No. 774,955. PATENTED NOV. 15, 1904.

C. F. SCOTT.

METHOD OF ROTATING THE FIELD MAGNETS OF ALTERNATING CURRENT GENERATORS.

APPLICATION FILED JUNE 30, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

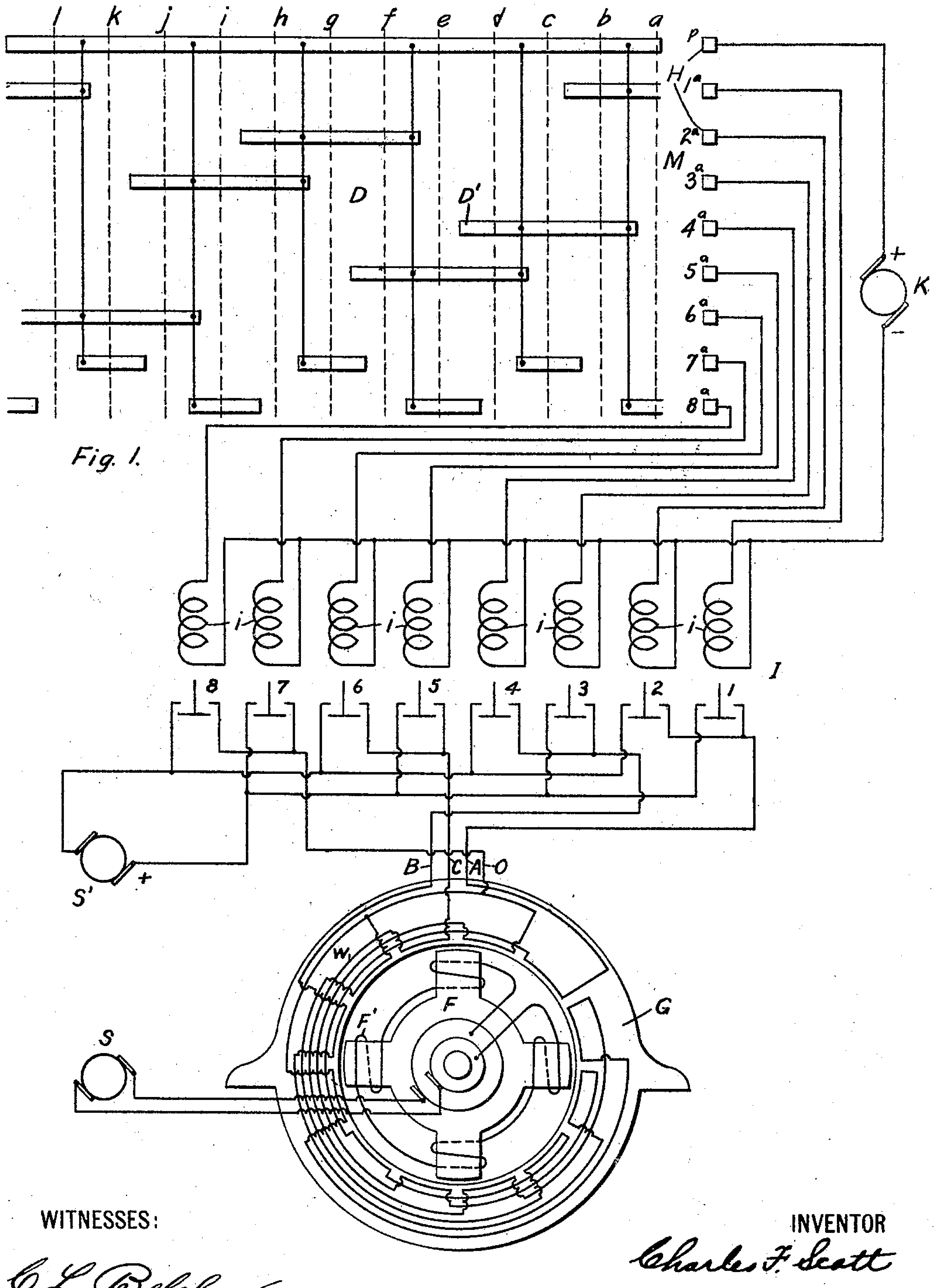


Fig. 1.

WITNESSES:

C. L. Belcher

Otto S. Schairer.

