(No Model.) 2 Sheets—Sheet 1.

M. IMMISCH.

METHOD OF REGULATING ELECTRIC MOTORS.

No. 414,052. Patented Oct. 29, 1889.

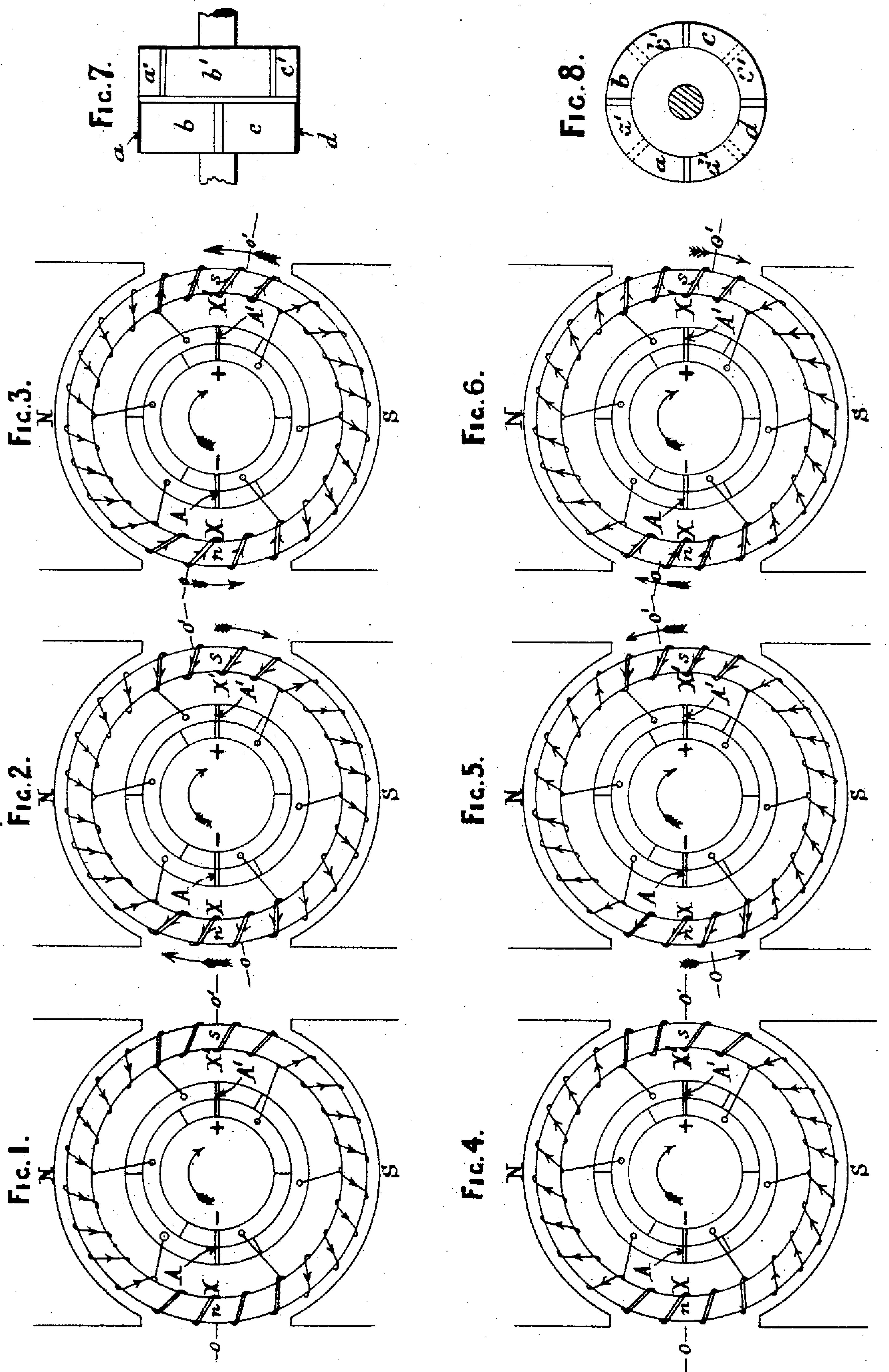

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Fig. 9.

