No. 616,111. Patented Dec. 20, 1898.

W. J. KELLY.

ARC LIGHT REGULATOR.

(Application filed Jan. 29, 1896. Renewed June 1, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

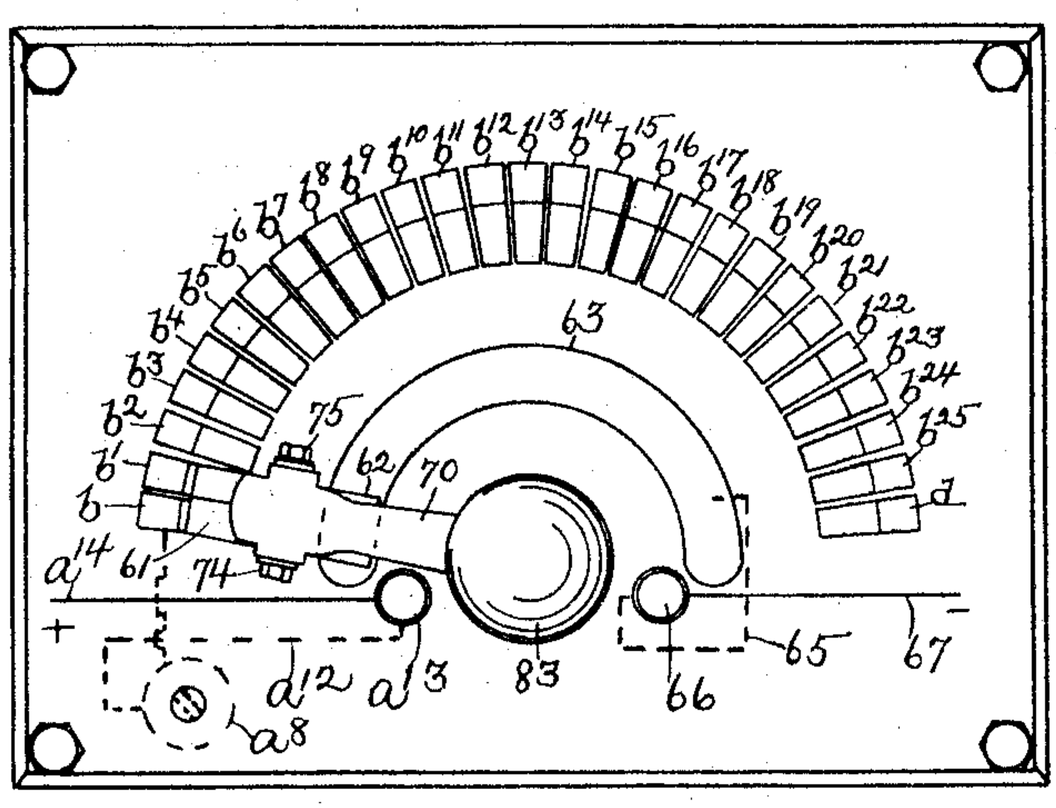
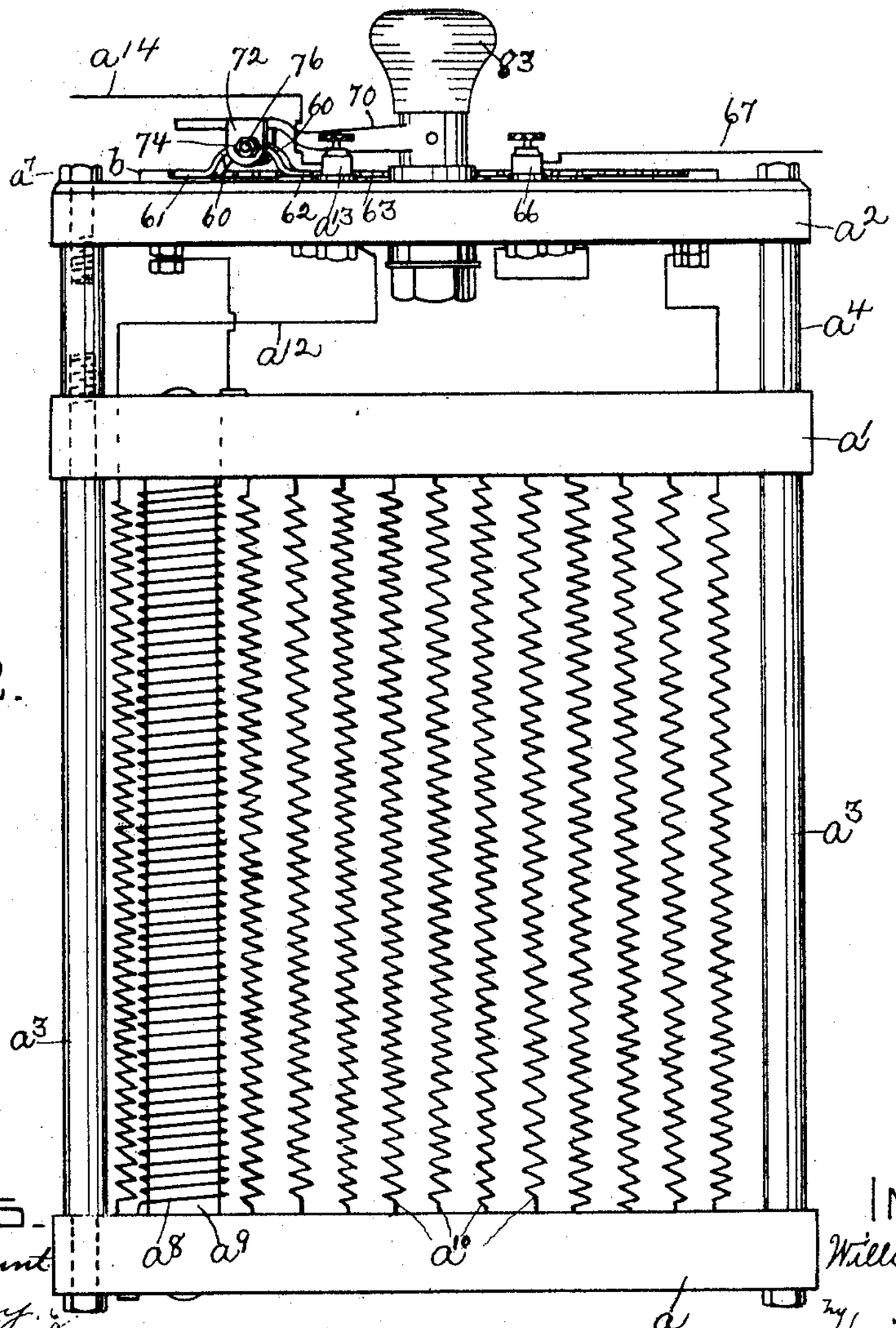


