(No Model.) 3 Sheets—Sheet 1.

E. THOMSON.

ALTERNATING CURRENT DYNAMO ELECTRIC MACHINE.

No. 382,335. Patented May 8, 1888.

Fig. 1.

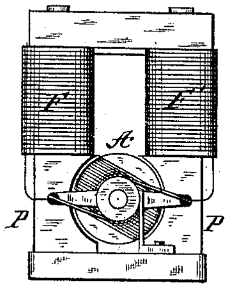


Fig. 2.

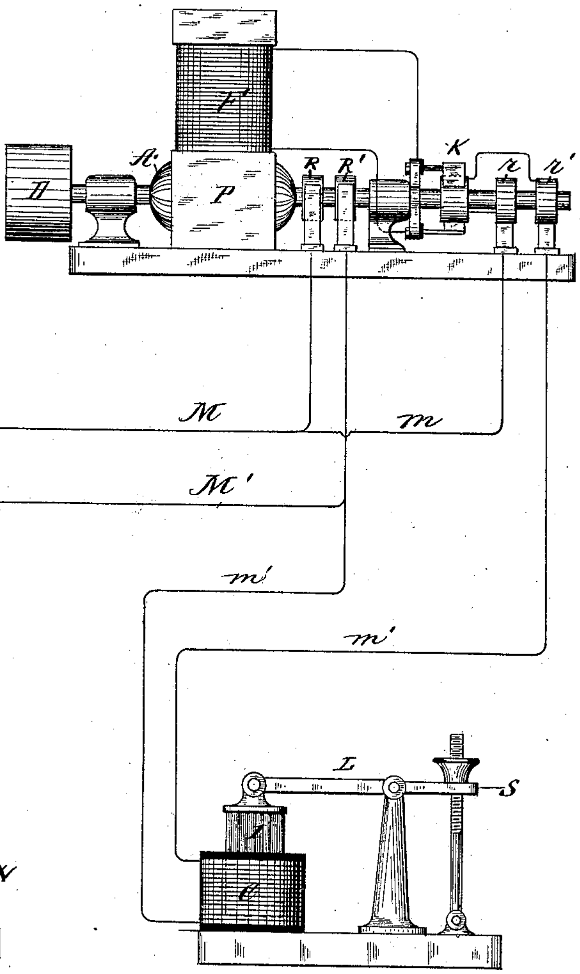
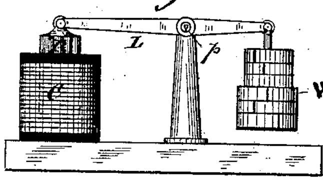


Fig. 3.



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(No Model.) 3 Sheets—Sheet 2.

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Fig. 4. Fig. 5.

