H. & E. ROSENBERG.

WINDING FOR ELECTRIC MACHINERY.

APPLICATION FILED JUNE 17, 1904. RENEWED MAY 28, 1909.

954,468. Patented Apr. 12, 1910.

4 SHEETS—SHEET 1.

Fig. 1.

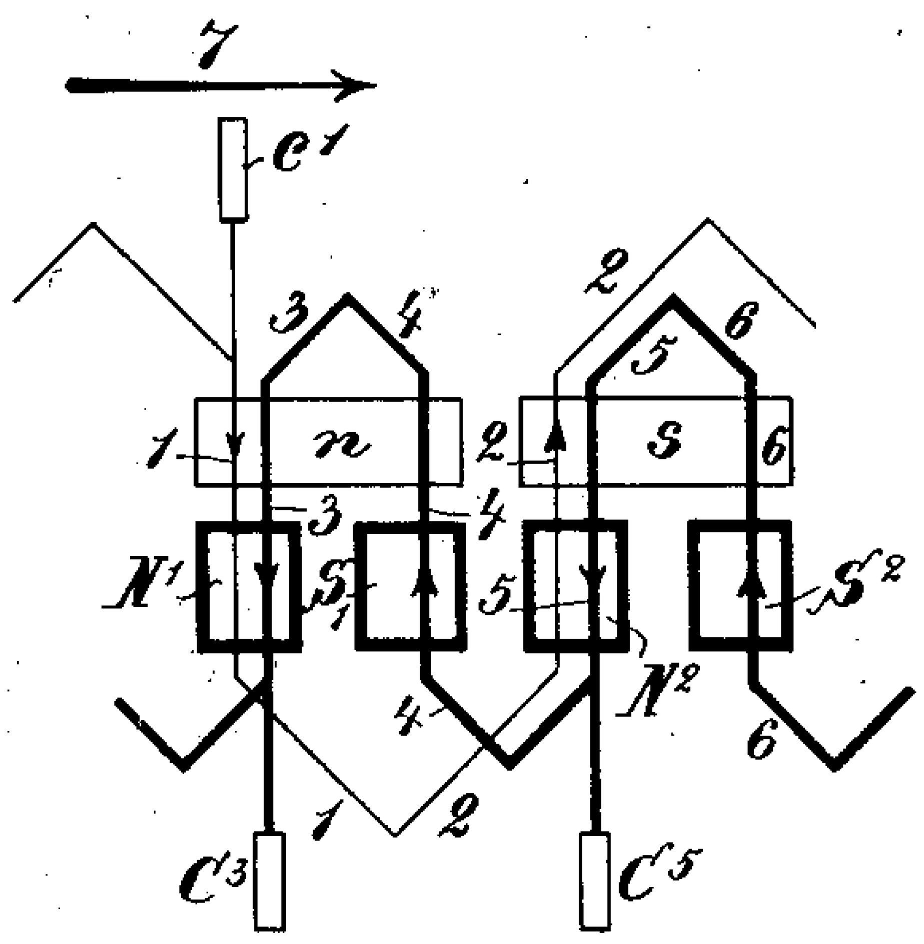

Fig. 2.

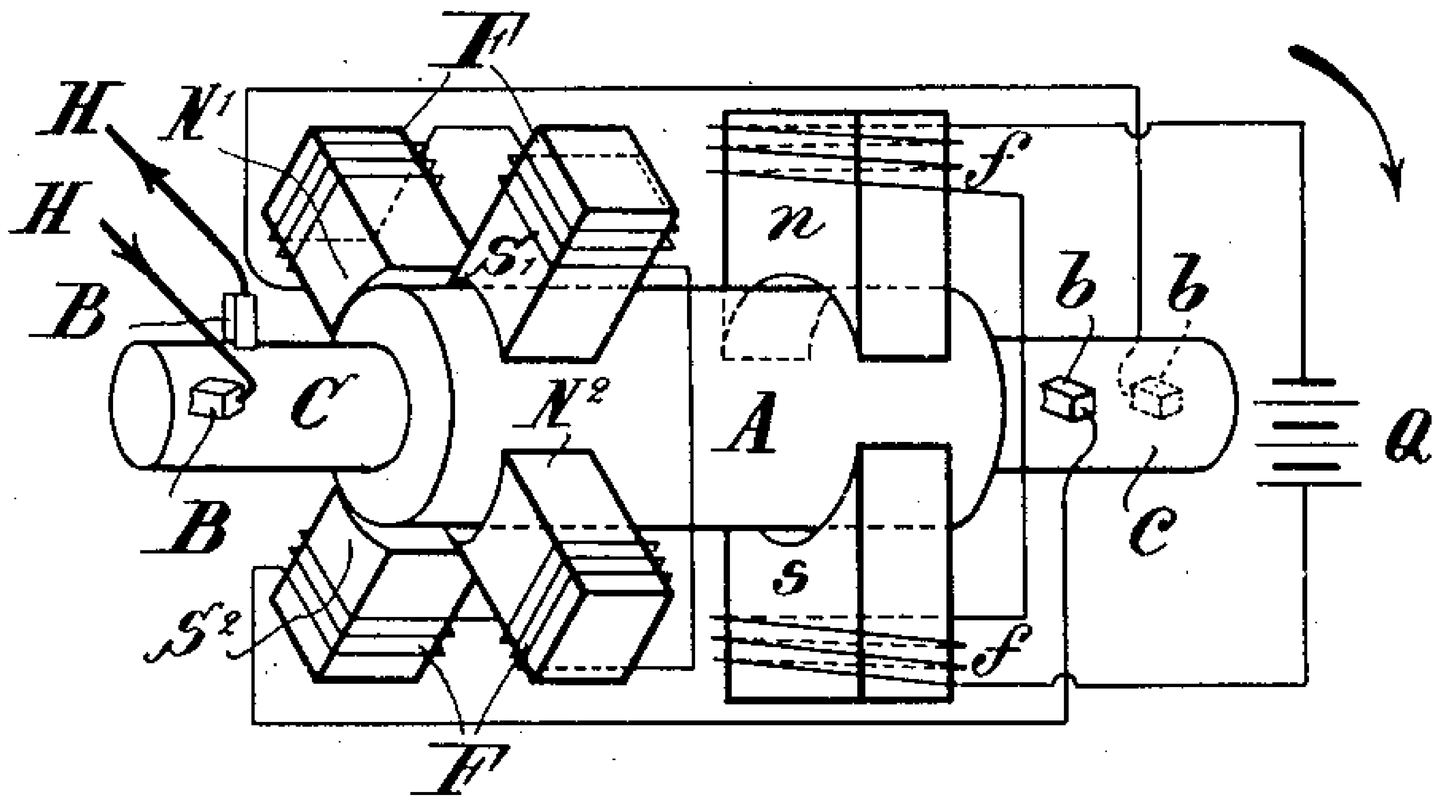

Fig. 3.

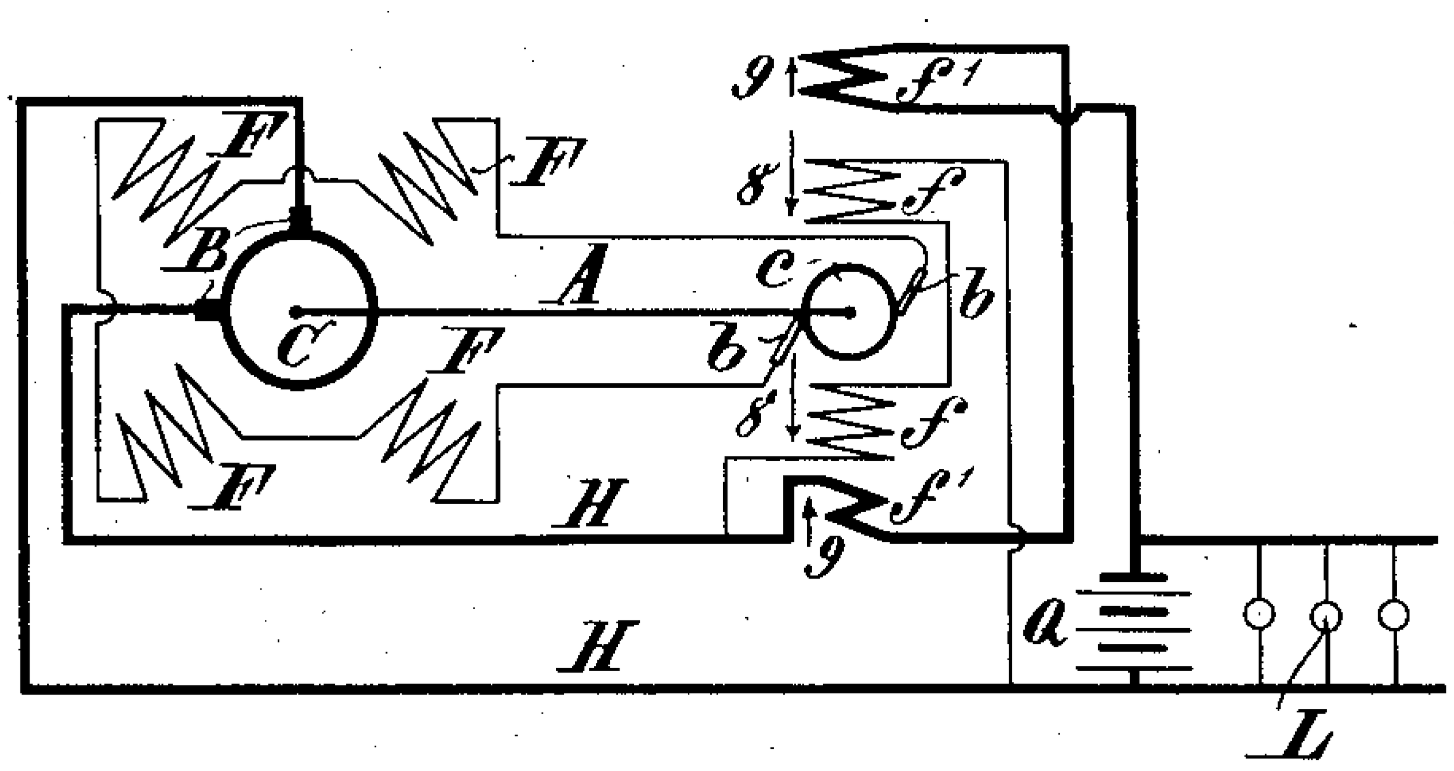

Fig. 5.

