(No Model.)

2 Sheets—Sheet 1.

E. W. RICE, Jr.

COMBINATION OF ELECTRIC GENERATORS.

No. 396,602. Patented Jan. 22, 1889.

Fig. 1

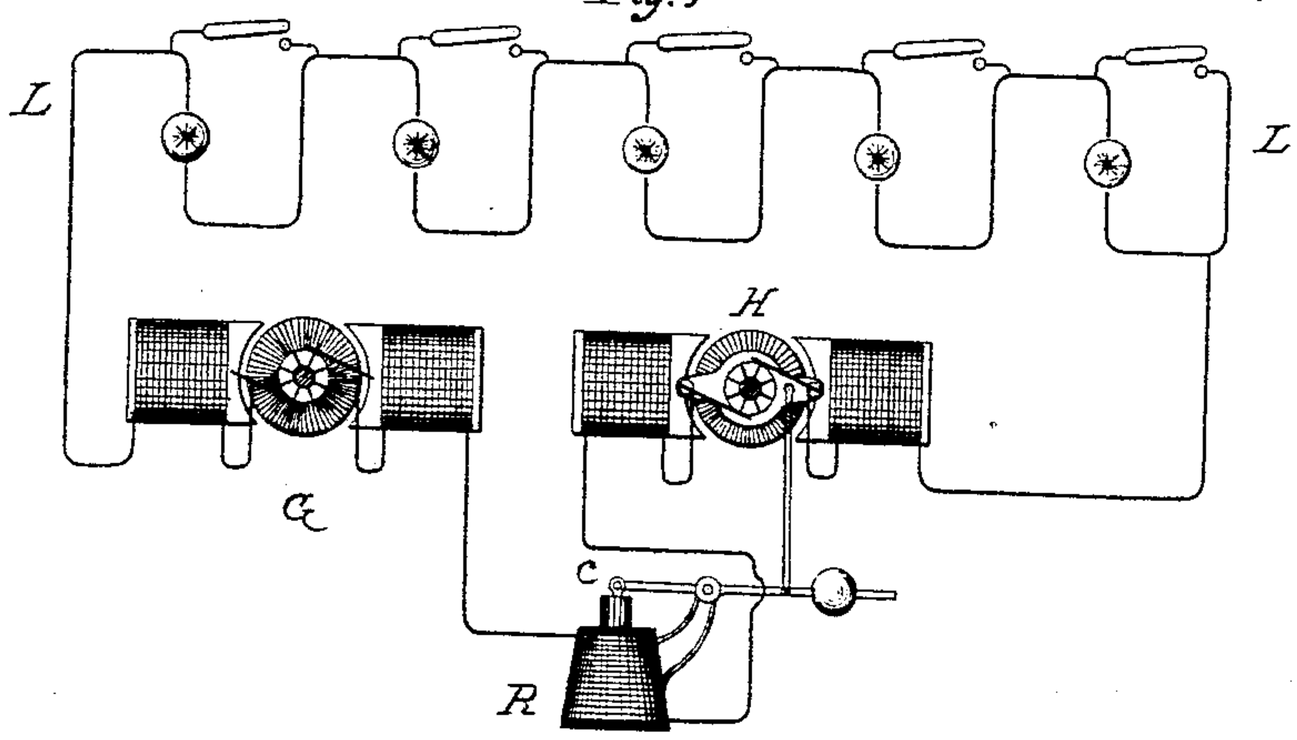


Fig. 3

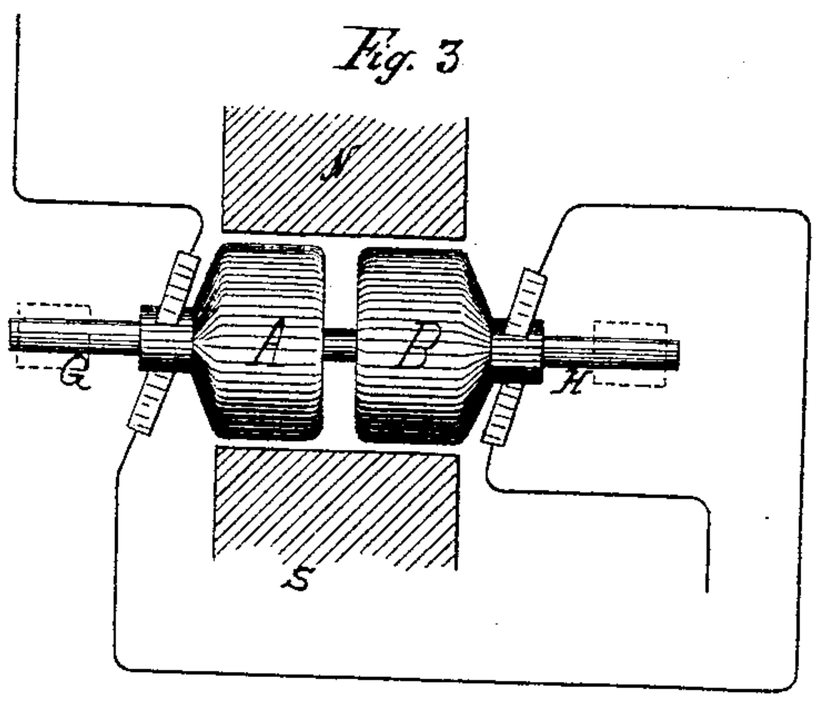


Fig. 2

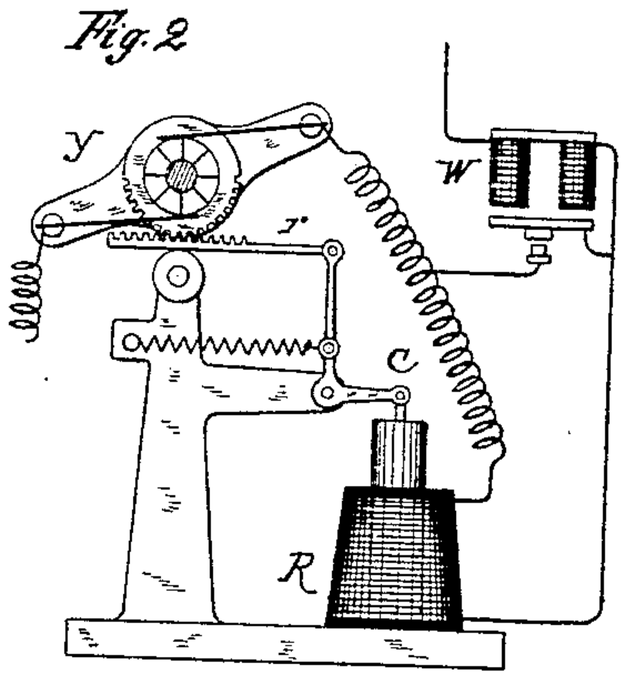


