(No Model.)

3 Sheets—Sheet 1.

W. J. & S. B. PAINE.

REGULATOR FOR ELECTRIC LIGHTS.

No. 321,748. Patented July 7, 1885.

Fig. 1.

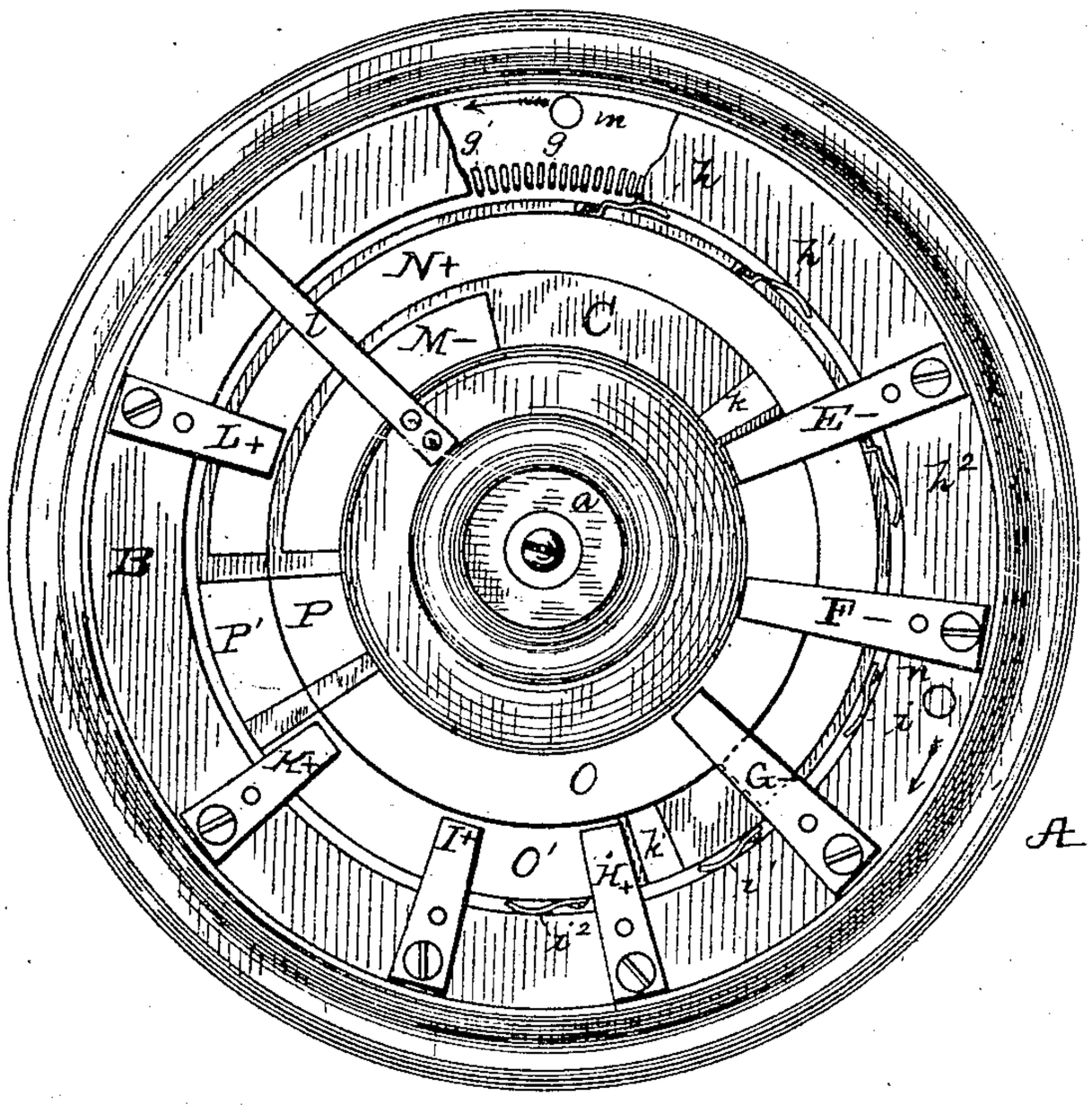
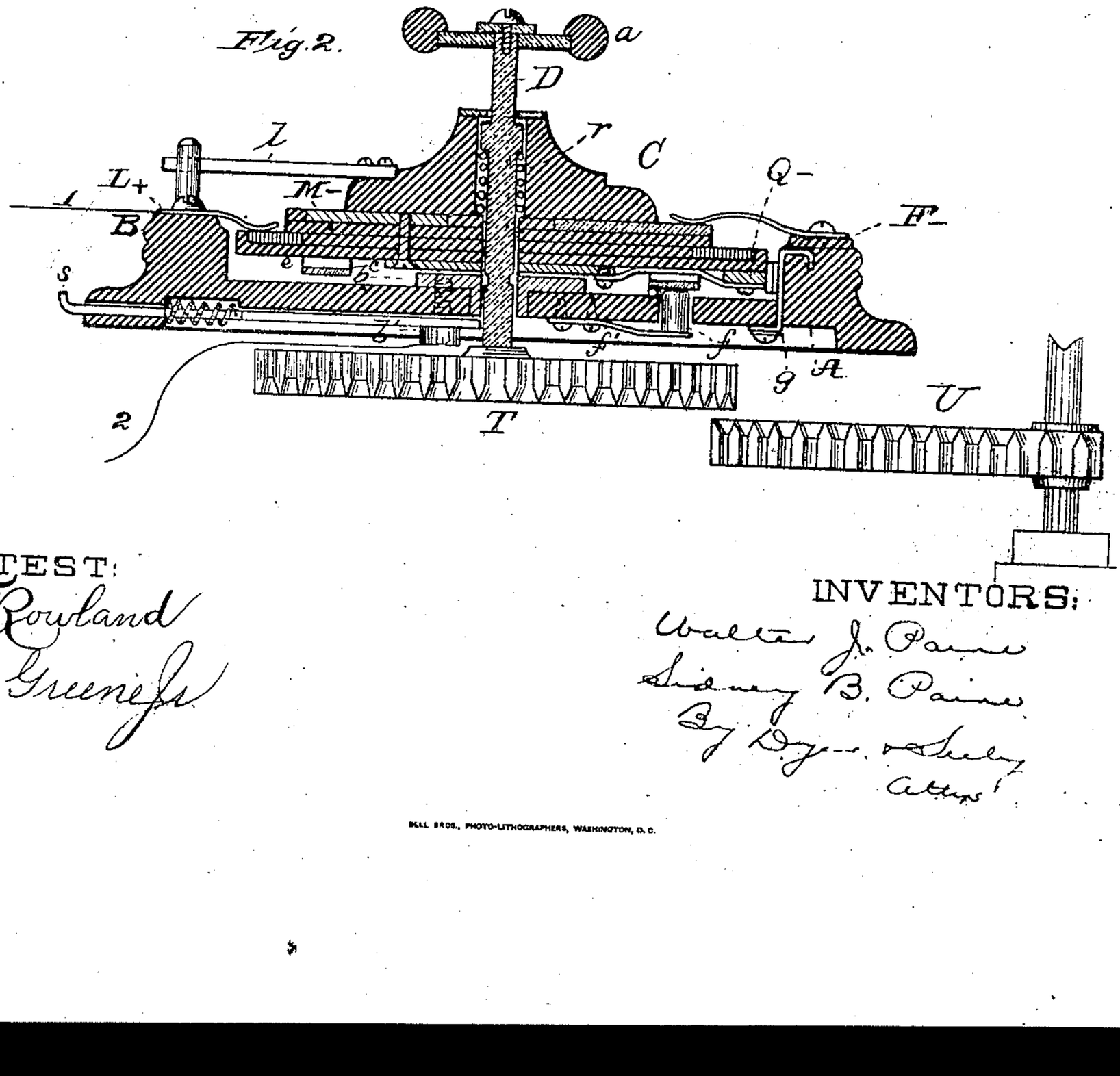


