C. H. KICKLIGHTER.

EXCITING ALTERNATOR.

APPLICATION FILED NOV. 9, 1908.

955,171.

Patented Apr. 19, 1910.

4 SHEETS—SHEET 1.

Fig. 1.

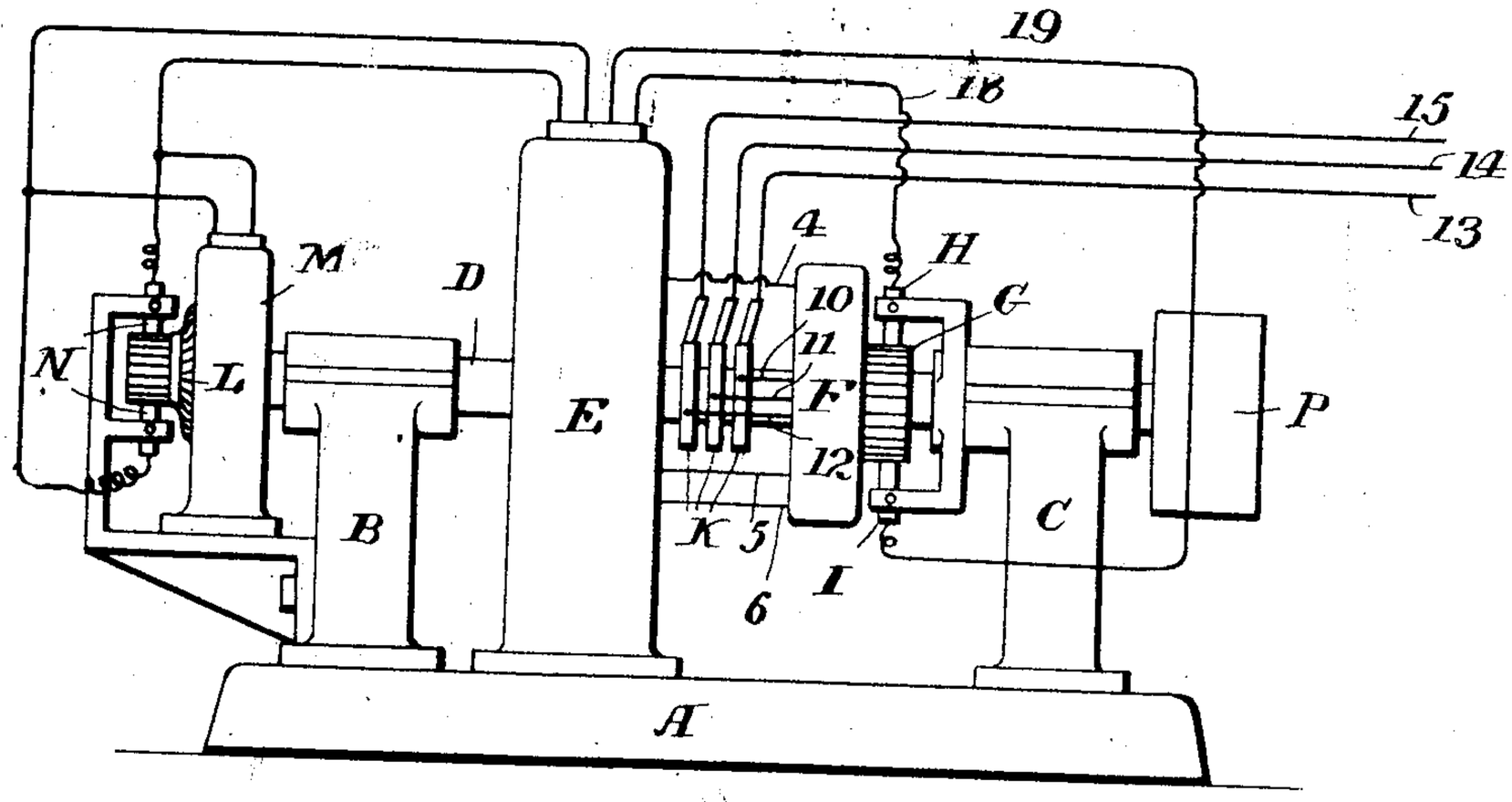
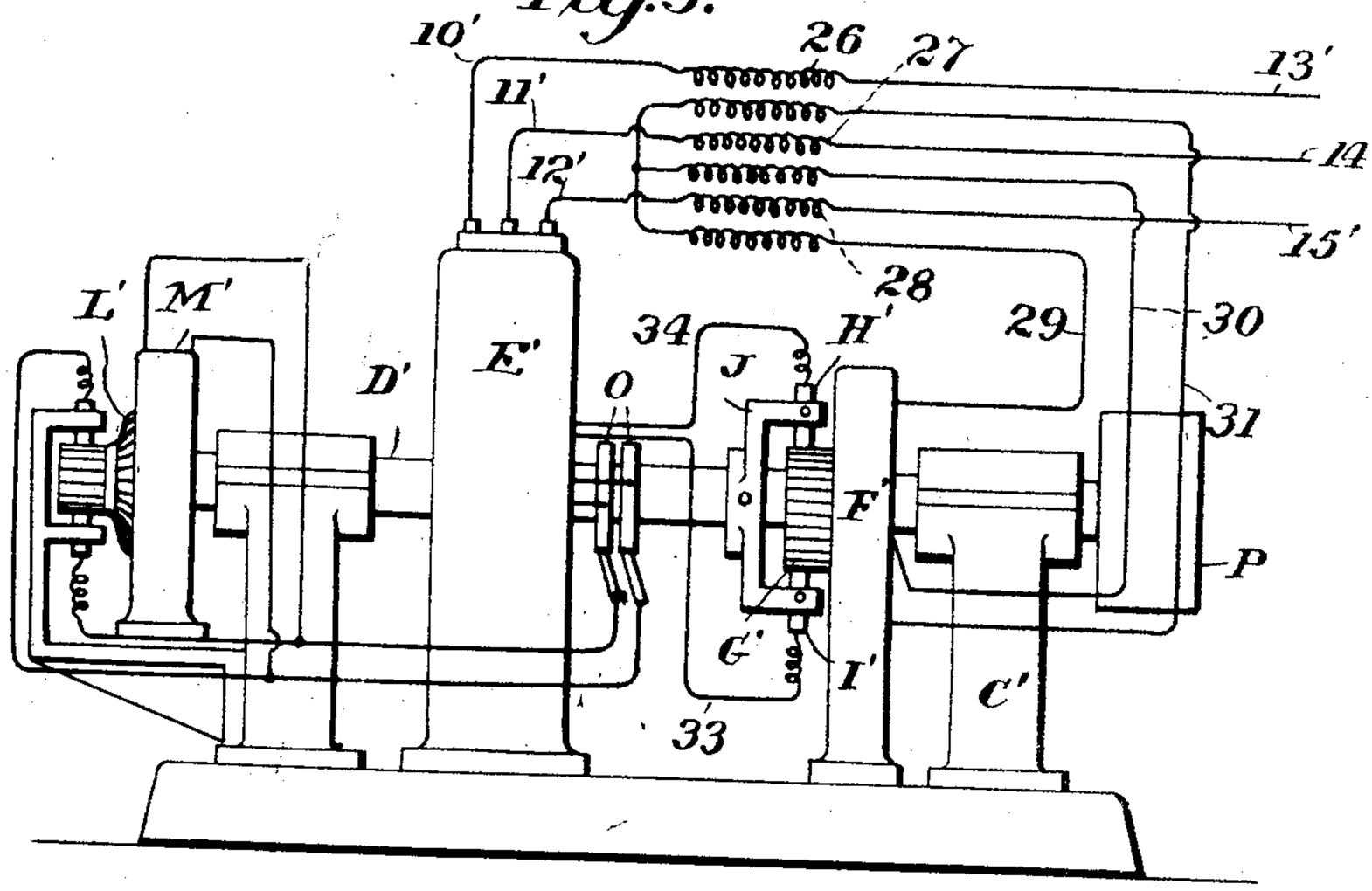


