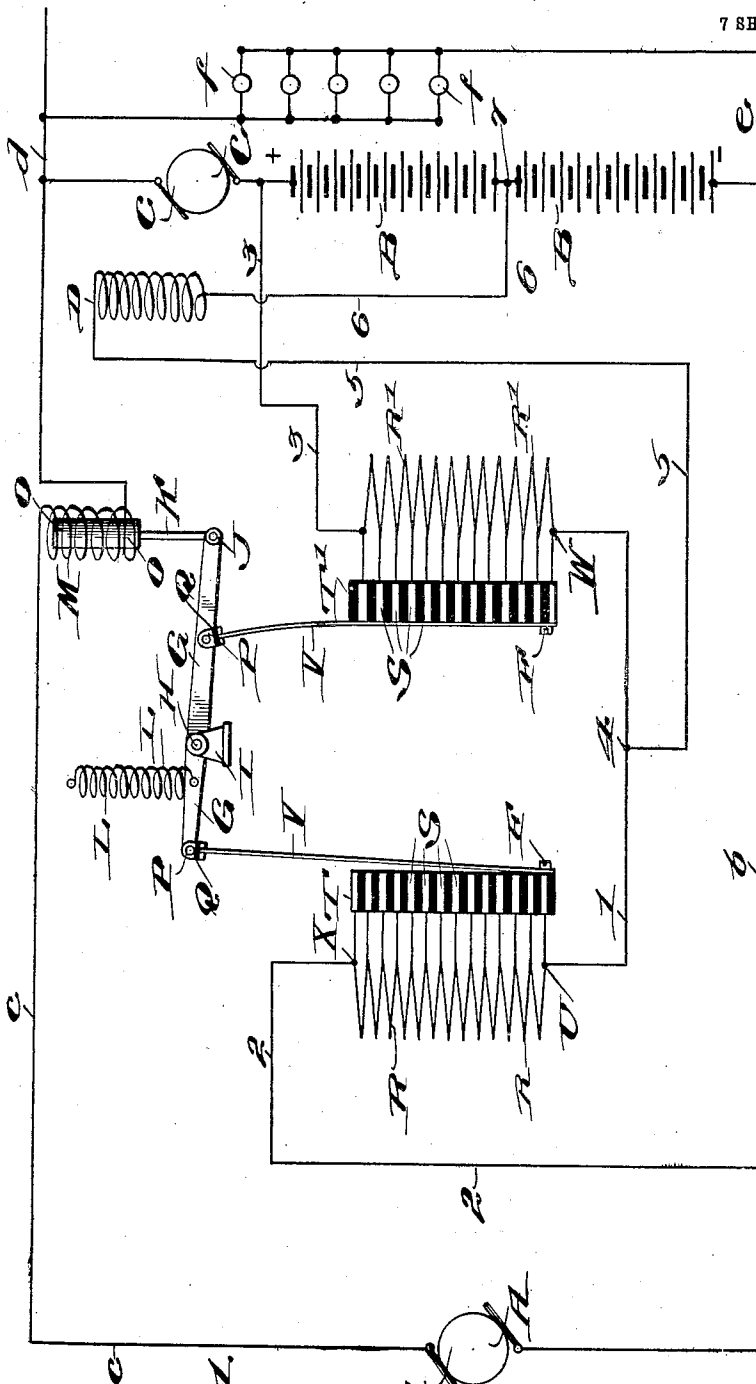


No. 839,708.

PATENTED DEC. 25, 1906.

J. BIJUR.
ELECTRIC REGULATOR.
APPLICATION FILED FEB. 9, 1905.

7 SHEETS—SHEET 1.



Witnesses
Comitche
R. W. Ashburn

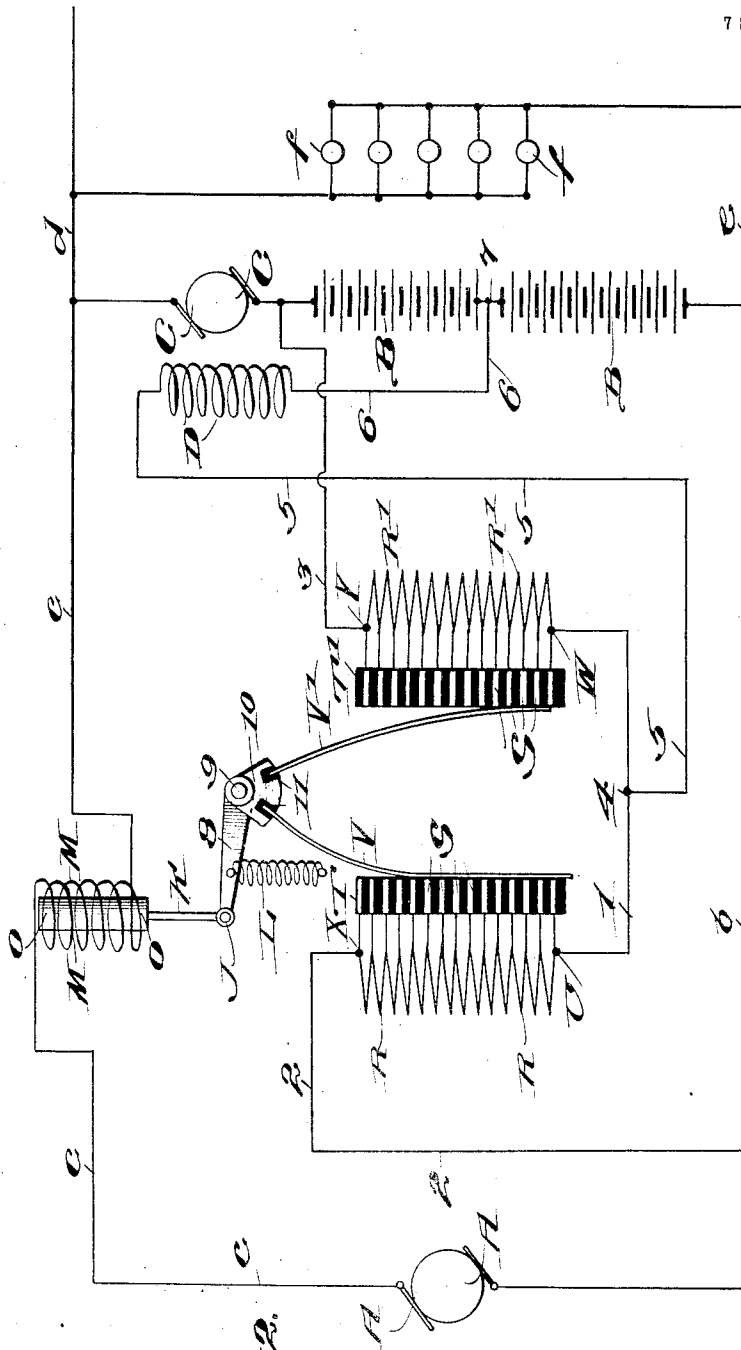
Inventor
JOSEPH BIJUR
by
Dickerson, Brown, Reagen & Binney
Attys