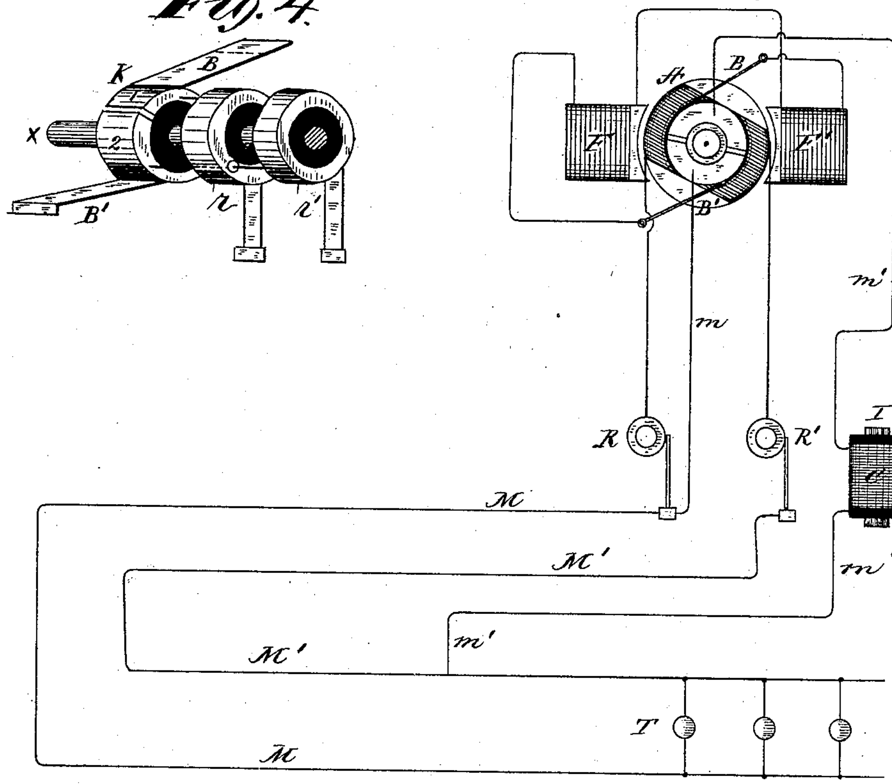

Fig. 6

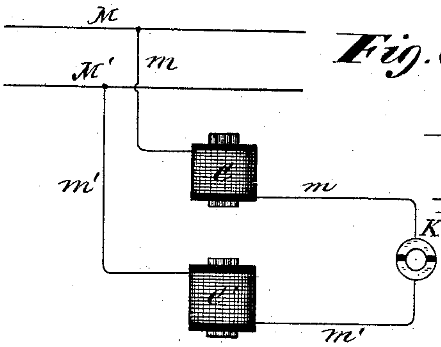

Fig. 7.

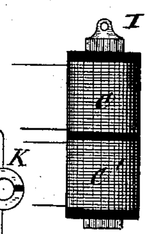

Fig. 8.

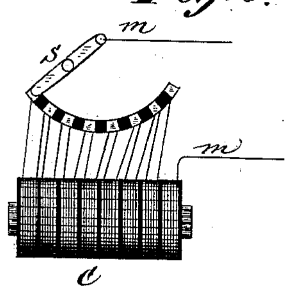

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Fig. 9.

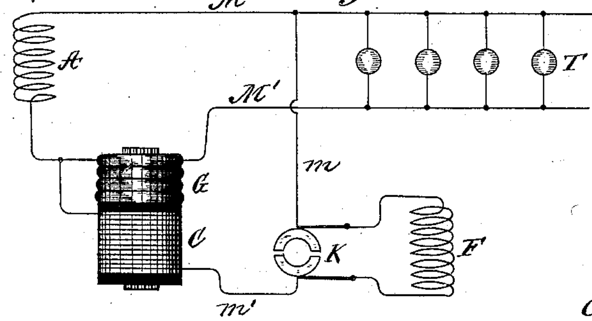


Fig. 10.

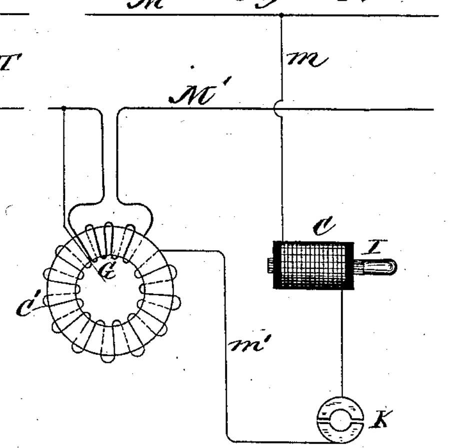


Fig. 11.

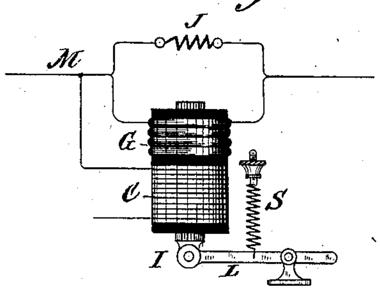


Fig. 12.