INVENTOR

Charles F. Scott

BY

Wesley G. Carr

ATTORNEY

No. 774,955. PATENTED NOV. 15, 1904.

C. F. SCOTT.

METHOD OF ROTATING THE FIELD MAGNETS OF ALTERNATING CURRENT GENERATORS.

APPLICATION FILED JUNE 30, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

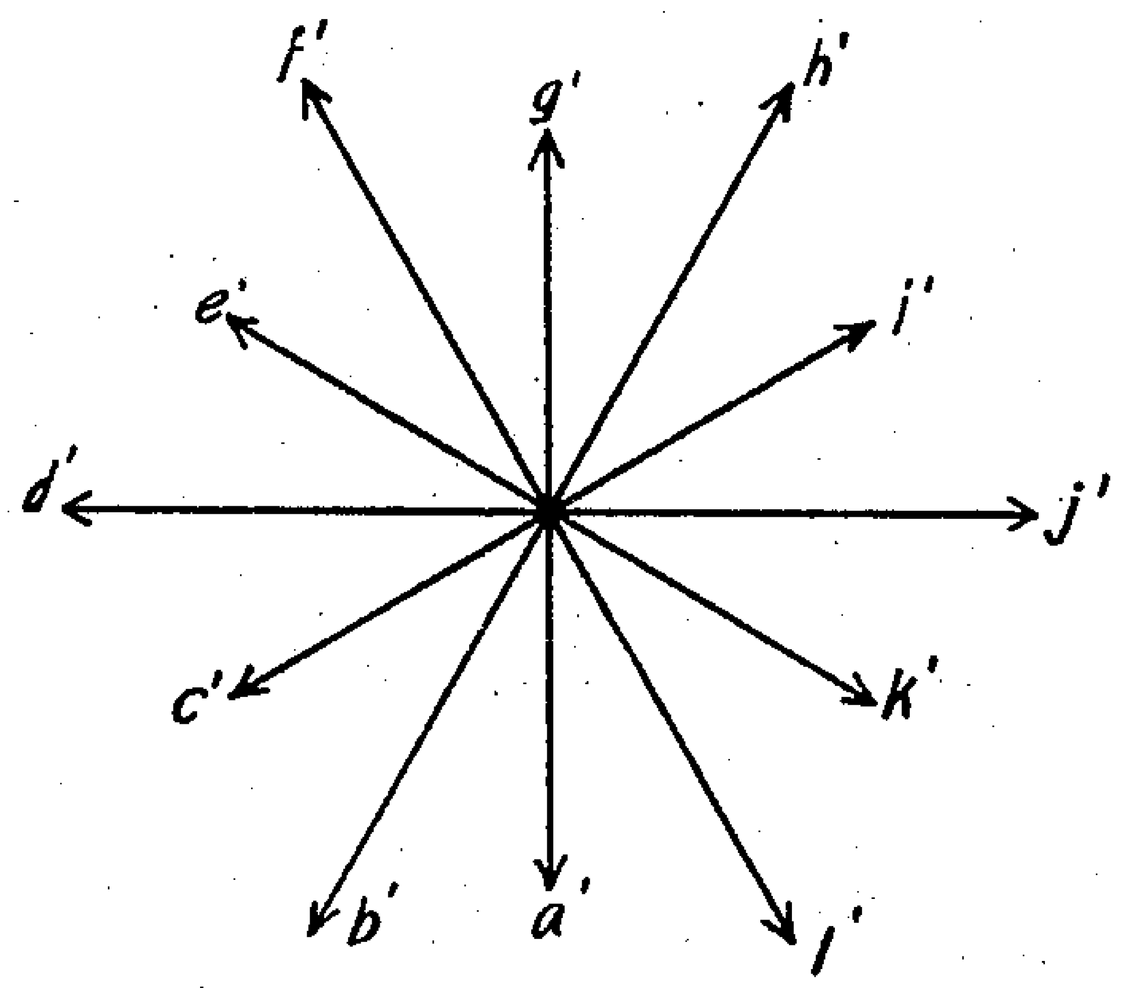


Fig. 3.

