No. 743,459. PATENTED NOV. 10, 1903.

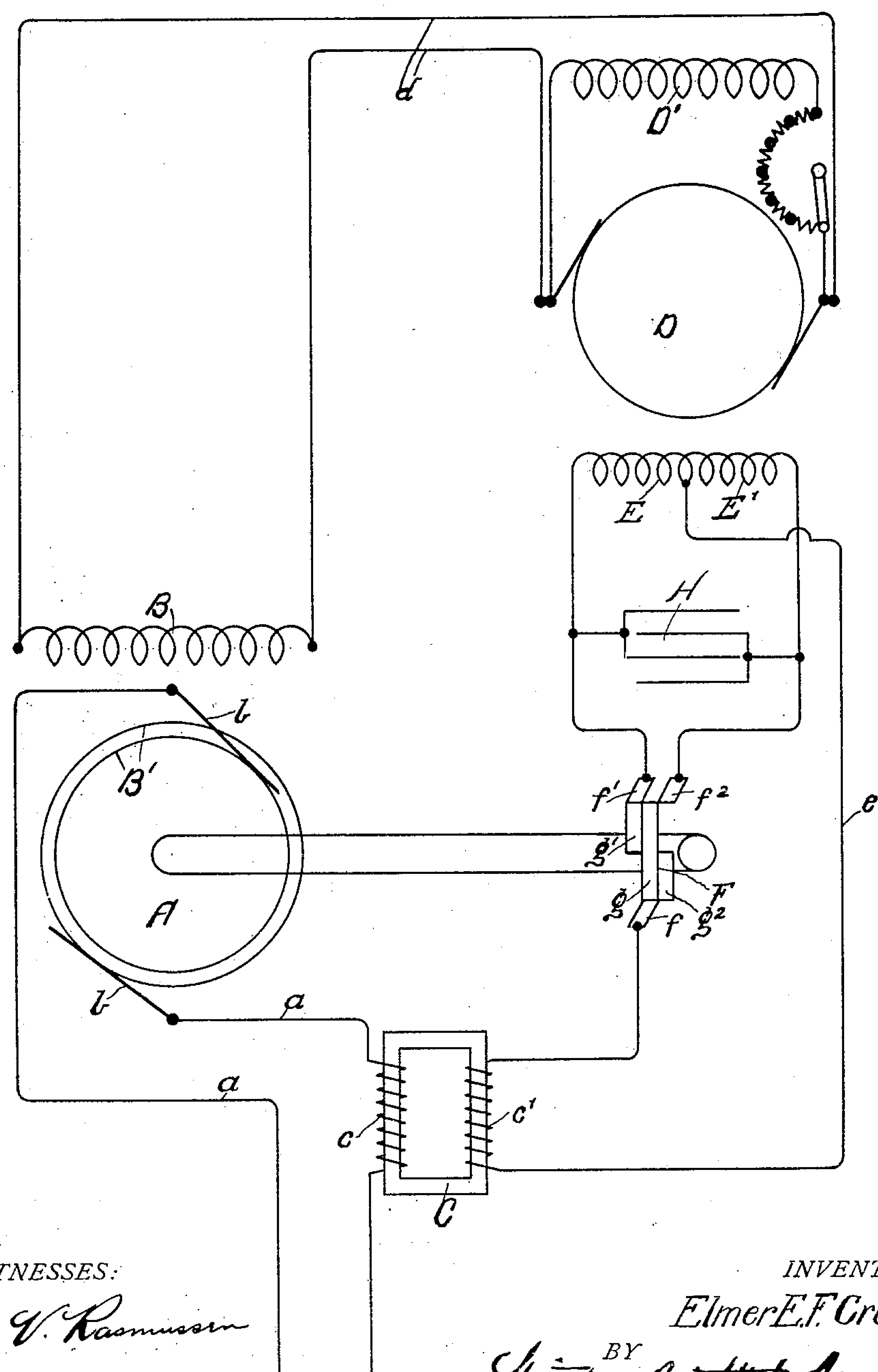
E. E. F. CREIGHTON.

COMPENSATING SYSTEM.

APPLICATION FILED JAN. 31, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

Geo. V. Rasmussen

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INVENTOR.

Elmer E. F. Creighton.

BY Mitchell Bartlett & Brownell

his ATTORNEYS

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NO MODEL. 2 SHEETS—SHEET 2.