Fig. 4

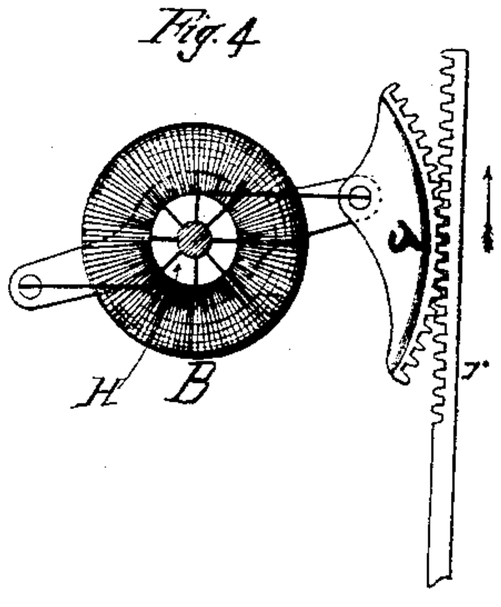
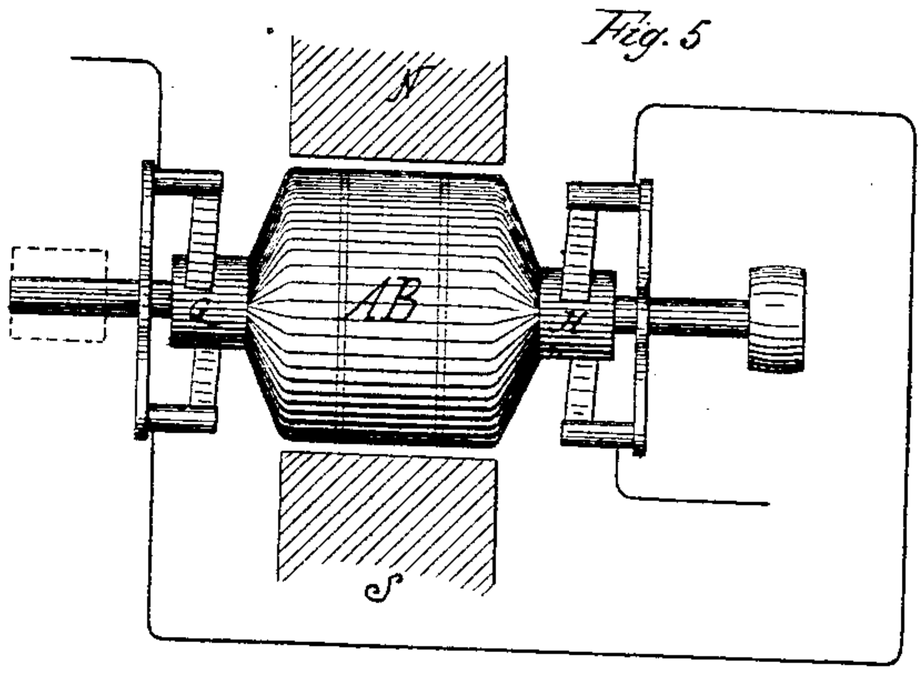


Fig. 5



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(No Model.)

2 Sheets—Sheet 2.

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COMBINATION OF ELECTRIC GENERATORS.