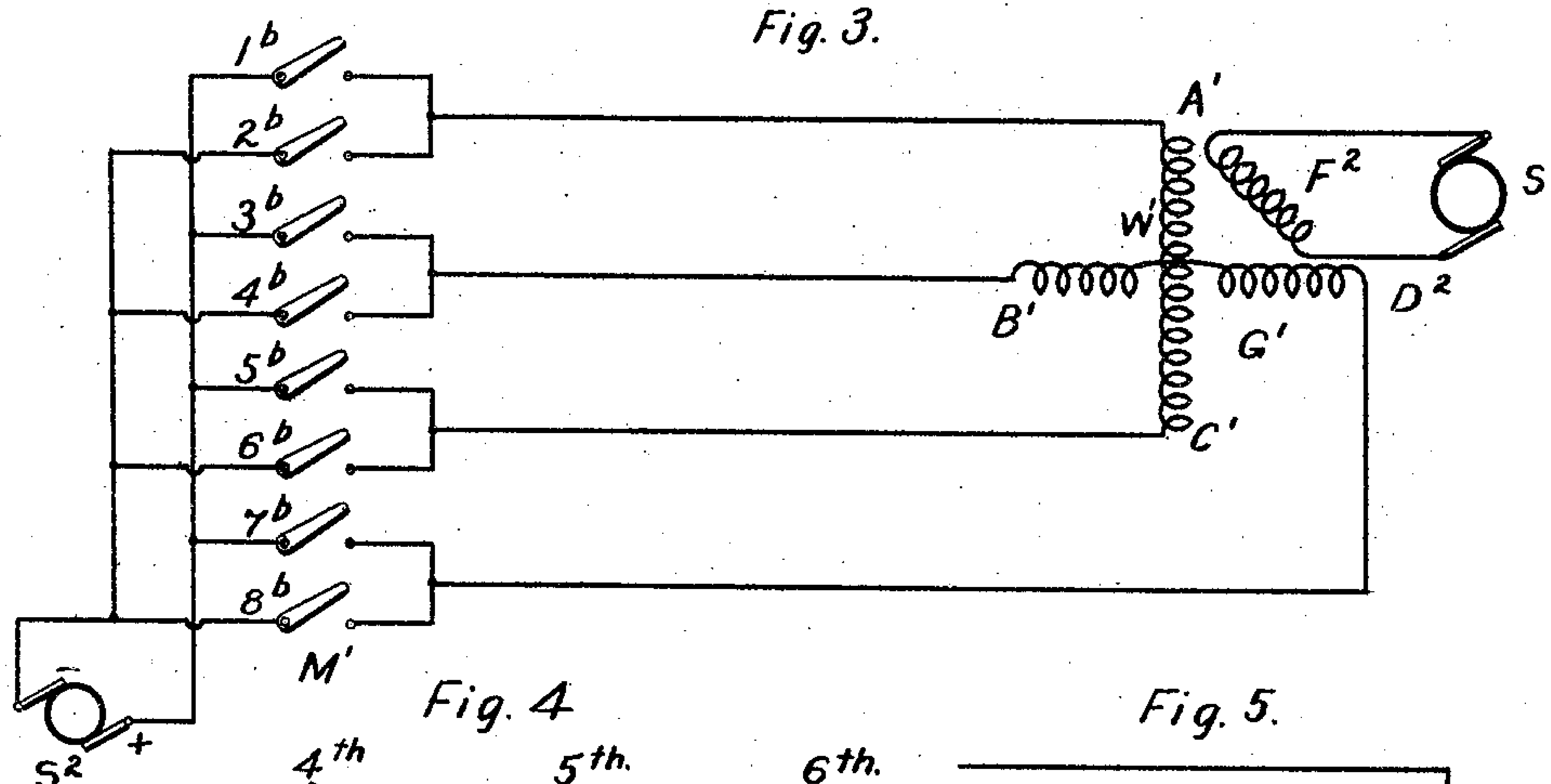


Fig. 4

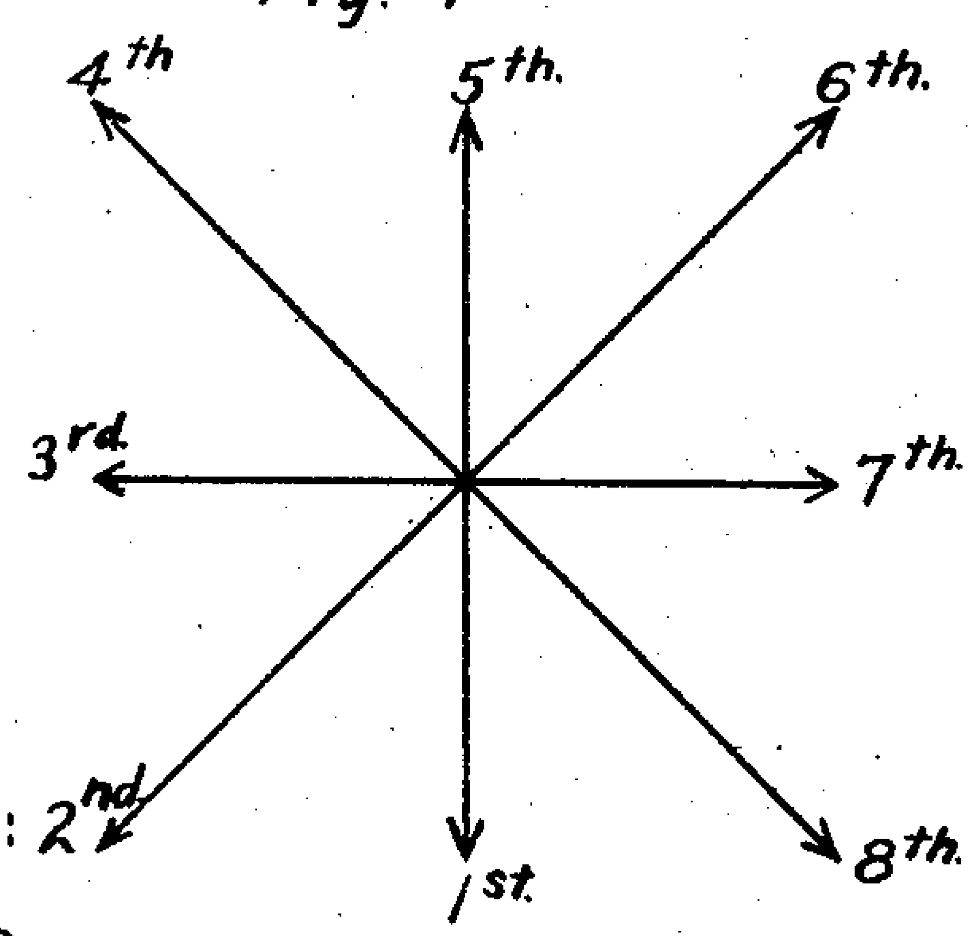