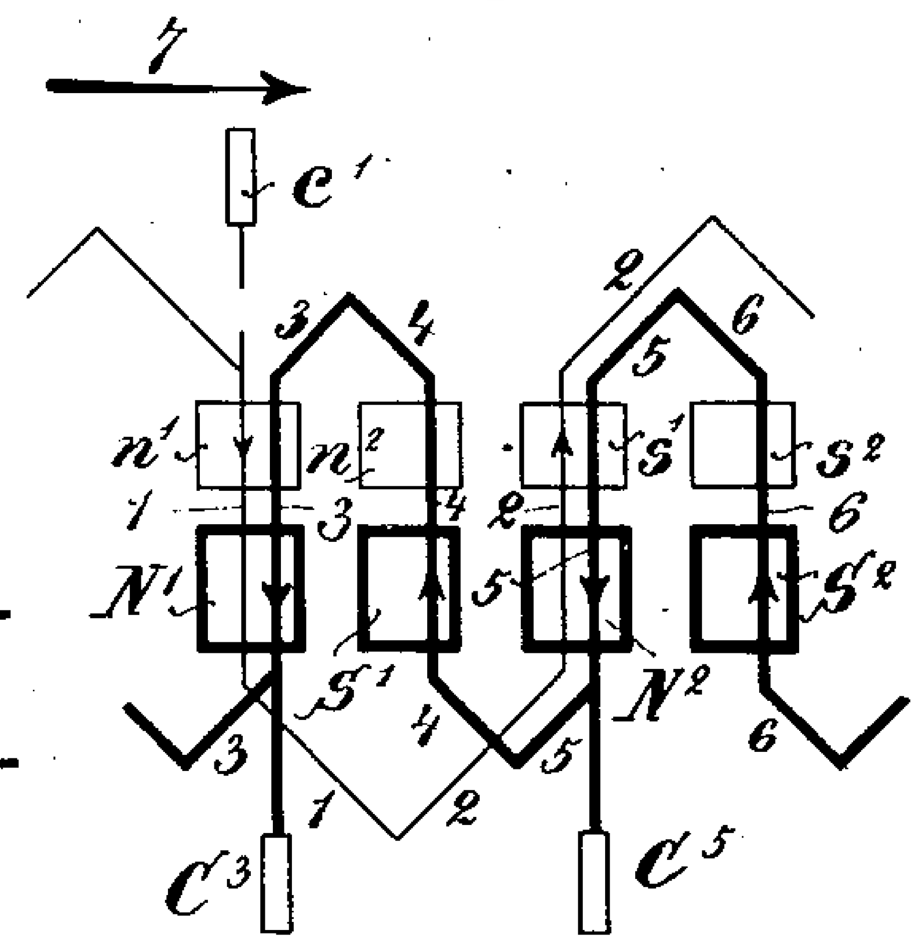

Fig. 4.

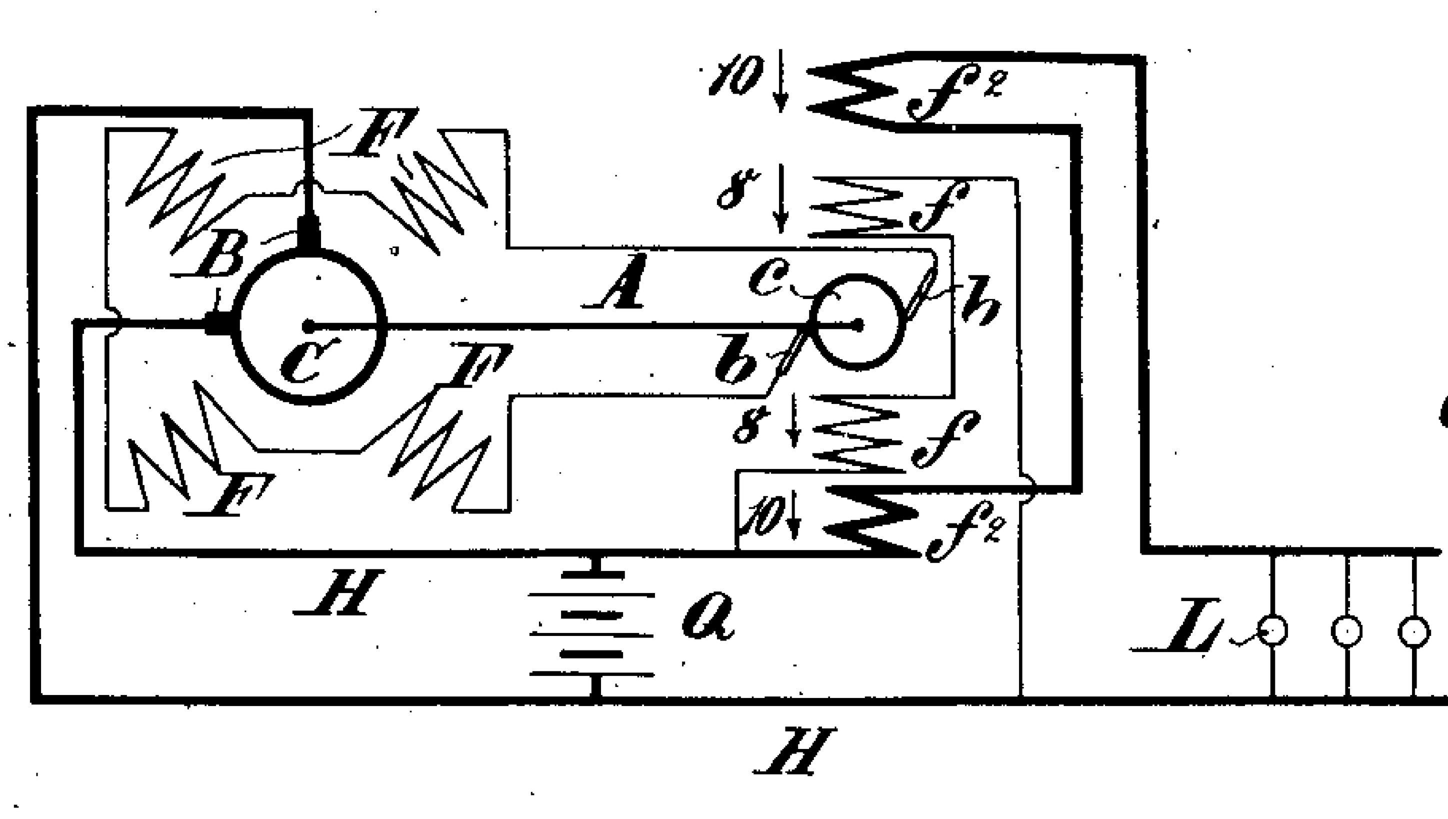

Fig. 6.

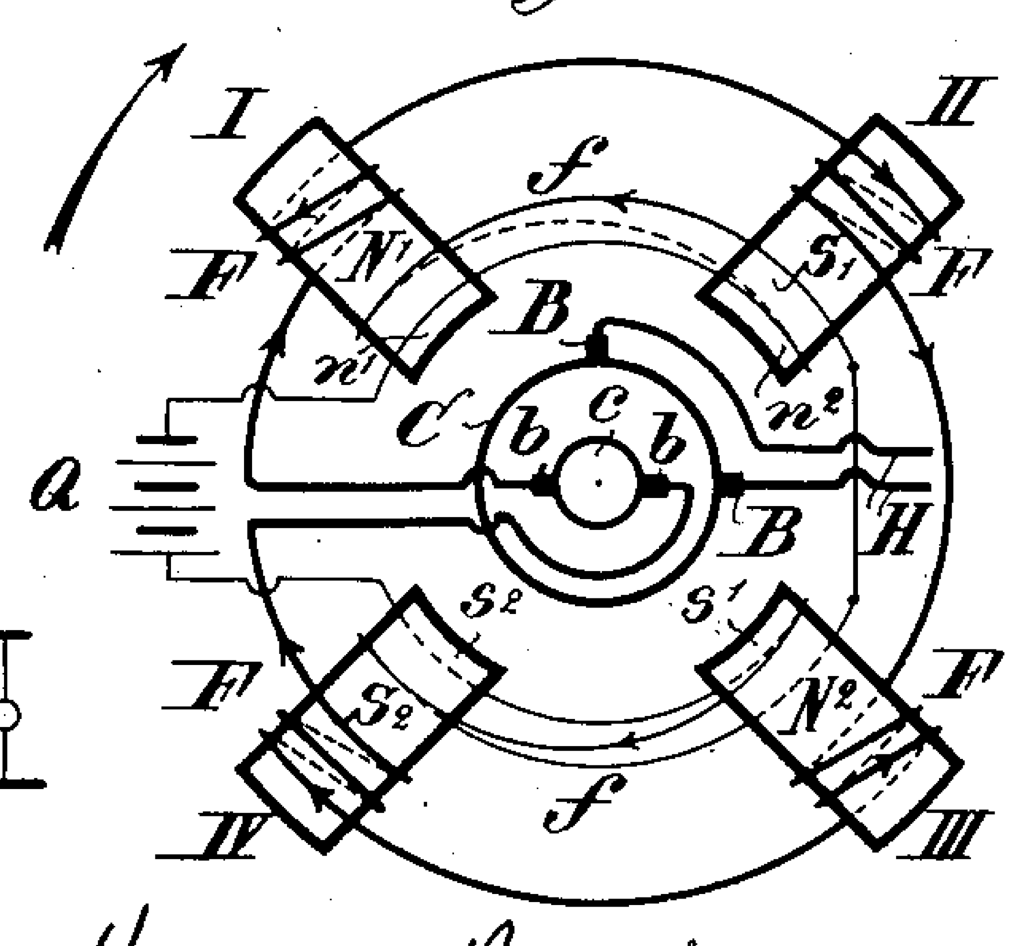

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Fig. 7.