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7 SHEETS—SHEET 2.

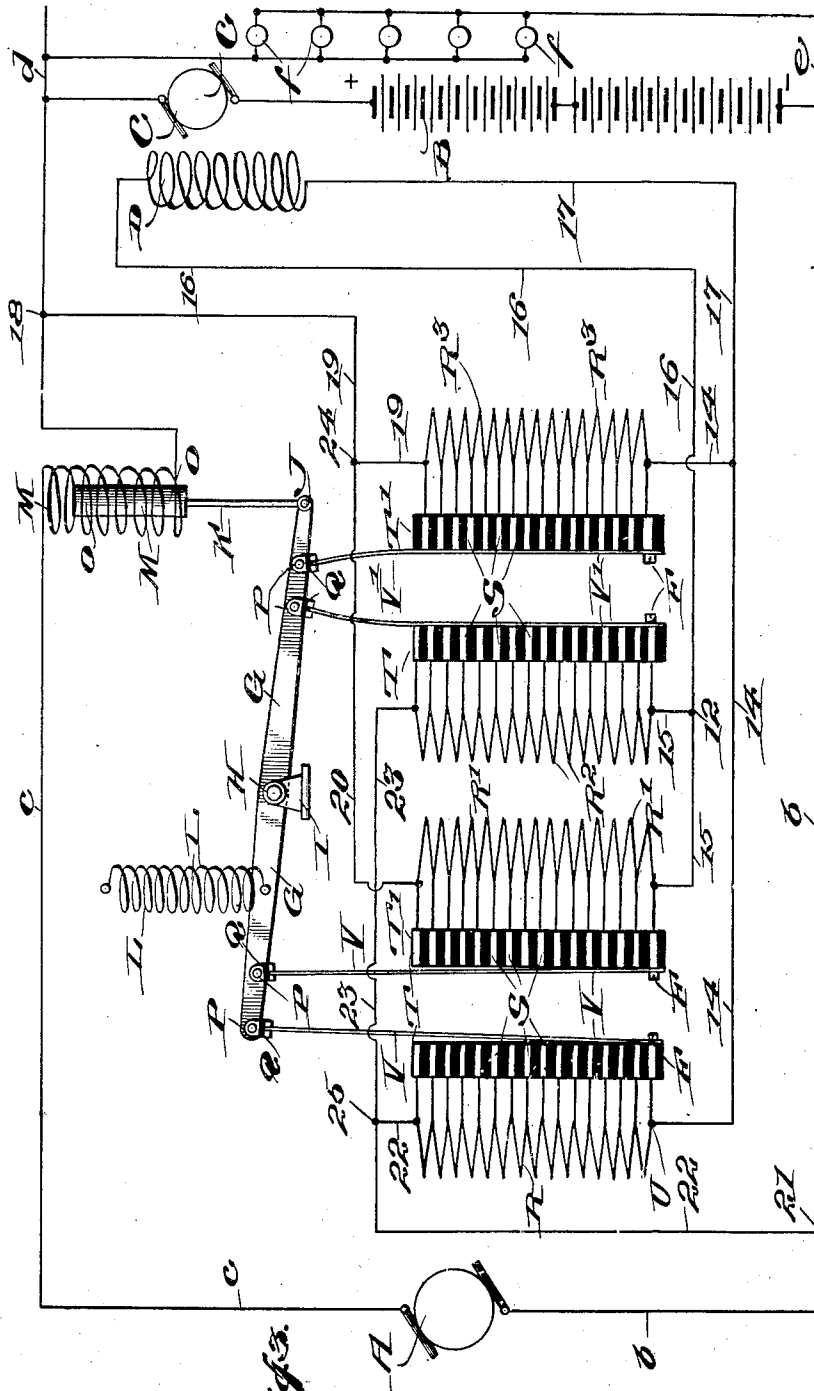


Witnesses
Comptell
W. C. Kelly

Inventor
JOSEPH BIJUR
by *Dickerson, Brown, Raegen & Binney*
attys

J. BIJUR.
ELECTRIC REGULATOR.
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7 SHEETS—SHEET 3.

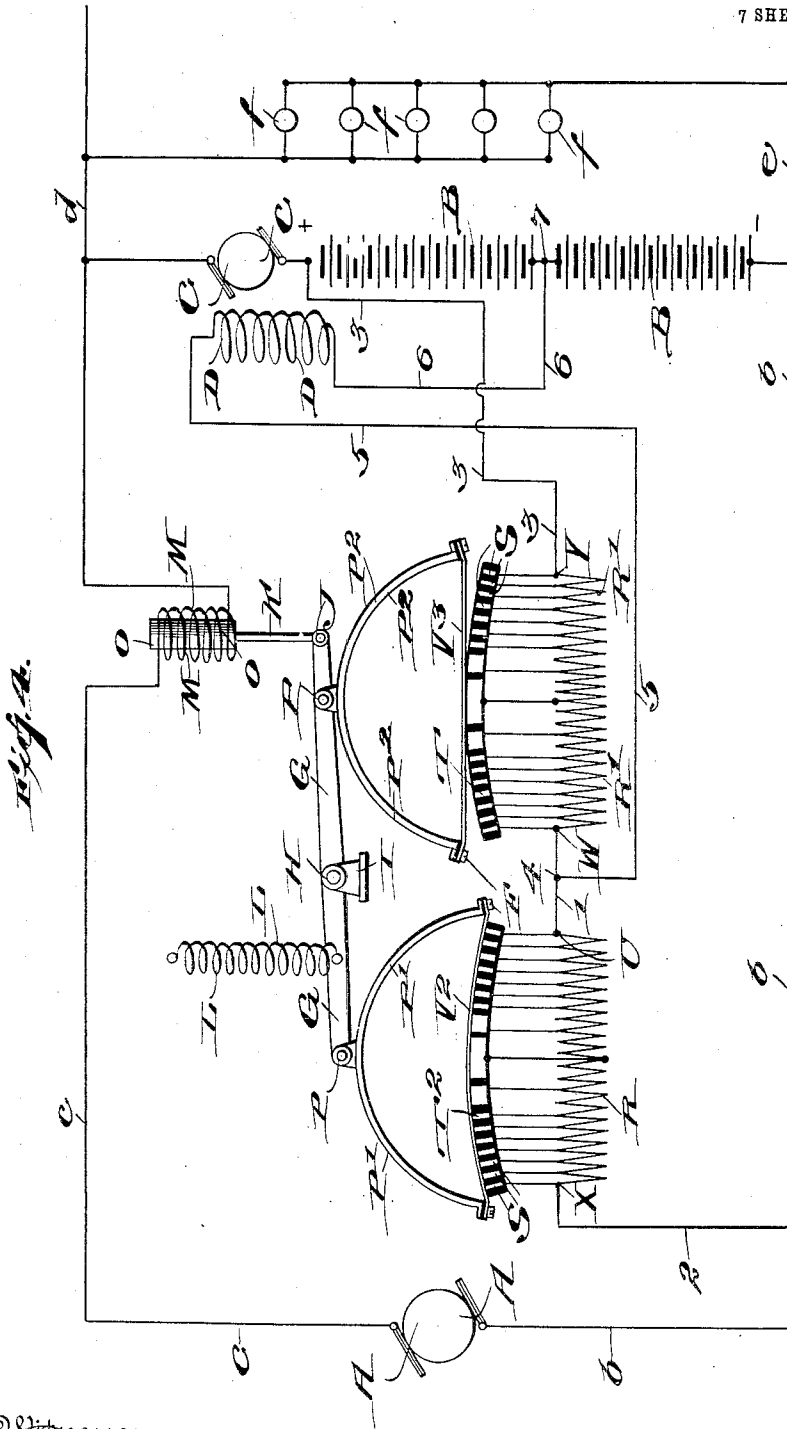


