No. 740,447. PATENTED OCT. 6, 1903.

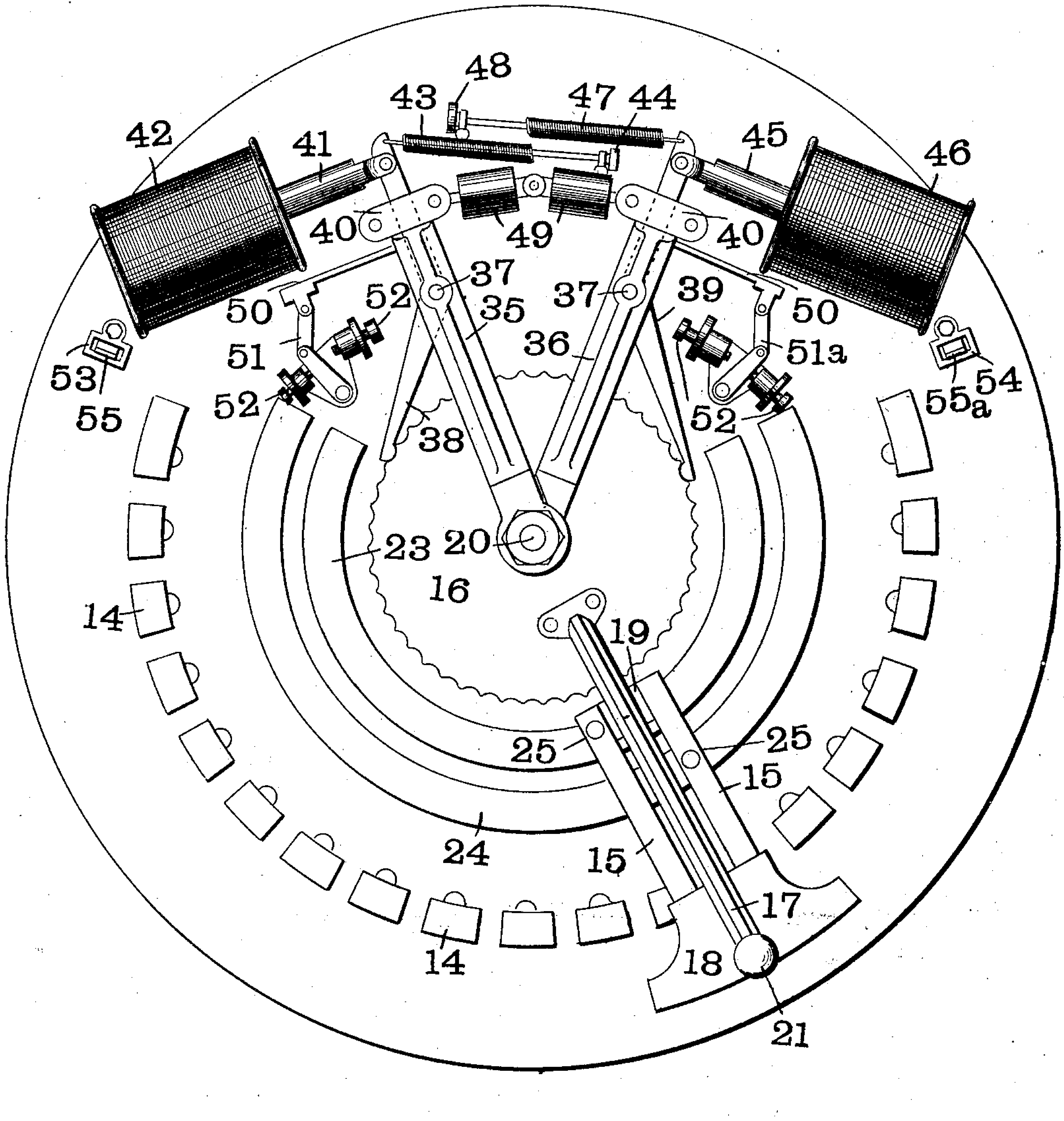
W. A. LAYMAN & F. SCHWEDTMANN.