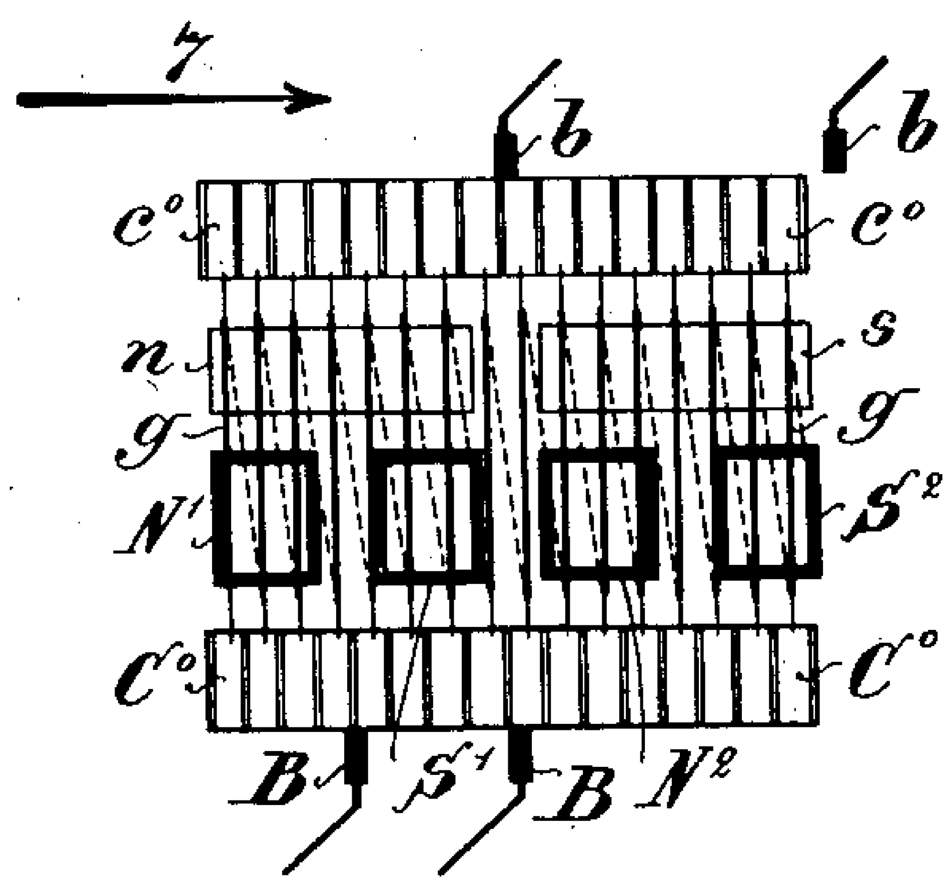


Fig. 8.

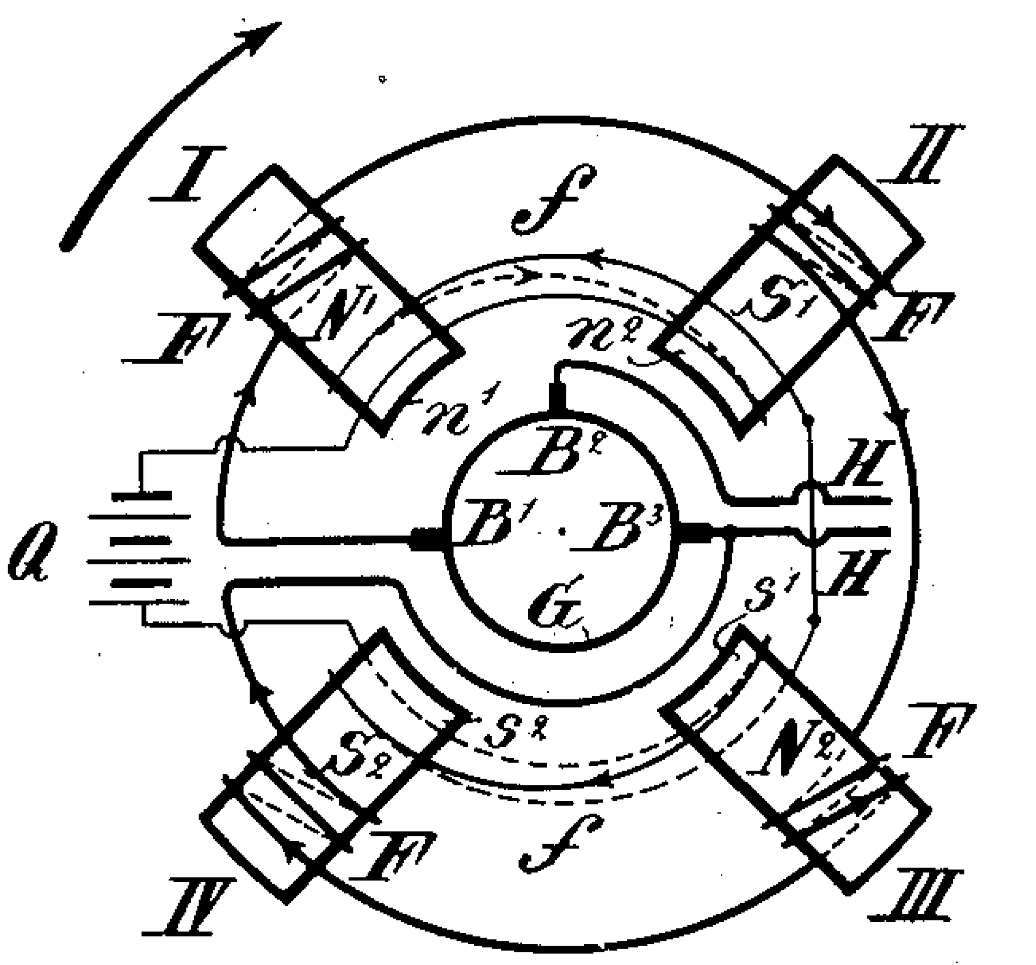


Fig. 10.

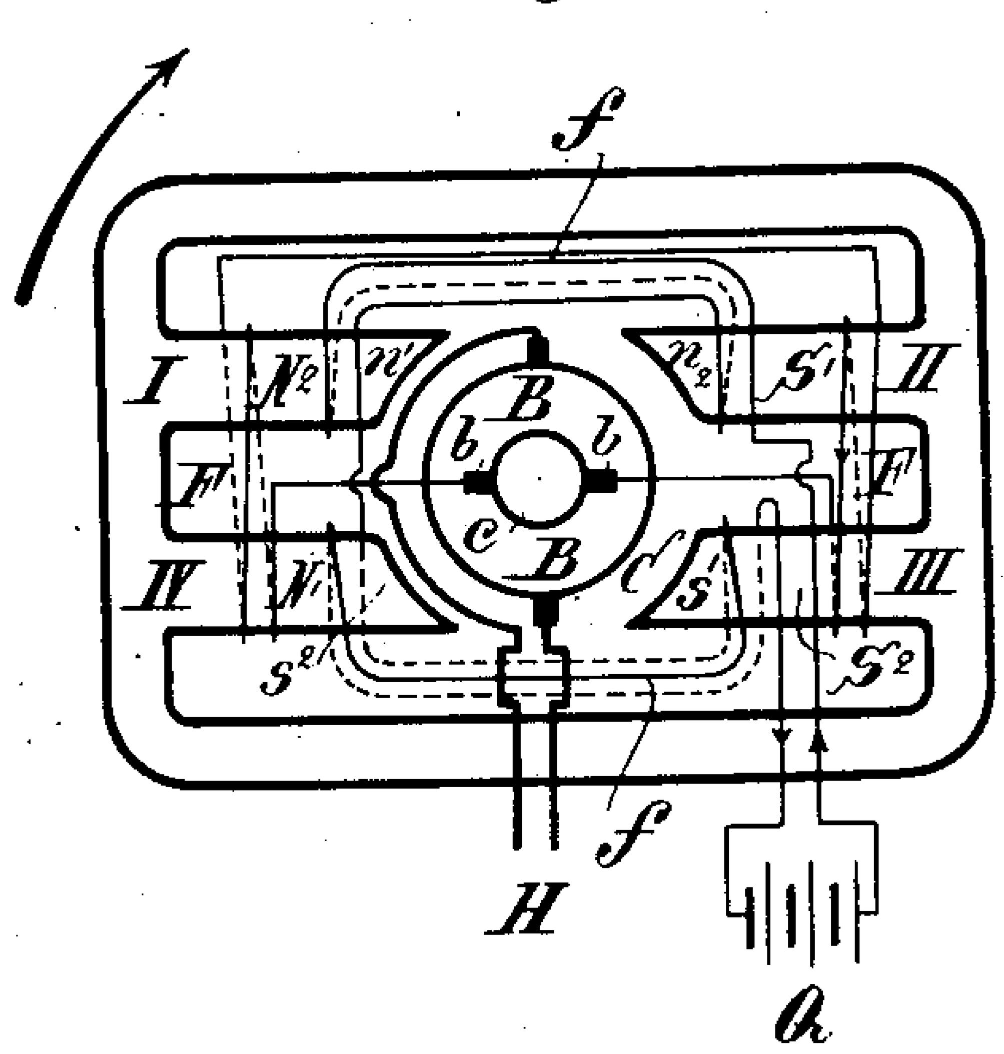


Fig. 9.