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

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Fig 4.

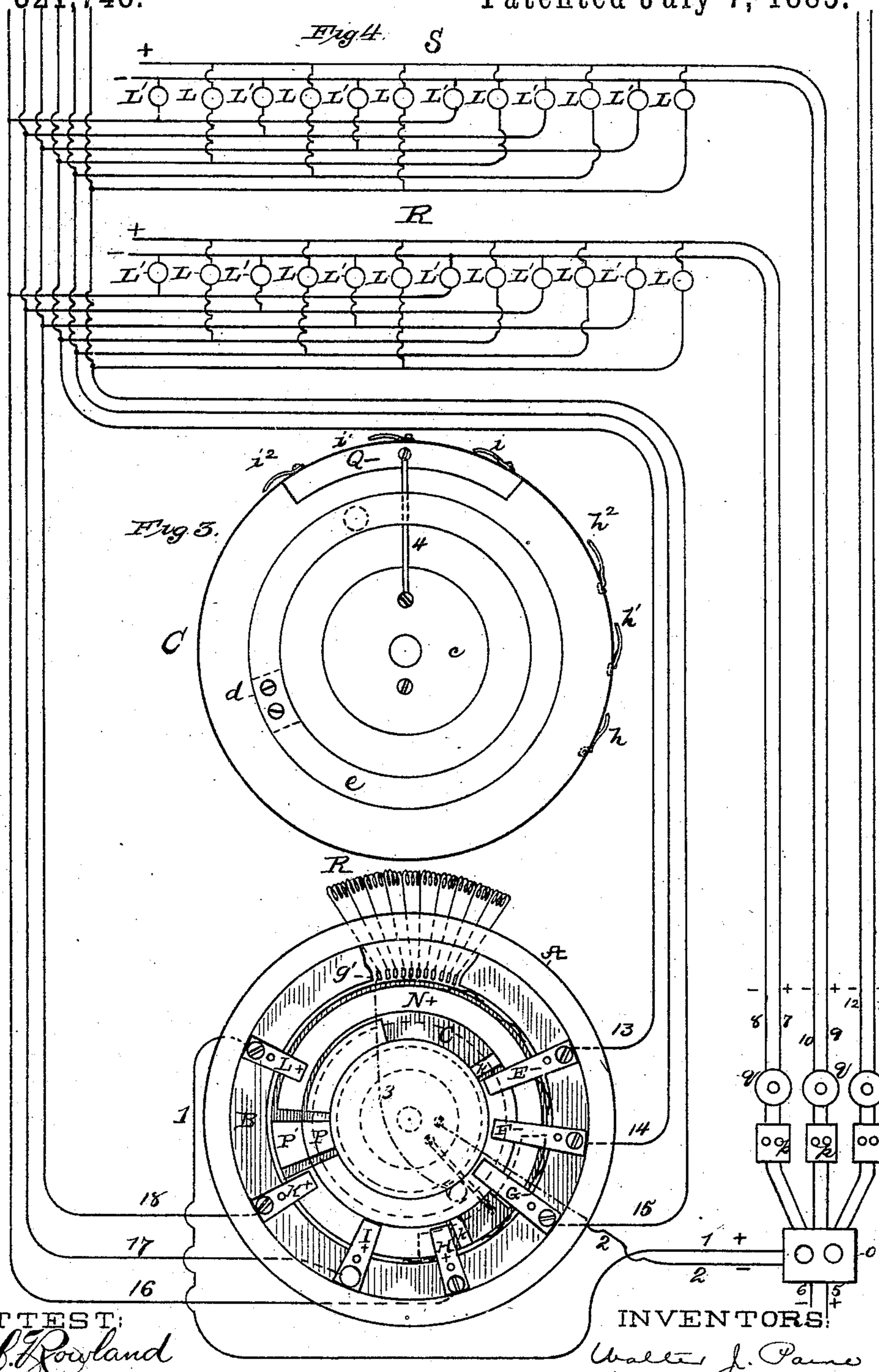

Fig 3.

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(No Model.) 3 Sheets—Sheet 3.