Witnesses
Comptroller
R. W. Ashburn

Inventor
JOSEPH BIJUR
by
Dickinson, Brown, Reagan & Binney
Attys

J. BIJUR.
ELECTRIC REGULATOR.
APPLICATION FILED FEB. 9, 1905.

7 SHEETS—SHEET 4.



Witnesses
Samuel
McArthur

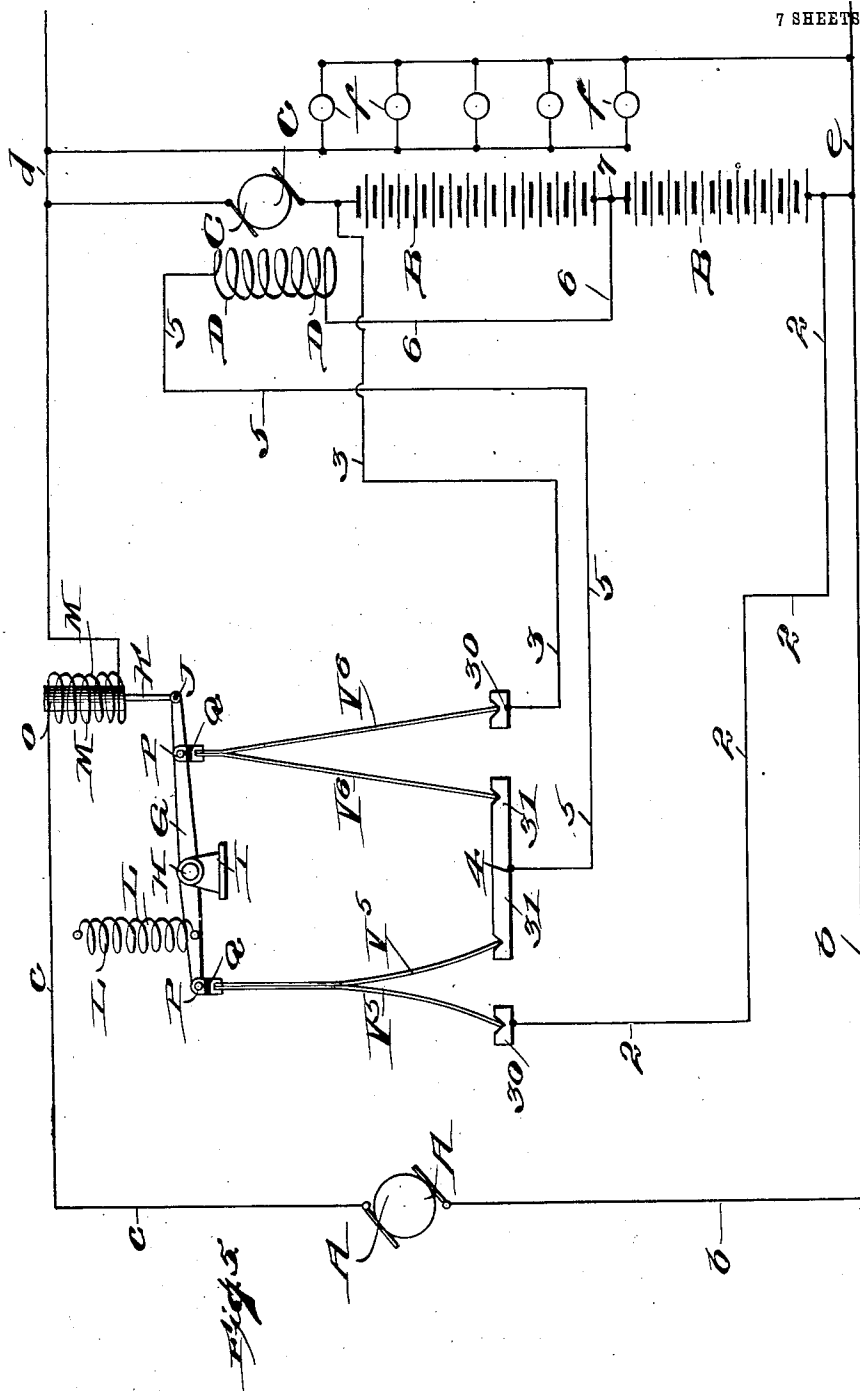
Inventor
JOSEPH BIJUR
by
Dickerson, Brown, Raegen & Birney
his attys