Fig. 3.



Witnesses

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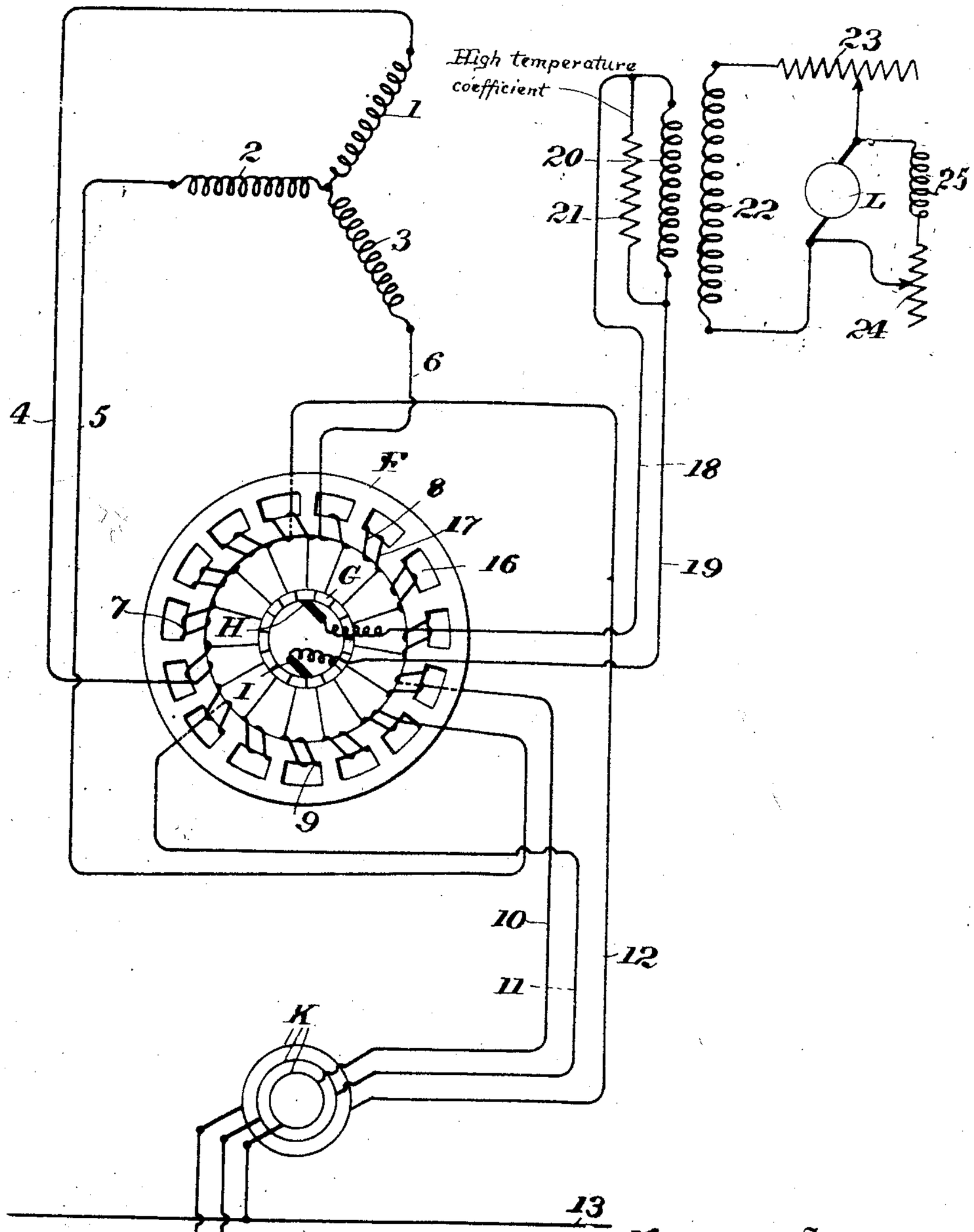
4 SHEETS—SHEET 2.

Fig. 2.