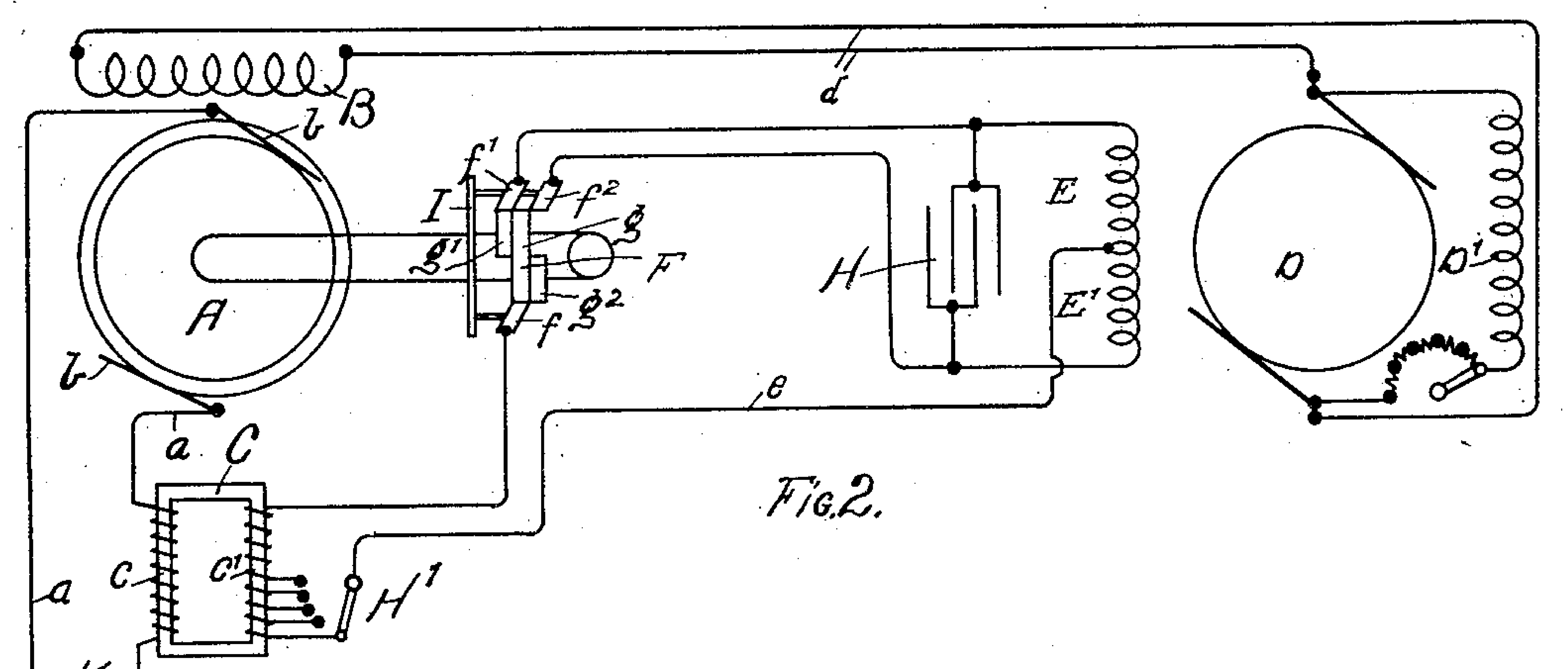

Fig. 2.