Fig. 2.



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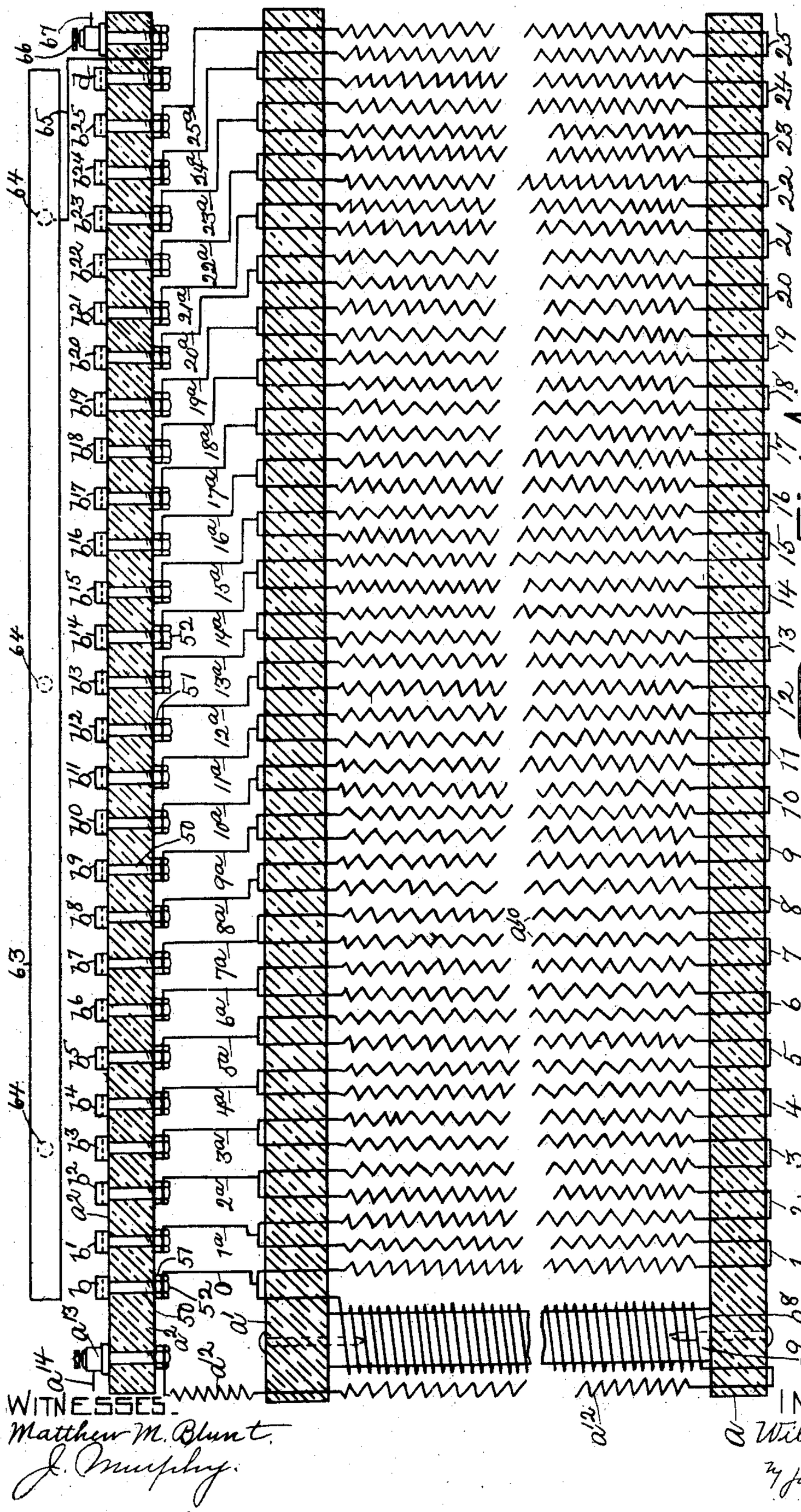

FIG. 4.

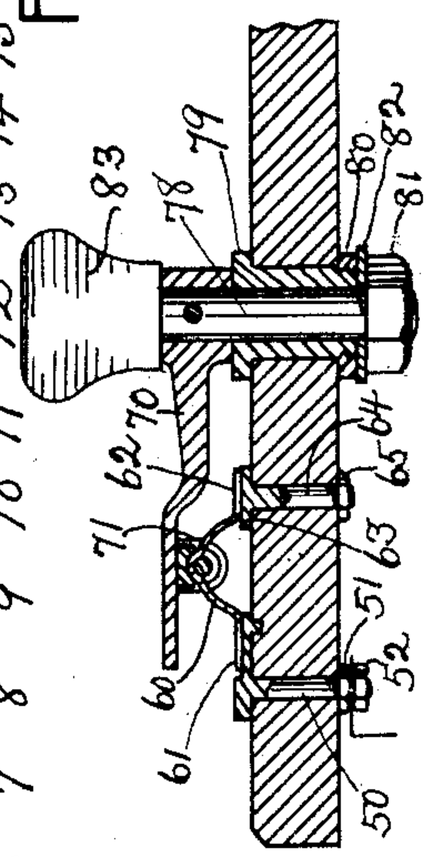

FIG. 5.