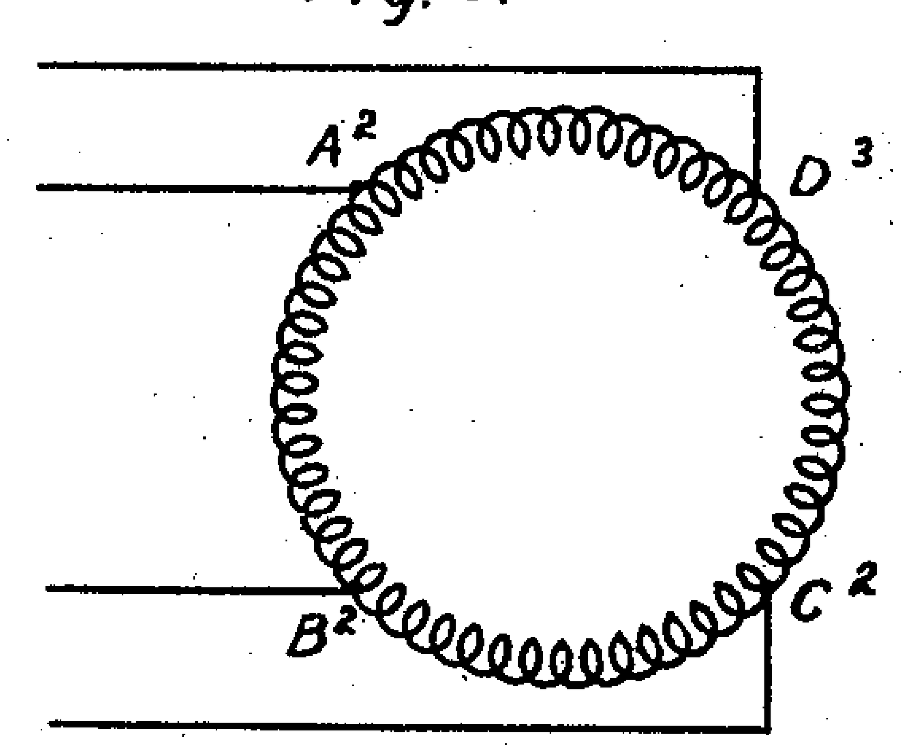


Fig. 5.