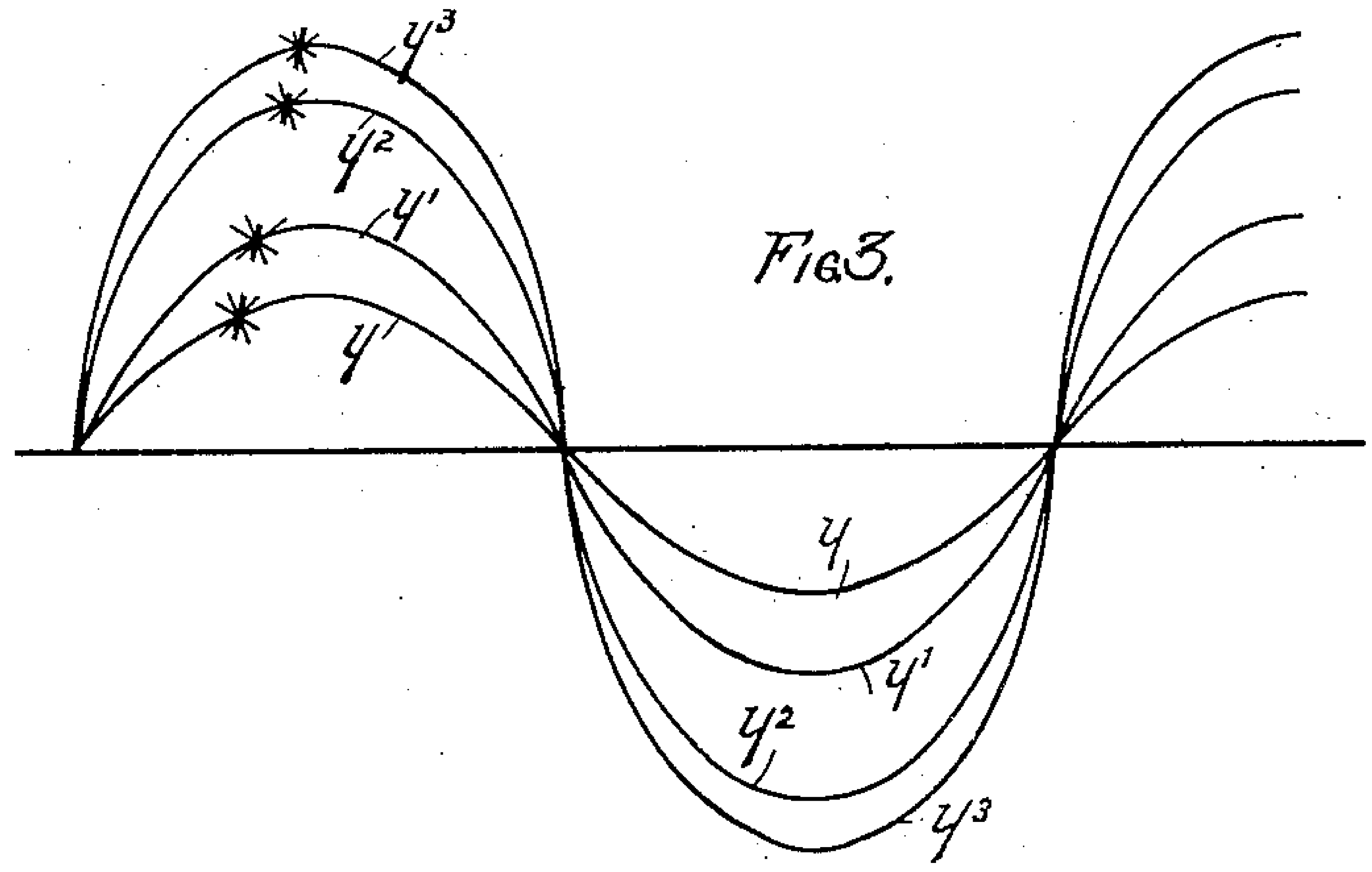

Fig. 3.