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ARC-LIGHT REGULATOR.

SPECIFICATION forming part of Letters Patent No. 616,111, dated December 20, 1898.

Application filed January 29, 1896. Renewed June 1, 1898. Serial No. 682,307. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM J. KELLY, residing in Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Arc-Light Regulators, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention has for its object to provide a regulator for automatic or self-feeding electric-arc lamps, and particularly arc-lamps of that class known as "automatic focusing" lamps, whereby the light emitted by the lamp may be gradually changed or reduced from a full light to a minimum light, and vice versa, which renders the focusing-lamp especially valuable in theaters and like places for producing scenic and other light effects.

Prior to this invention I am aware that incandescent electric lamps have been controlled or regulated so as to change the candle-power of the lamp from a maximum to a minimum light, and vice versa, which result is effected by interposing in the circuit of the incandescent lamp a gradual and progressively-increasing resistance; but prior to my present invention I am not aware that a regulator has been made which is capable of producing the same results with an arc-lamp, and a regulator made upon the principle of an incandescent-lamp regulator cannot effect the desired results with an arc-lamp, owing to the fact that the arc formed between the carbon pencils or electrodes is of variable size, and therefore is of variable resistance.

By a long-continued series of experiments I have obtained a regulator for self-feeding or automatic focusing arc-lamps with which I am enabled to reduce the candle-power of the said lamp from its maximum to its minimum light, and vice versa, without causing the lamp to flicker or jump, which action would be detrimental for scenic purposes and might spoil the whole effect of the scene, the changes in the candle-power of the lamp being gradual and substantially imperceptible and the lamp remaining lighted at all times.

As a result of the long-continued series of experiments referred to I have discovered that an automatic arc-lamp, and especially an automatic focusing arc-lamp, may be regulated from full candle-power or maximum light to a dull-red or minimum light by gradually interposing in the circuit of the lamp a series of resistances which vary substantially in accordance with the size or resistance of the arc—that is to say, the resistance interposed in the circuit when the lamp is burning at full candle-power may be a series of gradually-increasing resistances interposed step by step, which reduces the candle-power to less than full light, and the next resistance or series of resistances interposed is less than the prior resistances, so that the arc is held stationary, or it may be slightly increased, so as to form a new starting-point from which reduction takes place by interposing additional resistance. In other words, the reduction in the candle-power is effected by a series of increasing and diminishing resistances, corresponding to a series of pulling-down and building-up steps.

Electric circuits as now commonly connected with theaters usually carry a current of about forty amperes, and the focusing arc-lamps as now commonly constructed and known to me operate at full candle-power with twenty amperes, and therefore the current of forty amperes is reduced to approximately twenty amperes by a suitable resistance, which for the purpose of this invention I will designate as the "fixed" resistance, in order to distinguish it from the resistance forming the basis of this invention and which I prefer to designate as the "variable" resistance.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a top or plan view of one form of arc-regulator embodying this invention; Fig. 2, a front elevation of the regulator shown in Fig. 1, some of the resistance-coils being omitted; Fig. 3, a sectional detail to be referred to; and Fig. 4 a sectional view of a regulator, which may be supposed to be a developed view of the coils and contact-pieces or terminal steps shown in Fig. 1, but arranged in a straight line to enable the invention to be more easily explained.

In the present instance I have shown the

arc-light regulator in portable form, so that it may be easily transported from one place to another.