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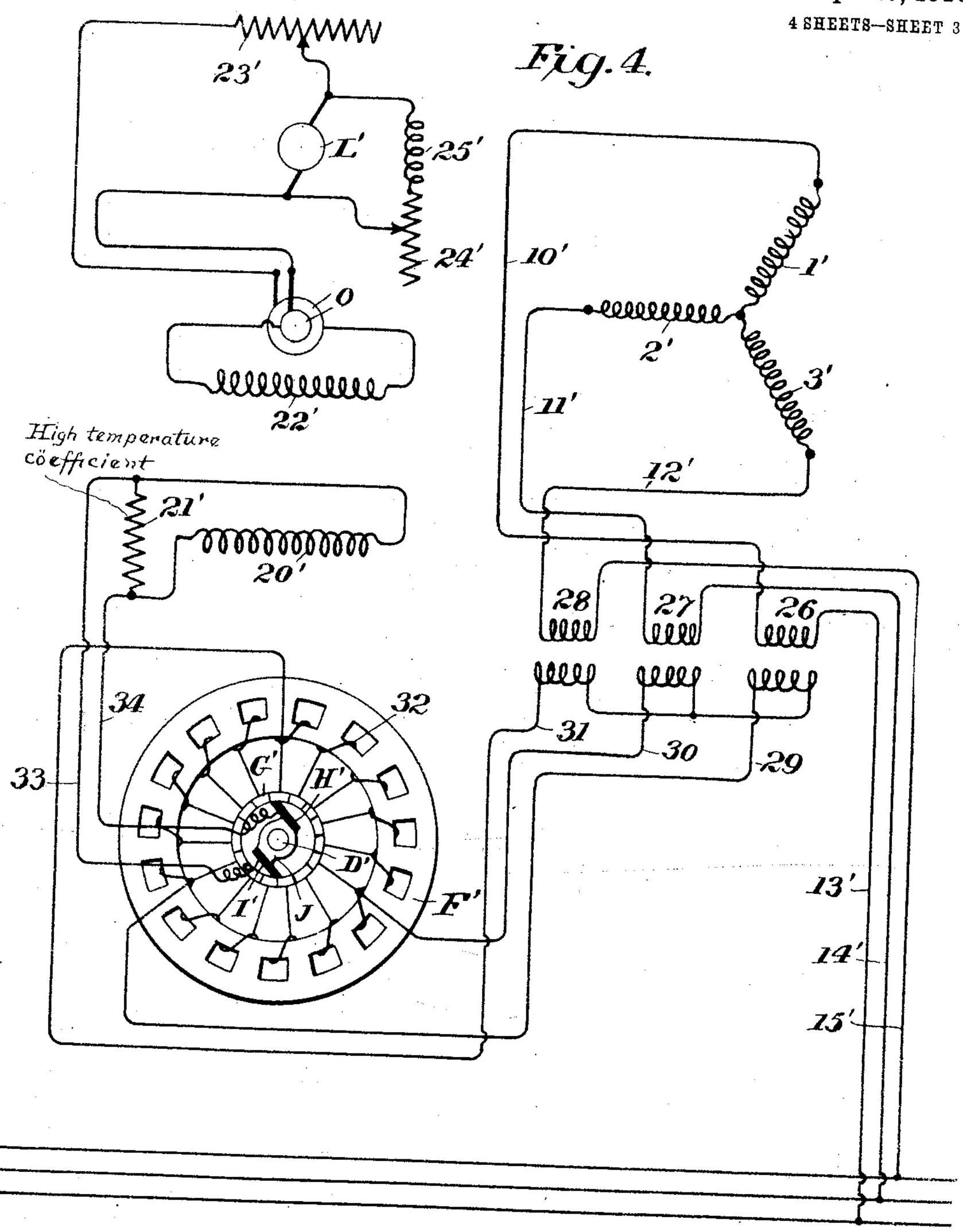
4 SHEETS—SHEET 3.

Fig. 4.



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4 SHEETS—SHEET 4.

Fig. 5.