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7 SHEETS—SHEET 6.

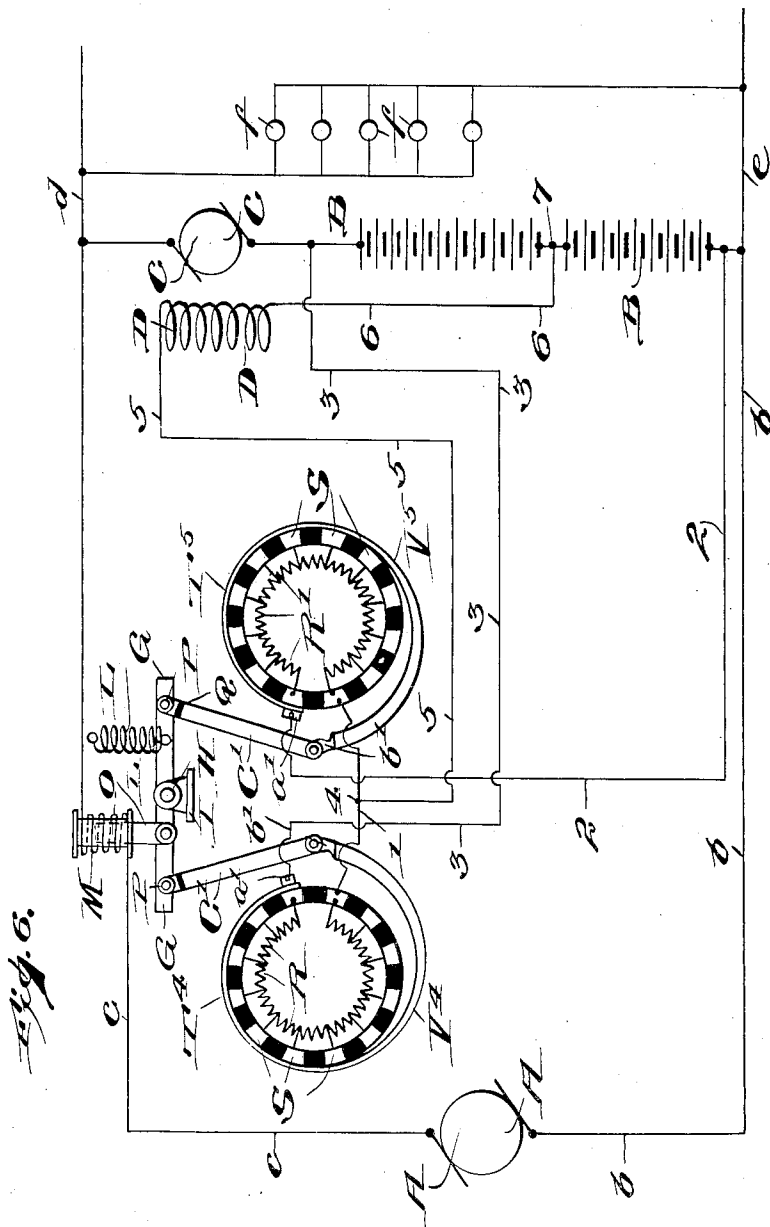


Witnesses
C. Mitchell
R. W. Ashburn

Inventor
JOSEPH BIJUR
by
Dickerson, Brown, Paegene & Binney
Attys

J. BIJUR.
ELECTRIC REGULATOR.
APPLICATION FILED FEB. 9, 1905.

7 SHEETS—SHEET 6.



Attest:
Comitche
W. L. L. L.