MEANS FOR REGULATING ALTERNATING CURRENT CIRCUITS.

APPLICATION FILED NOV. 23, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

Fig.1.



Witnesses

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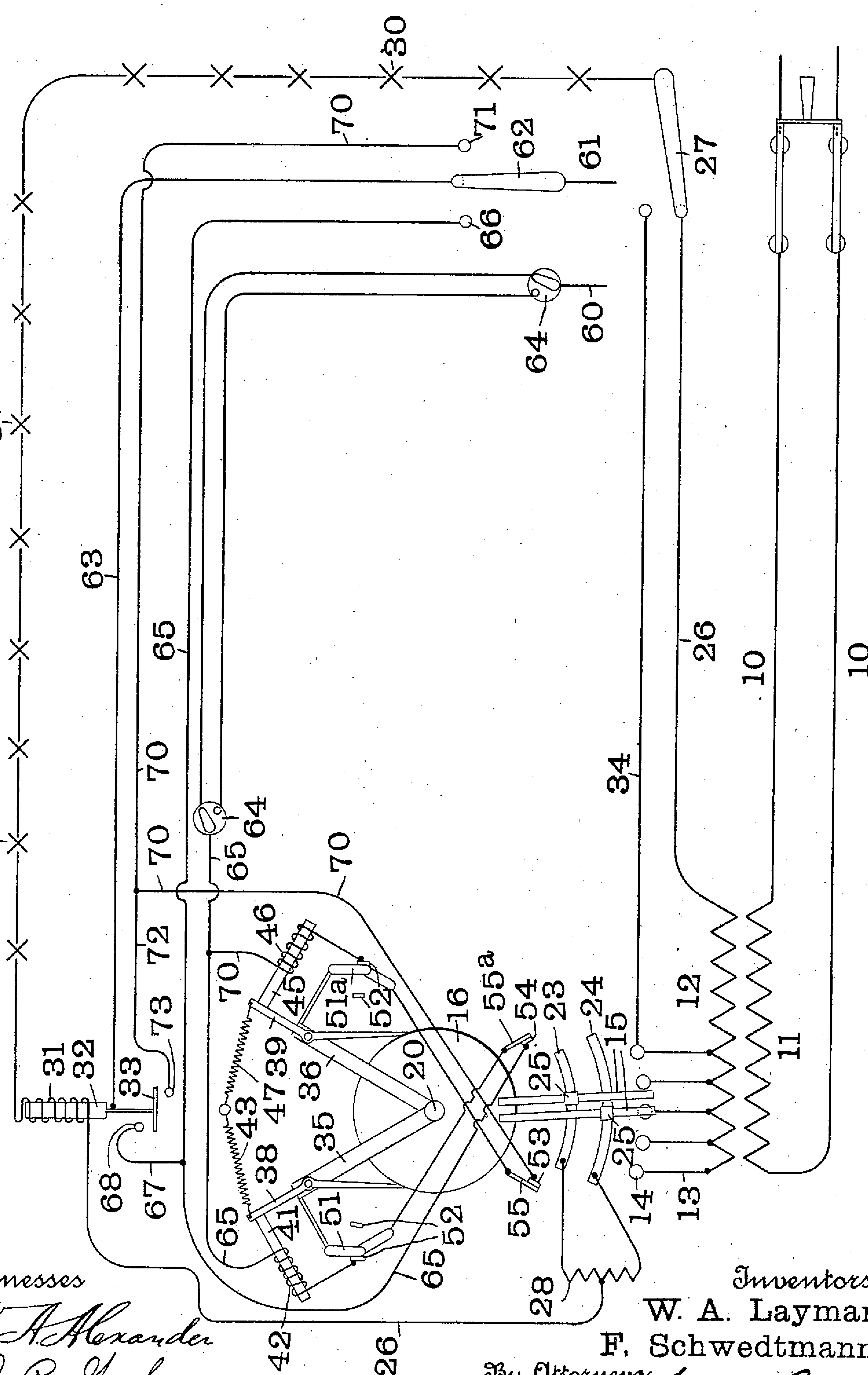

Fig. 2.

