No. 684,340. Patented Oct. 8, 1901.

M. H. BAKER.

REGULATING DEVICE FOR ARC LAMP CIRCUITS.

(Application filed Mar. 21, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

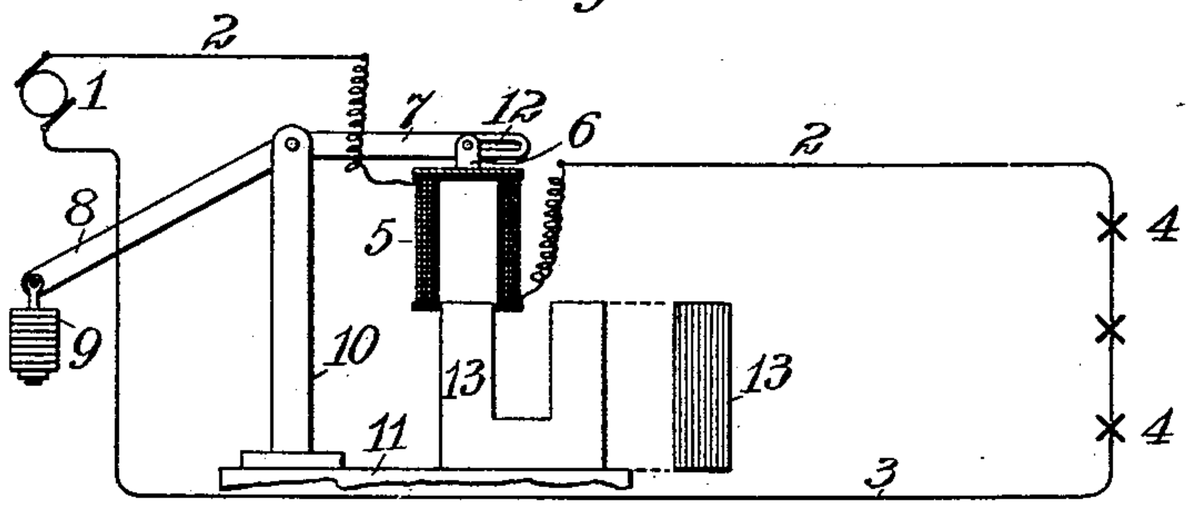


Fig. 2.

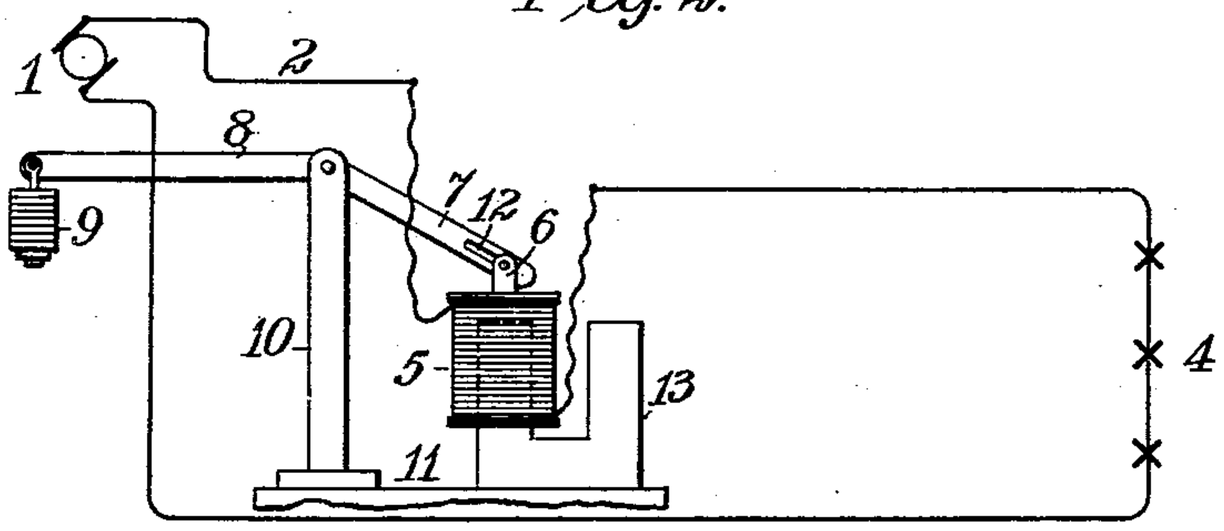
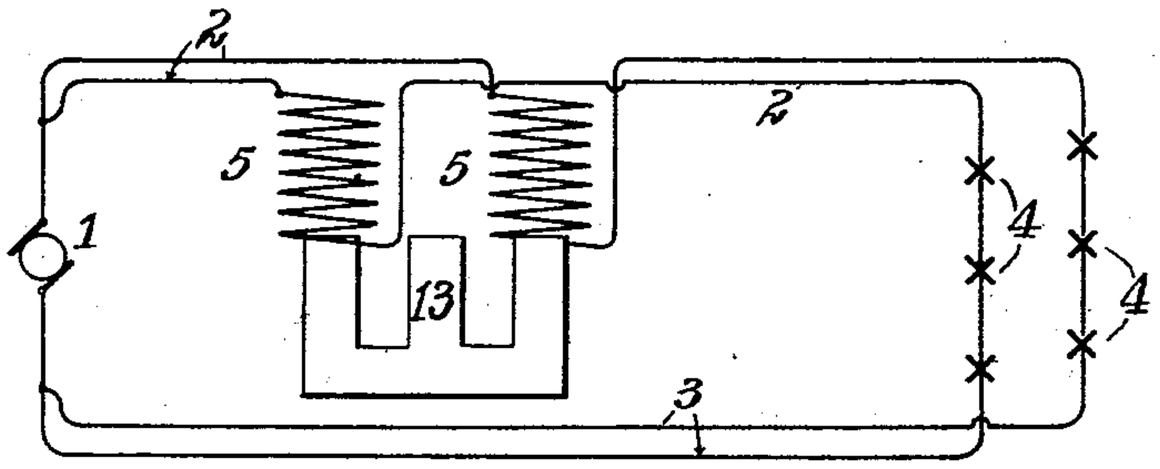