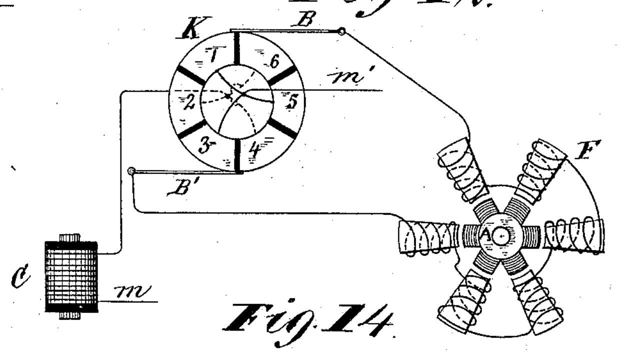


Fig. 13.

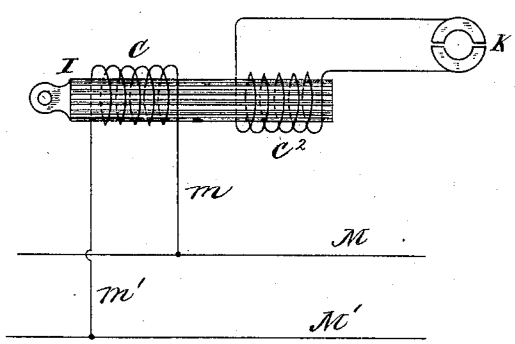
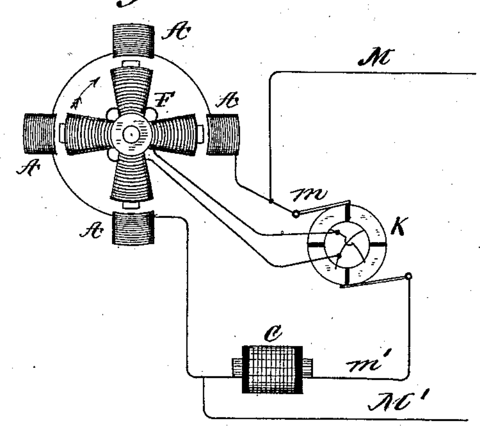


Fig. 14.



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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 382,335, dated May 8, 1888.

Application filed December 27, 1886. Serial No. 222,548. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, 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 Alternating-Current Dynamo, of which the following is a specification.

My invention relates to improvements in the connection and arrangement of alternating-current dynamos for supplying current to mains at a constant or nearly constant potential, maintained automatically or permitting such potential to be changed at will, for securing, when desired, an increase of potential when more load or more translating devices are used in multiple from its mains, (such compensation being made automatically and for the purpose of compensating for losses in the mains,) and for securing an excitation of the field-magnets of the machine in derived circuit to the alternating-current mains led from the machine to the translating devices, such as induction-coils or lamps in multiple.

The means whereby I accomplish the results mentioned are, briefly, the interposition between branch wires from the mains to the field-magnet coils of a reversing commutator or switch for causing the alternating impulses to become a continuous current through the field-coils, and the further interposition in one or both said branch wires of a self-inductive or reactive coil, exerting a counter-action or counter electro-motive force to that of the impulses from the mains through the branch wires. I prefer to make this counter-action a regulable one, either automatically or manually, as will appear.

By the interposition of the reactive coil, as stated, I obtain the ability to magnetize the field-magnets of the dynamo without a separate exciter, without passing the whole main current commuted to a continuous current through the field-coils, and without producing a short circuit of the main current when a branch is commuted, as would occur if no reactive coil were used. I also obtain the ability to regulate the field strength manually and automatically (one or both) by varying the reactive or counter force of the reactive coil, enabling me to produce variations in the electro-motive force of the machine, or to virtually compound the machine for constant potential, as will appear.