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UNITED STATES PATENT OFFICE.

WALDO ARNOLD LAYMAN AND FERDINAND SCHWEDTMANN, OF ST. LOUIS, MISSOURI; SAID SCHWEDTMANN ASSIGNOR OF HIS RIGHT TO WAGNER ELECTRIC MANUFACTURING COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

MEANS FOR REGULATING ALTERNATING-CURRENT CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 740,447, dated October 6, 1903.

Application filed November 23, 1901. Serial No. 83,415. (No model.)

To all whom it may concern:

Be it known that we, WALDO ARNOLD LAYMAN and FERDINAND SCHWEDTMANN, citizens of the United States, residing at the city of St. Louis, in the State of Missouri, have invented a certain new and useful Means for Regulating Alternating-Current Circuits, of which the following is such a full, clear, and exact description as will enable any one skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification.

Our invention relates to a new and improved means for automatically deriving and maintaining a constant alternating current in a circuit of varying resistance from the windings of a constant-potential transformer. It has been designed and will be hereinafter more particularly described with reference to its use in regulating constant-current series-arc-lamp circuits; but it will be obvious that there are other uses to which our invention can be put without departing materially from its principle.

In the drawings herewith, in which like characters of reference refer to similar parts in the different views, Figure 1 represents in front elevation our new and improved switch for automatically varying the connections of the transformer-coils; and Fig. 2 represents in diagram a constant-current series-arc-lamp circuit with our regulating-switch applied thereto, and, further, represents the electrical connections for automatically operating the switch.

Referring now to the drawings, 10 10 represent the primary mains of an alternating-current circuit to which is connected the primary coil 11 of a transformer, the second coil 12 of which is divided in the well-known manner into a plurality of sections by having lead out of it at various points taps 13, which terminate at a series of contact-plates 14, arranged in the arc of a circle. Adapted to engage at one end with any desired one of this series of contact-plates 14 are the contact-arms 15, which are rigidly carried at their other ends by the rotatable disk 16. The construction of these parts is shown more in detail in Fig. 1. The arms 15 are carried by a third arm 17, which is rigidly fastened to the disk 16. This arm 17 carries fastened to its under surface two insulating-blocks 18 and 19, to which the arms 15 are so fastened as to insulate them entirely from the disk 16. The disk 16 is centrally pivoted at 20, so as to permit the arms 15 to revolve over and make contact with the various contact-plates 14. This may be done by means of the knob 21, as shown in Fig. 1. 23 and 24 are conducting contact-strips segmental in form and concentrically located with respect to the axis 20, about which the disk 16 is adapted to rotate. Each of the arms 15 carries upon it a brush 25, which is in contact with one of the strips 23 and 24. The contact-arms 15 are so spaced with respect to each other and with respect to the contact-plates 14 and are of such width that neither one of said arms is capable of covering two of the contact-plates 14 at the same time; but it is possible that while one of said contact-arms 15 rests upon one of the contacts 14 the other of said contact-arms 15 may rest upon an immediately-adjacent contact-plate 14. 26 represents the circuit leading from one end of the transformer-secondary 12 through the circuit-changing device 27 and thence back to the contact-strips 23 and 24 through the inductive resistance 28. The object of this inductive resistance is to prevent injurious short-circuiting of the transformer-coils when the contact-arms 15 rest upon adjacent contact-plates 14. Its operation for this purpose is well known and will not be further described herein. In the circuit 26 are included in series a plurality of arc-lamps 30 and an inductive resistance 31, the core 32 of which is adapted to reciprocate inside of the coil and carries with it a contact-plate 33. 34 is a conductor lead from the first of the series of contacts 14 to a contact-point within the reach of the circuit-changing device 27. By throwing the circuit-changer 27 from its connection with the conductor 26 into connection with the conductor 34 a portion of the secondary winding of the transformer is cut out of the circuit 26. It will be evident by an inspection of the diagram of Fig. 2 that if the contact-arms 15 are rotated to the left the number of effective transformer-sections included in the circuit 26 will be increased, and that if the arms 15 are rotated to the right the number of effective transformer-sections included in the circuit 26 will be diminished. We will now describe our improved apparatus for so varying the effective sections of the transformer automatically with the variation of the number of lamps in operation and the consequent rise and fall of the current in the working circuit.