The arc-light regulator shown in Figs. 1 and 2 is provided with a supporting-frame, which may and preferably will be made as herein shown, and consists of the plates or slabs a a' a^2, preferably of slate or other suitable insulating material, which are tied together by suitable rods a^3 a^4, located at the corners of the said plates, as herein shown, the rods a^3, as represented in Fig. 2, having their ends reduced in diameter and inserted through suitable holes in the plates a a', the said rods having screwed upon their lower ends suitable nuts a^6, and the rods a^4 having in their opposite ends threaded sockets, into which extend the threaded upper ends of the rods a^3 and retaining-bolts a^7; but instead of the particular form and construction of framework herein shown I may use any other desired or suitable form of construction.

The plates a a' in the present instance support a fixed resistance, shown as a coil a^8 of wire wound about a post or block a^9 of slate or other suitable insulating material, and a variable resistance consisting, as herein shown, of a series or plurality of coils a^{10}, of a character as will be hereinafter more fully described, and which may vary in number according to the degree of fineness of the arc regulation desired or required.

In the present instance the variable resistance is represented in Fig. 4 as composed of twenty-five coils, numbered from 1 to 25, and each coil, as herein shown, is composed of two legs or is made U-shaped and passed through suitable slots or openings in the plates a a'.

Each coil a^{10} in practice is connected in series to its next adjacent coil, and for sake of simplifying the drawings the coils are represented as one continuous wire; but in practice each coil is preferably separate in order to obtain the desired resistance for each coil; but the said coils are soldered or otherwise electrically connected to have the effect of a continuous wire. The fixed-resistance coil a^8 has one end connected to the coil No. 1, and its other end is connected by the wire a^{12} to a binding-post or line-terminal a^{13}, suitably secured to the plate a^2 and having connected to it one line or circuit wire a^{14}. The resistance-coil a^8 has its other end connected with the first leg of the coil No. 1 and with a contact-piece or terminal b by the wire O. The variable-resistance coils 1 to 25, inclusive, are connected in similar manner to contact-pieces or terminals b' to b^{25}, inclusive, by wires marked 1^a to 25^a, inclusive, as clearly shown in Fig. 4. These contact-pieces are supported upon the top plate a^2 and are preferably arranged in the arc of a circle, as clearly shown in Fig. 1, each of the contact-pieces, as herein shown, having a stem or rod 50, which is extended down through a suitable hole in the top plate a^2 and is fastened by means of a clamping-nut 51, the wire connection being effected, as represented in Figs. 3 and 4, by means of a nut 52. Each of the contact-pieces or terminals b' to b^{25}, inclusive, constitutes what I prefer to designate as a "step" of the regulator, and the said contact-pieces have coöperating with them one end of a movable member of the regulator or circuit-controller, which member in the present instance is shown as a U-shaped metal piece 60, (see Figs. 2 and 3,) provided with extended ends 61 62, the end 61 coöperating with the contact-pieces or terminals b b', &c., and the other end 62 coöperating with a segmental plate 63, secured to the plate a^2, as herein shown, by means of studs or posts 64, extended down through suitable holes in the plate a^2 and secured thereto by nuts 65. In Fig. 4 I have represented the plate 63 as provided with three posts 64. The segmental plate 63 is connected by the wire 65 to the binding-post 66, to which the opposite line-wire 67 is connected. The movable contact member 60 of the circuit-controller in the present instance is represented as carried by an arm 70, provided with lugs or ears 71 72, between which the movable member 60 is clamped by means of nuts 74 75 on a threaded rod 76; but instead of this particular manner of securing the movable member 60 to the arm 70 I may employ any other desired or suitable construction. The arm 70 is represented in the present instance as secured to a pivot-pin 78, extended through a sleeve 79, inserted through a hole in the plate a^2, the said sleeve being clamped to the plate by means of a threaded ring or nut 80, and the pivot-pin 78 being clamped to the sleeve by means of a nut 81, a washer 82 being interposed between the said nuts.