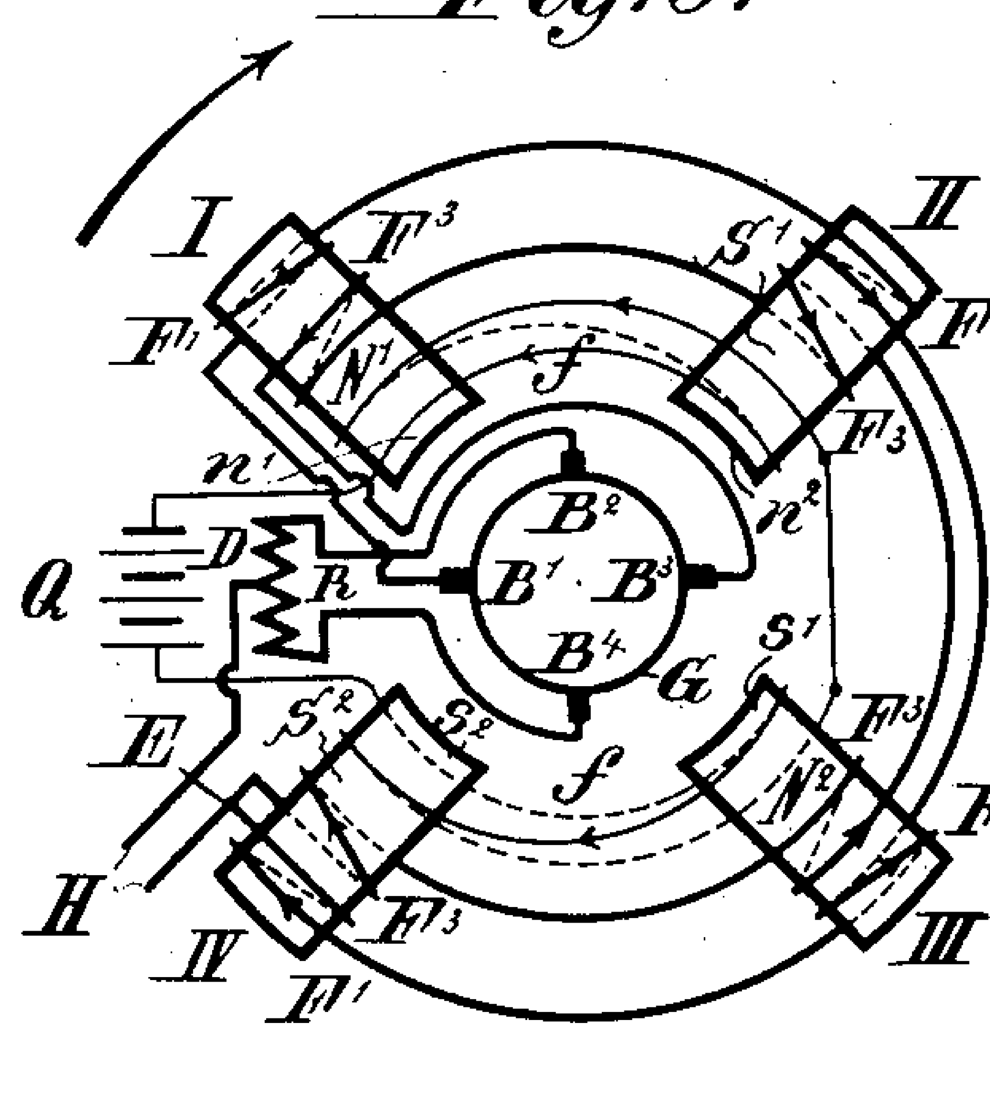
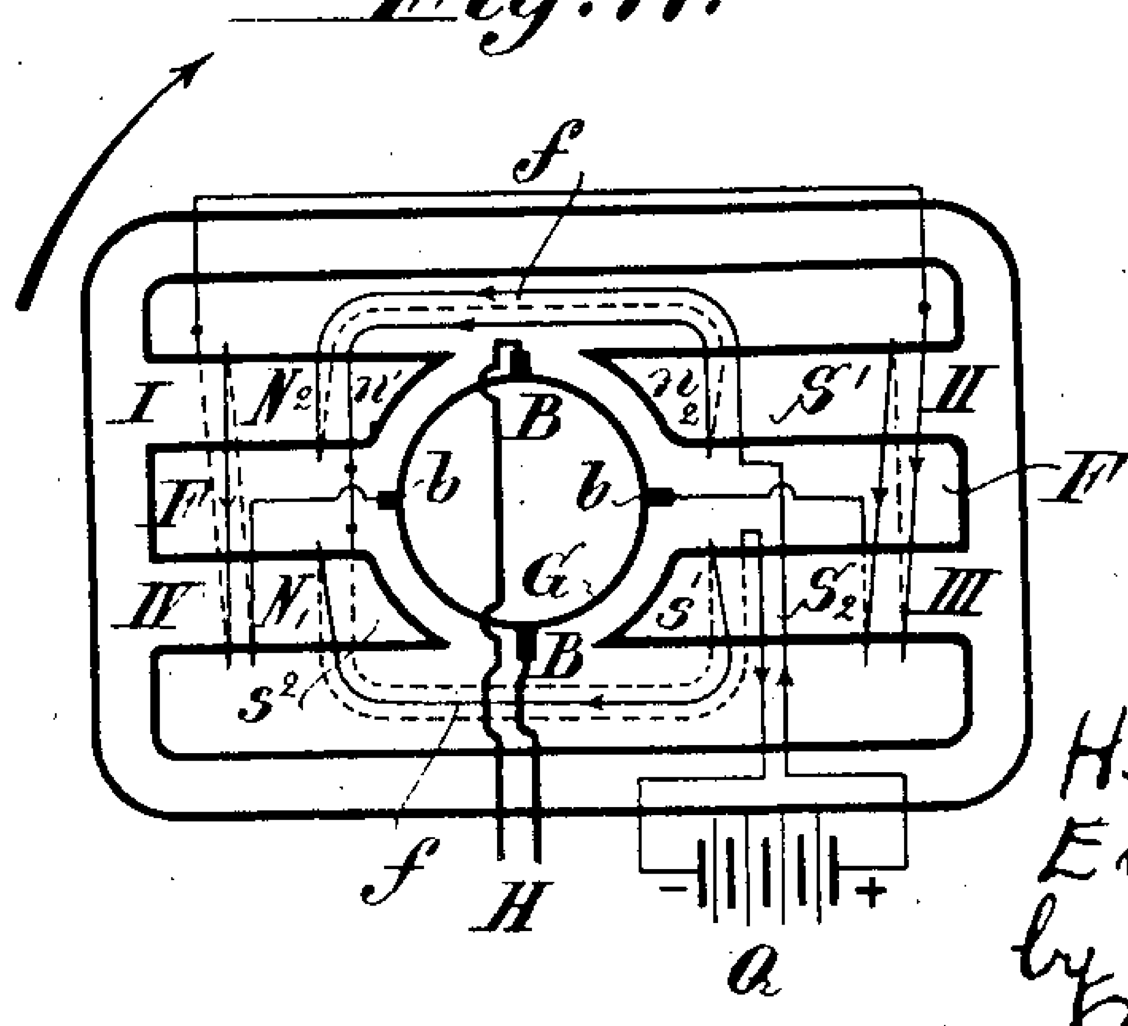


Fig. 11.



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4 SHEETS—SHEET 3.

Fig. 12.

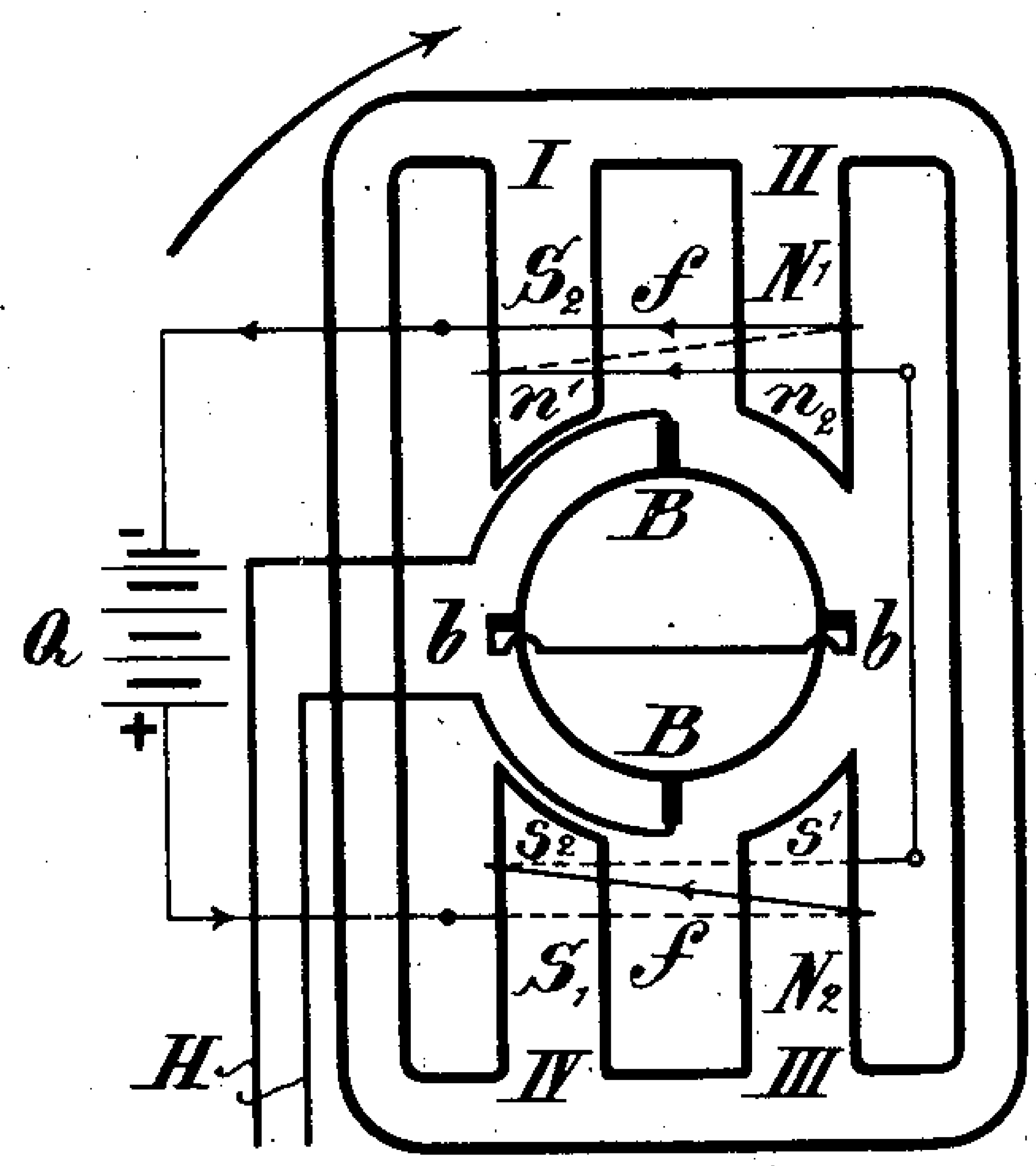


Fig. 13.