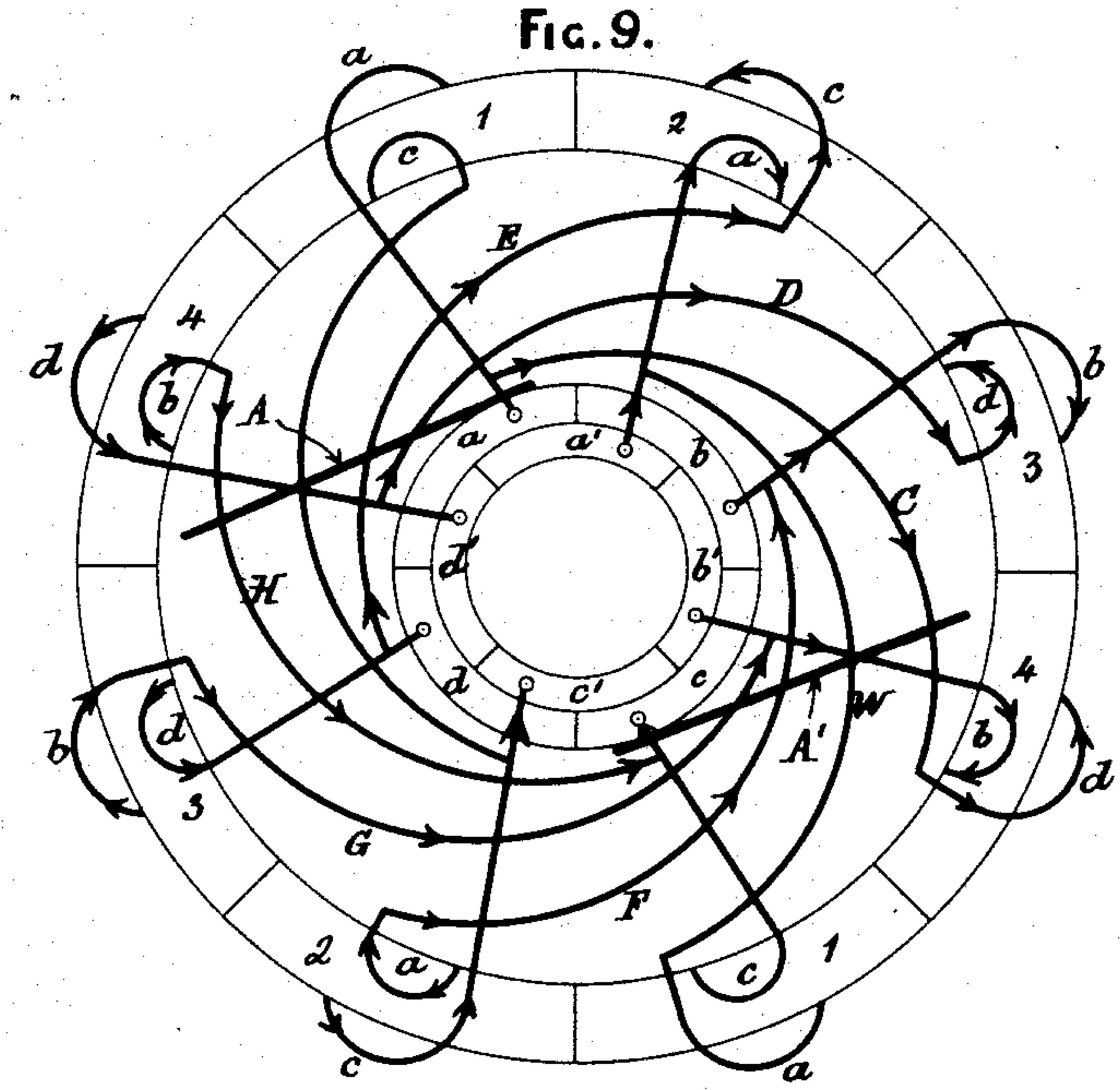