The pivot-pin 78 may be provided with a suitable handle or thumb-piece 83 for convenience in turning the arm 70. In the normal position of the arm 70 its movable member 60 is withdrawn from engagement with the contact-pieces or terminals connected to the resistances, in which position the lamp may be supposed to be cut out of circuit. When the fixed resistance a^8 is interposed in the arc-circuit, it will be understood, as above described, that the current flowing through the circuit is very considerably reduced—for instance, from forty to twenty amperes. The circuit with the fixed resistance may be traced as follows in Figs. 1 and 4: from one line-wire, as a^{14}, which may be regarded as the positive line-wire, to the binding-post a^{13}, thence by wire a^{12} through the fixed resistance a^8, wire O, to the contact-piece b, thence by the movable member 60 to the terminal segment 63, thence by the wire 65 and binding-post 66 to the line-wire 67. When the movable contact member 60 is in engagement with the contact or terminal b, the fixed resistance a^8 is included in the circuit, as above de-

scribed, and the lamp at such time may be supposed to be operating at its maximum candle-power or full light.

In order to produce scenic effects, it is desirable that the light should be decreased from full light to a dull-red or minimum light, or to such a dull light as will, in the case of an arc-lamp, be equivalent to substantially no light, yet leaving the lamp in the circuit and burning. To accomplish this result, I make use of a variable resistance consisting of a plurality of resistances, preferably in the form of coils, as herein shown, and in the present instance twenty-five in number. These coils are each of a different resistance, and by practical demonstration I have ascertained that a suitable resistance to first interpose in the circuit is .127 of an ohm, so that for the purpose of this invention the coil No. 1 of the variable resistance may be supposed to represent .127 of an ohm. Coil No. 2 is a resistance equal to .056 of an ohm, so that when the contact member 60 is brought into engagement with the terminal or contact-piece b^2 the total amount of variable resistance is equal to .183 of an ohm. This increase of resistance in the line-circuit reduces the candle-power of the focusing arc-lamp from full light; but the reduction is so slight as to be practically imperceptible, and a still further reduction is effected when the contact member 60 is brought into engagement with the terminal or contact b^3, so as to include the coil No. 3 of the variable resistance, which coil is equal to .040 of an ohm, making a total of .223 of an ohm now in the circuit in addition to the fixed resistance. It will be understood that when the coil No. 3 of the variable resistance is brought into circuit with the lamp a less amount of resistance is added than when the contact member 60 is moved from the contact-piece or terminal b' to the contact member or terminal piece b^2. In other words, the second step corresponding to the contact-piece b^2 adds to the line a resistance of .056 of an ohm, while the third step adds to the line a less resistance—namely, .040 of an ohm. When the contact member 60 is brought to the fourth step, or into engagement with the contact-piece b^4, the coil No. 4 is added to the circuit, which coil represents a resistance equal to .071 of an ohm, and when brought into contact with the terminal b^5 the coil No. 5 is added to the circuit, which equals .087 of an ohm, and on the continued movement to the