35 and 36 represent two arms adapted to rotate upon the axis 20 independent of each other and of the rotation of the disk 16. These arms have pivoted to them, respectively, at 37 the bent levers 38 and 39. These levers are limited in their movement by the yokes 40, carried at the tops of the arms 35 and 36, and the lever 38 is pivotally fastened at its upper end to the core 41 of the solenoid 42 and also has attached to it at its upper end the spring 43, the other end of which is held in place and made adjustable by the thumb-screw 44, fastened by means of an eye to the base-plate of the switch. Similarly attached to the top of the lever 39 are the core 45 of the solenoid 46 and the spring 47, which is in turn made adjustable and held in place by the thumb-screw 48, fastened to the base-plate of the switch in a similar manner as described with reference to the spring 43. To each of the arms 35 and 36 is attached a dash-pot 49, which is held in position by being fastened to the base-plate of the switch. The periphery of the disk 16 is provided with a number of teeth, as shown in Fig. 1, and with these teeth the extreme lower ends of the levers 38 and 39 are adapted to engage. Each of the arms 35 and 36 is further provided with a smaller arm 50 and 50ª, of resilient metal. These are adapted to operate knuckle-joints 51 and 51ª, the movable members of which impact against the ends of the set-screws 52. 53 and 54 represent metallic frames fastened to the base-plate of the switch and having normally in contact with them the spring-contacts 55 and 55ª, carried in such position as to be adapted to contact with the insulating-block 18 at the extreme points of its circular movement.

The electrical connections of this apparatus are best described with reference to the diagram of Fig. 2. 60 and 61 represent the sides of an electric circuit, which may be connected with any suitable source of electricity. The conductor 61 is connected through a circuit-changing device 62 with a wire 63, which is connected with the contact-plate 33. The conductor 60 is electrically connected through the double-contact device 64 with the wire 65, which in turn is connected with the solenoid 42, one of the set-screws 52 of the knuckle-joint 51, the movable member of the knuckle-joint 51, and contact-breaking devices 54 and 55ª, whence it leads back to the contact-point 66 within the reach of the circuit-changing device 62. A branch 67 carries the contact-point 68 within reach of the contact-plate 33. A second branch 70, leading from the wire 65, is connected with the solenoid 46, one of the set-screws 52 of the knuckle-joint 51ª, the movable member of the knuckle-joint 51ª, the contact-breaking devices 53 and 55, whence it leads back to the contact-point 71 within reach of the circuit-changing device 62. A branch 72 of this wire 70 leads to the contact-point 73 within reach of the contact-plate 33.

