(No Model.)

M. J. WIGHTMAN.

REGULATOR FOR ELECTRIC CIRCUITS.

No. 345,561. Patented July 13, 1886.

Fig. 1.

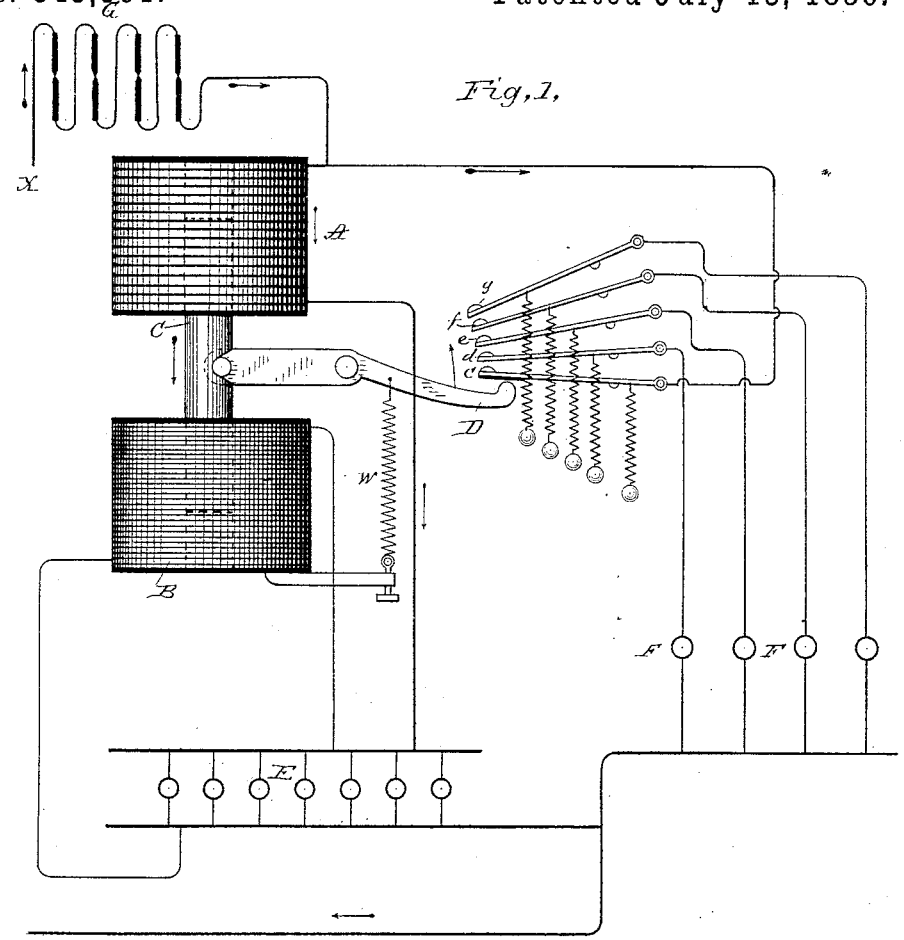
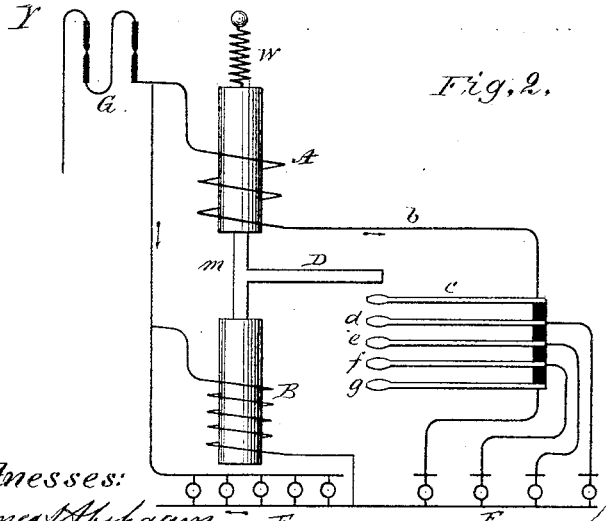


Fig. 2.



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UNITED STATES PATENT OFFICE.

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REGULATOR FOR ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 345,561, dated July 13, 1886.

Application filed July 8, 1885. Serial No. 170,984. (No model.)

To all whom it may concern:

Be it known that I, MERLE J. WIGHTMAN, a citizen of the United States, and a resident of Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Regulators for Electric Circuits, of which the following is a specification.