WITNESSES:

C. L. Belcher

Fred. H. Miller

INVENTOR

Charles F. Scott

BY

Wesley G. Carr

ATTORNEY

No. 774,955. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

CHARLES F. SCOTT, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

METHOD OF ROTATING THE FIELD-MAGNETS OF ALTERNATING-CURRENT GENERATORS.

SPECIFICATION forming part of Letters Patent No. 774,955, dated November 15, 1904.

Application filed June 30, 1904. Serial No. 214,815. (No model.)

To all whom it may concern:

Be it known that I, CHARLES F. SCOTT, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of Rotating the Field-Magnets of Alternating-Current Generators, of which the following is a specification.

My invention relates to a special operation of dynamo-electric machines that are directly connected to the engines by which they are normally driven; and it has for its object to provide a method of rotating the field-magnets of such machines at slow speeds and either continuously or intermittingly in order to adjust the driving-engines with reference thereto.

In the process of installing a large polyphase generator and its driving-engine it is found necessary to carefully adjust the engine so that the operation when final connection is made will be satisfactory, and in order to effect such adjustment it is necessary to rotate the field-magnet of the generator at a slow speed and under such control that it may be readily started and stopped when desired. This operation has heretofore generally been effected by means of an electric motor and suitable gearing between the same and the generator field-magnet. This has been found to be an expensive and not altogether satisfactory method, since the operating-motor must be coupled to the field-magnet by means of heavy gearing, and it is not convenient to arrange the motor so that it may be readily connected and disconnected.

In a prior application, Serial No. 172,481, filed by me September 16, 1903, I have set forth a desirable method of effecting a slow and controlled rotation of generator field-magnets, which consists in controllably supplying direct currents to the armature-windings in such amounts and in such order as will insure the direction and speed of rotation desired by the inductive action between the armature thus energized and the field-magnet. While I have thus set forth and claimed my said invention broadly in the application referred to, the specific illustration and description of the method is directed to the utilization of the several armature-windings corresponding to the different phases successively, and while this is specifically an operative and a satisfactory method I have devised a modification in which the armature-windings corresponding to the several phases are energized in a different order and in such manner as to provide a more evenly adjusted rotative effect. This method is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram showing a three-phase generator and the various instrumentalities employed for practicing the method, including a source of direct-current energy and controlling apparatus for applying such energy to the armature-windings of the generator in accordance with my invention. Fig. 2 is a diagram illustrating the number and strengths of the various rotative effects imparted to produce one complete rotation of the generator field-magnet. Fig. 3 is a simple diagram illustrating the application of my invention to a two-phase generator. Fig. 4 is a diagram illustrating the number and strengths of the rotative effect exerted when my method is utilized in connection with a two-phase generator, and Fig. 5 illustrates another type of two-phase generator in connection with which my invention may be employed.

Referring particularly to Figs. 1 and 2 of the drawings, the alternating-current generator G, the field-magnet F of which is to be slowly and controllably rotated by the method constituting my present invention, is indicated as having three-phase star-connected windings W, the outer terminals A, B, and C of which are connected to the stationary contact-terminals of a series of controlling-switches, which will be hereinafter more fully described. The common junction of the inner terminals of the windings W is also connected to certain of the controlling-switches by means of a lead O.

For convenience of description the several armature-windings W will be designated by the reference-letters which are applied to their terminal leads, and the positive or negative sign will be prefixed to the reference-letters according as the terminal leads are connected with the positive or the negative pole of the source of energy from which the windings are supplied.