terminal b^6 the coil 6 is brought into circuit, representing a resistance of .048 of an ohm. The seventh step of the resistance, represented by the engagement of the movable member 60 with the contact or terminal b^7, interposes the coil 7, representing .063 of an ohm, and when brought into contact with the terminal b^8 the coil 8 is added, representing .075 of an ohm, and when brought into engagement with the terminal b^9 the coil 9 is added, representing .034 of an ohm, and when brought into contact with the terminal b^{10} the coil 10 is added, representing .113 of an ohm. The remaining coils 11 to 25, inclusive, represent, respectively, the following resistances, namely: the coil 11, .097 of an ohm; coil 12, .275 of an ohm; coil 13, .115 of an ohm; coil 14, .231 of an ohm; coil 15, .161 of an ohm; coil 16, .272 of an ohm; coil 17, .308 of an ohm; coil 18, .878 of an ohm; coil 19, 1.681 ohms; coil 20, .355 of an ohm; coil 21, .834 of an ohm; coil 22, .485 of an ohm; coil 23, .807 of an ohm; coil 24, .530 of an ohm, and coil 25, 1.828 ohms. It will be understood that as the circuit-controlling member 60 is moved step by step from the position shown in full lines, Fig. 1, around into contact with the terminal b^{25} the resistance represented by each successive coil 1 to 25, inclusive, is added to the fixed resistance a^8. For instance, when the contact member 60 is in engagement with the terminal 15, .381 of an ohm is added to the fixed resistance, and when the said contact member is in engagement with the terminal b^{10} the added variable resistance is .714, and when brought into contact with the terminal b^{19} a total of 4.732 ohms is added to the fixed resistance, &c. It will be seen that as the contact movable member 60 is brought from the full-light position in contact with the terminal b around into successive engagement with the terminals b' to b^{25}, inclusive, a gradual increase of resistance is interposed in the line-circuit, but that this resistance is not a progressive increase of the same amount for each step, but, on the other hand, the individual steps add a predetermined amount of resistance, which may vary from the amount of resistance controlled by the immediate adjacent steps—as, for instance, the step b^2 adds .056 of an ohm, while the step b^3 adds only .040 of an ohm, and its next adjacent step b^4 adds .071 of an ohm, and the step b^5 adds a further increase of .087 of an ohm, while the step b^6 adds a decreased resistance of .048 of an ohm, which increases again on b^7 to .063 and on b^8 to .075 and decreases on b^9 to .034, immediately again increasing to .113, then decreases to .097, &c., according to the scale. This variation in the amount of resistance controlled by each individual step of the regulator is rendered necessary from the fact that the resistance of the arc between the carbon pencils or electrodes is a variable one, and the scale or schedule herein given is the result of practical demonstration. The theory or principle upon which the action of this regulator is based is that when an increased resistance is added—as, for instance, between the steps 1 and 2 of .056 of an ohm—the current flowing through the lamp is weakened, so that the carbons feed toward each other an imperceptible amount, yet sufficient to slightly diminish the length of the arc, and consequently decrease the resistance due to the arc, which diminution is substantially offset by the resistance interposed by the regulator, and the current flowing through the magnet-coil controlling the feed of the car-