Fig. 3.



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(No Model.) 3 Sheets—Sheet 2.

Fig. 4.

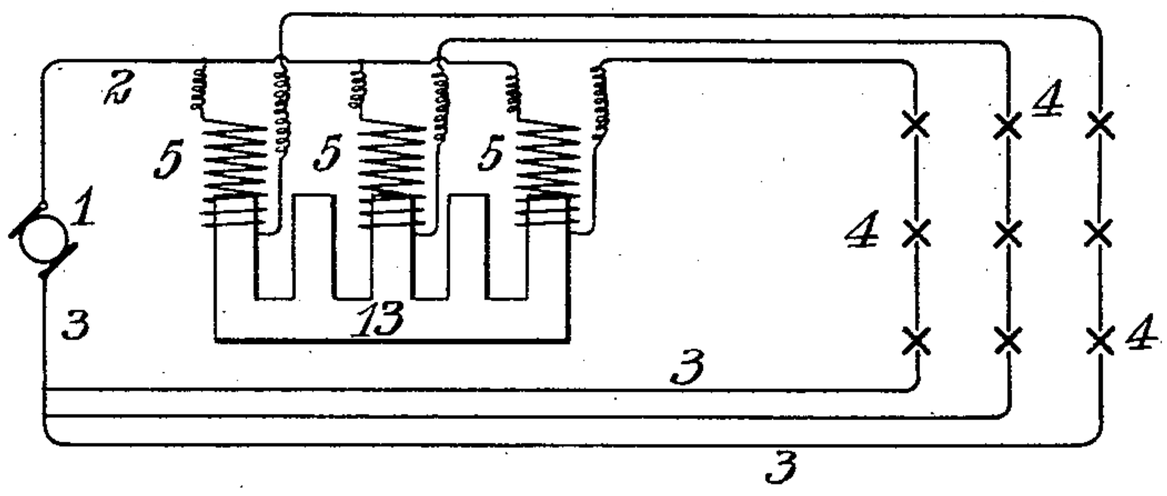
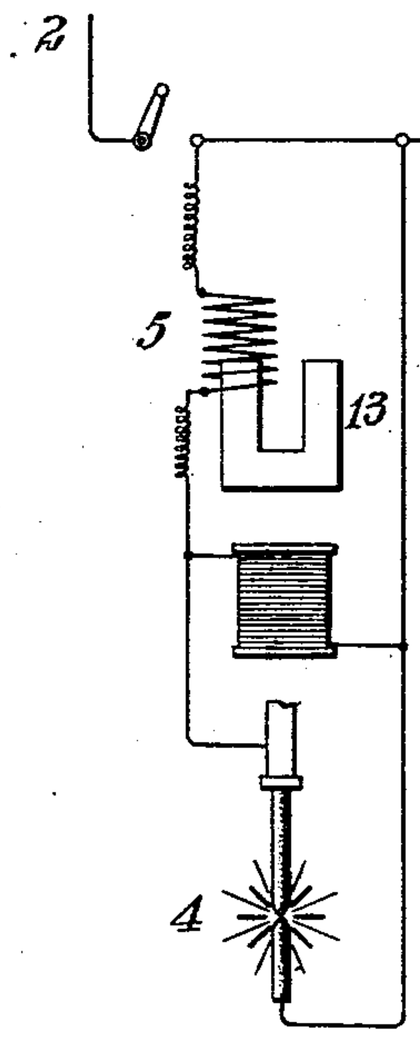