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Fig. 6

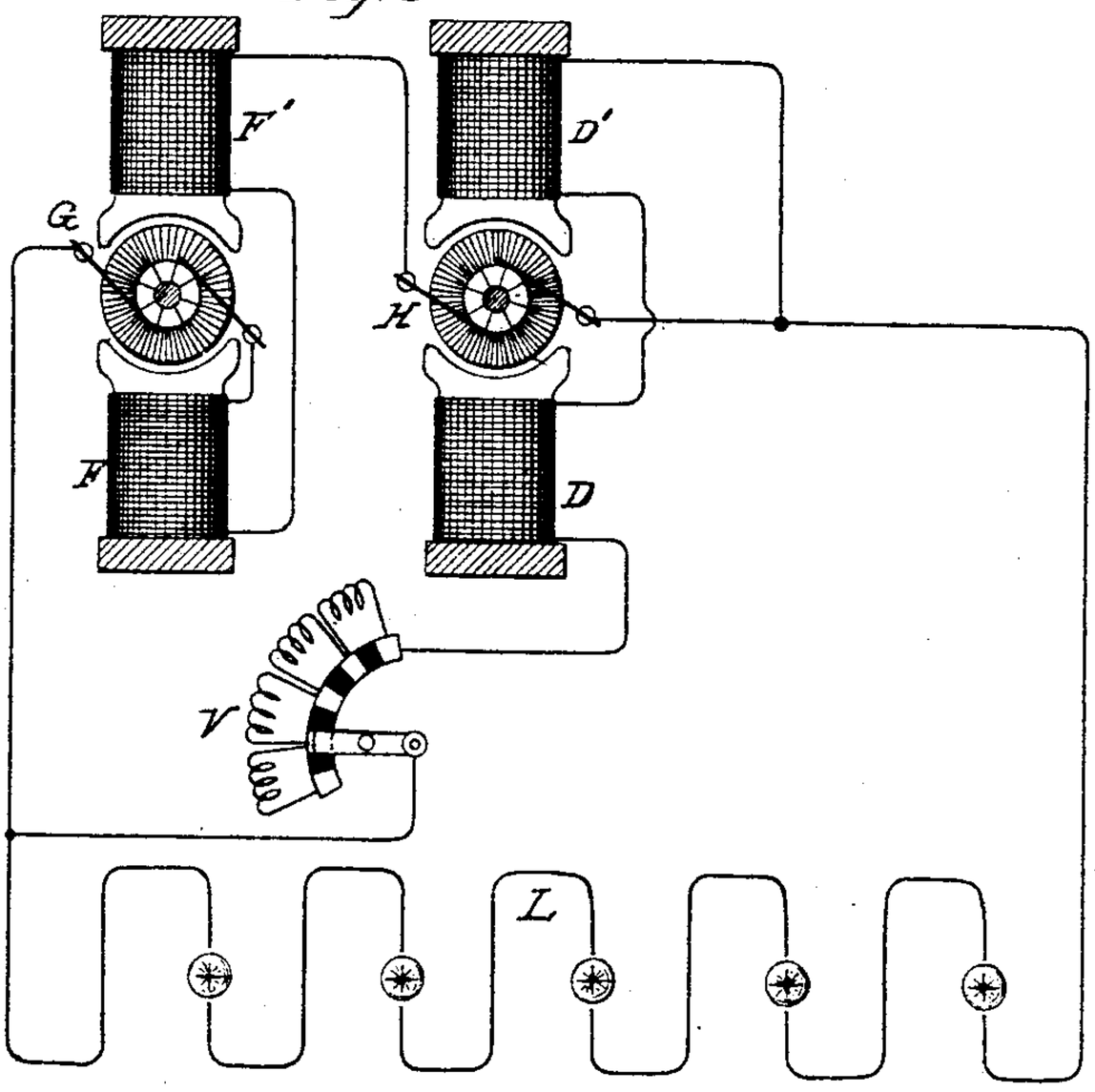