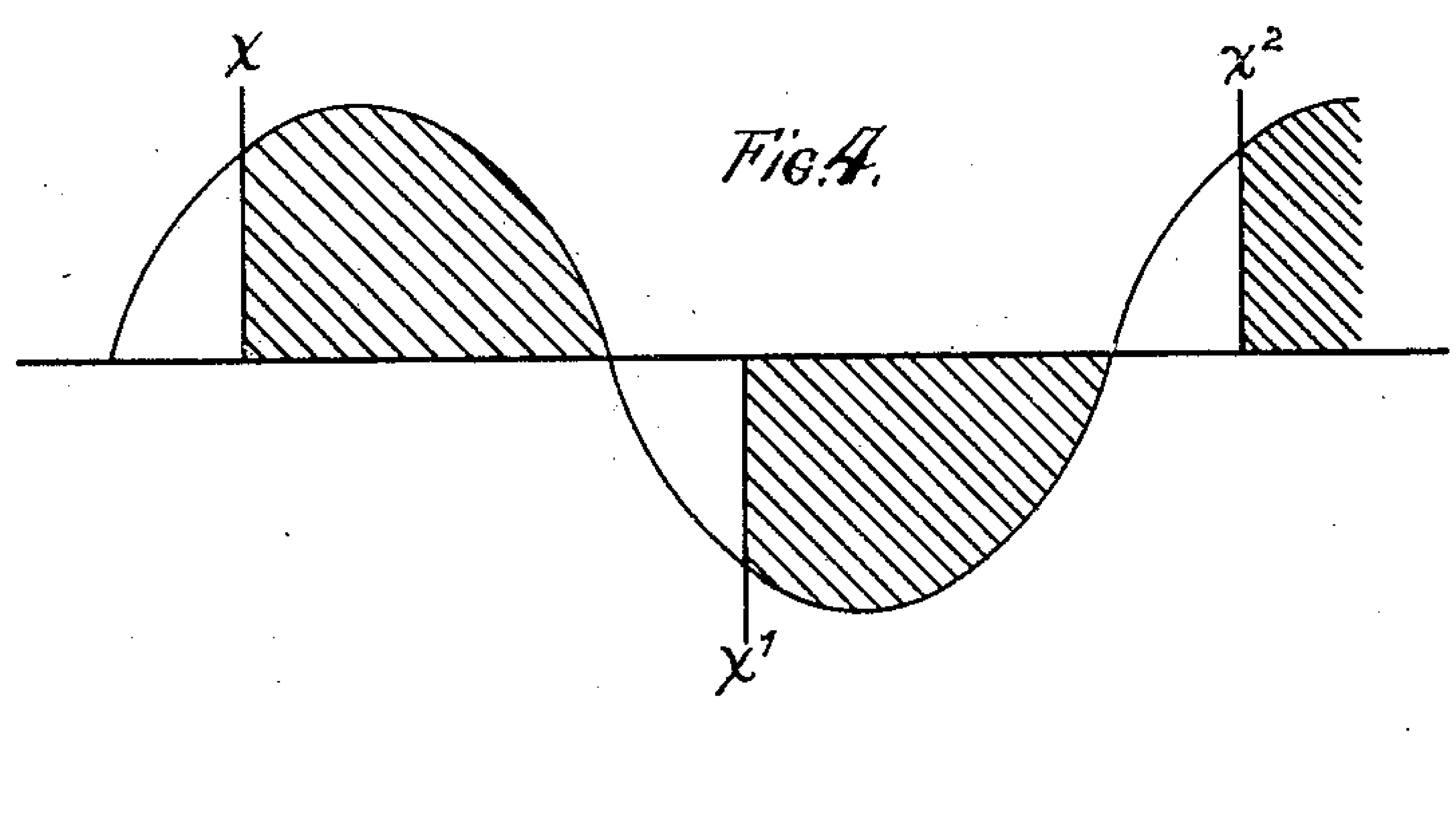

Fig. 4.

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No. 743,459. Patented November 10, 1903.

UNITED STATES PATENT OFFICE.

ELMER E. F. CREIGHTON, OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO STANLEY ELECTRIC MANUFACTURING COMPANY, OF PITTSFIELD, MASSACHUSETTS, A CORPORATION OF NEW JERSEY.

COMPENSATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 743,459, dated November 10, 1903.

Application filed January 31, 1903. Serial No. 141,323. (No specimens.)

To all whom it may concern:

Be it known that I, ELMER E. F. CREIGHTON, a citizen of the United States, and a resident of Pittsfield, Massachusetts, have invented certain new and useful Improvements in Compensating Systems, of which the following is a specification.

My invention relates to a method of compensating for the lag in alternating-current systems by increasing the voltage of the generator more and more as the lag increases, and also to compensate for the drop in voltage that would otherwise occur as the current increases in the circuit.

My invention in part relates to the system shown and described in my application filed December 20, 1902, Serial No. 135,983, which application claims certain apparatus and combinations of apparatus for this purpose, while it is my intention in the present application to claim the method for compensating which I have provided, with the use of which method the apparatus of the said former application may be used.

In part, also, my invention consists in a certain novel method for adjusting the elements of such a system of compensating, so that the lag due to the presence of an inductive load, as well as the drop caused by the presence of non-inductive load, will both be accurately compensated for. In these compensating systems it has been proposed to provide a local circuit in which a current is produced bearing a substantially constant volume relation to the current in the main circuit produced by the generator. The current in this local circuit is an alternating current, and it has been proposed or suggested to so manipulate this alternating current that it will produce magnetism which affects the voltage of the main circuit. By commutating or dividing each cycle of the current in the local circuit in such a way that the magnet-winding will receive a nearly-equal volume of current in each direction when no lag is on the line, while the presence of a lag will automatically provide an excess of current in one direction over that of the other, these two objects are at least to some extent effected.