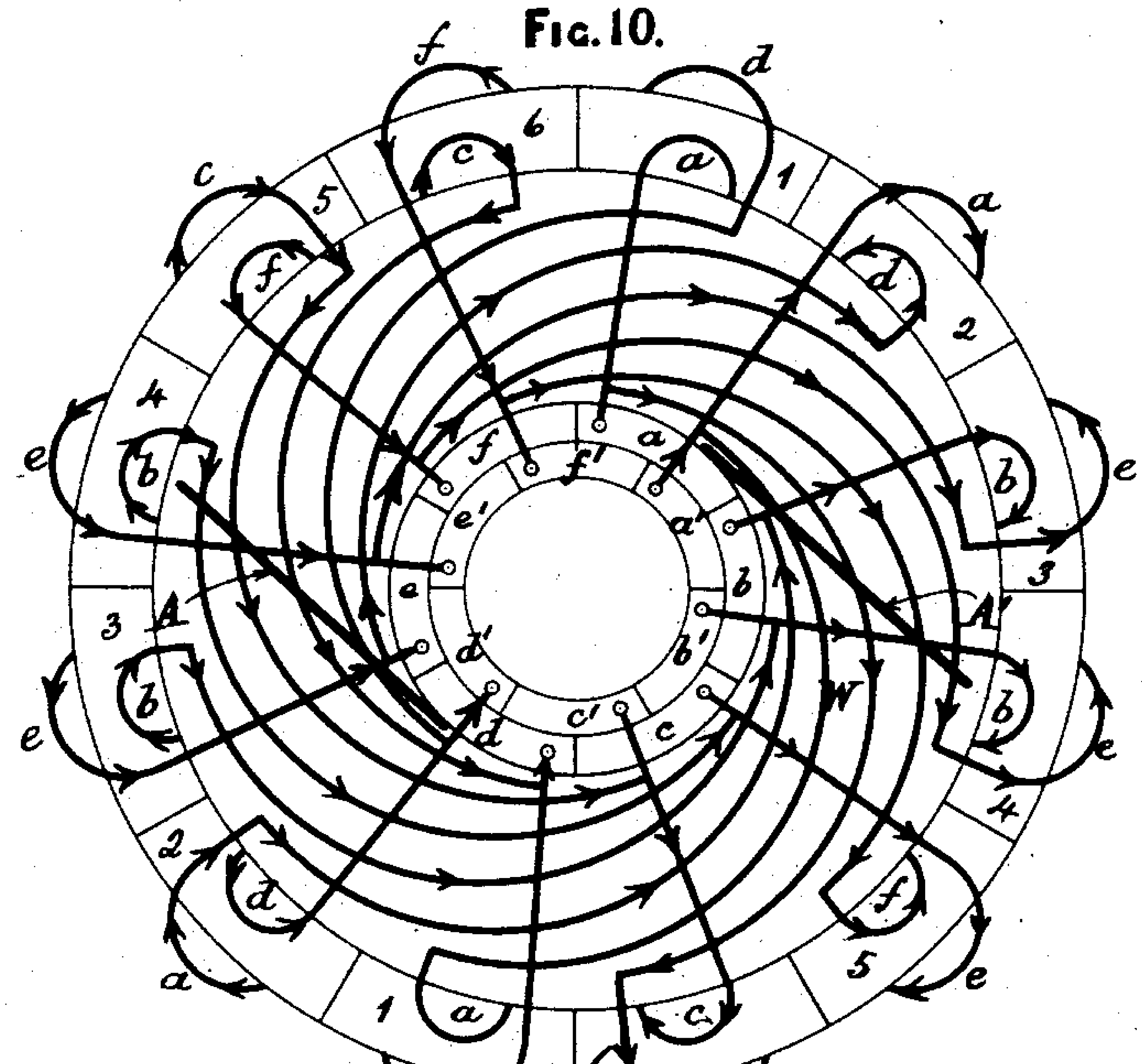