Fig. 7

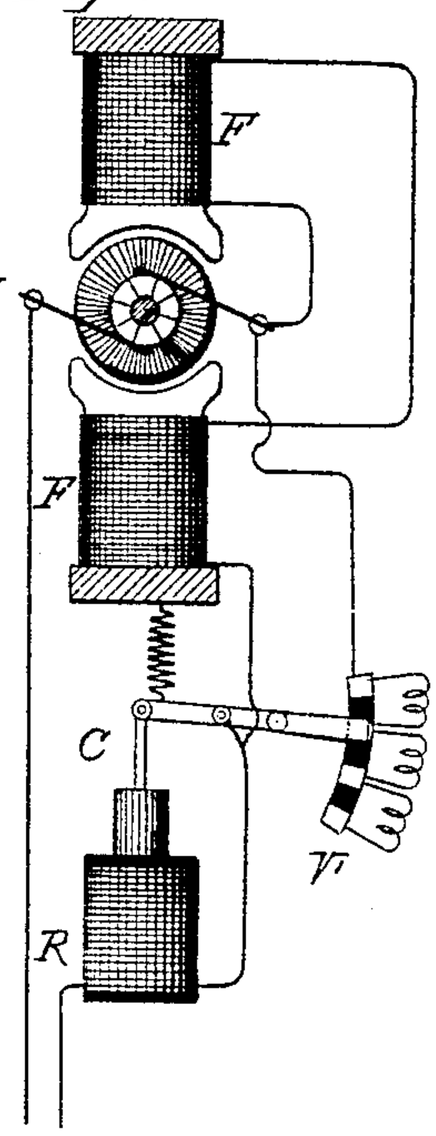
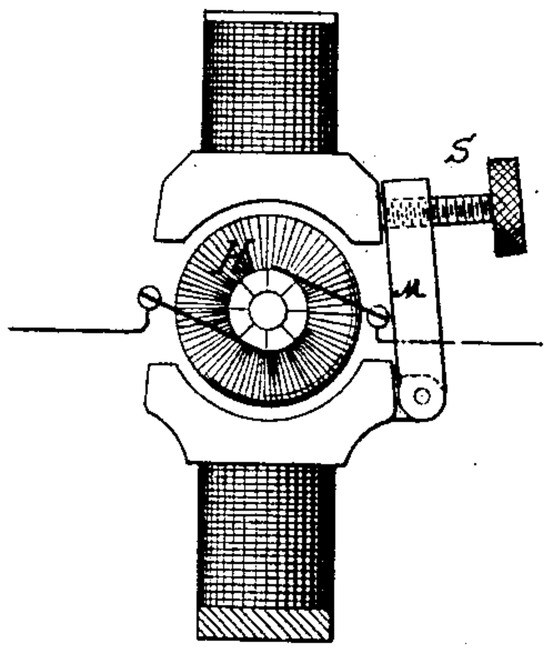