My invention relates to a means for regulating the flow of an electric current to one or more translating devices—such, for instance, as incandescent electric lamps—but is designed more especially for application to a group or number of incandescent lamps or other translating devices arranged in multiple arc with one another.

I have in the present specification described the group of lamps as arranged in series with other devices upon an electric circuit—such, for instance, as electric-arc lamps or other groups of incandescent lamps—since the application of the device to circuits known as "series multiple-arc circuits" designed for running electric-arc and incandescent lamps together is one of the more important uses to which it is intended to be put. I do not wish, however, to be understood as limiting myself to such particular arrangement.

My invention consists in the combination, with any device whereby the flow of current to the translating devices may be regulated, adjusted, or determined, of a derived circuit to the translating devices, containing a coil by which the regulating devices may be set or operated, and a second coil acting on the same devices and combined with suitable means whereby its effects may be automatically varied according to the set or adjustment effected by the operation of the derived-circuit coil. The two coils are preferably "main" and "derived" circuit coils, and act in the ordinary differential manner—that is to say, they oppose one another's effects either mechanically or electro-magnetically, so that the resultant action upon the current-adjusting devices is the resultant of the opposing actions of the two coils. It is not, however, necessary that the two coils should act in opposition to one another, or that the second coil should be in the main circuit, as the same results may be attained by causing the coils to conspire in pulling against a retractor. In the first case the difference of the effects of the two coils is to be kept within certain limits. In the latter case the sum of their effects is to be so regulated or controlled (through automatic variation of the effects of the second coil) that there shall be secured the compensation aimed at in my invention.

The especial object of my invention is to effect an adjustment of the current-regulating devices by means of the current diverted into the derived-circuit coil on an increase of resistance in the translating devices or group of devices, and at the same time to provide a means whereby the adjusting devices shall be prevented from falling back to their original position after an adjustment has been effected through the diminished strength of action of the derived-circuit coil consequent upon such adjustment.

My invention consists in giving to the second coil a decreasing or increasing effect automatically in accordance with the movement given to the adjusting devices by the action of the derived-circuit coil, so that the difference or the sum of their effects may be properly regulated, as will presently appear, and said devices may be held in their new adjusted position by the action of the derived-circuit coil.

The device for regulating the flow of current to the translating devices may be of any kind or pattern. As an effective arrangement for such purposes, in connection with the particular arrangement of translating apparatus that I have herein shown, I prefer to employ a variable resistance placed in a shunt or derived circuit around the translating devices, the mechanism for adjusting such resistance being operated by the current in the derived-circuit coil modified by the action of the current in the second coil.

As a preferred means of varying or adjusting the effect of the second coil when the same is a main-circuit coil and opposes the effects of the derived-circuit coil, I propose to employ a variable resistance in a shunt or derived circuit around said coils, and for the sake of economy I utilize the same resistance that is employed for varying the flow of cur-

rent to the translating devices or group of translating devices. The artificial resistance may be of any form, and, if desired, may consist of a series of electric lamps arranged in parallel circuits and combined with the switch appliances in such way that the number of lamps in multiple arc may be increased for the purpose of decreasing the resistance.

In the accompanying drawings, Figure 1, I have represented in side elevation and in diagram an arrangement of circuits and magnets whereby my invention may be carried out. Fig. 2 is a diagram illustrating an arrangement in which the second coil aids the derived-circuit coil and varies in its action in such way that the sum of the effects shall be kept at such point as to properly hold the adjusting devices in a new adjusted position.

E indicates a group of incandescent lamps or other translating devices arranged in multiple arc with one another upon a circuit, X Y, while G G indicate arc lamps arranged in series with one another and with the group of the translating devices upon said circuit.

B indicates a derived-circuit coil of high resistance in a derived circuit to the group of translating devices, so that upon a diminution in the number of translating devices in action current will flow in increased amount in the derived-circuit coil, owing to the increase of resistance in the group.

In the main circuit with the group of lights E is a main-circuit coil, A, acting in opposition to the derived-circuit coil B after a well-known manner, the coils B and A being wound upon the same magnetic core, C, so as to pull in opposite directions. The derived-circuit coil B tends to lower the core, and the main-circuit coil A to raise the same. A spring may assist the main-circuit coil, if desired, in this action.