Fig. 10.



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UNITED STATES PATENT OFFICE.

MORITZ IMMISCH, OF LONDON, COUNTY OF MIDDLESEX, ENGLAND.

METHOD OF REGULATING ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 414,052, dated October 29, 1889.

Application filed February 2, 1888. Serial No. 262,715. (No model.) Patented in England March 2, 1886, No. 2,956; in France March 24, 1886, No. 174,998; in Belgium March 25, 1886, No. 72,498; in Canada February 17, 1887, No. 26,030; in Victoria February 18, 1887, No. 4,937; in New Zealand May 25, 1887, No. 2,354, and in India June 14, 1887, No. 27.

To all whom it may concern:

Be it known that I, MORITZ IMMISCH, a subject of the Emperor of Germany, residing at 119 Torriano Avenue, London, in the county of Middlesex, England, have invented a new and useful Improved Method of Correcting Distortion in Electromotors, (for which I have obtained a patent in Great Britain, No. 2,956, dated March 2, 1886; in France, No. 174,998, dated March 24, 1886; in Belgium, No. 72,498, dated March 25, 1886; in Canada, No. 26,030, dated February 17, 1887; in India, No. 27, dated June 14, 1887; in Victoria, No. 4,937, dated February 18, 1887, and in New Zealand, No. 2,354, dated May 25, 1887,) of which the following is a specification.

In electromotors as ordinarily constructed a well-known difficulty arises through the distortion of the magnetic field when the load of the motor increases to any extent, as is always the case when it has to overcome the inertia of any machinery it is intended to drive, or when the load varies greatly, as in the case of driving tram-cars, for example. The immediate consequence of such a distortion of the magnetic field is that, while the brushes retain their position, the neutral points shift, and the brushes are then in connection with wire which moves in an active part of the magnetic field instead of moving in the neutral part. The result is loss of efficiency, useless heating, and considerable sparking. The obvious remedy would be to shift the "lead"—a mode of correction which is constantly resorted to in the case of generators; but it has occurred to me that in the case of motors the defect carries the germ of its own remedy, inasmuch as the difference of potential created through the want of symmetry in the magnetic field will, if it results in a current, cause this current to flow in such a direction as to restore the symmetry of the magnetic field, and thus render the lead a constant one. In the case of a generator the effect of such a current would be to still further distort the symmetry of the field, and consequently aggravate instead of remedying the evil. My device is therefore not applicable to generators, but relates to electromotors only.

The invention consists in the method hereinafter described of operating an electric motor with constant lead by short-circuiting opposite armature-coils successively and maintaining a continuous operative electrical connection between the terminals thereof during the entire time said coils are passing at the neutral zone through an arc equal in length to one of the coil-sections of the armature, whereby, as the positions of the polar points of the field-magnets change with varying load and speed, the short-circuited coils will themselves generate currents acting to correct distortion of the field of force.

In order to enable my invention to be understood, I refer to the accompanying drawings, in which—

Figures 1, 2, and 3 are diagrammatic views showing what happens in the short-circuited portion of the armature-wire in the case of a motor at the normal load, less load, and overload, respectively. Figs. 4, 5, and 6 are similar diagrammatic views showing what would happen if the system was employed for generators at normal load, less load, and overload, respectively. Fig. 7 is a side elevation, and Fig. 8 an end elevation, of the commutator I employ. Fig. 9 shows the application of my invention to an armature having four coils, and Fig. 10 its application to an armature having six coils.

In Fig. 1 the brushes A A′ are supposed to be placed at the non-sparking point while the motor does the work it is designed for. The short-circuited portion X X′ (shown by double lines) passing the neutral point, no current is generated.