Fig. 8



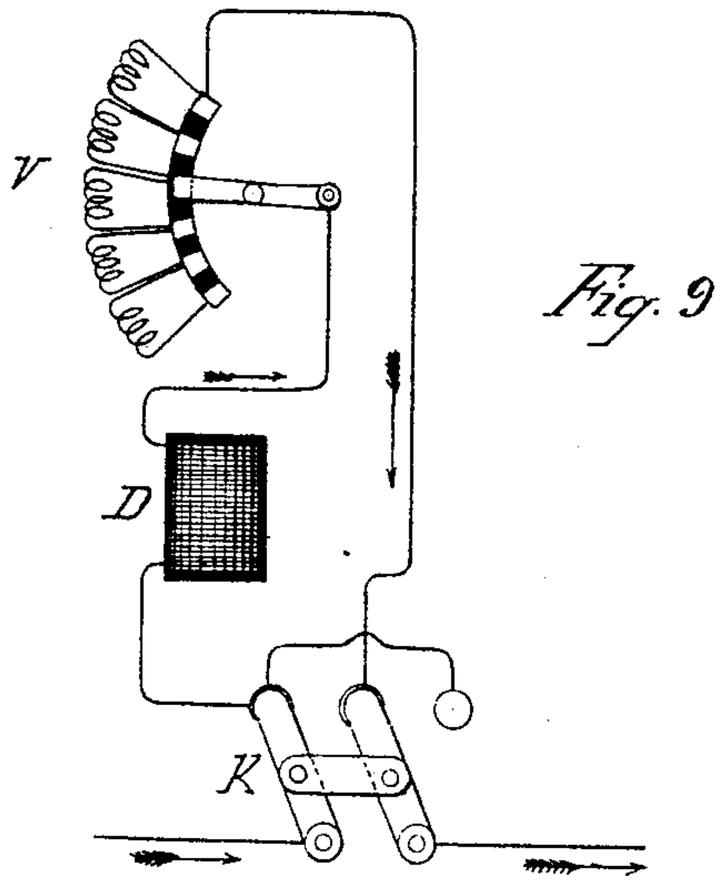


Fig. 9

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UNITED STATES PATENT OFFICE.

EDWIN WILBUR RICE, JR., OF LYNN, MASSACHUSETTS.

COMBINATION OF ELECTRIC GENERATORS.

SPECIFICATION forming part of Letters Patent No. 396,602, dated January 22, 1889.

Application filed October 28, 1887. Serial No. 253,666. (No model.)