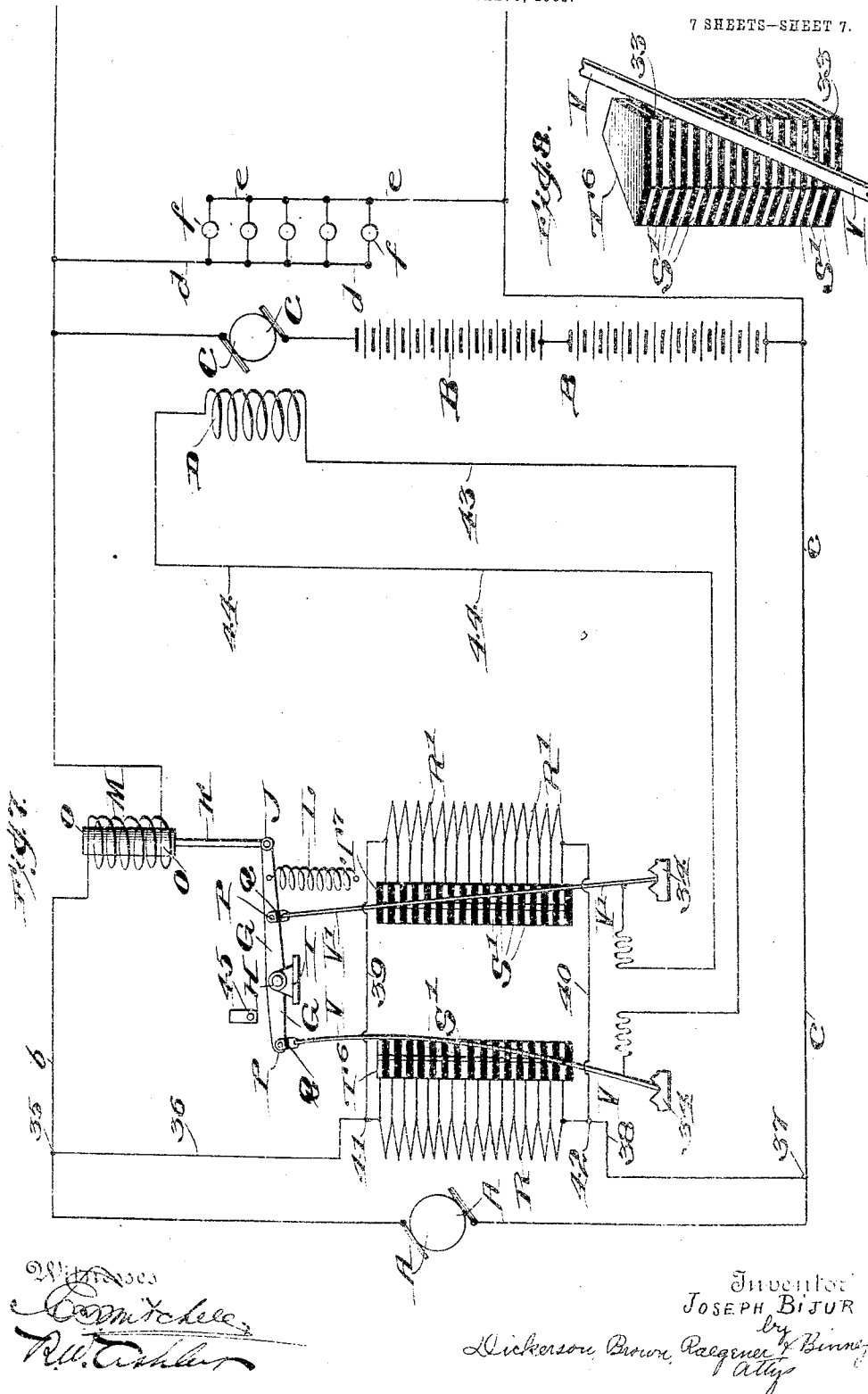
Inventor:
JOSEPH BIJUR
by
Dickerson, Brown, Ragener & Bimney
attys

No. 839,708.

PATENTED DEC. 25, 1906.

J. BIJUR.
ELECTRIC REGULATOR.
APPLICATION FILED FEB. 9, 1905.

7 SHEETS—SHEET 7.



UNITED STATES PATENT OFFICE.

JOSEPH BIJUR, OF NEW YORK, N. Y., ASSIGNOR TO THE GENERAL STORAGE BATTERY COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC REGULATOR.

No. 839,708.

Specification of Letters Patent.

Patented Dec. 25, 1906.

Application filed February 9, 1905. Serial No. 244,896.

To all whom it may concern:

Be it known that I, JOSEPH BIJUR, a citizen of the United States, and a resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Electric Regulators, of which the following is a specification, accompanied by drawings.

This invention relates to electric regulators and systems of regulation; and the objects of the invention are to improve upon the construction and operation of such regulators and obtain a large range of movement in the contact-controlling devices by means of a relatively small movement of an electroresponsive device, whereby regulation of the circuits may be more quickly and effectively produced than heretofore and the efficiency, sensitiveness, and certainty of operation of a system of electric regulation correspondingly increased.

To these ends the invention consists of a regulator and system of regulation for carrying out the above objects embodying the features of construction, combinations of elements, and arrangement of circuits, connections, and parts having the general mode of operation substantially as hereinafter fully described and claimed in this specification and shown in the accompanying drawings, in which—

Figure 1 is a side elevation of a regulator constructed in accordance with this invention, together with a diagrammatic arrangement of suitable circuits for the regulator. Fig. 2 shows a modification of the mechanical construction of the regulator shown in Fig. 1. Fig. 3 shows a modification of the circuits and system by means of which the number of resistances used is doubled. Figs. 4, 5, 6, and 7 show other forms of regulators constructed in accordance with this invention, in all of which latter the number of resistances may be doubled, if desired. In all of the figures there may be as many resistances as desired without departing from the spirit of the invention. Fig. 8 is a detail perspective view of the segments shown in Fig. 7.

The invention is shown in connection with a system of electric distribution in which storage batteries are used in addition to the generating-dynamo, and an auxiliary dynamo is provided to cause the battery to

charge or discharge as the external load decreases or increases. The voltage of the auxiliary dynamo is made to vary in direction and amount, or both, as the voltage requirements of the system may necessitate. The object of such a system is to maintain a substantially constant load on the generating-dynamo with a fluctuating external load, and my improved regulator is especially efficient in attaining the desired object, although, of course, the regulator may be used with any system or in any connection in which it may be found applicable.

Referring to all of the sheets of drawings, A represents a suitable dynamo or source of supply connected to the mains *b* and *c*, while the work portion of the system carrying the external load is represented by the conductors *d* and *e*. In this instance the load is represented by the lamps *f*, by way of illustration. Connected across the mains is shown a storage battery B, in series with which is arranged the armature of the auxiliary dynamo C, the field D of which is connected to be varied both in direction and amount by the electromagnetic controller which controls the resistances R and R', connected in circuit with the field-winding D of dynamo C. The electric controller is so connected as to be responsive to changes in the external load of lamps *f* or other electroreceptive devices.

In Fig. 1 two resistances R and R' are shown by way of illustration, in this instance connected in sections, as shown, to the individual segments S of the series of insulated segments T T'.

In Figs. 1 to 6, inclusive, the regulator is constructed to short-circuit one or the other of the resistances R R' in such manner that when all of one resistance is short-circuited the other resistance is all in circuit, there being intermediate positions of the regulator in which portions of each resistance are short-circuited.