In a branch around the group of lamps E and the main-circuit coil A is arranged a number of artificial resistances (indicated at F) in the form of incandescent lamps. These resistances are arranged in multiple arc to one another, and are connected severally to a series of springs or spring-actuated levers, *d e f g*, in line with one another, and adapted to be connected one after the other to a terminal spring-lever, *c*. For this purpose an arm or lever, D, or other operating device connected with the coil C, presses the spring-lever *c* up against the series of levers *d e f g*. The spring *c* is connected to the main circuit, as indicated, upon one side of the main-circuit coil A and the group of lamps E, while the resistances F are connected with the main circuit upon the other side of such apparatus. It will be obvious from this description and the arrangement shown, that when the arm or lever D is in the position indicated, no current can flow in the branch around the group of lamps E; but when the spring-lever *c* is pressed against *d* the lamps at F will be thrown into circuit one after the other, as the springs *d e f g* are pressed into contact, with the obvious effect of gradually diminishing the resistance in the branch containing them.

In the normal action of the apparatus, all the lamps in the group E being in the circuit current will flow in main-circuit coil A and in the derived circuit B in such proportion that the lever D will be held in the position indicated, or so as to permit the spring-lever *c* to stand out of contact with the contact on *d*. The adjustment may be effected through a spring, W, acting in opposition to the derived-circuit coil B. If, now, from accident or from any other cause, one of the lamps E is extinguished, the current which formerly passed through all of the lamps now has to pass through the remaining lamps of the group E, thus raising the potential at their terminals by reason of the increased total resistance of the group, and causing more current to pass through the fine-wire coil B. The circuit being a constant-current circuit, the current in the coarse-wire coil A will not have varied through the increase of resistance in the group, and the increase of circuit in the derived-circuit coil B will therefore cause the core to be drawn down against the action of the main-circuit coil and retractor. By this movement the arm D or other operating device is drawn down so as to force the contact *c* against the contact *d*, thus putting into circuit one of the individual resistances or lamps F, which latter are preferably constructed to possess individually a resistance equal to one of the group of lamps or other translating devices E. By this means the potential of the group is brought down to normal, there being now as many paths provided for the current as before, inasmuch as the lamp or other resistance at F, substituted for the lamp or translating device at E, removed from circuit, is of equal resistance, and is in multiple arc with said group. Under ordinary arrangements and without some special provision the core-armature or other magnetic device operated by the coil B would immediately fall back to its original position upon the effecting of the adjustment just described, inasmuch as the total resistance to which it forms a shunt has again become normal. In order to prevent this action from taking place, I automatically decrease the opposing effects due to the main-circuit coil A. This is done in the present instance by causing the current which passes through the variable resistance controlled by the arm D to shunt the current from the main coil A. As will be seen from Fig. 1, the main coil A is shunted in increasing amount as the number of resistances F in circuit is increased through depression of the arm D and contact springs *d e f*, &c. By properly proportioning the parts, which may be done by the electrical constructer, the decreased opposing power in the main-circuit coil A may be made such that when the adjusting devices assume each new position, the resultant of the opposing

actions of the coils B and A shall remain substantially the same for practical purposes. It will of course be understood that under the action just supposed the retractor W exerts an opposition of uniform amount. This might readily be secured in a practical way by making the spring W very long or by substituting for it a weight or other gravity-retractor properly arranged to oppose the effect of the derived-circuit coil B. Should the extinguished lamp be again put into circuit, the potential of the group is lowered, the current-flow in the shunt-coil B is weakened, and the arm D is drawn back by the retractor and the main-circuit coil A, thus cutting out lamps or individual resistances at F with the effect of increasing the resistance in the branch containing said lamps, and thus bringing the potential at the terminals of the group E E back to normal. The current that previous to such adjustment passed through the resistance at F now passes through the coarse-wire coil A, strengthening the same, so that the core and the arm or operating device D may be held in its new position.

I do not wish to be understood as limiting myself to any particular form of resistance at F, or to any particular construction of differential electro-magnet or solenoid.

I have shown the single core with the main and derived circuit coils wound thereupon and acting in opposite directions as a typical form of a differential arrangement.

The principles of the device shown in Fig. 1 would be preserved in any arrangement such that a differential action, mechanical or electro-magnetic, of the coarse and fine wire coils is obtained, the devices actuated or operated by such coils being made to actuate the adjusting devices for the variable resistance in the shunt around the group of devices E.