To all whom it may concern:

Be it known that I, EDWIN WILBUR RICE, Jr., a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Combination of Dynamo-Generators, of which the following is a specification.

My invention relates to means for furnishing and regulating the supply of electricity to an electric circuit; and it consists, essentially, in supplying the circuit from two or more generating sources, one of which is constantly at work supplying a definite or fixed amount of electricity, while the other is regulated by any suitable means for the purpose of adapting the current-supply to changes in the work on the circuit.

The generating source may be two or more dynamo-electric machines, or two or more armatures in one machine, or two or more sets of armature-wires on the same armature.

My invention is designed, chiefly, for application to electric circuits containing a number of arc lights or other working resistances in series, in which case an adjustment of the current-supply is required in order that a constant current may be maintained with a varying number of lights or other resistances in circuit. When my invention is applied to such a circuit, the two or more generating devices or sources are connected in series on the circuit and at least one of them is made capable of regulation to compensate for changes in the load on the circuit.

The accompanying drawings illustrate various arrangements of apparatus that may be used for carrying out my invention.

Figure 1 shows two machines coupled in series, one of which has a definite generating capacity and whose commutator-brushes are therefore fixed in position, and the other of which has its capacity made variable by automatic or other means in accordance with the external work or with the number of lights in series. Fig. 2 shows in diagram one of the modes of regulating that portion of the apparatus or that part of the generating device which is made variable. Other means of varying its electro-motive force, when used as a source of arc lighting, may be employed. Fig. 3 shows another form of my invention. Fig. 4 is an end view of one of the armatures in the same, showing means for rotating the regulating device. Fig. 5 shows another way in which my invention may be practiced. Fig. 6 shows the combination of a machine of constant or invariable current at any given speed with a machine which is automatically variable by another construction. Fig. 7 shows a substitute machine. Fig. 8 shows still another mode of regulation as applied to the variable element of my invention. Fig. 9 illustrates a modified arrangement of devices that may be employed for changing one of the generators into a counter electro-motive-force generator.

The advantage of my invention will be recognized in the fact that one comparatively small generating and regulating machine may be made to control all the variations occurring on a circuit the total capacity of which is comparatively great.

My invention includes also the use of the variable generating source itself as a counter electro-motive-force generator — that is, it may be a generator of electricity when the circuit is fully loaded, it may be reduced to be inert as a generator when the circuit has a portion of its load cut off, and it may be inverted in its functions and become a motor or counter electro-motive-force generator when the circuit is still less loaded.

In Fig. 1, L L represents a series of lights or other resistances capable of being cut out by a shunting-switch, as is usual in arc lighting. G represents a dynamo or generator of electricity of a definite power, as determined by the strength of its field, the revolutions of its armature, the construction of its armature, and the position of its brushes, while H represents a second generator of electricity coupled in series with the first machine G, the second generator, H, however, being made to vary in electro-motive force in any well-known way—such as by moving its commutator-brushes by hand or automatically, in accordance with the increase or decrease of the current strength in the circuit, by varying the strength of its field, by varying its speed, or by other means. I have shown a magnet, R, or coil acting on its armature or core C as a type of a regulating appliance, whereby, in response to variations in the main current traversing the lights L L and the machines, an adjustment

or renewed set of the brushes of the machine H is made, so as to raise or lower the electro-motive force in accordance with the decrease or increase of the current in the circuit due to variations of resistance or variations of load, such as a varying number of lights. It is not necessary to describe in exact detail how the regulating actions are carried out, as they may be substantially the same as appear in prior patents already issued in the United States. All that is essential in the combination shown in Fig. 1 is that the electro-motive force of the machine H should be varied in certain cases—that is, the electro-motive force may be made to assist the main-circuit current flowing over its resistance, and then, by a movement of the brushes or otherwise to be made to diminish, H becomes nil, or of no value as a generator. If desired, the machine H may, by a further movement of the regulating appliances, be made to oppose a counter electro-motive-force tendency, or, in other words, be run as a motor in opposition to the constant tendency of the generator G to develop a current in the circuit. It is assumed, of course, that both generators are driven by suitable power, which may be taken from the same source or from different sources of power. It is also assumed, as is plainly evident, that the machine G may be supplanted by two or more machines, and also that the machine H may be supplanted by two or more variable machines, as no invention would exist in making such combinations. It is also assumed that the field of force of each generator be set originally at some definite amount, either by winding or by suitable devices for that purpose.