The operation of our invention is as follows: We will suppose that with the contact-arms in the position shown in the diagram of Fig. 2 somewhat more than one-half of the lamps 30 are in operation and that thereafter the remaining lamps 30 are gradually lighted. As the resistance of the circuit 26 is increased with the lighting of additional lamps therein the current in said circuit will fall from its normal value—say 6.6 amperes—to a value slightly below the normal—say 6.5 amperes. This will weaken the power of the inductive resistance 31 over its core 32, and said core will drop slightly by gravity, causing the contact-plate 33 to touch the contact-point 73. The circuit will then be closed from the wire 61, through the circuit-changing device 62, wire 63, contact-plate 33, contact-point 73, branch 72, wire 70, circuit-breaking devices 53 and 55, movable member of knuckle-joint 51ª, one of the set-screws 52 of said knuckle-joint, solenoid 46, double-contact device 64, back to the other side 60 of the circuit 61. The energizing of the solenoid 46 will cause said solenoid to draw into it its core 45, carrying with it the bent lever 39 and its arm 36, which will cause the disk 16 to rotate slightly owing to the engagement of said lever with the teeth upon the periphery of said disk. This movement of the disk 16 will slightly rotate the arms 15 over the contacts 14 in such a direction as to tend to increase the number of transformer-coils in operation. This movement of the arm 36, however, causes the movable member of the knuckle-joint 51ª to be sprung away from the set-screw 52, connected in the circuit with which said movable member was formerly in contact and will cause said movable member to strike and remain in contact with the opposite set-screw 52, which is not connected with the circuit. This will break the circuit through the solenoid 46 and will cause the opposed spring 47 to return the arm 36 to its original position. Upon reaching said original position the movable member of the knuckle-joint 51ª will again be sprung into connection with that one of its set-screws 52 which is connected to the circuit, again closing the circuit through the solenoid 46, thus causing the disk 16 and its arms 15 to rotate farther in the same direction. The drawing back by the spring 47 of the arm 36 to its normal position will not cause any rotation of the disk 16, for the effect of the said spring 47 is to move the bent lever 39 in the yoke 40 to such an extent as to cause its lower end to become disengaged entirely from the disk 16 before any backward movement of the arm 36 is begun. It will thus be seen that by repeated energizing and deënergizing of the solenoid 46 the arm 36 will be made to vibrate rapidly back and forth, causing the contact-arms 15 to cut in a sufficient number of sections of the transformer to raise the current in the circuit 26 to its normal value, (in this case suppose 6.6 amperes.) As soon as the normal value of the current in the circuit 26 is reached the effect of the inductive resistance upon its core 32 will be sufficient to raise the plate 33 from contact with the contact-point 73, thus breaking the circuit through the solenoid 46 in such a way as to put a stop to its operation and the consequent rotation of the disk 16. In case the load upon the circuit 26 is so great as to require the entire potential to cross the transformer-secondary 12 the action of the solenoid 46 and spring 47 will be continued until the arms 15 have reached the last one of the contacts 14, thus cutting in the entire transformer-secondary 12. At this point in the movement of the arms 15 the insulating-block 18 will strike against the spring-contact 55 and move the same away from the frame 53, (see Fig. 1,) thus breaking the circuit through the solenoid 46 between the contact-breaking devices 53 and 55. In this manner the circuit through the solenoid 46 is again broken and the contact-arms 15 will cease to rotate. Upon the turning off of some of the lamps in the circuit 26 the movement of the arms 15 in the opposite direction will release the spring-contact 55 and cause it to again close the break in the circuit at this point.

It will be readily understood that if the normal current value in the circuit (6.6 amperes) should rise to, say, 6.7 amperes, owing to the turning out of some of the lamps in operation in the circuit 26, the core 32 will be drawn into its coil 31 until the contact-plate 33 touches the contact-point 68. In a similar manner to that we have above described with reference to the solenoid 46 the circuit through the solenoid 42 will then be closed, and by the alternate action of said solenoid 42 and spring 43 the arm 35 will vibrate, thus rotating the disk 16 and its attached contact-arms 15 in such a direction as to cut out some of the active coils of the transformer-secondary 12 from the circuit 26. It will also be understood that this movement of the contact-arms 15 will continue until sufficient sections of the transformer-secondary 12 have been cut out to restore the current in the circuit to its normal value, thus breaking the contact between the contact-plate 32 and contact-point 68 or until the greatest possible number of sections of the transformer-secondary 12 have been cut out of the circuit 26, when the contact of the insulating-block 18 with the spring contact 55^a in the frame 54 (see Fig. 1) breaks the circuit through the solenoid 42, thus bringing the contact-arms 15 to rest upon the first of the contact-plates 14.