In Fig. 2 the load is less than normal, and the lead consequently lengthens out, as shown by the greater distance between *o* and the attracting-pole N, and also between *o′* and the opposite attracting-pole S, than was the case in Fig. 1. This amounts to the same thing as if the brushes had been shifted forward from the position they occupied in Fig. 1, the consequence being that the short-circuited portion X X′, being in an active part of the field, generates a current, as indicated by the arrows in such portion, this current being in such a direction as to produce, taken by itself, + polarity at the lower part and − polarity at the upper part of the armature. The real position of the armature-poles is a resultant of the polarity at o o' and that formed by the current in the short-circuited portion X X′, whereby this current immediately shifts the poles forward to the same position as shown in Fig. 1, and the current would consequently cease to flow in the short-circuited portion.

Fig. 3 shows the motor as overloaded, with the result of the lead shortening, as shown by the different position of the line o o'. It will be seen that the current in the short-circuited portion X X′ now runs in the opposite direction to what it did in Fig. 2, producing + polarity in the upper and − polarity in the lower part of the armature, the resultant poles in this case shifting back to the position shown in Fig. 1, which is of course again the position of no potential in the short-circuited portion X X′ of the wire.

Referring now to Figs. 4, 5, and 6, it will be seen that in the case of a generator this regulating action does not only not take place, but the current in the short-circuited portion X X′ would be in such a direction as to still further increase the lead in Fig. 5, whereas it shortened the lead in the corresponding case of a motor, Fig. 2, while in Fig. 6 it would still further shorten the lead, instead of increasing same, as in the corresponding case of a motor, Fig. 3. Any such short-circuiting must therefore be carefully avoided in the case of a generator, while in the case of a motor it is highly beneficial.

In order to carry out my invention, I employ a double commutator such as is described in my previous patent, No. 327,797, dated October 6, 1885; but, whereas in that patent the double commutator was applied to electromotors and dynamo-machines having three or more open circuits, in the present case I apply such double commutator to the armatures of electromotors only having a single closed circuit, such as are commonly used in the well-known Gramme and Siemens armatures, without reference to any special number of coils.

The commutator is illustrated in Figs. 7 and 8 of the drawings, which represent a commutator for use with an armature having four coils, the same as shown in Fig. 9 of the drawings.

In Figs. 9 and 10 the two sets of commutator-segments are shown one within the other, so as to enable both sets to be seen in the same figure, and also the positions they occupy in relation to each other. There are double the number of commutator-segments that there are coils in the armature, and such segments are divided into two sets or series a, b, c, and d being in one set and a', b', c', and d' in the other set, the two sets having an angular displacement in relation to each other such that the line of division between two segments in one series is opposite the middle of a segment in the other series—that is to say, the line of division between segments b and c in one set is opposite the middle of segment b' in the other set and the other segments are similarly arranged in relation to each other. I employ only two brushes A and A′, each of which overbridges the two series of commutator-segments.

Referring to Fig. 9, in which an armature having four coils is illustrated, it will be seen that I connect the ends of each coil to consecutive segments belonging to different series. Part of each coil is wound on one section of the armature and the other part of such coil is wound on another section of the armature. For instance, it will be seen that coil a in Figs. 9 and 10 is wound partly on the section marked 1 and partly on the section marked 2; but the two parts are connected, as shown by line W, so that they form only one coil, and the other coils are similarly arranged.

In Fig. 9 it will be seen that one end of coil a is connected to segment a in one series, while the other end is connected to segment a', which is the consecutive or following segment in the other series. One end of coil b is connected to the next consecutive segment b in the first-mentioned series, while the other end of such coil b is connected to the next consecutive segment b' in the second series. One end of the coil c is connected to the next consecutive segment c in the first series, and its other end to the next consecutive segment c' in the second series. The coil d is similarly connected, and when more coils (and consequently more commutator-segments in each series) are employed they are connected in the same manner—that is, one end of each coil to a segment in one series and the other end of same to the following or consecutive segment in the other series.