My present method instead of commutating the current or else using only one-half of each cycle, as has heretofore been done, divides each cycle into two parts, and thus uses each of these two parts to produce magnetism in a relatively opposite direction. In other words, I pass the whole of the cycle to the magnet-winding which is to affect the voltage of the main circuit, and I do not commutate the current of that cycle; but I pass the current of one half the cycle in one direction through one section of a divided magnet-winding and the current in the other half of the cycle in the other direction through another section of said magnet-winding, thus having a commutation of the magnetism rather than a commutation of the electric current.

Other features of my novel method of compensation and their accompanying advantages will appear in the description hereinafter.

Another feature of my invention consists in a method of adjusting the apparatus of my compensating system so that the compensation will be accurate both for all values of lag in the circuit and for voltage drop due to ohmic resistance. So far as I know no method has heretofore been suggested that effects this result, which involves the careful adjustment of the relative volume of the current produced in the local circuit and an exact adjustment of the brushes of the switch or commutator used in the local circuit in order that the volume of current and the position of the brushes may bear such a relation to each other that both factors of the problem are properly provided for.

Referring to the drawings, Figure 1 illustrates diagrammatically my method of compensating. Fig. 2 shows the same system with added apparatus to aid in adjusting the system. Figs. 3 and 4 are diagrams illustrating the theories upon which the principles of my system are based.

Referring to Fig. 1, A is an alternating-current generator generating the current for the main circuit represented by the conductors a. b b are brushes engaging the rings B', which rings are connected with the field-winding B of the generator A.

C represents a transformer, the primary c of which is in series with one of the conductors a, and c' is the secondary winding of such transformer. This secondary winding c' forms the source of power for the local compensating circuit, and the current produced in such secondary should bear a substantially constant volume relation to that flowing in the primary, and therefore to that of the main circuit.

D represents the armature of an exciter which delivers the exciting-current through conductors d to the field-windings of generator A. D' is a field-coil for such generator D, and the coils E E' form a second winding for the said exciter. The center of this coil is connected by conductor e to one terminal of the secondary c'. This coil E E' is the coil in the local circuit intended to affect the potential of the main circuit, in the present case indirectly through the exciter D.

F is my rotating switch, which through brush f and ring g is constantly in connection with the opposite terminal of the secondary c'.

g' and g^2 are segments adapted to make contact, respectively, with brushes f' and f^2, which, as shown, are connected to relatively opposite ends of coils E and E'.

The switch F is connected to the generator A in such a way that its segments g' and g^2 rotate at the polar speed of the generator. Thus assuming the generator to be a two-pole generator and the switch, as indicated in the drawings, to be connected directly to the shaft of the generator, the segments g' and g^2 are each one hundred and eighty degrees, so that one complete revolution of the switch is made for each revolution of the machine. Of course with many-pole machines it may be preferable to gear the switch to the moving part of the generator, so that it may rotate once for each change of phase of the generator, or each segment g' and g^2 of the switch may be divided into as many segments as will correspond to one-half the number of poles of the machine, the essential thing being that the segments g' and g^2 are displaced with reference to each other, so that the current coming in at the brush f will during half of each cycle pass out through brush f' and during half of each cycle through brush f^2.

It will be seen from the foregoing description that the current generated in the secondary c' passes to the brush f and first passes through contact g', brush f', and coil E to the secondary and then is shifted so as to pass through segment g^2, brush f^2, and coil E' to the secondary. It will also be seen that when the current is thus shifted to the other coil it produces an opposite magnetic effect relative to the direction of the current in lead e, since for any given direction of the current in lead e it will pass in relatively opposite directions through coils E and E'. By this means I am enabled to divide each cycle into two parts, the excess of current of each of which in one direction over that of another direction can be utilized to energize with the same resultant polarity the magnet of exciter D, even though the excess passing through coil E is in one direction and the excess in coil E' is in another direction relatively to lead e. Thus, referring to Fig. 4, assuming that the brushes of the switch are at such a position that the current changes from the segment g' to the segment g^2 at the point x and changes back again to the segment g' at point x' of the current-wave shown, then that part of the cycle between x and x' will pass through coil E', and the effectiveness of this for magnetizing is represented by the excess of the shaded portion over that of the unshaded portion. Obviously, also, the other half of the cycle—that between x' and x^2—is useful in precisely the same way, since this half of the cycle passes through coil E in a direction relatively opposite as regards lead e, and the excess of the shaded portion over the unshaded portion is also in an opposite direction as regards lead e; but the excesses are in relatively the same direction as regards coils E and E', thus producing the same resultant magnetizing effect. In other words, the excesses of current in each half-cycle are in opposite directions as regards lead e, but are in the same relative directions as regards coils E and E'. It will be further noticed that the two parts of each alternation while in the same direction as regards lead e are in relatively opposite directions as regards E and E'.