Fig. 5.



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REGULATING DEVICE FOR ARC LAMP CIRCUITS.

(Application filed Mar. 21, 1900.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 6

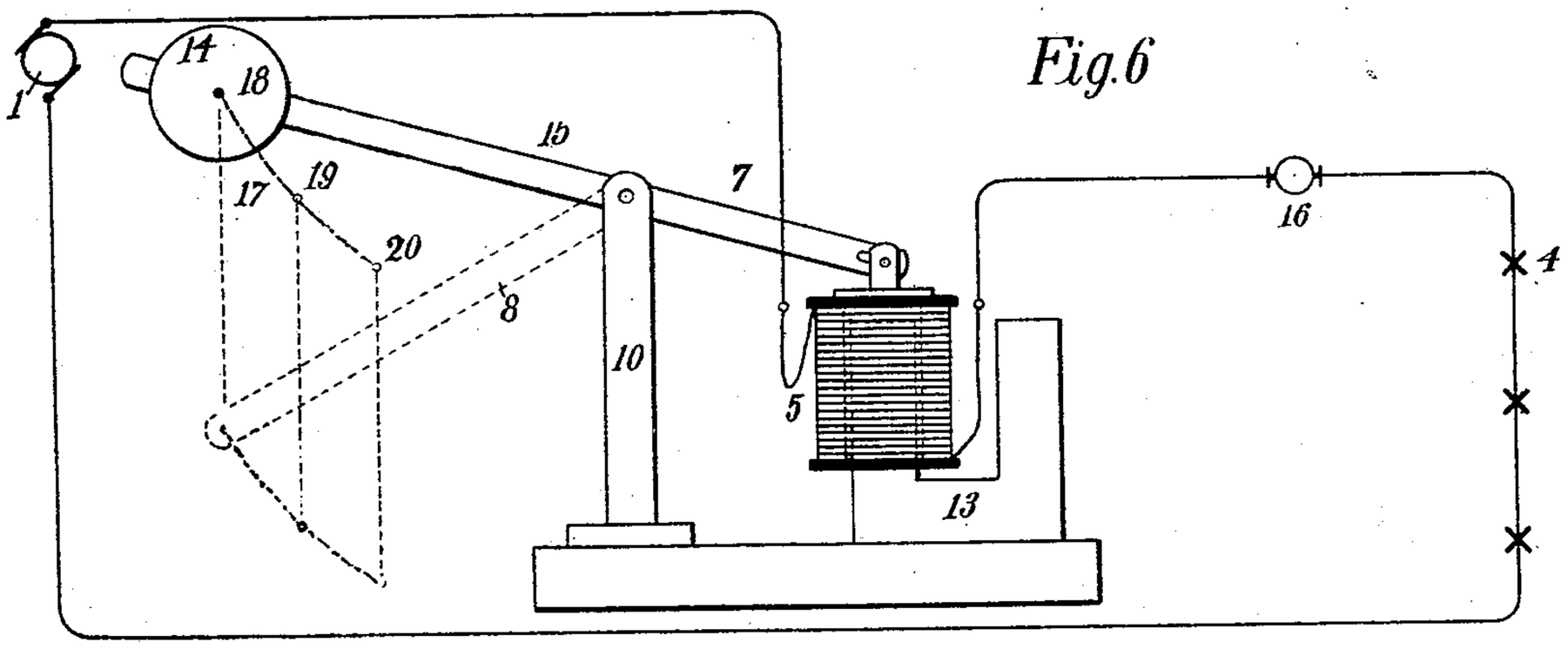


Fig. 7

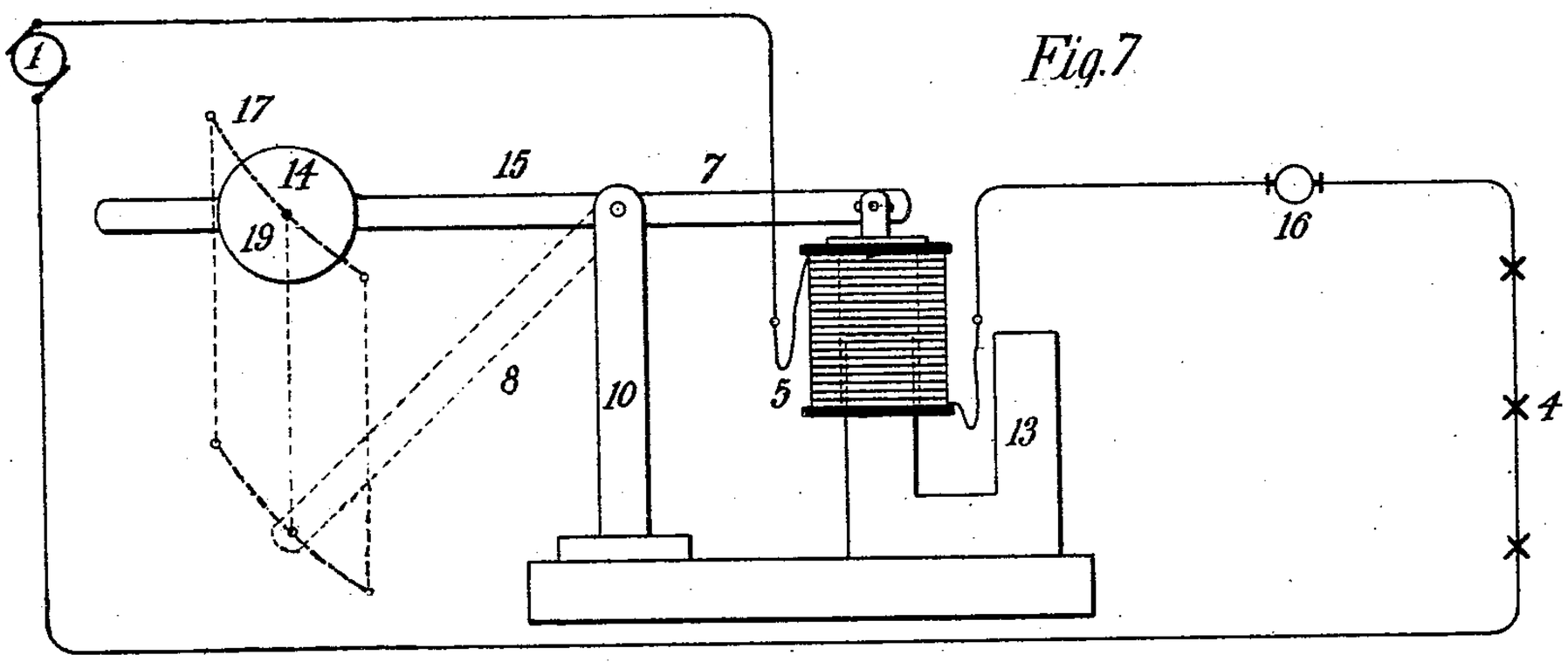
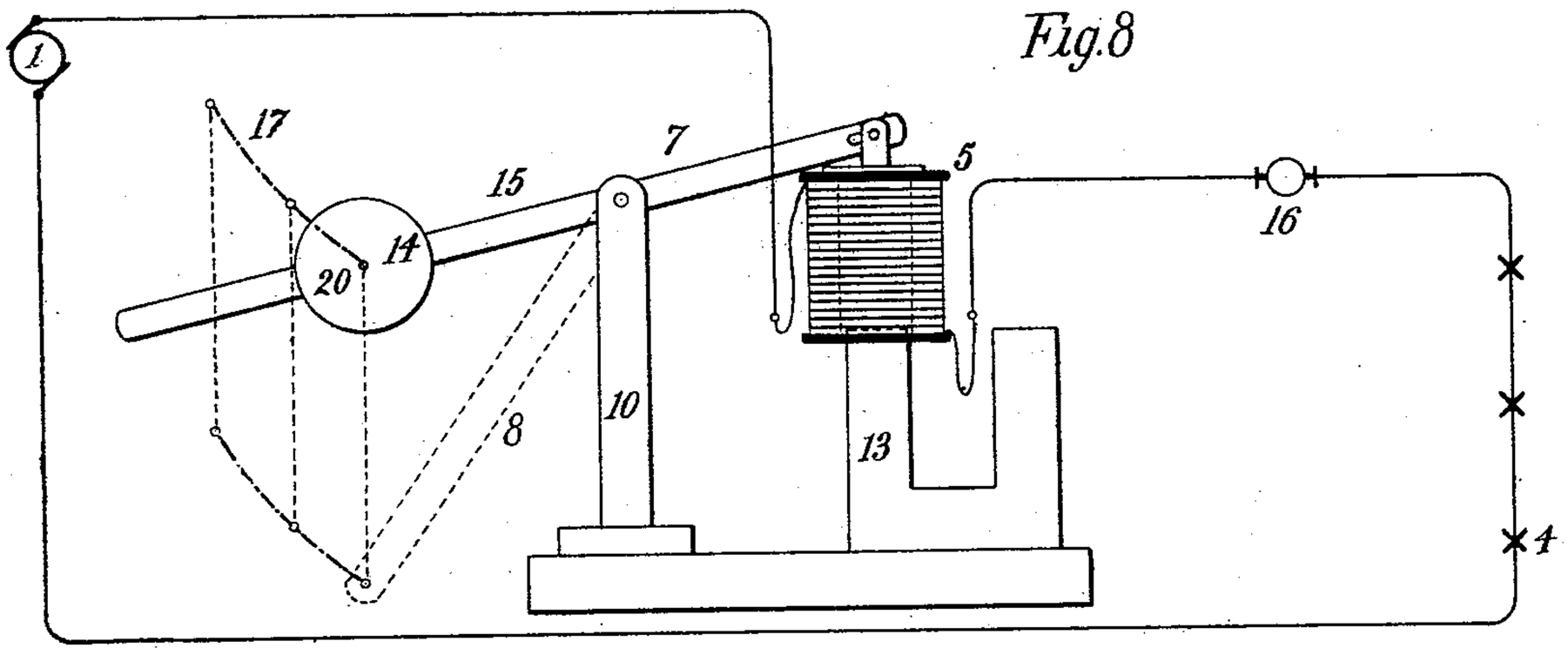