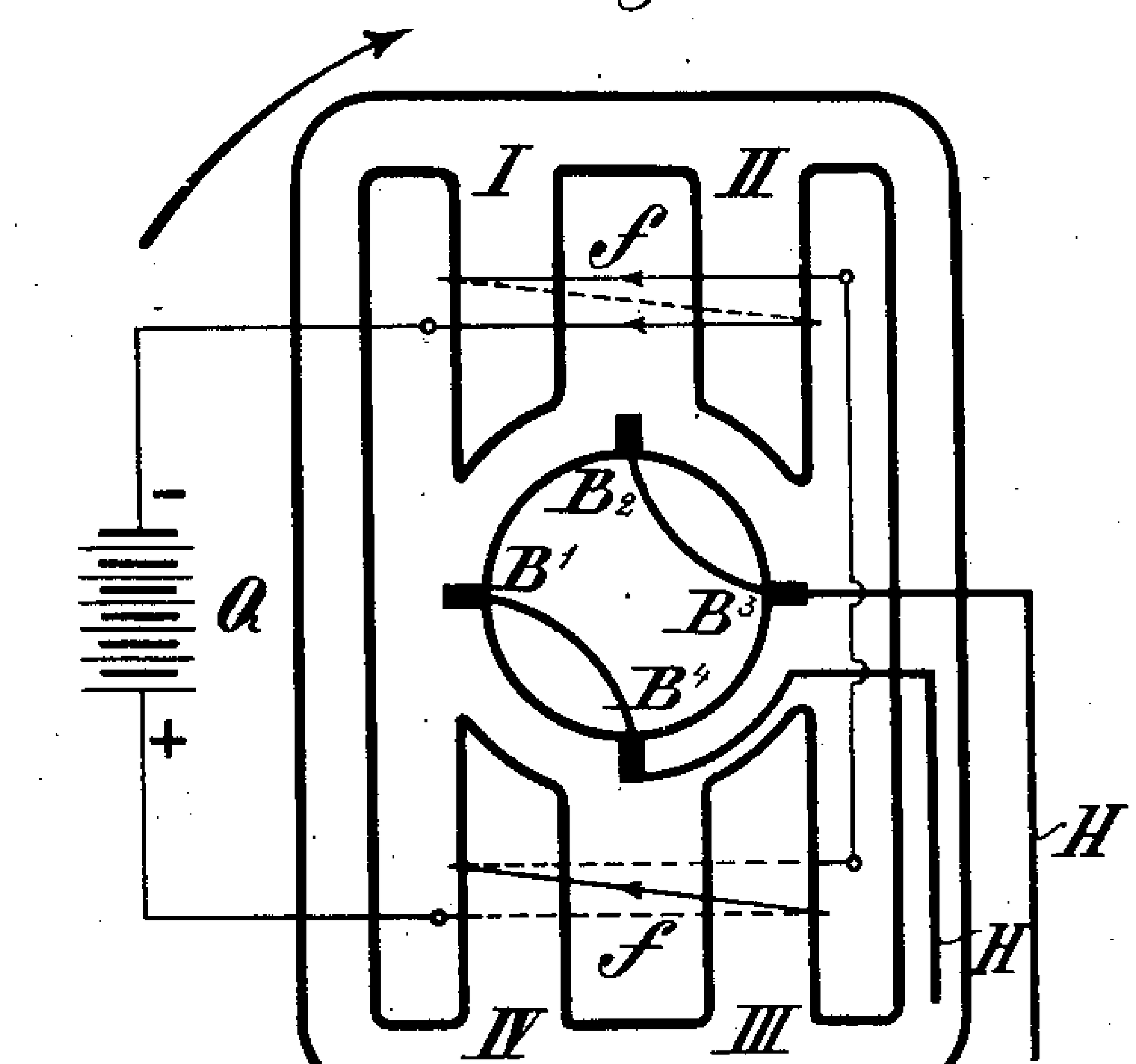


Fig. 14.

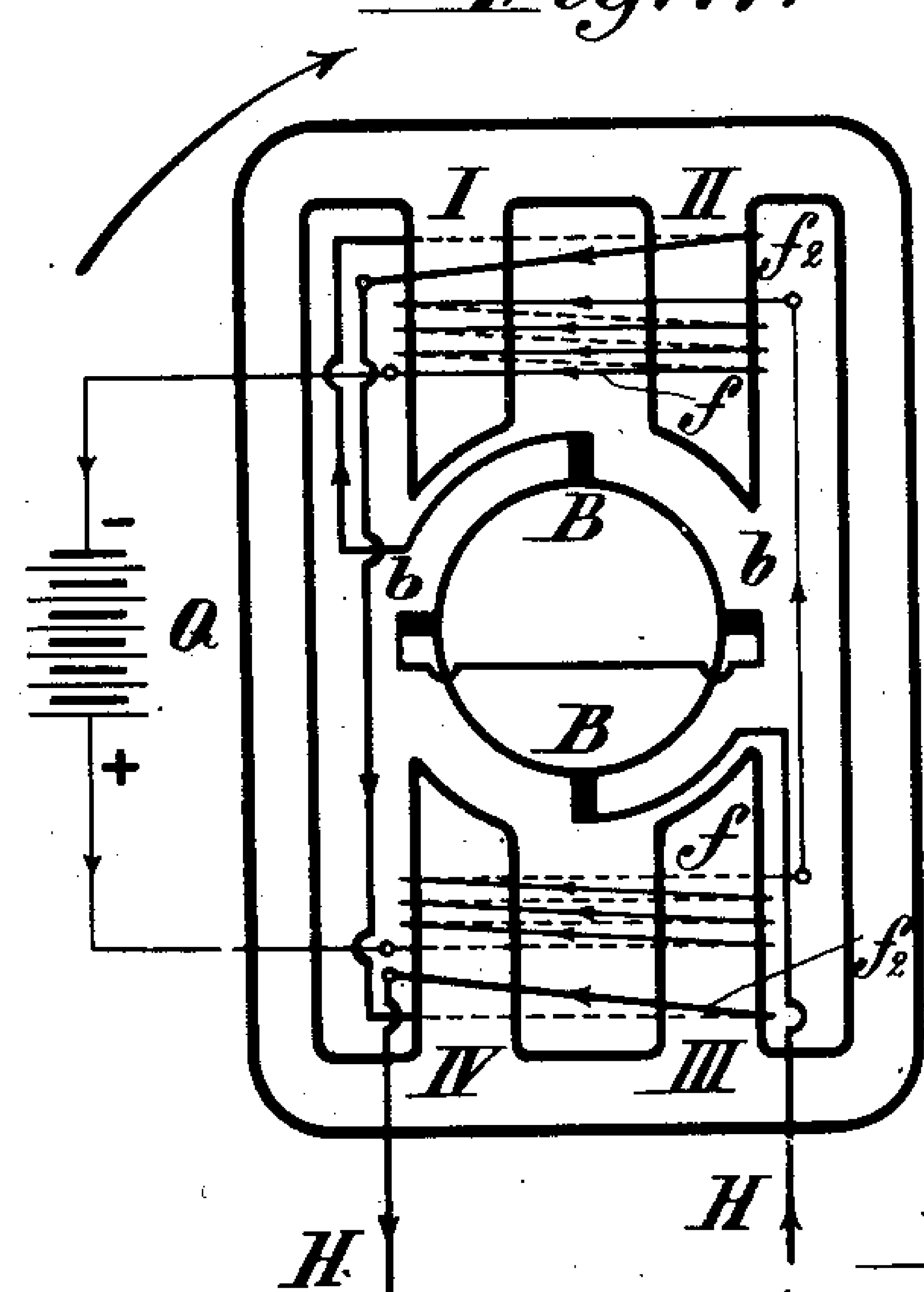


Fig. 16.