In Fig. 7 the resistances are controlled by a contact moving along the contact-segments, and thus including more or less of the resistances in circuit without, however, short-circuiting the same.

In all of the drawings the electric regulator is controlled by a suitable electroresponsive device (shown in this instance as an electromagnet M) included in the main line. The

regulator made in accordance with this invention is constructed to multiply motion, so that a very slight movement of the magnet-core O will produce a very much greater movement of the portions of the regulator which control the resistances R and R'. The sensitiveness of the apparatus is thus very greatly increased, and a substantially constant load on the generating-dynamo with a fluctuating external load is more readily obtained than heretofore, because a prompt response is given by the regulator when the load first begins to change.

One means for obtaining the desired multiplication of motion consists of the flexible conducting flat metallic springs V and V', respectively controlling the resistances R and R'. As shown, these springs are arranged opposite the faces of the series of segments and suitably fixed at one end, as by means of the screws F, which secure the lower ends to the lowermost segments of the series T and T', thereby also insuring an electric contact between the springs and the said lower segments. Suitable means are provided for flexing and straightening the springs alternately in such manner that as one spring V is straightened or extended and moved away from the segments T the other spring V' is bent or flexed and forced or sprung against the segments T'. In the position of the parts shown in Fig. 1 resistance R is included in circuit and resistance R' is short-circuited.

In Fig. 1 suitable devices are shown operatively connecting the core O of magnet M with the springs V and V' for carrying out the operations described. In this instance a suitable lever G is pivoted at H to a support I and also pivotally connected at J to a rod K, connected to the core O. A retracting-spring L is shown connected to the lever G to oppose the attractive action of the magnet M. The springs V and V' are suitably connected to the lever G, as by means of the pivoted blocks P, provided with insulation Q to insulate the springs from the lever G and from each other. As the core O moves up and down in accordance with the energization of magnet M it will be seen that one spring will be partially straightened as the other is bent more greatly.

Any suitable electric connections may be provided for causing an increase or decrease or reversal of the current in the field D of the auxiliary dynamo C, and, still referring to Fig. 1, it will be seen that in this instance the two ends U and W of resistances R and R' are connected by a wire 1, while the other end X of resistance R is connected by wire 2 to one side of battery B and the other end Y of resistance R' is connected by wire 3 to the other side of the battery B. From the point 4 on wire 1 a wire 5 leads to one side of the field-coil D, which coil is also connected by wire 6 to the point 7 midway of the battery B.

In the operation of the apparatus shown in Fig. 1 when the two resistances R and R' are equal—that is, when each is half cut out or short-circuited—no current flows through the booster-field D and the electromotive force of the booster C is zero. Under these conditions there is no current in the field D, because there is no difference of potential between the middle point 7 of the battery B and the junction-point 4 on the wire 1 between the resistances R and R'. The circuit is complete from one pole of the battery through the resistances R and R' to the other pole of the battery, and the drop through these two resistances in series, each half short-circuited, is equal to the voltage of the battery, and since the resistances are equal the drop through either one of them is equal to half the voltage of the battery. The drop, therefore, from the positive pole of the battery through resistance R' is equal to one-half the battery voltage, and there will be no difference of potential between the points 4 and 7.

If one resistance, as R', is completely short-circuited by means of the flexible member V', it is obvious that the potential of the point 4 will be the same as that of the positive pole of the battery, and therefore the full potential, equal to one-half the battery voltage, is impressed across the booster-field D, tending to cause a current-flow from the junction-point 4 through the field D to the point 7 on the battery. The drop from the junction-point 4 through the entire resistance R to the negative pole of the battery is equal to the full battery voltage.

Since the members V and V' move inversely to each other, when R' is short-circuited R has all its resistance in circuit. Conversely, when R is short-circuited all the resistance of R' is included in the circuit, and then the potential of the junction-point 4 is the same as that of the negative side of the battery, and the drop from the point 4 through the resistance R' to the positive side of the battery is equal to the full battery voltage. The current, therefore, will flow through the booster-field D from the point 7 to the negative pole of the battery—that is to say, in a direction opposite to that in which it flowed when R' was short-circuited. It is obvious, therefore, that the booster-field D may be varied in strength from zero to a maximum in either direction and that any desired number of intermediate field strengths may be obtained by varying the resistances R R' inversely to each other.

In Fig. 2 the circuits and connections are the same as in Fig. 1, with the exception that different mechanical devices are shown for operating the flexible members V and V'. In this instance an arm 8 is connected to the rod K and pivoted at 9. Carried by the arm 8 is a supporting-piece 10, to which the

flexible members V and V' are suitably connected and insulated therefrom by means of the insulation 11. Connected to the arm 8 is a retracting-spring L. As the core O of magnet M moves up and down it will be seen that the springs V and V' will be operated as described in connection with Fig. 1.

In Fig. 3 four resistances R, R', R², and R³ are shown connected to be operated by substantially the same mechanical appliances as illustrated in Fig. 1. In other words, Fig. 3 is like Fig. 1, except that two additional resistances are included in circuit and the electric connections are suitably changed to carry out the objects of the invention. In Fig. 3 the parts are so constructed and the connections are such that resistances R and R' are included in circuit by means of the flexible conductors V when resistances R² and R³ are short-circuited by the flexible conductors V'. In other words, the two conductors V are operated inversely to the two conductors V'.

The electric connections in reality constitute a Wheatstone bridge, in which the diagonally opposite resistances are varied alike, while the adjacent resistances change inversely to each other, the booster-field D of the booster C being connected between the points 12 and 13 on the system in a position corresponding to the usual galvanometer used with the Wheatstone bridge.

As shown, the resistances R and R³ are connected by wire 14, and the resistances R' and R² are connected by wire 15. The junction-points 12 and 13 are upon the wires 15 and 14. Wires 16 and 17 connect the field D with points 12 and 13. From the positive side of the system at the point 18 connection is made by wire 19 to one side of resistance R³ and by wire 20 to one side of resistance R'. From the negative side of the system at the point 21 connection is made by wire 22 to one side of resistance R and by wire 23 to one side of resistance R². As shown, wires 19 and 20 join at the point 24 and wires 22 and 23 join at the point 25.