Fig. 8



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by Charles A Terry Atty

UNITED STATES PATENT OFFICE.

MALCOLM H. BAKER, OF NEW YORK, N. Y., ASSIGNOR TO THE MANHATTAN GENERAL CONSTRUCTION COMPANY, OF SAME PLACE.

REGULATING DEVICE FOR ARC-LAMP CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 684,340, dated October 8, 1901.

Original application filed September 5, 1899, Serial No. 729,437. Divided and this application filed March 21, 1900. Serial No. 9,480. (No model.)

To all whom it may concern:

Be it known that I, MALCOLM H. BAKER, a citizen of the United States, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Regulating Devices for Arc-Lamp Circuits, of which the following is a specification.

My invention relates to improvements in regulators for circuits containing alternating-current arc-lamps arranged in series. Heretofore the regulation of this class of devices has been accomplished through the medium of very complicated and expensive apparatus. By means of my present invention all complication is avoided and the regulation of the current in an alternating arc-lamp series circuit is made certain and effective by the use of very simple mechanism having few parts and very little liable to get out of order.

My invention relates, broadly, to automatically varying the reactance in a circuit such as described to compensate for changes in the resistance of the circuit due to the cutting in or out of lamps or to any other cause.

Otherwise expressed, my invention relates to automatically varying the value of a variable reactance in the circuit in accordance with changes of resistance in the said circuit in such a manner as to maintain the current practically constant.