I have selected, in illustration of my invention, one of the simplest forms of alternating dynamo; but wish it understood that I do not confine myself to any special form, as my invention may be applied to multipolar-machines, &c., without change of principle.

It is also distinctly to be understood that the applicability of my devices as regulators will vary somewhat according to the type and proportioning of the different parts of the dynamo as to speed, relations of armature, and field-conductors, &c. As it is not my intention to confine my invention to any particular type, it is unnecessary here to enter into particulars of such proportioning, especially as it is subject to innumerable and wide variations.

In the accompanying drawings, Figure 1 is an end view of an alternating-current machine to which my invention may be applied. Fig. 2 is a side view of such machine, showing my invention used in connection therewith. Fig. 3 is a modified reactive coil. Fig. 4 is a detail of the field-magnet commutator. Fig. 5 is a diagrammatic view of the connections. Figs. 6, 7, and 8 show modifications in the disposition of the reactive coils. Fig. 9 shows the connections used when an automatic regulation according to load is desired; Fig. 10, the connections which may be used when automatic regulation according to load and manual regulation are used together. Fig. 11 shows a modified connection. Fig. 12 shows a detail of a modified apparatus. Fig. 13 shows another disposition of field-supply conductors. Fig. 14 illustrates the application of my invention to a dynamo-generator employed as a motor.

In Fig. 1 is illustrated a type of alternating-current machine to which my invention is applicable, there being a set of field magnets and poles, P P, of opposite polarity, between which an armature, A, wound in this case with a single coil of wire, is revolved. The field-coils F F′ are wound so that the electro-motive force developed in the coil on the armature A would if commuted through them far more than suffice to give the requisite magnetism to the field-magnets.

In Fig. 2 the connections used in my invention are shown with the devices for magnetizing the field F F'. The pulley D drives the armature-shaft, whose coil, at A, wound in any suitable way to give alternate impulses of current when revolved, has its terminals respectively carried to two conducting-rings, R R', upon which brushes attached to the main-circuit conductors M M' bear, as usual in such apparatus.

Translating devices T T—such as incandescent lamps—or any other devices—such as induction-coils—are fed by branches of the mains M M' from one to the other.

To magnetize the field of the machine the coils F F', Fig. 1, must be traversed by a continuous current in one direction, and this it is the province of my present invention to furnish from the mains M M', upon which alternating currents are used, and by branches from said mains at *m m'*. In such a machine, where but two reversals of current take place in a revolution, a commutator, K, of two half-circle segments is mounted to revolve with the shaft, and its brushes are attached to the terminals of the field-coils respectively, such brushes being diametrically placed. One segment of the commutator K is attached to a ring, *r*, and the other to a second ring, *r'*, carried on the shaft, and upon which rings brushes bear for conveying current to the segments of the commutator. The branch wire *m* is attached to the brush bearing on the ring *r*, and the branch *m'* to that bearing on the ring *r'*. The slots in the commutator K are inclined, as indicated, to prolong the contact of each segment with the brushes, and the slots are set to pass under the brushes just after the alterations in the mains are changing from + to — or the reverse.

It is preferable to have the brushes carried on a movable yoke in the usual way, so that they may be adjusted to the points of little or no spark on the commutator, and their position of adjustment may require changing somewhat with variations in the load or current furnished by the dynamo; but under the conditions the mains M M' would be short-circuited through *m m'*, and across the slots in the commutator when the brushes bearing thereon touch both segments; and as it is nearly impossible to have such contact occur just at the moment when the current in M M' changes its phase, or is at zero, such a short circuit would be a source of great danger to the apparatus, especially should the current in M M' be large and of high potential. To obviate trouble on this account I introduce into one or both branches *m m'* a coil of wire of low resistance, but of great self-induction, such as is secured by winding it upon an iron core, as of iron wires. This is indicated at C, Fig. 2, and its core I is preferably made movable or adjustable, as by a lever, L, and screw S, so as to vary the self-induction of the coil C.