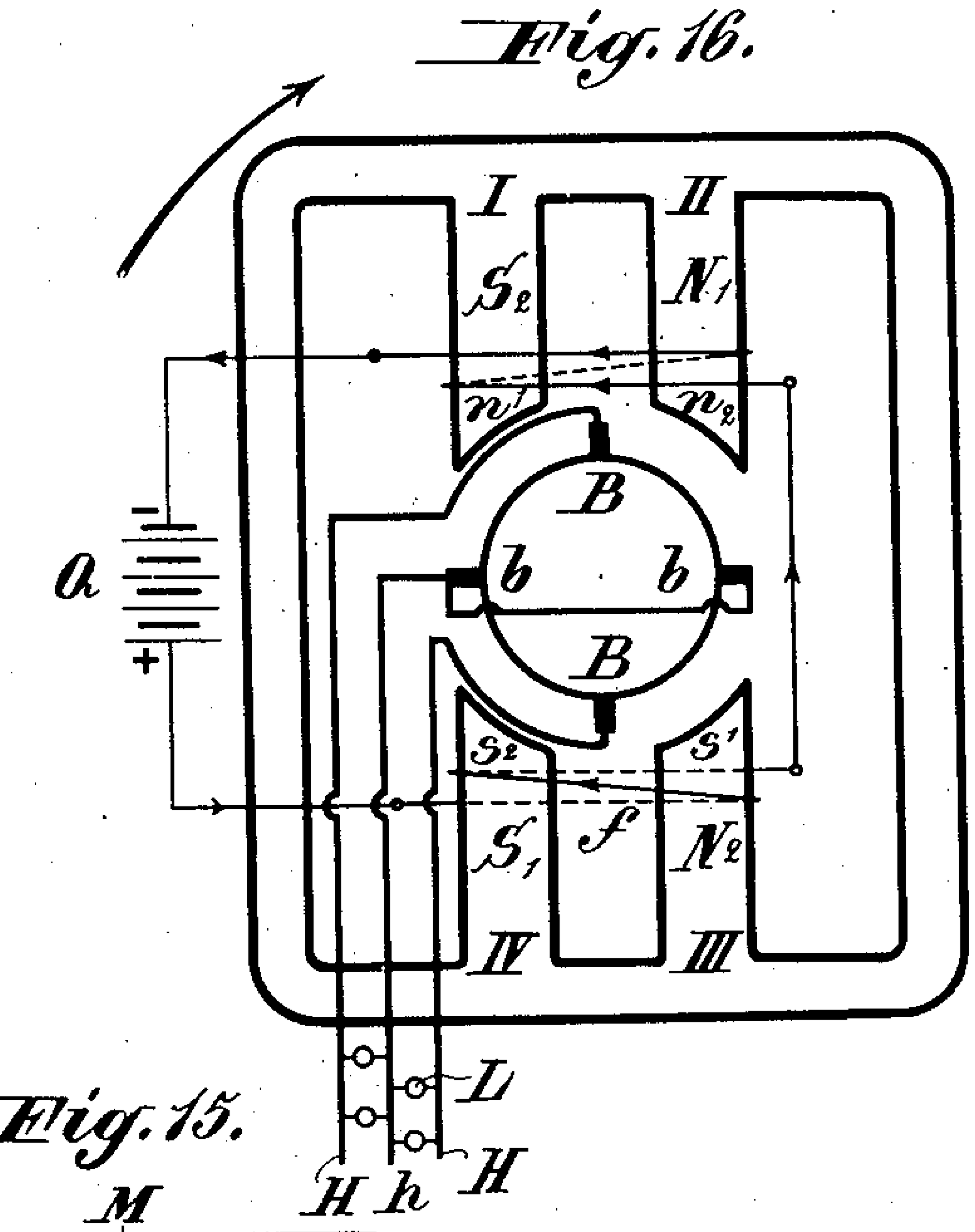
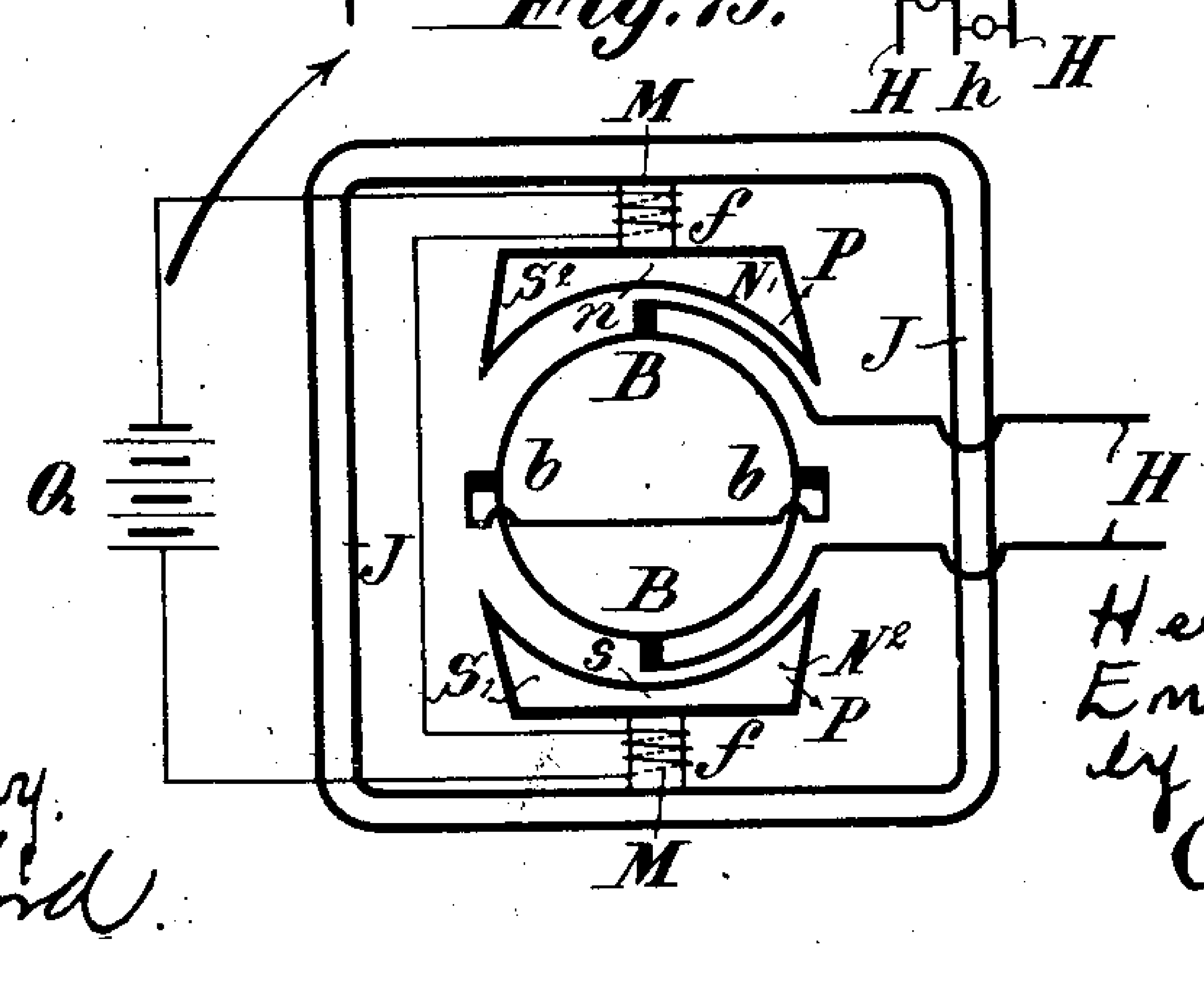


Fig. 15.



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4 SHEETS—SHEET 4.

Fig. 17.

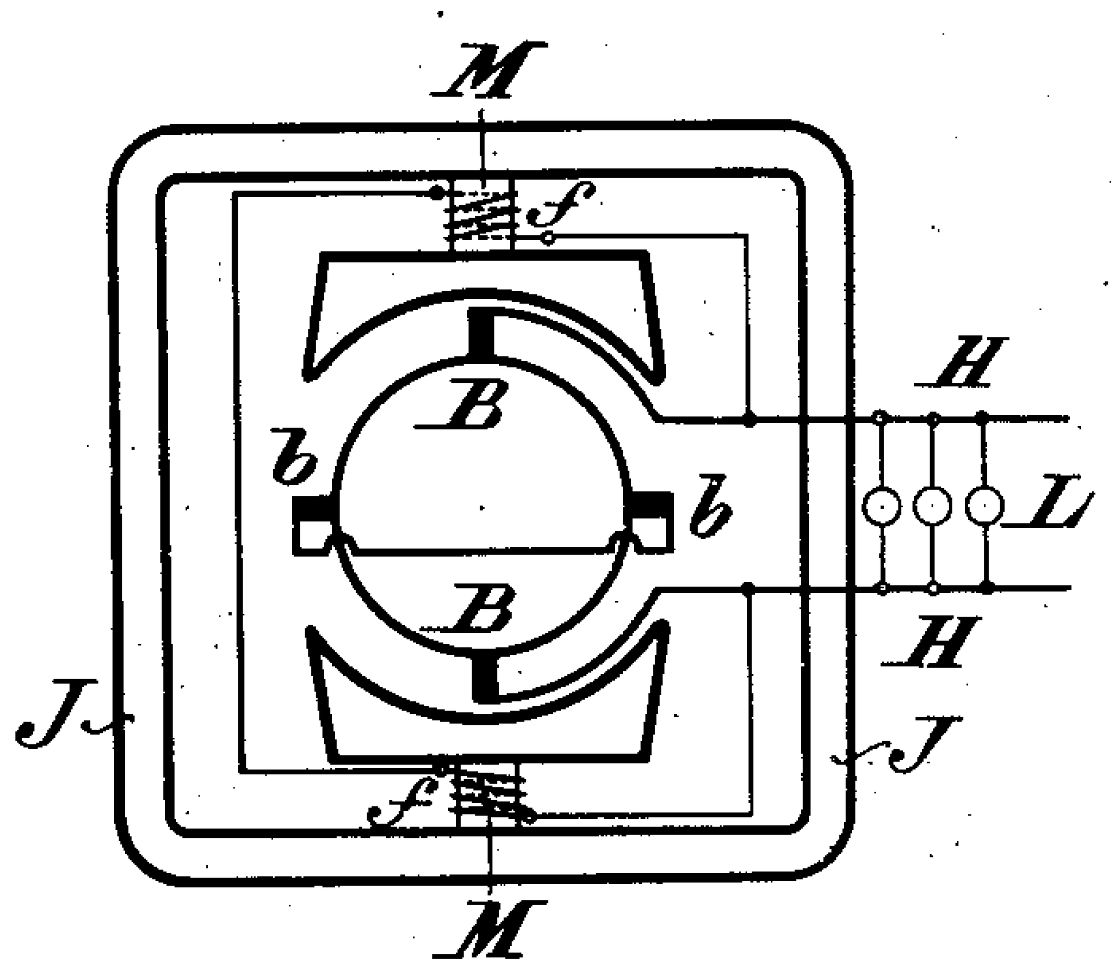


Fig. 18.