The device shown in Fig. 1 will usually in practice be located upon the transformer, and it may at times be found desirable to make or break the circuit through the same either at the transformer itself or at the main switchboard. For this purpose we have shown the double circuit-breaking device 64, the action of which is well known and which therefore need not be herein described. It may also be found desirable to cut in or cut out at any time from the main switchboard the subdivided portion of the transformer, and this may be done at will by moving the contact-lever 62 into contact either with the contact-point 66 or the contact-point 71. The effect of so doing is simply to close the circuit through the solenoid 42 or the solenoid 46 by hand instead of closing it automatically by means of the contact-plate 33 and one of the contacts 68 or 73, as above described in connection with the automatic operation of our regulating device. If either of the circuits through the solenoids is thus closed by hand at the main switchboard, the operation of the solenoid energized by that circuit will continue until the contact-arms 15 have moved either to one extremity or the other of the series of contacts 14. At this point the circuit will be broken, as above described, by the meeting of the insulating-block 18 with one of the spring contact devices 55 or 55^a.

It will be obvious that a considerable number of changes may be made in the particular form or our invention herein shown and described. For instance, instead of subdividing simply a portion of the transformer-secondary 12 the whole transformer-secondary might be similarly subdivided, or instead of cutting into and out of the circuit 26 the coils of the transformer-secondary our apparatus might also obviously be adapted to cut into and out of effective connection the primary coils of the transformer, thus producing a similar effect upon the circuit to that already described in connection with our apparatus. It will also be understood that our apparatus might be so connected with either the primary or secondary coil of the transformer as to reverse the connections of some of the sections of one or the other of said coils, thus opposing their electrical action to the electrical action of other sections of said coils, so as to neutralize the same, thus also producing the variation in potential, which is the result of the operation of our device when connected to the transformer as above described.

Having now fully described our invention, what we claim as new, and desire to secure by Letters Patent of the United States, is—

1. A transformer having independent primary and secondary coils, one of said coils being subdivided into a plurality of sections, a circuit connected with said transformer, a

switch for varying the amount of said subdivided coil in effective operation, electrically-operated mechanism for throwing said switch, a second circuit supplying current to said mechanism, and means controlled by the current in said first-named circuit for governing the flow of current in said second circuit.

2. A transformer having independent primary and secondary coils, one of said coils being subdivided into a plurality of sections, a circuit connected with said transformer, a switch for varying the amount of said subdivided coil in effective operation, electrically-operated mechanism for throwing said switch, a second circuit supplying current to said mechanism, and means controlled by the current in said first-named circuit for opening and closing said second circuit.

3. A transformer having independent primary and secondary coils, said secondary coil being subdivided into a plurality of sections, a circuit of variable resistance connected with said secondary coil, a switch for varying the amount of said secondary coil connected in said circuit, electrically-operated mechanism for throwing said switch, a second circuit supplying current to said mechanism, and automatic means controlled by the current in said first-named circuit for opening and closing said second circuit.

4. In an electric switch, a series of contacts, a member adapted to engage therewith, electromagnetic mechanism for moving said member in one direction over said contacts, electromagnetic mechanism for moving said member in another direction over said contacts, circuits for supplying current to said electromagnetic mechanism, means for opening and closing said circuits, and interrupters in said circuits for automatically breaking said circuits at predetermined positions in the movement of said member.

In testimony whereof we have hereunto set our hands and affixed our seals in the presence of the two subscribing witnesses.

WALDO A. LAYMAN. [L. S.]
FERDINAND SCHWEDTMANN. [L. S.]

Witnesses:
JAMES H. BRYSON,
ALICE F. CURTIS.