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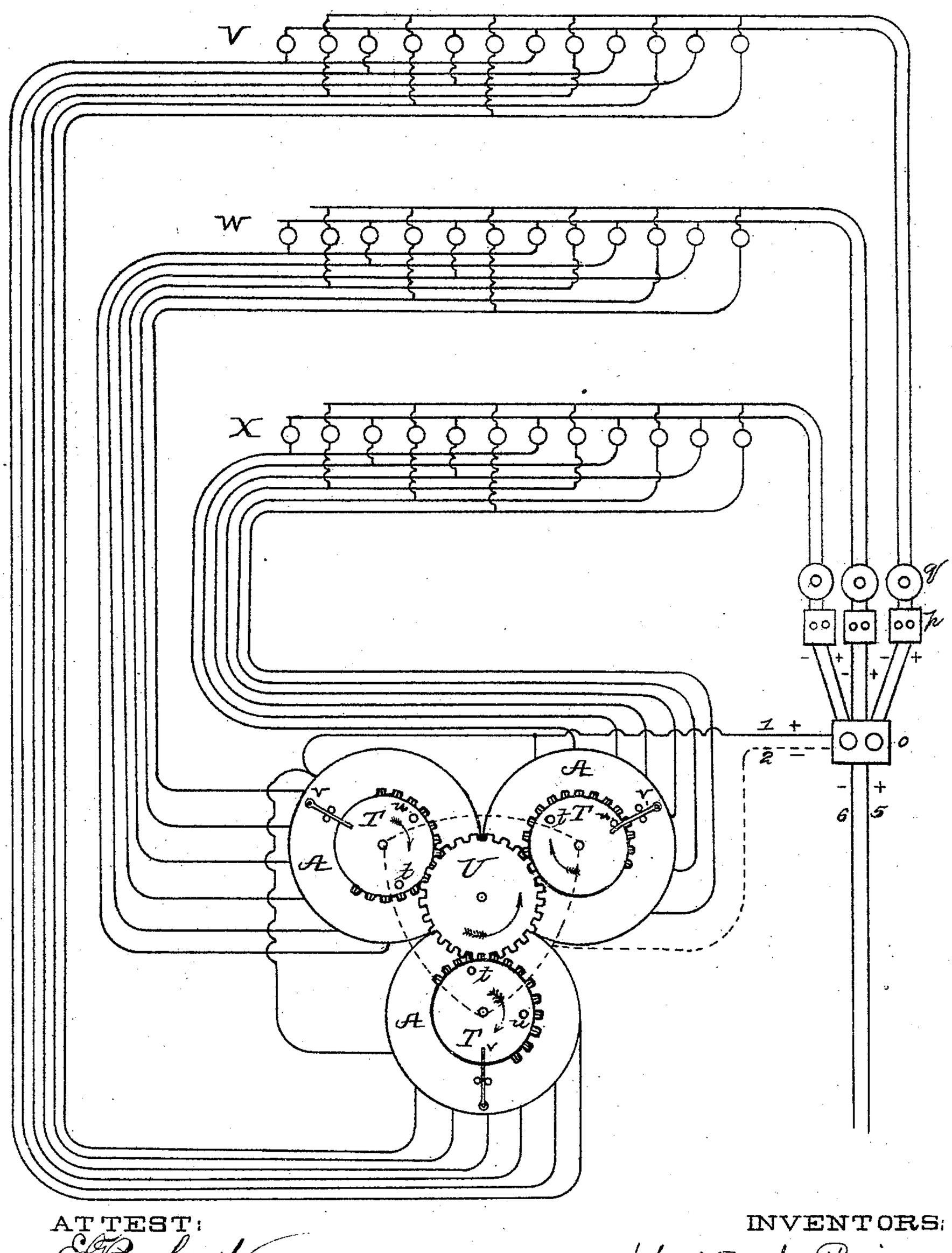
Fig. 5.



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UNITED STATES PATENT OFFICE.

WALTER J. PAINE AND SIDNEY B. PAINE, OF BOSTON, MASSACHUSETTS.

REGULATOR FOR ELECTRIC LIGHTS.

SPECIFICATION forming part of Letters Patent No. 321,748, dated July 7, 1885.

Application filed January 12, 1885. (No model.)

To all whom it may concern:

Be it known that we, WALTER J. PAINE and SIDNEY B. PAINE, both of the city of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and use ful Improvement in Regulators for Electric Lights, of which the following is a specification.

Our invention relates to apparatus for varying the illuminating effect of incandescing electric lamps, the same being an improvement upon the arrangements already devised by the said Walter J. Paine.

The object we have in view is to increase the efficiency of the apparatus so that the variations in the light will be more gradual. This we do by combining in a single progressively-acting switch the principle of throwing the lamps into and out of circuit in groups, with that of varying the candle-power of the lamps of each group, both by throwing the groups into and out of arrangements in series and by the use of external resistances.

A special feature of our invention is the progression of each group of lamps through different arrangements of series, to increase or decrease the candle-power of the lamps gradually (through two or more intermediate stages) independent of external resistances.

Our object, further, is to provide means for operating two or more of the switches together or separately, as desired; and our invention relates also to this feature and to other details of connections, arrangement, and construction, as will be fully hereinafter explained.

In the accompanying drawings, forming a a part hereof, Figure 1 is a top view of a switch with a portion broken away to show the series of resistance-contacts; Fig. 2, a vertical section of the switch; Fig. 3, a bottom view of the turning-disk; Fig. 4, a view, principally in diagram, showing a single switch, regulating all the borders of a theater; and Fig. 5, a similar view showing separate switches for regulating such border lights, the arrangement we prefer.