In carrying out my invention I include in the circuit in series with the lamps a reactive device consisting of a coil of wire so placed as to have a free relative movement with respect to a laminated core inside the coil. It is well understood that the current passing through a coil having such a relation to a magnetic core is more or less choked or impeded, according to the relative position which the coil and the core occupy, the choking or impeding effect increasing with the farther and farther insertion of the core within the coil and decreasing with the gradual withdrawal of the core from the coil. The relative movements of the coil and the core may be brought about by variations of the magnetic pull due to variations of the current passing through the coil. If now a force could be discovered which would automatically vary the choking effect produced in the coil in correspondence with variations in the resistance of the circuit, which force should oppose and vary with the magnetic pull of the said coil, the value of the current traversing the coil might be made practically independent of the resistance of the circuit, so that a constant current could be maintained irrespective of the number of lamps in operation in the circuit. I have discovered that such a force can be supplied mechanically in several ways. In the present instance I make use of a compensating lever carrying a weight, and I attach to the end of said lever remote from the weight either the laminated core or the coil, as the case may be, of a reactance device, and I pivot the said lever at such a point as to form a critical angle between the outer part of the lever and the inner part—that is to say, the two parts of the lever on opposite sides of the pivot—it being presupposed that the inner part of the lever will be approximately horizontal when the magnetic pull of the coil is at its minimum, while the outer portion of the lever will be in a position of least effectiveness at the same moment. A simple way of determining the critical angle for the lever of the compensating device is to construct a coil having a sufficient number of turns to show the proper voltage and amperage under the condition of no load and then to connect the moving part of the apparatus containing the coil with a straight lever pivoted at a point between its ends and carrying at its outer end a sliding counterbalance. Then by cutting into the circuit successively one lamp after another until the maximum number of lamps is cut in and at each successive step sliding the counterbalance into such a position that the readings of the ammeter will always show the normal current on the line it will be found that between the extreme limits of its movement the sliding counterbalance will have traveled through a curve which is approximately the arc of a circle. It is manifest that the center of the arc just described lies outside the pivot of the straight lever. The object sought in making the lever angular is to utilize this pivot as the center of motion, so that a weight

attached to the end of the lever by some permanent means of attachment, such as suspension therefrom, will during the movements of the movable part of the reactance device from one extreme of its motion to the other follow substantially the same curve as that traversed by the sliding counterbalance already described. It will be understood that as lamps are successively cut into the circuit in the process described above the sliding counterbalance has to be moved by hand nearer and nearer to the pivot in order to meet the conditions set forth above, and it will also be understood that the counterbalance moves during the same period through a curve in a downward direction, each successive change in the position of the counterbalance representing a single unit of movement corresponding to the switching in of a single lamp or other unitary translating device. The same will be true respecting the action of a weight of equal amount permanently attached to the end of a bent lever, provided the angle given to the lever is selected according to the method above described. We may suppose, for example, that the circuit is to carry a current of two thousand volts and seven amperes. The first requirement is that a coil should be provided having a sufficient number of windings to meet the described conditions and being provided with a core of sufficient size to prevent undue heating. These conditions being attained, it is easy to determine the critical angle for the lever.

In a working circuit including a maximum of thirty-three lamps and designed to operate at about seven amperes of current I have found it suitable to use a lever having approximately the proportions illustrated in Figures 1 and 2 of the drawings of the present application, the length of the inner and outer arms being, respectively, about twelve and one-half inches and twenty-two inches and the weight being about fifty pounds. These proportions I have employed in connection with a coil of No. 12 double cotton wire having about one thousand turns in combination with a laminated iron core having a cross-section of about six inches by four and one-half inches and a height of about ten inches. The critical angle in this instance is about one hundred and fifty degrees.

I have illustrated my invention in the accompanying drawings, in which—

Fig. 1 shows my apparatus connected up in series with a single group of lamps, the position of the parts being that which they occupy when the circuit is fully loaded. Fig. 2 is a similar view showing the position of the reactance device at minimum load. Fig. 3 is a diagram of my apparatus connected up with two groups of lamps. Fig. 4 is a diagram of my apparatus connected up with three groups of lamps. Fig. 5 illustrates diagrammatically my improved regulating-coil in connection with a single arc-lamp. Figs. 6, 7, and 8 are diagrammatic views illustrating the method by which the proper angle for the compensating lever is determined.

In the drawings, 1 is a suitable source of alternating current, and 2 and 3 are mains leading therefrom. The lamps are shown at 4 4, and the regulating or reactance coil appears at 5. Said coil is represented as surrounding one leg of a laminated iron core of horseshoe shape, and its top 6 is pivoted to the end of a lever 7, carrying on its remote arm 8 a counterweight 9. The said lever 7 8 is pivoted to a suitable upright or standard 10. The parts of my regulating apparatus described are supported upon a suitable base 11, of insulating material. I may provide a slot 12 in the lever 7 at its junction with the top of the coil to permit the free relative movement of the parts at that point.

It will be seen that the position of the coil 5 at full load is one in which the magnetic pull with relation to the core is comparatively slight. In this position the arm 7 is approximately horizontal, so as to give to the downward pull of the coil under magnetic influences its greatest possible effect. It will also be observed that the position of the weight 9 and the lever 8 is such that the effect of the said weight is at its minimum in this position of the parts. On the other hand, when the circuit has its minimum load, as illustrated in Fig. 2, the mechanical pull of the weight is at its maximum, while the magnetic pull as between the core and the coil is also at its maximum.