In the operation of the apparatus and system, with the position of the parts being such that resistances R and R' are entirely short-circuited, while resistances R² and R³ are entirely in circuit, the junction-point 13 will have the potential of the negative side of the system, which will be the potential applied to one terminal of the booster-field D. The junction-point 12 will be at the potential of the positive side of the system, which will also be the potential applied to the other terminal of the booster-field D. Therefore the full potential of the line or battery B is impressed across the booster-field D and in such a direction that current will flow from the point 18 on the positive side of the system, by wires 19 and 20, through resistance R' and wires 15 and 16, to and through field D, back

by wires 17 and 14 and resistance R and wire 22 to the point 21 on the negative side of the system. Conversely, if resistances R² and R³ are short-circuited, as shown in the drawing of Fig. 3, and resistances R and R' are entirely included in circuit it will be seen that the junction-point 12 will have the same potential as the negative side of the system, while the junction-point 13 will have the same potential as the positive side of the system and the current will flow from the point 18 on the positive side to the point 21 on the negative side, but in a direction through the field D the reverse of that just described. In this case current will flow from the point 18, by wire 19, through resistance R³ and wires 14 and 17 to and through the field D, back by wires 16 and 15, through resistance R², and out by wires 23 and 22 to the point 21 on the negative side. In either instance so far described the full potential of the line or battery B is impressed across the booster-field D. It is obvious, however, that the booster-field D may be varied in strength from zero to a maximum in either direction and any desired number of intermediate field strengths may be obtained in accordance with the inverse variations of the two sets of resistances R R' and R² R³.

In the operation of the regulator any change in the load on the generator A will result in a change in the magnetization of the magnet M, which varies the resistance and produces a corresponding change in the voltage of the auxiliary dynamo C. When the load on the external circuit exceeds the normal, an excitation is given to the field D of dynamo C, which causes the dynamo to generate an electromotive force that adds itself to the electromotive force of the battery, causing the battery to discharge and assist the generator. Conversely, when the external load falls below the normal an electromotive force is produced in the auxiliary dynamo C in an opposite direction, which assists the generator voltage to send current into the battery.

In Fig. 4 another form of regulator is shown, in which the resistances R and R' are connected to series of curved segments T² and T³. Suitably pivoted to the lever G are curved arms P' and P², connected at their free ends by flexible conductors or springs V² and V³, which are adapted to conform to the curved outline of the insulated contacts T² T³. As shown, the central contacts of the series T² and T³ are made wider or larger than the remaining contacts in order that the one or the other of the resistances R R' may be entirely cut into circuit when one of the flexible conductors V² or V³ is in the position shown at the right hand of Fig. 4. The curved arms P' and P² have a certain amount of spring or flexibility to accommodate the movements of the flexible conductors V² V³.

The electrical connections for the apparatus shown in Fig. 4 are precisely the same as those shown for the apparatus in Fig. 1, and the wires and junction-points are provided with the same reference characters. The operation of the apparatus shown in Fig. 4 is also the same as that described for Fig. 1.

In Fig. 5 a form of regulator is shown in which the resistances R and R' and series of segments T and T' are done away with, and in their stead the flexible conductors in themselves form resistances. In this instance two pairs of flexible conductors V^a and V^b are connected by means of the pivoted pieces P to the lever G . The lower ends of the pairs of conductors bear against suitable abutments 30 and 31, and the construction and arrangement of the regulator are such that when one pair of conductors V^a are compressed the other pair are extended.

As one of the pairs of conductors, as V^a , is compressed it will be seen that the conductors approach each other and make contact along their length, thereby decreasing the resistance in circuit, because the conductors V^a and V^b are actually included in the electric circuits. In Fig. 5 the conductors V^a are entirely included in circuit, while the conductors V^b are almost entirely short-circuited. The arrangement of electric connections is substantially the same as that described in connection with Figs. 1, 2, and 4. The abutments 30 and 31 are in this instance shown as electric conductors, so that the innermost conductors V^a and V^b are electrically connected through the abutment 31, to which abutment the wire 5 is connected at the point 4. The wire 3 is connected to one of the conductors V^b through the abutment 30, and the wire 2 is connected to one of the conductors V^a through the other abutment 30. According to the position of the conductors V^a and V^b the current will flow through the field D in one direction or the other, or else there will be no current-flow through said field.

In Fig. 6 another form of electric regulator is shown, in which the contact-segments are arranged in the form of circles, forming the series T^a and T^b . The resistances R and R' are shown connected in this instance inside the circular series of segments. Flexible spring-conductors (which may be termed "wrapping-conductors") V^a and V^b are suitably held in a fixed position at their thinner ends by means of the screws a' and are connected at their outer or thicker ends b' to the links c' , which in turn are pivoted to the lever G , connected to be controlled by the electromagnet M . Two ends of the resistances R and R' are connected by the wire 1, from the junction-point 4 of which the wire 5 leads to the field D of dynamo C . The other end of resistance R is connected by wire 3 to

the positive side of the battery, while the other end of resistance R' is connected by the wire 2 to the negative side of the battery. The wire 6 connects the field D to the central point 7 on the battery.

The mechanical devices of the regulator are so constructed that one conductor V^a will be unwrapped from the circular segments when the other conductor V^b is being wrapped upon its segments. In this way one of the resistances R and R' will be short-circuited, while the other will be included in circuit, and the direction and motion of current flowing through the field D of dynamo C will be controlled in accordance with variations on the line, as heretofore described in connection with Fig. 1.