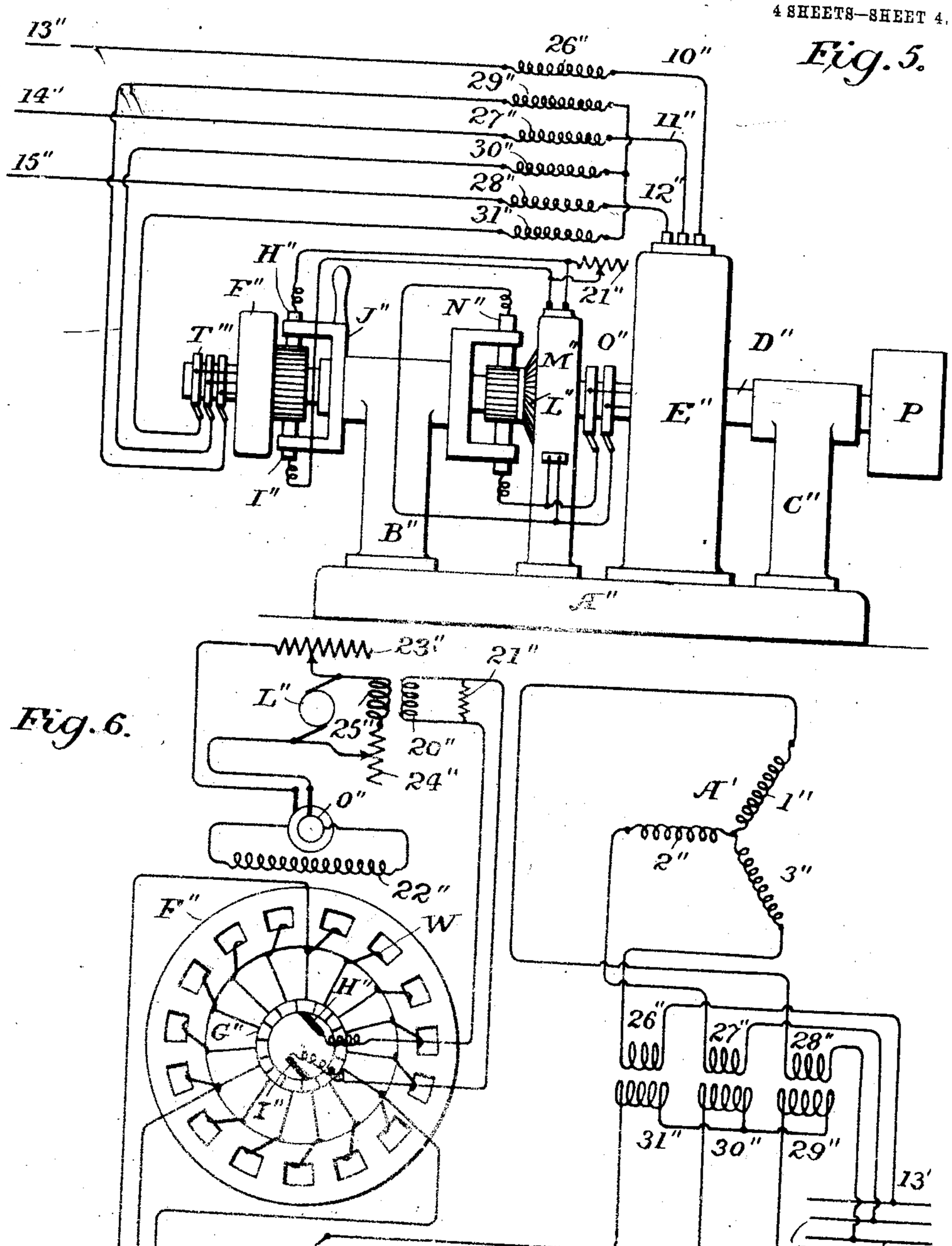

Fig. 6.

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UNITED STATES PATENT OFFICE.

CHARLES H. KICKLIGHTER, OF NEWBERRY, SOUTH CAROLINA.

EXCITING-ALTERNATOR.

955,171. Specification of Letters Patent. Patented Apr. 19, 1910.

Application filed November 9, 1908. Serial No. 461,761.

To all whom it may concern:

Be it known that I, CHARLES H. KICKLIGHTER, a citizen of the United States, and resident of Newberry, in the county of Newberry and State of South Carolina, have invented certain new and useful Improvements in Exciting-Alternators, of which the following is a specification.

The object of the present invention is to provide simple and efficient apparatus whereby an alternator may be rendered self exciting, that is, the current for exciting the field coils being derived from the armature coils, and whereby the pressure generated will be automatically regulated.

The invention can be best set forth in connection with the accompanying drawings in which,

Figure 1 is a side elevation of apparatus embodying the invention; Fig. 2 is a diagram showing the electrical connections of the apparatus shown in Fig. 1; Fig. 3 is a side elevation of modified apparatus embodying the invention; Fig. 4 is a diagram of the electrical connections suitable for the apparatus of Fig. 3; Fig. 5 is a side elevation of a still further modification; and, Fig. 6 is a diagram of the electrical connections of the apparatus of Fig. 5.