When the core I is fully in the coil C, the reaction due to self-induction must be such that the commuted current passing to F is sufficient to normally excite such field-coils, or a little less than sufficient.

It will be seen, then, that the actual current which can ever reach the commutator K from the mains M M' is limited by the reaction or counter electro-motive force developed in C, and the coils F may therefore be wound of comparatively low resistance.

By adjusting the core I in the coil C the opposing action of C may be varied, and the excitation of the field F' will vary in accordance therewith by the consequent changes of current strength involved. The brushes on the commutator K will in most cases need an adjustment in the usual way for neutral point or non-sparking points during the changes.

Besides giving the power to vary the field, the coil C renders a short-circuiting at K out of the question, even when the two segments are connected, because it offers a strong reaction to a sudden impulse of current and checks the flow. Adjustments of the core I may be made to maintain uniform or constant alternating potentials between the mains M and M', even though the number of translating devices T T be changed so as to demand different flow of currents in M M'.

In some cases it is desirable to make the core I movable, as in Fig. 3, and balance it by a weight, W, and lever L on a pivot, *p*, said weight W being made to not only balance the core I, but also to balance the tendency of the core to enter the coil C by magnetic action when a normal current flows through it. In such a case, should the potential between M M' increase from any cause, the result will be an increase of current in the reactive coil C, which will thereupon pull in its core and lessen the current in the field-coils F by the consequent increased reaction developed in C with its core I pulled in.

In Fig. 4 the arrangement of the commutator K is more fully shown, the segments being numbered 1 and 2, the brushes marked B and B', and the rings *r r'*, being shown connected respectively to segments 1 and 2, the whole being mounted on an extension of the armature-shaft X of the machine.

The connections, as described above in referring to Fig. 2, are displayed diagrammatically, and all parts similarly lettered in Fig. 5.

It is needless to say that the setting of the commutator K must be such as to take the impulses generated in A, and carried by R R' to M M', and reverse them to traverse the field F in the proper direction to magnetize the field, and in the proper way to generate and strengthen the armature-impulses. It is also scarcely necessary to say, in the present state of the art, that in an alternator-dynamo, in which the armature is stationary and the field revolves, the rings R R′ are dispensed with, and that alternate segments of K are attached to a terminal of the field-coils, which coils revolve, while the brushes B B′ are respectively in connection with the branches m m' from the mains, as shown in Fig. 14.

Fig. 6 illustrates the use of two reactive coils, C C′, one in each branch m m', from the mains. In this case the reaction required is only one-half as much for each coil as when a single coil is used.

In Fig. 7 is shown the placing of both coils C C′ of Fig. 6 upon a single core, I, which may be movable, as before described, to vary the reaction.

Other means of varying the reaction of the coil C may be used, such as that shown in Fig. 8, where the coil C is divided into sections, and a switch, S, includes a varying number of such sections, as desired in the branch m, and so controls the effective counter-force of the coil C.

Another phase of my invention is indicated in Fig. 9. In this case a portion of the main circuit G, from the armature-coil A or armature-conductor, is combined with C, to make a differential or compound coil, coil G being reversely wound to C, so as to tend to overcome the effect of self-induction in C or limit its amount according to the volume of current traversing the mains M M′, due to changes in the load or work taken by the translating devices T or other energy users.

The proportioning of the effect of the compensating-coil G upon that of coil C, Fig. 9, may be made such as to cause an increase of current to flow to the field-coil F, owing to weakened effect of coil C in counter-action thereto, whenever an increase of load or current exists on the mains M M′, of which coil G is a part, and such increase of current in F may be made of such amount as to maintain a constant average difference of potential between the mains M M′, notwithstanding the load variations; or, if needed, to increase as the load increases, so overcoming the resistance of the mains.