The weight of the counterbalance 9 having been properly selected, the adaptability of the described apparatus to the work of regulating the circuit depends upon the critical angle between the parts 7 and 8 of the lever connecting the weight and the coil. When the proper angle is chosen, the increased effectiveness of the weight as the coil travels downward in response to variations of the current caused by decreased resistance in the circuit will bear a direct ratio to the increased choking effect in the coil caused by the approach of the coil and the core relatively to each other. In this way a practically constant current will be maintained in the circuit at all times.

Figs. 3 and 4 show typical arrangements of the reactance or regulating coil for a plurality of circuits. The parts 13 are laminated iron cores, one leg of which is surrounded by a coil included in a separate group. The operation is obvious.

It is immaterial whether the weight 9 or any other counterweight or force is attached to the coil or the core, the relative movements of these two parts being the feature upon which the choking effect depends. When the compensating lever is attached to the core of the reactance device instead of to the coil, (it being assumed that the coil is arranged above

the core,) the core itself forms part of the mechanical force opposing the magnetic pull of the coil.

I may apply my regulating reactance-coil to a single lamp structure as well as to a circuit including a series of arc-lamps. In Fig. 5 I illustrate such an application. The regulating-coil is in this instance placed in series with the carbons—that is to say, it is connected up in the main circuit of the lamp. Its action is precisely the same as has already been described in connection with a series of lamps in circuit.

Figs. 6, 7, and 8 are diagrams intended to illustrate the mode of determining the curve through which the counterbalance is to move, and they accordingly constitute an illustration of the mode of determining the critical angle of the lever 7. In Fig. 6 a straight lever 15 is shown, having one end attached to the coil 5 and having arranged near its opposite end a sliding weight 14, acting as a counterbalance, in the manner already described. The position of the weight 14 when there is no load on the circuit is represented in Fig. 6. As lamps are successively switched into the circuit the coil 5 rises and the weight 14 descends, and in order to maintain a current of, say, seven amperes in the circuit at all times the weight has to be successively shifted toward the pivot of the lever 15. Figs. 6, 7, and 8 illustrate, respectively, the position of the weight and the lever under conditions of no load, medium load, and full load, it being understood that the weight 14 has been so shifted during the passage from one extreme condition of circuit to the other as to maintain the current on the line constant. It is plain that the weight during this process has traveled through a curve the center of which is outside the pivot at the top of the standard 10. The shifting of the weight in the process last described is accomplished by hand, the weight being moved in every instance until the readings of the ammeter 16 show the normal amperage—say seven amperes. In order to make the described operation automatic, I permanently attach a weight to the pivoted lever, and I provide the lever with a critical angle such that the weight while the circuit is passing through the conditions of no load, medium, and full load will occupy the same relative positions in a similar curve through the natural movements of the bent lever as the coil 5 is successively lifted. A standard or support of suitable height having first been selected, the bend in the lever can be so chosen as to utilize the selected standard by the means indicated in dotted lines in Figs. 6, 7, and 8. The three successive positions already described are indicated at 18, 19, and 20. The first step in determining the angle for the compensating lever is to drop perpendiculars from the points 18, 19, and 20 and then select a lever, as 8, of such length that the end to which the weight is to be permanently attached will cut these perpendiculars in a curve similar to the curve 17. The angle between the dotted portion 8 and that part of the lever 15 appearing at the right of the standard 10 is the critical angle of the compensating lever. In other words, the bent lever made up of the arms 7 and 8 is by virtue of the critical angle between the said arms capable of accomplishing the same results as the straight lever 15 with the sliding weight 14 upon it—that is to say, the bent lever accomplishes automatically what the straight lever can be made to accomplish by a proper shifting of the sliding weight.

It has not been thought necessary to show in Figs. 6, 7, and 8 a weight attached to the arm 8. It would be similar, however, if shown, to the weight 9 appearing in Figs. 1 and 2.

The method described in this application is not herein claimed, as the same forms the subject of another application filed by me September 5, 1899, Serial No. 729,437, and of which the present case is a division.

The invention claimed is—

1. In an electric circuit, a regulating reactance device having operating parts whose relative position determines the choking effect of the device, magnetic means for causing relative movements of the parts, and mechanical means for controlling such movements, these mechanical means being adapted to so control the movements as to produce definite predetermined choking effects.