The construction of the switch in the form represented is as follows: A circular base, A, of insulating material, is used, and this has a depressed center, leaving a raised annular periphery, B, which carries the stationary contacts. Within the annulus B turns the disk C, which is mounted on a spindle, D, turned by a suitable hand-wheel, *a*. The disk and spindle turn together, the spindle passing through a bearing-plate, *b*, on base A. The disk has a corresponding plate, *c*, secured to its under or rear side, which rides upon *b*. Upon the annulus B are secured three long spring-fingers, $E^- F^- G^-$ and four short spring-fingers, $H^+ I^+ K^+ L^+$. These are stationary contacts, the long fingers and three of the short fingers (except L^+) being lamp-contacts, while the short-finger L^+ is connected directly with the positive pole of the dynamo or other source of electric energy by wire 1. The disk has contacts upon two planes—an upper and lower plane—the long fingers extending to the former and the short fingers to the latter. The upper plane of the disk has a contact-plate, M^-, which is long enough to bridge the three long fingers. This plate, as shown in Fig. 2, is secured by a screw to the bearing-plate *c* on the back of disk. The bearing-plate *b* is connected by screw *b'* directly with the negative pole of the dynamo or other source of electric energy by wire 2, and hence the plate M^- always has a direct connection with said pole of the dynamo. The lower plane of the disk has a long plate, N^+, upon which the positive dynamo-contact L^+ rests throughout the movement of the disk, except for a short extent at the limit of lowest candle-power. The upper plane of the disk has a bridging contact-plate, O, which is long enough to take in a space equal to the distance from the first to the last of the six lamp-fingers, it having at one end a continuation, O', on the lower plane of the disk of sufficient length to bridge the three short lamp-fingers. The upper and lower planes of the disk have connected plates P P', which are secured by screws *d* to a metal ring, *e*, on the rear side of the disk, Fig. 3. Contact is maintained with ring *e* by block or brush *f* on a spring-arm, *f'*, the spring-arm being secured to the back of base A and the block *f* projecting through an opening in said base and bearing on ring *e*. On the opposite side of ring B from the lamp-fingers is located a series of resistance-contacts, *g*. These are vertical wires or plates secured to the inner side of the ring B, as shown in Fig. 2. They are secured to the bights of resistances R, Fig.

4, the last contact g' being connected with the spring-arm f' by a wire, 3, as shown in dotted lines in Fig. 4. The resistance may be wire or lamp or other resistances, as will be well understood. The resistance-contacts $g\ g'$ occupy the same space in the movement of the disk as do the plates P P', and they are arranged so that the moving contact-springs make connection with one contact before leaving a preceding one. To the periphery of the disk C are secured springs $h\ h'\ h^2$ and $i\ i'\ i^2$, the same in number as the brush-fingers, which springs rub over the resistance-contacts in succession. The three springs $h\ h'\ h^2$ are secured to the plate N^+, while the springs $i\ i'\ i^2$ are secured to a plate, Q^-, on the back of disk C. This plate Q^- is connected by wire 4 with bearing-plate c, and hence has a direct connection constantly with the negative pole of dynamo.

Between such of the contact-plates of the disk as are separated a considerable distance and are not intended to be bridged by the contact-fingers in passing from one to the other are located breaking-plates to take the spark when any circuit is broken before the brushes pass on to insulation, which would otherwise be destroyed by the spark. Two such plates are shown—one, k, directly after O, and between it and M^-, and another, k', directly after O', and between it and N^+. Insulating material is shown after the breaking-plates; but we may extend the breaking-plates over the entire space, each breaking-plate being divided into sections, each not sufficiently long to bridge any two fingers. Upon the disk C is a suitable stop-arm, l, which strikes in its movement limiting-stops $m\ n$, the former stop fixing the limit for highest candle-power and the latter for the lowest candle-power.

The connections for a single switch, with lamps regulated by it and forming the border lights of a theater, are shown in Fig. 4. 5 and 6 are the positive and negative dynamo-conductors, These run to a junction-box, o, in which conductors 1 and 2 are connected with 5 and 6. From box o extend conductors 7 8, 9 10, and 11 12, which run to the borders shown at the top of the drawings, two borders being developed. The conductors 7 8, 9 10, and 11 12, are protected by double-pole safety-catches p, and have also double-pole switches q. The switches q are simply used to completely break the circuit to all the lamps of the borders, so that any one or more borders can be taken out of the operation of the regulating-switch.

The two developed borders, R S, are shown, for purposes of illustration, as composed each of twelve lamps. The wires 7 8 run to border R, 9 10 to border S, and 11 12 to a border not shown. The lamps of each border are divided into two sets, the lamps L of one set being connected on one side with the positive conductor 7 or 9, and the lamps L' of the other set being connected on one side to negative conductor 8 or 10. The lamps L are connected on their other sides with conductors 13 14 15, running to long fingers $E^-\ F^-\ G^-$, such lamps being divided equally among the three conductors, two to each, while lamps L' are connected on their other sides in a similar manner to three conductors, 16 17 18, running to short fingers $H^+\ I^+\ K^+$. The lamps connected with each finger may be considered a group. In the arrangement shown the lamps to be regulated are divided into groups, half of the groups being connected between the positive pole of the dynamo and the switch, while the rest of the groups are connected between the negative pole of dynamo and the switch. In the position of the switch shown the groups are in a balanced-series arrangement, three groups being in series with three groups. The long and short spring-fingers being all bridged or connected together by the plates O O', the current will be from dynamo through positive conductors to lamps L, and from thence by wires 13 14 15 to long spring-fingers, across plates O O' to short spring-fingers (except L^+) by wires 16 17 18 to lamps L', and back to dynamo by negative conductors. The lamps of all the groups will have the same incandescence—that of a red heat. This is an intermediate position of the switch, the stop-arm l not being against either stop m or n.