The winding F′ of the field-magnet F is energized by means of direct current from a suitable source S in the usual manner. The current for energizing the armature-windings is supplied from a suitable source S′, and the application of the current from this source to the armature-windings in the proper order and relation is regulated and controlled by means of a controlling apparatus M, comprising a drum D, having contact strips or plates D′ of suitable dimensions and properly located and connected, a series of contact-fingers H, so disposed as to make engagement with the contact strips or pieces D′ as the drum is rotated, and a series of circuit making and breaking switches I, which I have respectively designated as 1 to 8, inclusive.

The several switches of the set I are operated by means of magnet-coils *i*, which receive energizing-current from a suitable source K, that may be either a dynamo or a battery. The drum D of the switching apparatus M is designed to have twelve operating positions, which I have indicated as *a* to *l*, inclusive. The individual contact-fingers of the set H, I have designated as *p*, 1^a, 2^a, 3^a, 4^a, 5^a, 6^a, 7^a, and 8^a, the finger *p* being connected to one terminal of the generator K and continuously in contact with a corresponding contact-ring on the drum D and the other fingers of the set being connected to the corresponding terminals of the several switch-magnets *i* and making contact with the corresponding drum-strips D′ in order to close the switches 1 to 8 in the order which will be now described.

In position *a* of the controller-drum switches 1, 4, and 8 will be closed and the armature-circuit will be +A −O, the rotative effect upon the field-magnet being represented in Fig. 2 by the line marked *a*′.

In position *b* switches 1 and 4 will be closed and the armature-circuit will be +A −B, the strength of the rotative impulse imparted to the field-magnet being represented by the line *b*′ in Fig. 2.

In position *c* of the controller-drum switches 4 and 7 are closed and the armature-circuit is −B +O, the strength of the rotative impulse being represented in Fig. 2 by the line *c*′.

In position *d* of the controller-drum switches 4 and 5 are closed and the armature-circuit is −B +C, the strength of the rotative impulse being represented by the line *d*′ in Fig. 2.

In position *e* switches 5 and 8 are closed and the armature-circuit is +C −O, the strength of the rotative impulse being represented by the line *e*′ in Fig. 2.

In position *f* of the controller-drum switches 2 and 5 are closed and the armature-circuit is −A +C, the strength of the rotative impulse being represented by the line *f*′ in Fig. 2.

In position *g* switches 2 and 7 are closed and the armature-circuit is −A +O, the strength of the rotative impulse being represented by the line *g*′ in Fig. 2.

In position *h* switches 2 and 3 are closed and the armature-circuit is −A +B, the strength of the rotative impulse being represented by the line *h*′ in Fig. 2.

In position *i* switches 3 and 8 are closed and the armature-circuit is +B −O, the strength of the rotative impulse being represented by the line *i*′ in Fig. 2.

In position *j* switches 3 and 6 are closed and the armature-circuit is +B −C, the strength of the rotative impulse being represented by line *j*′ in Fig. 2.

In position *k* switches 6 and 7 are closed and the armature-circuit is −C +O, the strength of the rotative impulse being represented by the line *k*′ in Fig. 2.

In position *l* switches 1 and 6 are closed and the armature-circuit is +A −C, the strength of the rotative impulse being represented by the line *l*′ in Fig. 2.

It will be seen from the foregoing description that current is first supplied to the armature-winding corresponding to one of the phases and then to the windings corresponding to two of the phases connected in series and that the current is reversed at the end of each one hundred and eighty electrical degrees of rotation.

The approximate relative values of the rotative impulses which are indicated by radial lines in the diagram of Fig. 2 are representative of those values only on the assumption that a constant voltage is applied at the terminals of the various portions of the armature-winding. If the resistances of the various phases of the armature-winding were disregarded, the ratio of the impulses due to the energizing of a single phase of the winding to the impulses due to the energizing of two phases of the winding in series would be as 1 is to 1.73. In Fig. 2 the radial lines representing the directions and values of the rotative impulses are shown more nearly equal than this ratio indicates, since the resistance is greater with two phases of the winding in the circuit than with only one phase in the circuit, and hence the ratio of the corresponding rotative impulses is greater than the above ratio.