Referring to the drawings, and first to Figs. 1 and 2, the apparatus comprises a bed plate A having pedestals B and C which carry the bearings for the rotatable main shaft D. Also mounted upon the bed plate A is a frame E of the main alternator, which in this case carries the field winding, while the armature of this alternator is fixed upon and rotated with the shaft D. Also mounted upon the shaft D is the core F. Upon this core is placed a winding which on the one hand receives alternating current from the armature coils of the alternator, in this case three phase, and on the other is provided with the commutator G through which, and the brushes H and I, current to field winding of the alternator is supplied. The main current is taken from the alternator through the slip rings K. The brushes referred to are stationary, being mounted upon the bearing of the pedestal C. Also mounted upon the shaft D and rotating therewith is an armature L of a direct current exciter having the field frame M. Upon the commutator of the armature bear the brushes N through which current is supplied to the field winding of the alternator.

Referring now to Fig. 2, the armature windings of the different phases 1, 2 and 3 are connected by conductors 4, 5 and 6 with a distributed winding upon the core F, which winding is wound in three sections 7, 8 and 9, each of said sections extending over approximately 120° of the core. One end of each of the armature windings is connected to an end of one of the distributed winding sections, while the other ends of those sections are connected by conductors 10, 11 and 12 with the slip rings K whence connection is made with the main line conductors 13, 14 and 15. The core F as shown is of annular form and constitutes the magnetic circuit of the distributed winding, there being no other means provided for completing the circuit of this winding such as the field frame which is ordinarily employed in dynamo electric machines for completing the magnetic circuits through the winding on the armature. As will be seen, the core F is provided with holes as 16 through which the distributed winding is passed and by this means magnetic circuits completed by magnetic material are formed about the various portions of the distributed winding.

Wound side by side with the distributed winding just referred to and in close inductive relation thereto, is a second distributed winding 17 to which is connected the commutator G. From the brushes H and I which bear upon the commutator G extend the conductors 18 and 19 which lead to the direct current winding 20 upon the field of the main alternator. This winding 20 may be termed the compounding winding of the alternator. It will be seen that the sections 7, 8 and 9 are connected in series between the respective phases of the armature windings of the alternator and the main line conductors and that therefore the distributed winding sections referred to carry current in proportion to the current flowing in the armature windings which is of course proportional to the load upon the external circuit. The rotating magnetic field set up in the core F by the currents of different phase in the winding sections will induce in the winding 17 an electromotive force which is proportional to the current flowing therein and since the resistance of the circuit across the brushes H and I is substantially constant the current through the circuit across those brushes will be substantially

proportional to the working current, that is the current flowing in the armature windings of the alternator.

The excitation produced by the winding 20 may be adjusted in any suitable manner. In the present instance an adjustable resistance 21 is shunted across the field winding so that a greater or less amount of current can be shunted from the winding by decreasing or increasing the resistance 21. Moreover, upon heavy loads the field may approach saturation so that a larger change in current is required to produce a given change in the magnetic field than is the case when the magnetic circuit is far from saturation. To compensate for this effect, the shunt 21 may be made of material, such as iron wire, which has a high temperature coefficient. With this arrangement, when the current is heavy the resistance of the shunt will rise rapidly thereby shunting a larger portion of current through the field winding so that the larger the exciting current, and therefore the higher the magnetic excitation, the more current in proportion will pass through the field. The compounding winding 20 it will be seen, therefore, is for varying the excitation of the machine in accordance with the load upon the exterior circuit. It is usual to provide a winding for producing a substantially constant excitation. The direct current field winding 22 is such a winding connected across the armature L of the direct current exciter the potential of which is substantially constant. The excitation of the winding 22 may be adjusted by an adjustable resistance 23 in series therewith. This excitation may also be adjusted by a resistance 24 in circuit with the field winding 25 of the exciter.

It will be apparent from the foregoing that the alternator is supplied with direct current field windings and alternating current armature windings and that the field is supplied with a constant excitation and also with an excitation which varies with the load upon the machine. In other words, the alternator is compounded whereby the potential at its terminals may be maintained constant or caused to rise or diminish with increase in load according to the adjustments as is well understood in connection with the compounding of generators.