bons is maintained of such a strength as to keep the said magnet active or sufficiently strong to prevent its separating action upon the carbons being overcome by gravity, and this theory is evidently correct from the fact that if a substantially equal amount of resistance—namely, .056 of an ohm—should be added by turning the movable contact member 60 into engagement with the step b^3 the strength of the coil would be diminished and the carbons would immediately fall toward each other so rapidly that on the addition of a few more steps—say three—the carbons would meet and the lamp would be suddenly extinguished, owing, as I believe, to the fact that the successive interpositions of the same or a greater amount of resistance by the regulator would diminish the strength of the current more than would be offset by the decrease in the size of the arc, and the current flowing through the magnet would not be sufficient to maintain the carbons separated, so as to keep the arc alive. Therefore instead of adding an equal or substantially equal amount of resistance on the next step—namely, with the contact member 60 in engagement with the step or terminal b^3—a less amount is added, which diminishes the current imperceptibly, yet not sufficiently to materially affect the feed of the carbons, and leaves the magnet in such condition as to be substantially unaffected by the interposition on the next step of a higher resistance—namely, .071—but to be sufficiently affected to feed the carbons slightly. In other words, the arc-regulator herein shown consists, essentially, of a variable resistance composed of separate or independent resistances of varying amounts.

In the present instance I have given one scale suitable for a regulator to be used in conjunction with a line-wire carrying originally forty or approximately forty amperes; but I do not desire to limit my invention to the particular schedule herein shown, as this schedule may vary under different conditions, that is, according to whether the circuit carries a greater or a less amount of current, and also according to other conditions of the circuit, such as the resistance of the lamp, &c.; but the principle herein explained remains the same in any case—that is, in the present instance I have selected .127 of an ohm as a starting-point for the first step and then have added .056 for the second step, .040 for the third step, &c.; but instead of starting with .127 of an ohm as the first step I may select any desired resistance and add to it, in substantially the amounts designated for the various steps, additional resistances, so that the total amount of resistance interposed in the circuit under such conditions would vary from the total amount herein given. It will be noticed that each of the last few steps of the regulator—namely, from b^{19} to b^{25}—adds a substantially large amount of resistance as the carbon pencils approach in close proximity to each other; but, if desired, the amount of the resistance added by each of these steps may be made smaller and the number of steps correspondingly increased.

In the present instance I have shown the arc-regulator as embodied in a portable form, with the fixed resistance carried by the supporting-frame; but I do not desire to limit my invention in this respect, as in some places—for instance, in theaters—it may be found desirable to place the fixed resistance in a separate frame from the variable resistance; but when so constructed the fixed resistance will be coupled or electrically connected with the variable resistance after the manner herein shown.

From the above description it will be seen that the gist of this invention and that which enables the automatic arc focusing-lamp to be brought from full or maximum light down to a dull-red or minimum light without flickering, jumping of the carbons, and with an imperceptible graduation of the light, and vice versa, resides in the variable resistance, the coils or steps of which vary from each other after the manner above described.

In practice I have provided the regulator with an additional contact-piece d, which is blank or disconnected from the line-circuit and with which the movable contact member may be engaged whenever it should be desired to completely cut out the arc-lamp. This contact-piece d is in close proximity to the contact-piece or terminal b^{25}, so that the lamp may go from a dull red to total darkness and may be brought from total darkness gradually up to full light. I may prefer to arrange the contact-steps or terminals b to b^{25}, inclusive, in the arc of a circle, as shown in Fig. 1, and to employ in conjunction therewith a rotatable contact member, such as 60; but I do not desire to limit my invention in this respect, as the contact-steps or terminals may be otherwise arranged—as, for instance, in a straight line, as represented in Fig. 4—and the movable contact member may be moved over the said contact-steps or terminals in a straight line.

I claim—

1. In a regulator for automatic arc-lights, the combination with a variable resistance composed of a series of resistances, increasing and diminishing irregularly as described, to enable the arc-lamp to be regulated without interfering with its functions, and a circuit-controller coöperating with the said variable resistances, substantially as described.

2. In a regulator for automatic arc-lights, the combination with a supporting-frame provided with a series or plurality of contacts or terminals, of a series of resistances connected in circuit with each other and to the said contacts or terminals, the resistance connected to some contacts being less than that connected to other contacts on opposite sides of them, and a circuit-controller coöperating with said contacts or terminals, substantially as described.

3. In a regulator for automatic arc-lights, the combination with a supporting-frame provided with a series of contacts or terminals, a movable circuit-controller coöperating with said contacts or terminals, a series of variable increasing and diminishing resistances connected to the said contacts or terminals and controlled by the movable circuit-controller and a fixed resistance carried by the said frame and connected to one of the said contacts or terminals but not under the control of the movable circuit-controller, substantially as and for the purpose specified.

4. In a regulator for automatic arc-lights, the combination with a plurality or series of contacts or terminals, and a coöperating movable circuit-controller, of a plurality of resistances connected to the said contacts or terminals and of varying resistances, lower or diminishing resistances being connected to contacts or terminals intermediate of contacts or terminals to which higher or increasing resistances are connected, substantially as and for the purpose specified.

5. A regulator for automatic arc-lights provided with a resistance consisting of a plurality of variable increasing and diminishing resistances connected in sequence to effect the regulation of the arc-light from full light to substantially no light and vice versa without interfering with the functions of the lamp in its regulation, substantially as described.

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

WILLIAM J. KELLY.

Witnesses:
JAS. H. CHURCHILL,
J. MURPHY.