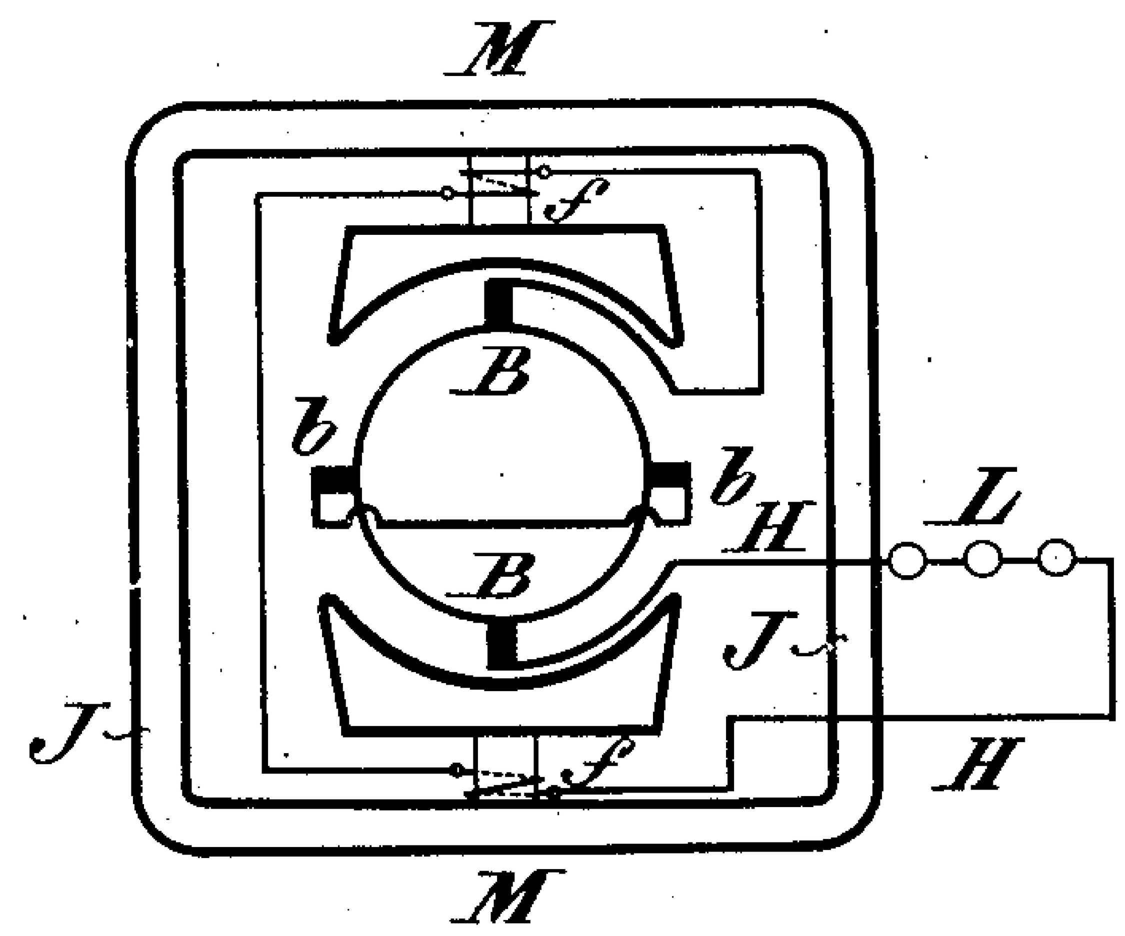
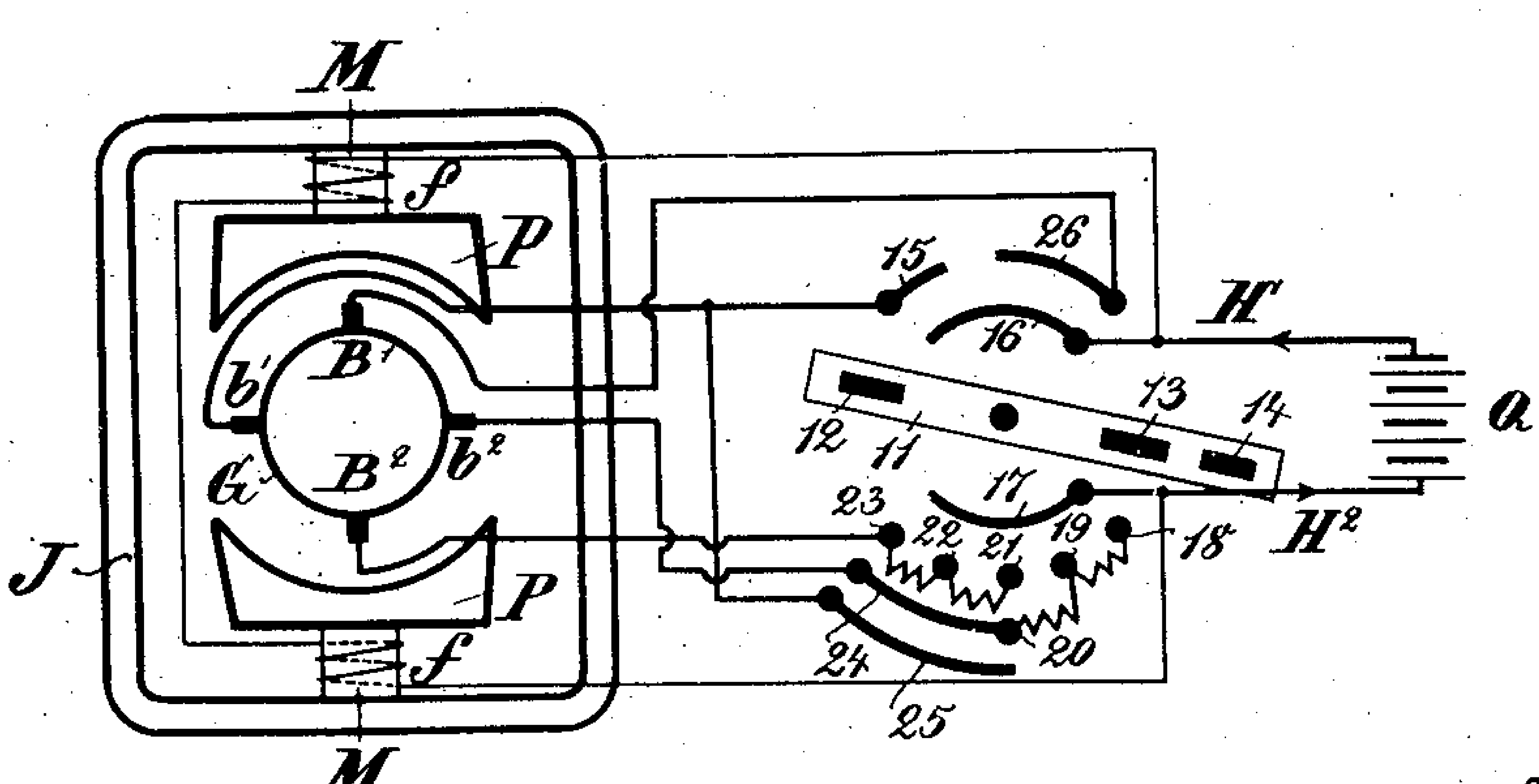


Fig. 19.



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UNITED STATES PATENT OFFICE.

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WINDING FOR ELECTRIC MACHINERY.

954,468. Specification of Letters Patent. **Patented Apr. 12, 1910.**

Application filed June 17, 1904, Serial No. 213,015. Renewed May 28, 1909. Serial No. 498,962.

To all whom it may concern:

Be it known that we, HEINRICH ROSENBERG, of Vienna, Austria-Hungary, (whose post-office address is No. 21 Liechtensteinstrasse, Vienna, IX[1],) and EMANUEL ROSENBERG, of Berlin, Germany, doctor of technics, (whose post-office address is No. 59 Brunnenstrasse, Berlin,) both subjects of the Emperor of Austria-Hungary, have invented a new and useful Winding for Electric Machinery, of which the following is a specification.

The present invention relates to dynamos which, in consequence of the arrangements provided for their excitation, have special advantages in connection with their regulation. In the first place in order that the invention may be clearly understood, it will be shown that one armature can be influenced by two magnetic fields, so that a double action takes place and the single dynamo works like a dynamo set consisting of main dynamo and regulating dynamo to produce a self-regulating current of constant direction although the direction of rotation and velocity are subjected to variations.

The invention is illustrated by the drawings, in which—

Figure 1 is a diagram of armature coils of different pitch of poles. Fig. 2 is an illustration of a dynamo with one armature acted upon by two magnetic fields of different pitch of poles. Figs. 3 and 4 are diagrams showing modifications of the excitation. Figs. 5 and 6 are modifications of Figs. 1 and 2 respectively. Fig. 7 is a modification of Fig. 1 with a Gramme armature winding. Figs. 8 and 9 are modifications of Fig. 6 with a single commutator. Fig. 10 represents a form of dynamo with two magnetic fields of the same pitch of poles at right angles to each other. Fig. 11 the same with a single commutator. Fig. 12 is a modification founded on the principle of armature reaction. Figs. 13, 14, 15 are modifications thereof. Fig. 16 shows the same modification in connection with a three wire system. Figs. 17 and 18 are modifications with self-excitation. Fig. 19 shows the invention applied to a motor with means for starting.

The self-regulating action of the illustrated dynamos is in close connection with the remarkable feature that they are able to give current of the same polarity for either direction or rotation.

It is well known that the polarity of dynamo brushes remains the same, if the magnetic field and the direction of rotation are simultaneously reversed, for instance if the field of a main dynamo is excited by the armature current of a directly coupled exciter whose field has a constant direction. In the present invention, however, a separate exciter is avoided and the dynamo itself acts as the exciting dynamo and also as the main dynamo. The problem is to cause two magnetic fields to act upon a single armature with one or two windings; one field never becoming reversed, so that a current changing with the direction of rotation is supplied from the armature brushes appertaining thereto, and a second field excited by the above mentioned current and changing therefore with the direction of rotation so that the armature brushes appertaining thereto have a constant polarity independent of the direction of rotation. In order to attain this result it is of course necessary to cause the direct action of each field on the armature winding which does not appertain to it to be small. The present invention discovers two ways to attain this result, the one by arranging the two fields and windings for a different number of poles, the other by arranging the magnetic axes of the two fields, in the case of a two pole field, to be approximately at right angles one to another.

In Fig. 1 it is diagrammatically shown that a two pole drum wave winding and a four pole drum wave winding wound at the same armature can be acted on inductively at the same time by a two pole field and by a four pole field and that the inducing effect is the same as if each winding were only acted on inductively by the field of the corresponding number of poles. The fine drawn lines 1 and 2 represent the wires forming an element of the two pole winding, the full drawn lines 3, 4, 5, 6 represent an element of a four pole drum wave winding. The wires 1, 3, 5 are connected respectively with commutator bars c^1 on the one side and

C^3 and C^5 on the other side in such a way that coördinate wires and bars are situated in the same line as is usually the case with Gramme armatures. That is done in order to have no difference with regard to the position of the brushes in the following illustrations whether a Gramme winding or a drum winding may be employed. There is shown also a two pole field *n s* in fine lines and a four pole field N^1 S^1 N^2 S^2 in full lines. It is to be understood that the winding is seen from the interior of the armature the poles lying behind the wires of Fig. 1. If now the wires are moved to the right hand as indicated by the arrow 7, north pole *n* will induce in wire 1 a voltage directed downward, south pole *s* in wire 2 a voltage directed upward. It is true, wire 1 is influenced also by the north pole N^1 of the four pole field, that tends to induce also a downward directed voltage. But as at the same time the second north pole N^2 of the four pole field tends to induce a downward directed voltage in wire 2 the resulting voltage of the element 1, 2 remains the same as if the four pole field did not exist. The four pole field affects only the E. M. F.'s of the single wires 1 and 2 and makes them unequal; whereas the sum of the E. M. F.'s is unaffected. In the wires 3 and 5 a downward directed voltage is induced by the poles N^1 and N^2, in the wires 4 and 6 an upward directed voltage by the poles S^1 and S^2. North pole *n* of the two pole field induces in both wires 3 and 4 a downward directed E. M. F., but as they oppose each other the voltage of the whole element is not affected by them. In the same manner the upward directed voltages in the wires 5 and 6 induced by the pole *s* of the two pole field have no effect in the sum voltage. The two pole field, although acting inductively upon each wire of the four pole winding, has no influence on the total voltage of the winding. If now the two pole field is excited in a constant sense, the current supplied from the two pole armature winding will alter of course its direction if the direction of rotation is reversed and this current may be employed for the excitation of the four pole magnetic system, so that a rectified current which is independent of the direction of rotation can be supplied from the four pole armature winding.