In practice it may be found desirable to vary the form or construction of the switch devices controlling the resistance F; but there are many well-known constructions of switches for such purposes. I do not deem it necessary to describe any such in detail, as the manner of applying and operating them is well known to electricians, and may be varied indefinitely and yet at the same time effect the particular operations necessary to produce a variation of resistance in the branch around the group of lamps.

In the arrangement shown in Fig. 2 the coil A assists the derived-circuit coil, and I have therefore to automatically increase instead of decrease its effects when the derived circuit effects an adjustment for extinguishment of a lamp or lamps at E. The coils are here shown as acting in separate cores connected by a non-magnetic link, *m*, although they might obviously act on the same core, as is well understood in the art. The coils conspire to move the cores in the same direction (downward in the figure) against any suitable retractor, which may be a spring, or preferably a weight, as the retractile power of the latter may be made constant for all temperatures, and does not vary, as does a spring, under differences of extension. It is obvious that the parts might be inverted in position, so that the coils would have to act against the gravity of the cores. The coils A are in a circuit with the artificial variable resistance, instead of in the main circuit, the obvious effect being that current will flow through them in increasing amount under conditions of adjustment or action which in Fig. 1 would cause current to flow through them in decreasing amount. The coils B and C act in conjunction to pull down the cores and lessen the resistance in the branch around the group of lamps E. Normally their action is so counterbalanced by the retracting force that there is no shunting effect. If a lamp be cut out, the coil B increases in power, and with the assistance of A effects the adjustment before described with the effect of diminishing the current flowing in its own coils. This diminution is compensated for and the core prevented from falling back by the increased flow of current in the coils A, which, being in the variable shunt around E, obviously carry more current than they did before the adjustment took place. The principle of action is obviously the same as in the first instance. The contacts are here shown as mounted on springs instead of upon spring-actuated levers.

As before intimated, I do not limit myself to any special construction of coils, cores, or magnets, my invention consisting, broadly, in the application of the second coil to the derived-circuit coil and in automatically governing the effects of said second coil, so that the sum or the difference of action of the two coils may be regulated or governed in accordance with the variations in the power of the derived-circuit coil consequent upon the lowering of its power by the effect of an adjustment for variations in the number of translating devices that are at any time in multiple are at E.

What I claim as my invention is—

1. The combination of an adjustable or variable resistance, a working resistance of variable amount, a derived-circuit coil, and a main-circuit coil, said main and derived circuit coils acting in combination to effect an adjustment of the resistance, and means controlled by the set or adjustment of the parts for giving the main-circuit coil a variable action or effect, as described.

2. The combination, with a working resistance, of devices for adjusting the flow of current to the same in accordance with variations of working resistance, a derived-circuit helix carrying the current by which the adjustment is effected, and an opposing main-circuit helix around which is an automatically-variable resistance, as described.

3. The combination, with a working resistance and a variable resistance, of a main and derived circuit coil or helix by the differential

action of which the resistance is adjusted, said resistance being in a branch around the main-circuit helix, as described.

4. The combination, with a group of incandescent lamps or other working resistance arranged in multiple arc, of a variable resistance in a branch around the lamps, and a main and derived circuit helix by the differential action of which the resistance is adjusted, said main-circuit helix being arranged in derivation with the adjustable resistance, as described, so that the current flowing to the main-circuit coil will decrease with any decrease of resistance effected by the increased power of the derived-circuit helix.

5. The combination, with a multiple-arc group of incandescent lamps arranged in series with other working resistances or groups of resistances, of a variable resistance and a main circuit, and a derived-circuit helix by the differential action of which the resistance is adjusted, said resistance being a shunt to the group of working resistances and to the main-circuit helix.

6. The combination, substantially as described, of a group of translating devices, a derived-circuit helix, devices governed thereby for governing the flow of current to the group, a second helix, and devices for automatically varying the power of the same, as described.

7. The combination, substantially as described, of a derived-circuit coil, a second or main-circuit coil, a mechanism to be adjusted by said coils, and devices acting automatically and simultaneously with an adjustment of said mechanism for controlling or determining the action or effect of said second coil in accordance with the extent of adjustment effected, whereby the derived-circuit helix may hold the mechanism in a new adjusted position with the same flow of current.

Signed at Hartford, in the county of Hartford and State of Connecticut, this 23d day of May, A. D. 1885.

MERLE J. WIGHTMAN.

Witnesses:
CHAS. E. DUSTIN,
W. H. NEWELL.