Let the machine G have a capacity for sustaining twenty lights in series, and let the machine H have as its maximum capacity twenty lights in series. Then the two machines in series will have a combined capacity of forty lights in series. If, however, the machine H is made sufficiently variable, it will be able to compensate for any change in the number of lights on the combined circuit—that is, any or all of the forty lights may be shunted—and this without substituting resistances in place of them. It is only necessary in this case to construct the machine in accordance with principles well known in the art, so that its brushes may be movable to cut down the electro-motive force to nothing, and still further movable until it opposes an active counter electro-motive force against that of the generator G. To do this requires a greater range of motion than is customary where ordinary brush regulation is used, either manual or automatic—that is, the brushes must be capable of swinging through a greater range.

I have shown in Fig. 2 a magnet, R, and core C as acting to move a rack, *r*, which is geared to the commutator-brush carrier or yoke Y, having a range of movement which will throw the brushes around through an angle, say, of one hundred and twenty degrees. The magnet R while in the main circuit may be under the control of a controlling-magnet or sensitive relay-governor responsive to changes in the main-line current, in accordance with the principles of patent to Thomson & Houston, No. 238,315; but I wish it distinctly understood that I do not limit myself to regulation by the brushes alone, as will further appear.

In Fig. 3 I have shown an equivalent arrangement in which a single-dynamo generator is constructed with two armatures either upon the same shaft, by preference, or upon distinct shafts mounted in separate bearings. These armatures on the same shaft are indicated at A B. The brushes on the commutator G are supposably fixed, and the armature A has therefore a definite capacity when revolved between the field-poles N S. The brushes of the commutator of the armature B are made revoluble around the axis of the commutator, so as to vary the electro-motive force given to the circuit from the armature B, and this armature is mechanically revoluble with the armature A in the field N S. Although I have shown the field-poles N S as two massive poles embracing both armatures, it will readily be understood that the armature A may have its field-poles separate from those which act upon the armature B. In the case of the two armatures and one set of field-poles the two machines become converted into one.

In Fig. 4 *r* indicates a rack-rod engaging with an arc-gearing, J, whereby upon a movement of the rack-rod *r* the brushes of the commutator H of the armature B may be thrown around. This is merely used as a typical device for the purpose. Any other suitable device may be substituted.

In Fig. 5 I have shown the armatures A B combined in one armature, A B—that is, the armature A B, Fig. 5, is wound with two sets of coils distinct from each other—and the commutators G and H are arranged as in Fig. 4—that is, the brushes of the commutator G are fixed, while those of the commutator H are movable—both commutators being put into the circuit in any well-known way, either directly, as shown, or through other parts of the circuit. The pole-pieces N S embrace the armature in the usual manner, and are energized either through the circuit itself or from a separate source of current.

The preceding figures show the regulation of the variable element of my invention by a movement of the commutator or its brushes. It is evident that the same effects may be produced by a movement of the commutator itself on the shaft, by a movement of the armature with respect to its commutator, by a movement of the field-magnets around the armature, leaving the brushes fixed, by moving the field-magnets bodily toward and from the armature, or the armature in and out of the field; but I have shown what I consider the most desirable means for the purpose,