While the commutator brushes are shown as directly connected to the compounding field winding it will be apparent to those skilled in the art that the effect of this current might be communicated to the field of the alternator in many other ways and the apparatus varied in numerous particulars without departing from the spirit of the present invention.

In the apparatus just described the field of the alternator has been described as stationary while the armature was the movable member. Also the core F with its winding and commutator was described as movable while the brushes were stationary. Also two distributed windings were provided upon the core F. The invention, however, is applicable to an alternator in which the armature windings are stationary and the field movable; also where there is but a single distributed winding upon the core F and also where the core F with its winding and commutator are stationary while the brushes are movable. The apparatus embodying these changes in construction is shown in Figs. 3 and 4 to which reference is now made. Upon the shaft D′ of the alternator is mounted a revolving field excited by a direct current winding. The armature windings 1′, 2′ and 3′ are mounted upon the stationary frame E′ and from the terminals of these windings extend the conductors 10′, 11′ and 12′ which are connected through the transformer primaries 26, 27 and 28 to the external circuit line wires 13′, 14′ and 15′. The secondaries of the transformers are connected through conductors 29, 30 and 31 with the distributed winding 32 upon the core F′. A three phase alternator being shown, the conductors 29, 30 and 31 are connected to the distributed winding at points displaced at approximately 120° from each other. The distributed winding is connected to a commutator G′, as shown, and the brushes H′ and I′ which bear upon the commutator are carried by a holder J which is fixed to and rotates with the shaft D′. The core F′ together with its distributed winding and the commutator therefor is stationary, being mounted upon the base plate as shown. The brushes H′ and I′ are connected by conductors 33 and 34 with the terminals of the compounding winding 20′ upon the rotating field structure, a shunt 21′, similar to that described in connection with Figs. 1 and 2, being placed across the compounding winding. The field structure is also provided with a winding 22′, for furnishing a substantially constant excitation, the current for this winding being supplied by the exciter having the field member M′ and armature L′, the armature being mounted upon the shaft D′. In all respects the exciter of Figs. 3 and 4 is similar to the exciter shown and described in connection with Figs. 1 and 2, it being provided with the field winding 25′ and a regulating resistance 24′ therefor. Also a regulating resistance 23′ in series with the winding 22′ is provided. Inasmuch however as the field windings rotate while the exciter brushes are stationary slip rings O are provided through which connection is made with the winding 22′.

The apparatus illustrated in Figs. 5 and 6 comprises a bed plate A″ supporting the pedestals B″ and C″ which carry the bear-

ings in which the shaft D'' is rotatably supported. The stationary frame of the alternator E'' is carried by the bed plate and upon this frame the armature coils are mounted, the field coils being rotatable with the shaft D'' in a manner as is well understood in the art. The terminals of the field winding are brought out to the slip rings O'' while the terminals of the armature windings, in this case three-phase, are connected by the conductors 10'', 11'' and 12'' through the transformer primaries 26'', 27'' and 28'' with the mains 13'', 14'' and 15'', these primaries being thus connected in series with the mains and carrying currents proportional to the armature currents. The secondaries 29'', 30'' and 31'', of the transformers are connected in Y and to the slip rings T'''. These slip rings are connected with the distributed winding W upon the core F'', the winding just referred to being also connected with the commutator G''. The construction and arrangement of the core F'', its winding and connected commutator and slip rings are the same as that in Fig. 4. The core F'' is fixed to and rotates with the shaft D'', this core being mounted outside the pedestal B''. A rocker arm J'' carries the brushes H'' and I'' for collecting the currents from the commutator G'', this rocker being carried by the pedestal B'' and adapted to be rocked or adjusted thereon to facilitate proper adjustment of the brushes.

Carried by the bed plate A'' is the stationary field frame M'' of a direct current exciter having an armature L''. Upon the commutator of this exciter bear brushes N'' which are carried by an adjustable arm mounted upon the pedestal B''.

The electrical connections will be best understood from the diagram of Fig. 6 from which it will be seen that the exciter is provided, in addition to the armature L'', with a shunt field winding 25'' which is connected across the terminals of the armature in series with an adjustable resistance 24''. Also this exciter is provided with a compounding field winding 20'' which is connected across the brushes H'' and I'' while a regulating shunt 21'', similar to that described in connection with the previous apparatus, is connected across the winding 20''. As a further means of regulation an adjustable resistance 23'' may be connected in series with the exciter armature L'' and the rotating field winding 22'' of the alternator which is connected with the armature L'' through the slip rings O''.

