adjacent commutator-bars in a manner similar to wires 69 and 70. If desired, resistances may be placed in circuit with each of the above-named wires, as indicated in the sketch. The operation of this device is practically that as shown in the above figures, save that the member 33 after a certain degree of revolution causes, through instrumentality of the pin 63, the bridging-piece 66 to electrically connect the various bars of 67, thus practically joining together through resistances, if desired, a portion of the first bars of the commutator lying beyond the bar A. The pin 62 and finger 68 are so arranged that after the revolution of the member 33 has caused 66 to bridge the members of 67 the said pin may pass clear of the finger 68, allowing a further revolution of the member 33. As the speed slows down and 33 approaches its original position the pin 63 passes under 68 and the member 33 revolves, leaving 66 bridging the pieces of 67 until the pin 62 engages the member 68, when further revolution of 33 will break the connection between the bars of 67 and return the various parts to the position shown in the sketch. A similar arrangement may also be provided for the generator field-circuit; but as it is entirely independent of the one shown and exactly similar it is omitted in the sketch and description.

Fig. VI shows substantially the same apparatus as Fig. V, save that the connection between the various bars of the member 67 is made by a contact member and actuated electromechanically. With reference to this figure and Fig. I it will be seen that after the member 33 passes through a considerable of its normal revolution the brush 44 will pass beyond the two commutator-bars, which are shown in Fig. VI as connected by the wires 82 and 83, which include the resistance 84 and the electromagnet 77 in circuit therewith. In passing over these two bars the field-current will flow through the magnet 77, causing the lever or armature 76 to join together the various contacts, (indicated at 67.) These will stay connected together until the slowing down of the generator shall cause the brush 44 to pass over the two bars shown as joined together by wires 79 and 80, including in their circuit the resistance 81, magnet 78. When the brush 44 shall have passed over these bars, current of course will flow through the magnet 78, breaking the contact between the various parts of 67, causing the various members to assume the position as shown in Fig. VI. It is obvious that the lever 76 may be made to cut out any desired amount of the field resistance.

It will be noticed that in Fig. I the generator is shown as provided with two coils besides the differential coil 6. The one coil 4 is placed in shunt across the brushes permanently and is so proportioned as to furnish a little less than the field excitation required when running at the maximum speed. The coil 5, which derives current from the battery, is so proportioned that, together with coil 4, it gives the full field at a speed necessary to give the required voltage to close the switch 18. It is obvious that with this arrangement the least possible current is carried through the contacts of the variable-resistance device and also that on varying the resistance and cutting out this coil there is little tendency to spark, owing to the effect of mutual induction, the voltage of self-induction of course being materially lessened on account of the closed coil 4 being interlinked with the magnetic flux through the magnet 3 and set up by coil 5.

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

1. In a system of electrical distribution the combination of a generator, a mechanical governor or regulator therefor and electric means for compensating for the lag of the governor.

2. In a system of electrical distribution the combination of a generator, a mechanically-operating governor therefor and electrical means under the control of the governor for compensating for the lag thereof.

3. In a system of electrical distribution the combination of a generator and an external circuit, a mechanical governor for the generator and the external circuit, and means for compensating for the lag of the governor.

4. In a system of electrical distribution the combination of a generator, a mechanical governor, regulating the field resistance and the resistance of the external circuit and means for compensating for the lagging tendency of the governor.

5. In a system of electrical distribution the combination of a generator, a mechanical governor therefor, means for regulating the external circuit actuated from the governor and means for causing the variations of the governor and the regulating means to occur in harmony with each other.

6. In a system of electrical distribution the combination of a generator, a mechanical governor and regulating means for the field-circuit of the generator and for the external circuit and means for causing variations in the governor and in the regulating means to occur in harmony with each other substantially as described.

7. In a system of electrical distribution the combination of a centrifugal governor, electro-magnetic means in circuit with the generator for aiding the said governor in its action and circuit-controlling means operated by the governor.

8. In a system of electrical distribution the combination of a mechanical governor, a plurality of means for controlling the field-circuit and the external circuit, means for operating one controlling means from the governor and the other controlling means from the first-mentioned controlling means.

9. In a system of electrical distribution the combination of a generator, a centrifugal governor and means for controlling the external circuit and the field-circuit of a generator from the said governor, comprising in its structure means for so operating the circuit-controlling means as to compensate for the lagging tendency of the generator.

10. In a system of electrical distribution the combination of a generator, variable resistances for controlling the output of the generator, a mechanical governor for the generator and means for controlling the variable resistances from the governor and compensating for the lagging tendency of the governor.

11. In a system of electrical distribution the combination of a generator, variable resistances for controlling the output of the generator, and a governor therefor constructed and arranged to augment the strength of the field when delivering current to the lamps.

In testimony whereof I, JOHN L. CREVELING, have signed my name to this specification, in the presence of two subscribing witnesses, this 11th day of July, 1901.

JOHN L. CREVELING.

Witnesses:

ELMER E. ALLBEE,

H. C. HUNTER.