Let us observe the changes effected by the switch in turning disk to the left so that arm l will move toward stop n, which marks the limit of highest candle-power. The first change results in bringing short finger K^+ upon plate P', the spring h striking the resistance-contacts g before K^+ leaves O', and K^+ passing from O' to P' without breaking circuit, the fingers being wide enough to bridge the space between these plates. Now the group of lamps connected with K^+ is no longer in series relation with any other group, but is receiving current by wire 1 to finger L^+, plate N^+, and spring h, and through resistance R, wire 3, spring f', block f, ring e, to plate P', and from thence by finger K^+ and wire 18 to lamps of group and back to dynamo. As the movement of disk C is continued the resistance R is cut out of circuit by the passage of spring h over contacts g, such spring approaching the last contact g' (the one connected with arm f') as it advances. When K^+ touches N^+, contact g' has been reached by h, and the group of K^+ is raised to full candle-power, it then receiving the full current directly from plate N^+. After K^+ has left P', finger I^+ reaches P', and the operation just described is repeated for group of I^+, as it also is subsequently for group of finger H^+. The groups of $H^+\ I^+\ K^+$ are all at full candle-power; but the groups of $E^-\ F^-\ G^-$ are out of circuit. As the groups of $K^+\ I^+\ H^+$ pass in succession from P' the balanced-series arrangement which exists when the parts are as shown in the drawings is changed. First, there are three negative (or long-finger) groups opposed to three positive (or short-finger) groups. When K^+ passes from O', there will be three negative and two positive groups

opposed. This will result in raising the candle-power of the two positive groups and lowering that of the three negative groups. When I^+ passes from O', the three negative groups will oppose one positive group, resulting in a further increase of candle-power of lamps H^+ and decrease in candle-power of lamps E^- F^- G^-. Now when H^+ leaves O' the lamps of the negative groups will be out of circuit; but since the lamps are intermingled the general effect will be an increase of light, the movement of the switch in this direction producing a regular increase of the light.

It will be observed that the groups of H^+ I^+ K^+ are progressed from low candle-power in series through different arrangements of series connected separately with a gradually-reduced resistance, and finally connected directly in multiple at full candle-power without breaking the circuit.

Attention is called to the fact that the parts of the switch should be arranged so the groups of K^+ I^+ H^+ in being connected to the resistance through plate P' should start on the resistance at somewhat different points, since they have different candle-power when the fingers reach P', as just explained.

When K^+ reaches P', *h* should be on first contact, *g*. When I^+ reaches P', *h'* should be somewhat advanced on contacts *g*—say one-fifth the distance—and when H^+ reaches P', h^2 should be advanced a corresponding distance over *h'*. This result is readily accomplished in the setting of the springs *h h' h²*. This is indicated in Fig. 3, the distance between springs *h'* and h^2 being less than that between springs *h* and *h'*. As H^+ leaves P', G^- reaches P, and *i* reaches the resistance-contacts. The group of G^- is now in circuit through the resistance, the current, which is reversed through said resistance, flowing from dynamo through lamps of group of G^- to G^- and plate P, and via ring *e*, block *f*, arm *f'*, wire 3, resistance R, spring *i*, plate Q^-, wire 4, plates *c b*, and wire 2 back to dynamo. G^- passes from P to M^- without breaking circuit, and the lamps of G^- are brought up to full candle-power in a multiple-arc relation, the plate M^- having a direct negative connection with dynamo. When G^- leaves P, F^- reaches that plate, and after F^- leaves P, E^- makes contact with P, the groups of F^- and E^- being raised in succession on the resistance and brought to full candle-power on M^-. With H^+ I^+ K^+ upon N^+ and E^- F^- G^- upon M^-, all the lamps are at full candle-power, and the arm *l* strikes stop *n*. The disk C being turned in the opposite direction, effects exactly the reverse of those described are produced. Group E^- is first thrown upon the resistance reduced in candle-power and put out; groups F^- and G^- follow in the same way; then group H^+ is thrown upon the resistance and into series with E^- F^- and G^-, and groups I^+ K^+ follow in same manner. The position shown in drawings is now reached. By further movement in this direction, E^- passes upon *k* and its circuit is broken. H^+ at the same time passes upon *k'* and has its circuit broken. This movement is continued, the circuits of F^- and I^+ are broken. H^+ passes upon N^+; but L^+ having left that plate, no circuit is established through H^+. When L^+ reaches edge of P', and just before touching O', arm *l* strikes *m*. This is position of lowest candle-power produced by switch. G^- and K^+ are still in circuit and in series with each other. This circuit can be broken at the separate switches *q*. By increasing the size of the switch it can be made to break all the circuits completely; but we have found that in practice this is not necessary.