It will be seen that by this method, which may broadly be considered as magnetism commutation, I am enabled to use the whole of the current in the local circuit, and at the same time I avoid all the troubles of an electric commutation, which troubles I need not enter into, as they are well understood by those familiar with the art.

H shows a condenser placed in shunt to brushes f' and f^2 and also in shunt to coils E E'. This condenser reduces the sparks on switch f and very much increases the efficiency of the system, as it enables it to be operated more uniformly, since the character of the spark is no longer affected by local drafts and similar conditions. Moreover, the condenser eliminates the kick of the coils E E' without taking any energy therefrom, since it delivers back whatever energy it takes to the coils.

Referring now to Figs. 2 and 3, I show, in addition to the parts shown in Fig. 1, a switch H' for regulating the number of secondary turns. I also illustrate diagrammatically a brush-shifter I for the brushes f' and f^2, in order that the position of the brushes relative to the segments g' and g^2, and therefore the position of the points x' and x^2 of Fig. 4, may be adjusted. At J is a voltmeter to measure the voltage of the main circuit. K is an alternating-current motor or other electric device, which is in the nature of an inductive load, while L L represent banks of lamps representing a non-inductive load. k and l represent switches for introducing the motor or the banks of lamps in circuit as desired.

My method of adjusting the circuit may be understood from Fig. 3, in which is shown four current-waves representing different volumes of current for the local circuit according to the position of the switch H'. The stars on these curves represent positions of the brushes f' and f^2 in relation to the segments in which they bear.

If the brushes be arranged to shift the current from coil E to E', and vice versa, at the points of maximum voltage in each direction, the maximum amount of compensation for lag relatively to the volume of current in the local circuit will be provided; but, on the other hand, there will not be an efficient compensation for increased volume of current, as when the current is increased due to the provision of a non-inductive load. Indeed, with the brushes so placed there will be no compensation whatever for such an increase of current when there is no lag on the line. To obtain efficient compensation, therefore, for increase of current due to non-inductive loads the brushes must be set at points in advance of the points of maximum voltage; but this decreases the proportion of the wave effective for lag compensation, so that the volume of current must be greater. From these considerations it follows that the volume of current in the local circuit and the point of division of each cycle must bear such a relation that both of the disturbing factors—lag and current increase—will be perfectly compensated for. In Fig. 2 I show how this may be done. Let us suppose that both of the switches k and l are open and that the switch H' is closed to give a current curve y. The switch l may now be closed, placing a non-inductive load L in the working circuit. By adjusting the brushes f' and f^2 at the position indicated by the star of curve y it is found that the pressure in meter J is exactly 110, as required. Switch l is now opened and switch k closed, placing an inductive load K upon the line. This produces such a lag that the star in curve y is, in relation to the current curve, moved to the left, so that there is a greater excess of current effective for compensation than before; but the volume of current indicated by curve y is shown to be too small by the fact that meter J shows, let us say, but one hundred volts. To adjust this, switch H' is shifted and wave y^3 is produced, and the voltage when load K is present is found to be correct at one hundred and ten volts; but when load L is substituted for load K it is found that one hundred and fifteen volts are present, so that there is overcompensation for non-inductive loads. If, however, brushes f' and f^2 be shifted to the point indicated by the star on curve y^3, the compensation is found to be that desired for non-inductive loads; but it is now probably too high for lag compensation. It is therefore necessary to reduce the current volume to perhaps y'. Finally, a volume and position of the brushes is found, represented, perhaps, by wave y^2, which will compensate with substantial exactness for each condition.