In Fig. 7 a form of regulator is shown for varying the direction and amount of current in the field D of dynamo C , but constructed somewhat differently from the short-circuiting regulators heretofore described. In the regulator illustrated in Fig. 7 the resistances R and R' are not short-circuited by the flexible spring-conductors V and V' ; but a definite point of contact between the segments and the conductors is made to travel along the series of segments. The series of segments T^a and T^b in this instance are shown angular in form, as illustrated in Fig. 8. In the construction of the apparatus the points 33 of the triangular portions of the segments S' are presented to the edges of the spring-conductors V and V' , as illustrated in front view in Fig. 7 and in perspective in Fig. 8. The spring-conductors V and V' are provided with suitable abutments 34, so that according to the movement of the lever G one or the other of the conductors will be compressed or bent, as shown at V in Fig. 7. As the pressure on one or the other of the conductors V or V' varies its form will change and the point of contact between a conductor and a series of segments will travel up and down the length of the series of segments.

In order that the required variations of current may be produced in the field D , any suitable electrical connections are provided. As shown, the resistance R is connected across the line from the point 35 by wire 36 and from the point 37 by wire 38. The resistance R' is connected by wires 39 and 40 to points 41 and 42 on wires 36 and 38. The field D of dynamo C is connected by wires 43 and 44 to the flexible spring-conductors V and V' , respectively. Preferably an adjustable stop 45 is provided adjacent one end of the lever G to prevent the voltage of the booster C from rising above a predetermined amount when charging.

When the springs V or V' each bear upon the central segments of the series T^a or T^b , there will be no difference of potential, because the voltage drop through the resistance R is equal to that through resistance R' , and

there will be no difference of potential between the middle portions of the series of contacts T^6 and T^7 . It is obvious that in intermediate positions in which the springs bear upon the segments between the middle portions and the upper and lower segments there will be various values of electromotive force between the springs in one direction or the other, by means of which construction and operation the excitation of the field D, and consequently the voltage of the armature of the auxiliary dynamo C, will vary in position and amount with the distortion of the springs under compression or extension.

When the springs are in the position shown in Fig. 7, so that the contact between spring V and the segment T^6 is made at the lower segment S' and the contact with spring V' is made at the upper segment S' of the series T^7 , it will be seen that the spring V' will be at the same potential as the positive side of the system, while the spring V will have the potential of the negative side, and there will be between these two springs, which are, as described, included in circuit, the full voltage of the source of exciting-current for the field D, the current passing from the point 35 on the positive side of the system by series 36 and 39 to and through spring V' , thence by wire 44 to and through the field D of dynamo C, thence by wire 43 to and through a portion of spring V, and thence by wire 38 to the point 37 on the negative side of the system. When the position of the springs V V' is reversed, the full line potential will be impressed upon the field D, but in the opposite direction.

According to this invention it will be seen that in all of the figures the change in resistance included in circuit is produced by the distortion of a flexible member, and consequently a large range of motion is produced by comparatively small range of movement of an applied force. The surfaces of contact between the flexible member and the segments may be so shaped as to give any desired increment of resistance change with a given change in applied force. The flexible members may be so proportioned as to cut in or out any desired or given amount of resistance for a given change in the actuating force. The resistances between adjacent points or along a given or predetermined distance may be so proportioned as to produce any desired change of resistance in circuit for a given change in actuating force.

Obviously some features of this invention may be used without others and the invention may be embodied in widely-varying forms.

Therefore, without limiting the invention to the constructions shown and described nor enumerating equivalents, I claim, and desire to secure by Letters Patent, the following:

1. In an electric regulator, the combina-

tion of a series of insulated contacts, a resistance connected thereto, a resilient flexible conducting-strip adapted to bear against the faces of said contacts and thereby short-circuit the resistance, electroresponsive means for operating said strip in one direction, and means for exerting a mechanical force in an opposite direction.

2. In an electric regulator, the combination of a series of insulated contacts, a resistance connected thereto, a resilient flexible conductor adapted to bear against said contacts and thereby short-circuit the resistance, electroresponsive means for bending said conductor in one direction and means for exerting a mechanical force in an opposite direction.

3. In an electric regulator, the combination of a series of insulated contacts, a resistance connected thereto, a resilient flexible conductor adapted to bear against said contacts and thereby short-circuit the resistance, electroresponsive means for distorting said conductor in one direction to control the resistance, and means for exerting a mechanical force in an opposite direction.

4. In an electric regulator, the combination of two series of insulated contacts, resistances connected thereto, resilient flexible conducting-strips, adapted to bear against the faces of said series of contacts and thereby short-circuit the resistances, electroresponsive means for operating said strips and means for exerting a mechanical force opposing said operating means.

5. In an electric regulator, the combination of two series of insulated contacts, resistances connected thereto, resilient flexible conducting-strips adapted to bear against the faces of said series of contacts and short-circuit one resistance while including the other in circuit, electroresponsive means for operating said strips, and means for exerting a mechanical force opposing said operating means.

6. In an electric regulator, the combination of a plurality of series of insulated contacts, resistances connected thereto, resilient flexible conducting-strips adapted to make contact with said insulated contacts, electroresponsive means for distorting said strips in one direction to vary the resistances, and means for exerting a mechanical force in an opposite direction.

7. In an electric regulator, the combination of a plurality of series of insulated contacts, resistances connected thereto, flexible conducting-strips adapted to make contact with said insulated contacts, electroresponsive means for distorting said strips in one direction and thereby varying said resistances inversely, and means for exerting a mechanical force in an opposite direction.

8. The combination of a plurality of series of insulated contacts, resistances connected

thereto, flexible conducting-strips adapted to make contact with said insulated contacts, means for distorting said strips to vary the resistances, means controlled by said resistances, and a stop to limit the distortion of the flexible members.

9. The combination of a plurality of series of insulated contacts, resistances connected thereto, flexible conducting-strips adapted to make contact with said insulated contacts, means for distorting said strips and thereby varying said resistances inversely, means controlled by said resistances, and a stop to limit the distortion of the members.

10. In an electric regulator, the combina-

tion of a series of insulated contacts, a resistance connected thereto, a resilient flexible conducting-strip adapted to cooperate with and make contact against the faces of said contacts and thereby short-circuit the resistance, electroresponsive means for operating said strip and means for exerting a mechanical force opposing said operating means.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOSEPH BLJUR.

Witnesses:

E. VAN ZANDT,
H. G. OGDEN, Sr.