The operation of the apparatus will now be apparent. The current flowing from the stationary armature windings 1'', 2'' and 3'' through the primaries 26'', 27'' and 28'' to the mains 13'', 14'' and 15'' will induce in the secondaries 29'', 30'' and 31'' currents which will flow through the slip rings T''' to the distributed winding upon the core F'' and thence they will flow through the commutator G'' and brushes H'' and I'' as direct current, to the compounding winding 20'' of the exciter. The result is that the field excitation of the exciter will vary with the current flowing to the mains and consequently the voltage and current supplied to the field winding 22'' of the alternator will vary. It will be observed however that with the apparatus just described it is simply necessary for the transformers, the core F'', the winding thereon and connected apparatus to be of sufficient capacity to supply compounding current to the exciter. Obviously this compounding current is much less, and therefore the apparatus may be made smaller, than is required when the compounding current is supplied directly to the field winding of the alternator as in apparatus hereinbefore referred to. Also but a single winding upon the field of the alternator is required. However, both modes of influencing the field excitation of the alternator are within the scope of the present invention and either may be employed as circumstances may dictate. It will, of course, be understood also that the above described methods of compounding may be employed whether the exciter is direct connected or belt driven, or where separate excitation is employed.

Other embodiments of the invention may also be employed and while it has been illustrated in what is considered its best application it may be included in other structures than those shown without departing from the spirit of the invention, which is not therefore limited to the structures shown in the drawings.

What I claim is—

1. The combination with an alternator including direct current field windings and polyphase armature windings, of a converter including a core of magnetic material, distributed windings thereon, said core constituting the magnetic circuit for said distributed windings, connections between the armature windings and a part of said distributed windings to produce a rotating field in said core, a commutator, brushes bearing on said commutator, connections between a part of said distributed windings and one of said last two elements, means connected to the other of said last two elements for supplying said field windings with a current varying with the current passing through said distributed windings, said commutator and brushes being relatively movable, and means connecting the movable of said last two elements with the shaft of the alternator, said converter forming a unit with said alternator.

2. The combination with an alternator

including direct current field windings and polyphase armature windings, of a converter including a core of magnetic material, distributed windings thereon, said core constituting the magnetic circuit for said distributed windings, connections between the armature windings and a part of said distributed windings to produce a rotating field in said core, a commutator, brushes bearing on said commutator, connections between a part of said distributed windings and one of said last two elements, and means connected to the other of said last two elements for supplying said field windings with a current varying with the current passing through said distributed windings, said commutator and brushes being relatively movable, the movable of said last two elements being directly mounted upon the shaft of the alternator.

3. The combination with an alternator including direct current field windings and polyphase armature windings, of a converter including a core of magnetic material, a distributed winding thereon, connections between the armature windings and said distributed winding to produce a rotating field in said core, a second distributed winding on said core in inductive relation to the first distributed winding, said core constituting the magnetic circuits for said windings, a commutator, brushes bearing on said commutator, connections between said second distributed winding and one of said last two elements, means connected to the other of said last two elements for supplying said field windings with a current varying with the current passing through said distributed windings, said commutator and brushes being relatively movable, and means connecting the movable of said last two elements with the shaft of the alternator, said converter forming a unit with said alternator.

4. The combination with an alternator including direct current field windings and polyphase armature windings, of a converter including a core of magnetic material, distributed windings thereon, said core constituting the magnetic circuit for said distributed windings, connections between the armature windings and a part of said distributed windings to produce a rotating field in said core, a direct current dynamo mounted upon the shaft of the alternator and connected to the direct current field windings, a commutator, brushes bearing on said commutator, connections between a part of said distributed windings and one of said last two elements, means connected to the other of said last two elements and operating in connection with the direct current dynamo for supplying said direct current field windings with a current varying with the current passing through said distributed windings, said commutator and brushes being relatively movable, and means connecting the movable of said last two elements with the shaft of the alternator, said converter and dynamo forming a unit with said alternator.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES H. KICKLIGHTER.

Witnesses:

JNO. M. KENARD,

J. N. MCCAUGHRIN.