In Fig. 10 an armature having six coils is shown. No matter what number of coils are employed the whole are connected so as to form one continuous or closed circuit, and the mode of connection of the different coils themselves to the two sets of commutator-segments is in all cases identical with that above described.

In Fig. 9 the positive brush A is shown as resting on segment a in one series and segment a' in the other series, while the negative brush A′ rests on segment c in one series and segment c' in the other series, it being remembered that each brush overbridges or rests upon the two series of segments. When the brushes are in this position, it follows that a current entering by brush A is conveyed to segment a, and as the same brush also rests on segment a' in the other series it follows that as one end of coil a is connected to segment a and the other end to segment a' the part of coil a on section 1 of the armature (that is, the part of such coil between segment a and segment a') will for the time being form, so to speak, part of such brush—that is, it will have no connection with the negative brush—and consequently no current can pass through this half of coil *a*, which will remain thus short-circuited upon itself so long as brush A rests upon both of the segments *a* and *a'*. Similarly, the part of coil *c* on section 1 will be short-circuited upon itself, because as long as the negative brush A' rests on segment *c* in the one series and also on the segment *c'* in the other series it follows that as one end of coil *c* is connected to segment *c* and the other end to segment *c'* the part of coil *c* on section 1 (that is, the part between the segments *c* and *c'*) will form for the time being, so to speak, part of such brush—that is, it will have no connection with the positive brush—and consequently no current can pass through this part of coil *c*, which will remain thus short-circuited upon itself so long as the brush A' rests on both segments *c* and *c'*. The whole of the wire on section 1 will thus be short-circuited upon itself. The current, however, supplied by positive brush A will have an outlet through the connection between coil *a* and the part of coil *d* on section 4 of the armature, as shown by line C, and such current will pass through this part of coil *d*, then by connection D to the other part of coil *d* on section 3, thence by connection E to the part of coil *c* on section 2, and as this part of coil *c* is connected to segment *c'*, on which the negative brush A' bears, the current will thus be taken off. At same time, as positive brush A also rests on segment *a'*, the current will also pass through the part of coil *a* on section 2 by connection F to the part of coil *b* on section 3, and by connection G to the part of coil *b* on section 4, and as the latter is by connection H joined to the part of coil *c* on section 1, and this is connected to segment *c*, on which brush A' also bears, the current will thus be taken off. The arrows show the course of the current. It thus follows that, although the part of the armature-wire on section 1 is short-circuited upon itself when the brushes are in the position shown, the whole of the other part of such wire is operative and tends to produce poles in the armature at that part of the core which is surrounded by the wire which is short-circuited upon itself. A similar action takes place when the brushes by the rotation of the armature occupy different positions to those shown. For instance, when brush A rests on segments *b* and *b'* and brush A' on segments *d* and *d'* the whole of the wire on section 3 will be short-circuited upon itself, while the wire on the other sections of the armature will all be operative.

The above action will take place in an armature having any number of coils, and Fig. 10 shows the application of the system to an armature having six coils, the connections and operation being the same as that above described; but as there are a greater number of commutator-segments the short-circuiting will occur a greater number of times in each revolution, while the amount of the total length of wire short-circuited each time will be less than in the former case.

What I claim as my invention, and desire to secure by Letters Patent, is—

The method herein described of operating electric motors with constant lead, which consists in short-circuiting opposite armature-coils successively and maintaining a continuous operative electrical connection between the terminals thereof during the entire time said coils are passing at the neutral zone through an arc equal to the length of one coil-section of the armature, whereby as the positions of the polar points of the field-magnets change with varying load and speed the short-circuited coils will themselves generate currents acting to correct distortion of the field of force, substantially as described.

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Witnesses:

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P. K. WOODWARD.