In moving from the position shown in the drawings to the limit of lowest candle-power the candle-power of all the lamps is kept at the same low point until extinguished, the groups being thrown out of circuit in pairs—one negative and one positive together—and hence the candle-power of lamps remaining in circuit is not changed. In advancing from limit of lowest candle-power to position shown in drawings the groups are thrown into circuit in pairs, a short finger reaching O' at the same time that a long finger reaches O. The series relation is not changed by the throwing in of the groups until the position shown is reached, when the groups are thrown singly upon the resistance, as already explained.

In regulating theater-lights, we prefer to connect a number of our switches for simultaneous operation, as shown in Fig. 5. The spindle D of each switch has a cog-wheel, T, secured to its inner end. The cog-wheels T of the switches operated together mesh with a central cog-wheel, U, by turning which the disks C of the connected switches are turned. The spindle D of each switch is arranged to have a longitudinal movement in disk C and back-board, A, it being kept forward in the position shown in Fig. 2 by the spring *r*. In this position wheel T does not mesh with U, and the switch can be operated independent of other switches. By pressing inwardly upon handle *a*, spindle D will be moved, compressing spring *r*, and the wheel T will be caused to mesh with U. This position is maintained by a spring-catch *s*, which engages with the groove in spindle D. (Shown in Fig. 2.) Catch *s* is a spring-rod extending to outside of switch and having a turned end, by which it can be drawn out to release the spindle, when spring *r* will throw spindle outwardly and release T from U. To facilitate meshing of T and U, the teeth of the wheels are beveled to edges on facing sides, as shown in Fig. 2, so that they will always mesh. The wheels T are not provided with teeth for their entire circumference, but only to such an extent that the wheel U can turn them to the limits for which they are constructed. Stops *t u* upon wheels T engage springs-arms *v* on back of A. The stops *t u* of each switch strike spring-arm *v* just before last tooth of T leaves

U. The spring-arm exerts a pressure to force wheel T back on U, so that when movement of U is reversed all the wheels T will mesh and turn with it.

The switch-wheels are intended to be thrown into and out of gear with the driving-wheel, each at any point of adjustment without reference to the others, and hence the switch-wheels may reach the limit of their movement at the same or at different times, and the movement of the driving-wheel may be continued until all the switch-wheels reach the limit. This further movement does not affect the switch-wheels already at the limit, since the driving-wheel has reached the point of no teeth on the particular switch-wheels; but the spring-arms exert constantly a pressure tending to throw the switch-wheels into gear with the driving-wheel, which is done when the driving-wheel is reversed in its movement. It is evident that the cog-wheels could be replaced by friction-gearing.

In Fig. 5 the sets of lamps V W X are the border-lights of a theater, or one set may be the foot-lights. Each set has its own switch, and the lamps of the set can be varied to any extent independent of the other sets, and at any time two or more sets can be varied together. We prefer to couple switches for all the borders of a theater in this way, and the foot-light switch may also be arranged for simultaneous operation with the border-switches; but this is not of so much importance.

It is evident that our switch is capable of application to other special uses than those hereinbefore particularly referred to.

Each switch may be designed to control as many or few groups of lamps as may be desired, (two or more,) and each group can be composed of a large number of lamps or of a small number, (two or more.)

The switches can be used for regulating incandescing electric lamps in any of the many locations and for any of the numerous purposes in and for which such lamps are now or may be employed when it is desired to vary the lighting effect.

For domestic use a switch could be employed for the lamps of a room, or even those of a single fixture.

The method of regulating electric lights hereinbefore described is not claimed, since it will be made the subject of a separate application for patent.

What we claim is—

1. The combination, with groups of incandescing electric lamps, of a regulating-switch having moving and stationary contacts, constructed and connected to throw the lamps into arrangements in series, and a resistance and contacts for throwing such resistance into connection with the groups successively, substantially as set forth.

2. The combination, with two or more groups of lamps connected directly part with one side of the circuit and part with the other side, of a regulating-switch, with which such groups are also connected, the current flowing to and from the switch through lamps, substantially as set forth.