Referring now to Figs. 3 and 4, the generator G′ is indicated merely by diagrammatic representations of its windings, the field-magnet winding F^2 being energized by current from a suitable source S, as is indicated in Fig. 1, and the armature-windings W′ being of the two-phase type. The outer terminals of the windings W′ are designated as A′, B′, C′, and D^2, and for convenience of description the windings will be designated by means of these reference-letters. The energy for rotating the field-magnet is derived from a suitable source S^2 and is applied to the armature-windings by means of a suitable controller M′, which is here indicated for convenience as comprising a series of switches 1^b, 2^b, 3^b, 4^b, 5^b, 6^b, 7^b, and 8^b, which may be independently opened and closed either by hand or by suitable automatic means, as may be found convenient or desirable. For the first position switches 1^b and 6^b will be closed, thus making the energized armature-circuit $+A' -C'$. In the second position switches 1^b, 3^b, 6^b, and 8^b will be closed, thus making the energized armature-circuit $+A' +B' -C' -D^2$. In the third position switches 3^b and 8^b will be closed, thus making the active armature-circuit $+B' -D^2$. In the fourth position switches 2^b, 3^b, 5^b, and 8^b will be closed, thus making the active armature-circuit $-A' +B' +C' -D^2$. In the fifth position switches 2^b and 5^b will be closed, thus making the active armature-circuit $-A' +C'$. In the sixth position the switches 2^b, 4^b, 5^b, and 7^b will be closed and the active armature-circuit will be $-A' -B' +C' +D^2$. In the seventh position switches 4^b and 7^b will be closed, thus making the active armature-circuit $-B' +D^2$. In the eighth and final position the switches 1^b, 4^b, 6^b, and 7^b will be closed, thus making the active armature-circuit $+A' -B' -C' +D^2$.

The strengths of the several rotative impulses imparted to the field-magnet by the armature - circuits above described are approximately indicated in Fig. 4 and are designated as "1st," "2d," "3d," "4th," "5th," "6th," "7th," and "8th," corresponding to the several positions of the controller-switches. The values of each two of said successive impulses are approximately in the ratio of 1 to 1.41.

If the armature-winding of a two-phase machine is of the closed type, as shown in Fig. 5, the diagram of Fig. 4 will still represent the relative directions of the rotative impulses, if the portion of the winding between the terminals A^2 and B^2 be first energized, then the two portions between terminals A^2 and C^2, then the portion between terminals B^2 and C^2, then the portion between the terminals B^2 and D^3, and so on in a similar manner. The relative values of the impulses, however, will be slightly different from what are shown, for the reason that in the first instance the various portions of the armature-winding are energized singly and in parallel alternately, and in the second instance they are energized singly and in series alternately, and consequently the relative resistances are different in the two cases.

While I have shown separate sources of energy for supplying direct current to the armature and field-magnet windings, it is evident that if the amount of current required by each of these windings is approximately or nearly the same they may be supplied in series from a single source.

The instrumentalities employed in practicing my invention may be further varied as regards structure and arrangement of parts, the means herein shown and described, being set forth merely for the purpose of demonstrating the practicability of the method, and not as limiting it to the use of any one specific means.

I claim as my invention—

1. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and supplying direct current to the armature-winding corresponding to a single-phase and to series-connected armature-windings corresponding to two phases alternately and successively, and reversing said current when one hundred and eighty electrical degrees of rotation have been produced.

2. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and energizing, by direct currents, first the armature-winding corresponding to one phase, then the armature-windings corresponding to two phases, in series, then the winding corresponding to the second phase and so on successively and reversing the energizing-current when the field-magnet has completed one hundred and eighty electrical degrees of rotation.

3. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and alternately energizing, by direct currents, the armature-winding corresponding to a single-phase and series-connected windings corresponding to two phases.

4. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and alternately energizing, by direct currents, one portion of the armature-winding alone and then two portions of the said winding in series.

5. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and alternately energizing, by direct currents, a portion of the armature-winding corresponding to one phase and a portion of said winding corresponding to two successive phases and continuing such operation progressively so long as rotation is desired.

6. The method of rotating the field-magnet of a polyphase alternating-current generator which consists in energizing the field-magnet and alternately energizing, by direct currents, one portion of the armature-winding alone and then two portions of the said winding together.

In testimony whereof I have hereunto subscribed my name this 25th day of June, 1904.

CHAS. F. SCOTT.

Witnesses:
J. C. DIECKMANN,
BIRNEY HINES.