However, in some cases it might be found preferable to modify my invention, as shown in Fig. 6. Here the generator G, as in Fig. 1, is a distinct source of current, whose field-magnets F F′ may be placed in series with the work. The generator H, or variable element, has its field-magnet coils D D′ in shunt with the work or lights L, preferably through a variable resistance, though not necessarily. The variable resistance is indicated at V. Now as lights are cut out from the circuit at L the energizing power of the derived-circuit coils D D′ diminishes in proportion, and I am thus enabled, by arranging the apparatus and properly proportioning the parts of the machine H and the resistance of the field-coils D D′, or the circuit in which they are placed—as by the use of a variable resistance, V—to obtain a fairly good regulation of the electro-motive force fed to the circuit in proportion to the load. Where a complete regulation is required, the generator H should be considerably larger in size than the generator G, unless devices are used to reverse the current in the field-coils D D′ upon a predetermined fall of resistance in the circuit L, as will be indicated.

In Fig. 7 a substitute machine for H is shown; but it requires either automatic regulation to be applied to its field-coils F F′ or a manual adjustment to be made. The field-coils F F′ are put in the main circuit or direct circuit and provided with a variable shunt, V, which is automatically responsive to variations in the main circuit by any suitable device—such as a coil, R—in such circuit, and the core C, moved thereby, or which is adjusted by hand in any well-known way.

Another mode of regulating the strength of the field of such a machine as that in Fig. 7 is to use a magnetic shunt, M, across the field-poles or pole-pieces, and vary the position of the magnetic shunt, as by a screw, S, Fig. 8.

If it is desired to convert the machines, Figs. 6 and 7, into motors or into counter electro-motive-force generators, the direction of the current flowing in their field-coils may be reversed at some stage of the operation, or the position of their brushes may be suddenly reversed. It would be preferable, however, to reverse the current in their field-coils after passing a certain point in the load on the main-line circuit. I have shown in Fig. 9 the variable resistance V of Fig. 6, and the field-coils, Fig. 6, combined with an ordinary reversing-switch, K, the position of which when changed from left to right causes the current to circulate through the coils D and rheostat V in the reverse direction to that taken with the switch placed as shown. It will be seen, however, that my preference for utilizing a movement of the brushes for regulation is found not only in the fact that a single progressive movement of the brushes in one direction need only be made to bring the electro-motive force of the machine H, Fig. 1, of the armature B, Fig. 3, or of the armature A B, Fig. 5, which is connected to the commutator H, to a neutral position, so far as the generation of electro-motive force and its delivery to the main circuit is concerned, but that this movement of the brushes can also be made to transcend this position and actually cause the armature above mentioned to become an opposing source of electro-motive force, whereby the always active energy of the fixed element G may find an opposition sufficient to prevent it from developing undue current in the main circuit or lighting-circuit L L, Fig. 1, even though very few lights remain unshunted.

What I claim as my invention is—

1. The herein-described method of furnishing a regulated current from a number of dynamo-generators, consisting in keeping one or more of said generators constantly at work supplying a definite or fixed amount of electricity to the circuit and regulating the remaining generator to adapt the total current-supply to the demand of the circuit.

2. The herein-described method of furnishing a regulated current from two or more dynamo-generators coupled in series, consisting in keeping one or more of said generators constantly at work supplying a definite or fixed amount of electricity, and on a decrease of the demand upon the generators to a determinate extent converting one or more of the generators into a counter electro-motive-force generator, as and for the purpose described.

3. The herein-described method of regulating the current upon a circuit, consisting in supplying the bulk of the current from a generator or generators of suitable capacity doing continually a predetermined or constant amount of work, and controlling the variations of current by regulating a comparatively small regulable generator in series with the main generator or generators and of a capacity for regulation determined by the normal variations of load on the circuit.

4. The herein-described method of furnishing a regulated current to a circuit supplied from dynamo-generating sources in series, consisting in running one or more of said sources with its commutator in a fixed or invariable position, and adjusting the commutator of another generator or generators to vary the electro-motive-force of the same.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 22d day of October, A. D. 1887.

E. WILBUR RICE, JR.

Witnesses:
ELIHU THOMSON,
J. W. GIBBONEY.