3. The combination, with two or more groups of lamps connected directly part with one side of the circuit and part with the other side of the circuit, of a regulating switch having contacts with which said groups are also connected, and contacts for connecting and disconnecting the group-contacts on the switch for throwing the groups into and out of series, substantially as set forth.

4. The combination, with groups of lamps connected directly part with one and part with the other side of the circuit, of a regulating-switch with which said lamps are also connected, and a resistance with which the groups are successively connected, substantially as set forth.

5. The combination, with groups of lamps connected directly part with one and part with the other side of the circuit, of a regulating-switch with which said lamps are also connected, contacts for connecting and disconnecting the groups in series at the switch, and a resistance with which the groups are successively connected, substantially as set forth.

6. The combination, with groups of lamps, of two main conducting-wires extending to said groups which are connected directly part with one and part with the other side of the circuit, a regulating-switch having direct connections to both sides of circuit, and connections between the contacts of said switch and all of said groups, substantially as set forth.

7. The combination of two or more sets of lamps, each composed of two or more groups, one or more regulating-switches for regulating the candle-power of the lamps, and a separate circuit making and breaking switch for each set of lamps, whereby any set of lamps can be removed from the action of the regulating-switch, substantially as set forth.

8. The combination, with two or more sets of lamps, each composed of two or more groups, a separate candle-power-regulating switch for each set, and a driving mechanism connecting the switches mechanically for simultaneous operation, substantially as set forth.

9. The combination, with two or more sets of lamps, each composed of two or more groups, a separate candle-power-regulating switch for each set, a common driving mechanism for the two or more switches, and devices permitting each switch to be connected with such driving mechanism or disconnected therefrom independent of the other switch or switches, substantially as set forth.

10. The combination, with two or more sets of lamps, each composed of two or more groups, of the separate regulating-switches, one for each set, having spindles capable of longitudinal movement and carrying gear-wheels, a central gear-wheel for operating the switches together, a catch for locking each switch-wheel in gear with the driving-wheel, and a spring

for throwing each switch-wheel out of gear with the driving-wheel, substantially as set forth.

11. The combination, with two or more sets of lamps, each composed of two or more groups, and separate regulating-switches, one for each set, of the driving-wheel, the switch-wheels on spindles parallel to that of driving-wheel and adapted to be moved into and out of gear with the driving-wheel, the teeth of the wheels being beveled on opposing faces, substantially as set forth.

12. The combination, with two or more sets of lamps, each composed of two or more groups, and separate regulating-switches, one for each set, of the driving-wheel, the switch-wheels engaging the driving-wheel for a part only of their circumference, and the stops and spring-arms, substantially as set forth.

13. In a regulating-switch, the combination of the pole-plates N^+ M^- with the bridging contact-plates O O′, and the two sets of fingers connected through lamps to opposite sides of the circuit, substantially as set forth.

14. In a regulating-switch, the combination of the pole-plates N^+ M^- with the resistance-contacts and springs, the resistance-plates P P′, bridging-plates O O′, and the two sets of fingers connected through lamps to opposite sides of the circuit, substantially as set forth.

15. The combination, with two or more lamps or groups of lamps, of switching-contacts for throwing a lamp or group of lamps from a series to a multiple-arc arrangement, and vice versa, the contacts being constructed and arranged relatively, substantially as described, whereby these changes will be effected without breaking the circuit of or extinguishing the lamp or group of lamps, substantially as set forth.

16. The combination, with two or more lamps or groups of lamps, of an adjustable resistance and switching-contacts for throwing a lamp or group of lamps from a series arrangement into connection with said resistance and into a multiple-arc arrangement, or vice versa, the contacts being constructed and arranged relatively, substantially as described, whereby these changes will be effected without breaking the circuit of or extinguishing the lamp or group of lamps, substantially as set forth.

17. The combination, with a current-supplying circuit of lamps and a regulating-switch connected to both sides of the circuit, of a resistance arranged, substantially as described, to be thrown by said switch into connection with either side of the supplying-circuit, substantially as set forth.

18. The combination, with a regulating-switch, of a resistance connected with the switch-contacts, substantially as described, whereby it will be thrown into circuit successively with different lamps or groups of lamps, the switch-contacts for said resistance being arranged to throw the resistance into connection with the lamps or groups of lamps at different points, whereby the initial incandescence of the lamps or groups so connected will be varied, substantially as set forth.

This specification signed and witnessed this 5th day of January, 1884.

WALTER J. PAINE.
SIDNEY B. PAINE.

Witnesses:
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E. C. ROWLAND.