2. In an electric circuit, a regulating reactance-coil having a moving part adapted to increase the choking effect in the coil, a number of translating devices in series with the coil, a pivoted lever connected to the moving part and a weight attached to the lever, the connection between the moving part and the lever being made at a critical angle whereby the varying effects of the weight and the magnetic pull of the coil cause varying choking effects which are adapted to maintain the current in the circuit constant.

3. In an alternating-current arc-lamp, a regulating reactance-coil in series with the carbons, the said coil having a moving part adapted, when moved to different positions by the magnetic pull of the coil, to cause varying choking effects in the coil, the moving part being acted upon by a force opposing the magnetic pull, which force is so adjusted throughout its effective range of operation as to balance the magnetic pull when the moving part is in positions adapted to produce constant current.

4. In an alternating circuit, a series of translating devices and a regulating reactance-coil having a moving part adapted, when moved to different positions by the magnetic pull of the coil, to cause varying choking effects, the said moving part being acted upon by a force opposing the magnetic pull, which force is so adjusted throughout its effective range of operation as to counterbal-

ance the magnetic pull when the moving part is in such positions with respect to the coil as are adapted to produce constant current.

5. In an arc-lamp, a pair of carbons and a regulating reactance-coil in series therewith, the said coil having a moving part adapted to increase the choking effect in the coil, a pivoted lever connected to the moving part and a weight on the lever, the connection between the moving part and the lever being made at a critical angle, whereby the varying effects of the weight and the magnetic pull of the coil cause varying choking effects which are adapted to maintain the current constant.

Signed at New York, in the county of New York and State of New York, this 17th day of March, A. D. 1900.

MALCOLM H. BAKER.

Witnesses:

WM. H. CAPEL,

GEORGE H. STOCKBRIDGE.

Disclaimer in Letters Patent No. 684,340.

DISCLAIMER.

684,340.—*Malcolm H. Baker*, New York, N. Y. IMPROVEMENT IN REGULATING DEVICE FOR ARC-LAMP CIRCUITS. Patent dated October 8, 1901. Disclaimer filed February 14, 1902, by the assignee, the *Manhattan General Construction Company*, of New York, N. Y.

Enters its disclaimer—

To that part of the specification and claims which is identified as follows, to wit:

The construction illustrated in Figure 5 of the drawings and described in the specification and claims in the following words:

"Fig. 5 illustrates diagrammatically my improved regulating-coil in connection with a single arc-lamp.

"I may apply my regulating reactance-coil to a single lamp structure as well as to a circuit including a series of arc-lamps. In Fig. 5 I illustrate such an application. The regulating-coil is in this instance placed in series with the carbons—that is to say, it is connected up in the main circuit of the lamp. Its action is precisely the same as has already been described in connection with a series of lamps in circuit.

"3. In an alternating-current arc-lamp, a regulating reactance-coil in series with the carbons, the said coil having a moving part adapted, when moved to different positions by the magnetic pull of the coil, to cause varying choking effects in the coil, the moving part being acted upon by a force opposing the magnetic pull, which force is so adjusted throughout its effective range of operation as to balance the magnetic pull when the moving part is in positions adapted to produce constant current.

"5. In an arc-lamp, a pair of carbons and a regulating reactance-coil in series therewith, the said coil having a moving part adapted to increase the choking effect in the coil, a pivoted lever connected to the moving part and a weight on the lever, the connection between the moving part and the lever being made at a critical angle, whereby the varying effects of the weight and the magnetic pull of the coil cause varying choking effects which are adapted to maintain the current constant."—[*Official Gazette, February 25, 1902.*]

Disclaimer in Letters Patent No. 684,340.

DISCLAIMER.

684,340.—*Malcolm H. Baker*, of New York, N. Y. REGULATING DEVICE FOR ARC-LAMP CIRCUITS. Patent dated October 8, 1901. Disclaimer filed August 3, 1906, by the present assignee, Westinghouse Electric & Manufacturing Company,

Enters its disclaimer—

"To that part of the claim in said specification which is in the following words, to wit:

"1. In an electric circuit, a regulating reactance device having operating parts whose relative position determines the choking effect of the device, magnetic means for causing relative movement of the parts, and mechanical means for controlling such movements, these mechanical means being adapted to so control the movements as to produce definite predetermined choking effects."—[*Official Gazette, August 14, 1906.*]