Fig. 10 shows the employment of a compound reactive coil, G C′, wound upon a ring-core in the branch m' to K, precisely as in Fig. 9, and in addition a manually adjusted coil, C, in the branch m to K, for securing automatic regulation, and when needed a manual regulation.

Fig. 11 shows a device giving the same advantages of manual and automatic regulation of the reactive coil, so as to cause the field-magnetism to be changed manually or automatically, according to the varying actions of the coil.

The compound or differential reactive coil G C has its core I mounted on a lever, L, having an adjustable spring, S. By changes of position of said core the interactions of the two coils may be weakened or strengthened. Thus by lowering the core I it is withdrawn from the coil G, and the effect of current in G is lessened so far as the action of opposition to the reactive power of C is concerned. The effect of G may also be regulated by other means, such as shunting it by variable-resistance wires, as J, Fig. 11.

I have described my invention as applied to an alternator with only two field-poles and an armature-conductor subject only to two alternations of current per revolution. Generally, however, such apparatus is more complex, there being a multiple of field-poles—as four, six, or eight—and the armature-conductor gives four, six, or eight alternations per revolution. In applying my invention to such cases very little modification is needed, and this is found only in the commuting devices for changing the alternating impulses to one direction before passing them through the field-coils.

Fig. 12 illustrates the case of six field-poles of alternate north and south polarity existing, as at F, the brushes B B′ being connected to the terminals of the field-conductor, respectively. The commutator will then require to commute six impulses and will contain six segments. The segments are connected alternately in two sets of three, as 1 to 3 and to 5, and 2 to 4, and to 6, in the figure. The common union of segments 1, 3, and 5 is carried to m, a branch from one of the armature-conductor mains, and the other common union of segments 2, 4, and 6 to m', the branch from the other main.

The reactive-coil devices C are suitably introduced into one or both such branches m m', and have the same functions as before described.

It would be consistent with my invention not to lead the branch current of m m' direct to the field-commutator K, but instead, as in Fig. 13, to cause it to induce in a second coil, C^2, upon the same core an alternating current, which is carried to K, to be commuted as before; but in this case, in order to secure the requisite reaction, an additional reactive coil may be placed in the branch m m', or, better, the core I may be made movable in and out of the axis of the coil C^2. In this case the induction in C^2 may be governed, and the reaction in coil C will vary in accordance therewith.

The same devices are suitable for exciting the field of a motor fed by alternating currents, the generator being connected to the mains. In such cases the motor must be brought to a speed corresponding to the rate of the current impulses before putting on the current to the motor.

This application of my invention is illustrated in Fig. 14, where M M indicate the mains delivering an alternating current. A A indicate stationary magnets, through which such alternating current flows, and F a set of revolving magnets sustained by current derived from the mains through a commutator, K, and a reactive coil, C. The commutator K revolves with the moving member F of the motor, and in starting the motor the member F is brought to a speed of revolution such that the presentations of its poles to the poles of magnets A shall correspond in rapidity to the rapidity of the alternations.

It is obvious that the circuit to which the commutator is connected might carry alternating currents from any source, and that the reaction-coil would have the same substantial function, no matter what the nature of the source of the electric vibrations or pulsations.

I do not limit myself to the application of the devices to a field-coil of a dynamo-machine, since it is obvious that the commutator and coil might be interposed in a branch in which the commutated currents are to be utilized for any purpose whatever. Neither do I limit myself, in the application of the reactive coil C, or its equivalent, to a branch from the mains of the machine itself for exciting the field, as it will be equally useful if the field be excited by a branch taken from the circuit of another alternating-machine, in which branch circuit the reactive-coil commutator and field-magnets of the first machine are placed. In any such case, as well as in the case in which the machine is self exciting, as herein described, from its own mains, I obtain the great advantage that considerable variations in the speed of the driving mechanism, and consequently in that of the machines, may take place without any practical effect in raising or lowering the potential between the mains. This is due to the fact that with a diminished speed the rate of or rapidity of the alternations produced is lessened; and since the reactive coil diminishes in its effect when less rapid impulses pass through it, more current passes through the reactive coil to the field-magnet coils, and when the rapidity of the alternations is increased the coil increases in reactive effect and diminishes the current which reaches the field. These compensations take place without any movement of parts in the reactive coil, as when the core is held stationary, and result in the field strength of the machine being raised when a diminished speed occurs, and weakened when an increased speed exists, a condition resulting in a compensation which maintains a nearly uniform potential between the mains during changes of speed of driving-power.