From the foregoing explanation it will be seen that the two disturbing factors are provided for by adjusting the volume of current and point of dividing each cycle so that the excess of current effective for compensation is, when no lag is present, sufficient to compensate for non-inductive loads, while the increase of such excess caused by the presence of a lag is sufficient to compensate for said lag.

It is clear that the method I have described for enabling accurate compensation for all conditions is not only applicable for use with systems embodying the other features of my invention, but it is also applicable to other known systems, such as those which have auxiliary generators instead of a transformer, commutators or switches that utilize only half of each cycle for compensation, &c. In this respect, therefore, I am not limited in the employment of my invention, nor do I wish to be limited in the employment of my invention to any particular apparatus, since my present invention resides in the novel method of compensating, as set out in the appended claims. Moreover, in some respects my invention involves a new method for utilizing an alternating current for producing magnetism which obviously has advantages for systems other than compensating systems, and therefore I do not limit myself to its use in relation to compensating systems.

Having thus described my invention, what I claim, and desire to protect by Letters Patent, is—

1. The method of compensation for an alternating-current circuit which consists in developing current in a local circuit bearing a substantially constant volume relation to that of the main circuit, dividing each alternation of each cycle of the local circuit into two parts and directing the two parts in relatively opposite directions through magnet-windings adapted to affect the voltage of the main circuit.

2. The method of compensation for an alternating-current circuit, which consists in developing current in a local circuit bearing a substantially constant volume relation to that of the main circuit, dividing each alternation of each cycle of the current in the local circuit into two parts without altering the character of the alternations of said current, and directing the current in the two parts in

relatively opposite directions through magnet-windings adapted to affect the voltage in the main circuit.

3. The method of compensation for an alternating-current circuit which consists in developing current in a local circuit bearing a substantially constant volume relation to that of the main circuit, dividing each cycle of the local circuit into two parts and directing the two parts through different magnet-windings adapted to affect the voltage of the main circuit.

4. The method of compensation for an alternating-current circuit which consists in developing current in a local circuit bearing a substantially constant volume relation to that of the main circuit, dividing each cycle of the local circuit into two parts and directing the two parts through different magnet-windings of a magnet adapted to affect the voltage of the main circuit.

5. The method of compensation for an alternating-current circuit which consists in developing current in a local circuit bearing a substantially constant volume relation to that of the main circuit, dividing each cycle of the local circuit into two parts without altering the character of the alternations of said current, and directing the two parts through different magnet-windings of a magnet adapted to affect the voltage of the main circuit.

6. The method of compensation for an alternating-current circuit which consists in causing the current in the main circuit to induce a local current, dividing each alternation of each cycle of the local current into two parts without altering the character of the alternations of said current and directing the two parts in relatively opposite directions through different magnet-windings of a magnet adapted to affect the voltage of the main circuit.

7. The method of compensation for an alternating-current circuit which consists in causing the current in the main circuit to induce a local current dividing each alternation of each cycle of the local current into two parts without altering the character of the alternations of said current and directing the two parts in relatively opposite directions through different magnet-windings of the field-magnet of the exciter for the alternating-current generator.

8. The method of regulating a compensating circuit which consists in adjusting the relative volume of compensating current and the point of commutation or division of the cycles thereof in such relation that accurate compensation is obtained both for currents due to inductive loads and to currents due to non-inductive loads.

9. The method of regulating a compensating circuit consisting in adjusting both the relative volume of current in said circuit and the point of commutation or division of the cycles thereof in such relation that the excess of the current in one direction over that in the other direction will accurately compensate for increase of current volume, while the increase of said excess due to a lag in the current will accurately compensate for said lag.

10. The method of regulating a compensating circuit which consists in varying the relation between the current therein and the current of the main circuit and varying the point at which the cycles of the compensating current is commutated or divided until such current relation and division-point adjust the compensating circuit to compensate with equal accuracy both for increase of current and lagging currents.

11. The method of regulating a compensating circuit which consists in varying the relation between the current therein and the current of the main circuit and varying the point at which the cycles of the compensating current are commutated or divided until such current relation and division-point adjust the compensating circuit so that a constant voltage is maintained in the main circuit whether inductive or non-inductive loads are connected therein.

Signed at Pittsfield, Massachusetts, this 26th day of January, 1903.

ELMER E. F. CREIGHTON.

Witnesses:

RICHARD EYRE,

MABEL GOUDCHAUX.