I do not limit myself to alternating currents on the main line, since it is obvious that some of the features of invention herein described would be applicable to a case where the currents on the main line are pulsatory or intermittent.

What I claim as my invention is—

1. In a self-exciting alternating-current generator, a commutator for rectifying the current taken from the machine to the exciting coil or circuit, in combination with a reactive coil in the connection to the commutator, as and for the purpose described.

2. The combination, with the armature supplying alternating currents to mains, of a field-exciting coil or circuit connected with a branch, a commutator in said branch, and a reactive coil between the commutator and the main.

3. The combination, with the main carrying alternating currents, of a branch, a commutator for rectifying the currents in the branch, and a reactive coil between the commutator and main, as and for the purpose described.

4. The combination, with the branch supplied with current from a main carrying alternating currents or their equivalent, as described, of a commutator in the branch, and a reactive coil provided with means for adjusting its self-induction or reaction, as and for the purpose described.

5. The combination, with the reactive coil and core on an alternating or other vibratory current circuit, of a counterbalancing-retractor, whereby the immersion of the core in the coils may be stationary with a normal flow of current, and may be increased on an increase of current, so as to automatically adjust the reaction to the strength of the alternations or vibrations, as and for the purpose described.

6. The combination, with the alternating-current main, of the branch containing a commutator, a reactive coil in said branch between the main and commutator, and a main-circuit coil combined with the reactive coil in inductive relation thereto, as and for the purpose described.

7. The combination, with a reactive coil in the alternating-current branch, of a compensating coil in a circuit from which the branch is derived, as and for the purpose described.

8. The combination, with an alternating-current dynamo having a field-coil in a branch or derived circuit, of a self-inductive coil in said branch, whereby a field-coil of comparatively low resistance may be employed.

9. The combination, with a commutator connected with a source of alternating currents or their equivalent, as described, of a reactive coil in the commutator-connection, as and for the purpose described.

10. The combination, with an alternating-current dynamo whose field is sustained by the action of current on a branch, of a commutator for rectifying the currents that are used to excite the field, and a compound reactive coil, part of the winding of which is traversed by the branch current and a part by the main current.

11. The combination of the field-circuit of a dynamo-machine and a commutator for said field-circuit, with a reactive coil in an alternating-current circuit to said commutator and a source of alternating current, the rapidity of the alternations in which is dependent on the speed of the dynamo, increasing and decreasing with such speed, for the purpose of automatically varying the current in the field-circuit to compensate for differences of potential developed at different speeds by regulating the strength of the field magnetism.

12. The combination, with a dynamo-machine, of an alternating-current source delivering alternating currents whose rapidity varies with the speed of the machine, and a reactive coil in the connection between said source and the wires or connections which deliver field-exciting energy to the machine, as and for the purpose described.

13. A compound or differential reactive coil placed on an alternating-current circuit and having one portion, G, wound and adjusted, as described, so as to tend to overcome the effect of the self-induction in the other or active portion.

14. In an alternating-current dynamo, a field-sustaining branch from the main containing a reactive coil, in combination with a compensating main-circuit coil, as and for the purpose described.

Signed at Lynn, in the county of Essex and State of Massachusetts, A. D. 1886.

ELIHU THOMSON.

Witnesses:
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E. WILBUR RICE, Jr.