In Fig. 2 an armature core A is shown, the two windings of which are supposed to be arranged in accordance with Fig. 1. The armature has two different commutators *c* and C, the first belonging to the two pole winding, the second one belonging to the four pole winding. The right hand commutator *c* is provided with two brushes *b b* 180° apart, the left hand commutator C with two brushes B B 90° apart connected with the main conductors H H. The armature is influenced by the two pole field *n s* and by the four pole field N^1 S^1 N^2 S^2. The coils *f f* of the first field are connected with a battery Q, whereas the coils F F F F of the second are connected with the brushes *b b* of the commutator *c* belonging to the two pole armature winding. A clockwise rotation will produce a current of a certain direction, flowing through the brushes *b b* and the coils F F F F to the effect, that the polarity of the four pole field may be north and south as indicated by the letters N^1 S^1 N^2 S^2 in the Fig. 2 and the main current delivered by the brushes B B may have the direction indicated by the arrows of the conductors H H. When the direction of the rotation is counter clockwise, then the current delivered from the brushes *b b* and therefore the polarities of the single poles of the four pole field will be reversed; but the direction of the current delivered from the main brushes B B will remain the same as the polarity of the inducing field and the direction of rotation have reversed at the same time. Since the main brushes B B give now a current of constant direction independent of the direction of rotation quite as well as the battery Q it is of course also possible to influence the strength of the constant directed two pole exciting field by the current or the voltage of the main brushes B B or by any part of the current or the voltage. Such arrangements are shown diagrammatically in Figs. 3 and 4.

In Fig. 3 the armature A is indicated by a line connecting the centers of the two commutators *c* C. The armature windings and the iron parts of the field magnets are not shown in the drawing. The two pole field is fitted with coils *f f* excited from the main conductors H H that lead from the main brushes B B to the outer circuit consisting of a battery Q and lamps L L. The coils *f f* produce magnetic lines indicated by the longer arrows 8. There are also coils f^1 f^1 traversed by the main current in such a direction that they tend to weaken the field produced by the stronger coils *f f* as indicated by the short arrows 9. By these means the strength of the main current is limited because with the increase of the current the magnetism of the two pole field and in consequence the voltage of the exciter brushes *b b* and therefore the magnetizing current in the coils F F F F of the four pole field is weakened. The current regulates itself and can never reach an excessive amount no matter whether the speed may be a very high one or whether the resistance of the outer circuit may be a very small one. This arrangement with or without a battery is well fit for generators driven with variable speed as in the case of train lighting dynamos driven from the axle and is also very good in all cases in which the outer resistance often varies and in which short circuits occur.

In Fig. 4 instead of the weakening coils f^1 assisting coils f^2 are employed, traversed by a part of the main current feeding the lamps L L and assisting the coils f f as indicated by the arrow 10. By these means a regulation of the field according to the strength of the external current can be effected.

It is not necessary to employ separate pole pieces for the two pole and four pole magnetic field. In the first place it is of no importance whether the poles n s of Fig. 1 are one piece each or divided into two smaller pieces n^1 n^2 s^1 s^2 as shown in Fig. 5. Now, of course, the action upon the wires 1 and 3 will remain the same, whether they really are influenced by the two different poles n^1 and N^1 or by a single pole, whose magnetism represents the sum of the magnetisms of n^1 and N^1. In the same manner the action upon wire 4 will remain the same if it is influenced by a single pole whose magnetism represents the difference of the two poles S^1 and n^2 of Fig. 5 that influence the wire. Therefore the two magnetic fields may be combined and the same pole pieces fitted with the coils for the two pole and for the four pole field.

In Fig. 6 the two pole armature winding is only indicated by its commutator a smaller inner circle a with two brushes b b 180° apart, the four pole armature winding is indicated by its commutator C a larger circle with two brushes B B 90° apart. The four magnet pole pieces I, II, III, IV have a double winding, the one exciting winding f which is supplied with current by a battery Q generating in the two upper pole pieces north poles n^1 n^2, in the lower pole pieces two south poles s^1 s^2. A second winding F is fed from the exciter brushes b b and is so connected up that by this winding alone any two neighboring poles would have alternating polarity for instance the polarities N^1 S^1 N^2 S^2 indicated in Fig. 6 for a clockwise rotation. Now, as each of the four pole pieces is influenced by two windings a strength of magnetic field will result in each that is either the sum or the difference of both components and the dynamo of Fig. 6 will work in exactly the same manner as the dynamo of Fig. 2. It is possible to go still one step further, and to supply the exciting current, which is to change its direction with the direction of rotation, from the same winding and the same commutator as the main current, the direction of which must remain the same during a change of the direction of rotation.

In Fig. 7 a Gramme winding is indicated by the wires g g which are connected with commutator bars c^0 c^0 on the one side and with bars C^0 C^0 on the other side. The fields n s and N^1 S^1 N^2 S^2 are corresponding to those of Fig. 1. There are shown brushes b b on the first commutator at a distance of half the commutator from each other and brushes B B on the second commutator at a distance of quarter of the commutator from each other. Now it is easily to be seen that the voltage between the brushes b b is only due to the two pole field n s and is theoretically not affected by the four pole field N^1 S^1 N^2 S^2 whereas the voltage induced in the part of the armature winding between the brushes B B is affected as well by the south pole S^1 as by the right half of the north pole n. Provided, however, that the two pole field is much weaker than the four pole field its influence on the voltage between B B will be but small. If the polarity of the four pole field is reversed at the same time with the rotation of the armature the voltage of the brushes B B will differ somewhat in its value but the direction of the voltage will remain the same. Now, instead of the 2 commutators and four brushes of Fig. 7 a single commutator with 3 brushes may be applied. Fig. 8 is a modification of Fig. 6 with a Gramme armature indicated by its commutator G and 3 brushes thereon of which B^1 and B^3 serve as exciter brushes, B^2 and B^3 as main brushes. One may have also 4 main brushes as it is usually the case in four pole dynamos with Gramme armature and use 2 of them as main brushes as well as exciter brushes.

In Fig. 9 a Gramme armature G with four brushes B^1 B^2 B^3 B^4 is diagrammatically represented. The four pole pieces have different windings. The winding f fed by the battery Q generates in the pieces I and II north polarity n^1 n^2, in the pieces III and IV south polarity s^1 s^2. With this excitation alone the machine represents a two pole machine, so that between the brushes B^1 and B^3 a difference of potential exists, whereas B^2 and B^4 would be at the same potential. The four pole winding corresponding to the winding F in Fig. 8 is here divided in two parts F^1 F^3 and there is one coil of each part on every pole piece. Both windings F^1 and F^3 are in series inserted between the brushes B^1 and B^3 in such a way, that a current flowing from B^1 through the coils to B^3 would make the pole I a north pole N^1, the pole II a south pole S^1, the pole III a north pole N^2 and pole IV a south pole S^2. This would be the case for a clockwise rotation of the armature. Now the four pole field so produced will be superposed over the two pole field already existing. The four pole field for itself would produce in the rotating Gramme armature a difference of potential between any neighboring brushes whereas any two opposite brushes would be equipotential.

The dynamo of Fig. 9 may be considered as a four pole dynamo with a lack of symmetry in the magnetic field caused by the two pole winding *f*. With a Gramme armature every lack of symmetry in the field causes equalizing currents flowing between the brushes connected together. Here the brushes B^1 and B^3 are not connected by a copper bar as usual but by the coils F^1 and F^3 and therefore the equalizing current is used to produce the four pole field in the manner set forth. The brushes B^2 and B^4 may be connected by a resistance R. The mains H H are connected on the one hand with the middle D of the resistance R and on the other hand with the terminal E, in which the ends of the windings F^1 and F^3 are connected. The main current flowing from B^1 and B^3 respectively through the coils F^1 and F^3 to the terminal has no magnetizing effect, if the coils are equivalent because, for this current, coils F^1 and F^3 oppose each other. It is self evident that for an opposite direction of rotation the current between B^1 and B^3 will change its direction, so the superposed four pole field will be reversed and the direction of the voltage between the terminals E and D will remain the same.

In the preceding illustrations it was shown that two fields with different pitch of poles may work upon the same armature in the desired manner. The manner of obtaining the object of the present invention according to the second principle consists in arranging an auxiliary magnetic field the axis of which, if the field be a two pole field, is at right angles to that of the main field. In some cases it may be advisable to halve each pole piece in order to bring all the brushes into a neutral zone, as was shown in Fig. 5 with regard to the two pole field n^1 n^2 s^1 s^2.

The armature can be fitted with two separate windings and commutators as indicated by *c* and C in Fig. 10. The field winding *f* excited by the battery Q magnetizes the pole pieces I and II as north poles n^1 n^2, the poles III and IV as south poles s^1 s^2. Between the brushes *b b* corresponding to this field magnet coils F F are inserted wound around the poles II III and IV I. If the armature rotates, there will flow a current from the brushes *b b* through the coils F F and for clockwise rotation south poles S^1 S^2 will be superposed in the pole pieces II and III and north poles N^1 N^2 in the pole pieces IV and I. As in the previous cases we may consider each field as existing independent from the other and influencing only its own armature winding. For, the voltage between the horizontal brushes *b b* will theoretically be the same whether the second field S^1 S^2 N^1 N^2 exists or not, since north pole N^2 assisting the north pole n^1 raises the voltage of the left upper quarter of the the armature winding appertaining to *c* as much as the voltage of the right upper quarter is reduced by the pole S^1 opposing north pole n^2; and the voltage of the right lower quarter is elevated by S^2 as much as the voltage of the left lower quarter is reduced by N^1. In the same manner the voltage of the vertical brushes B B of the commutator C represented by the outer circle is theoretically in no way directly affected by the field n^1 n^2 s^1 s^2 but only due to the field N^1 N^2 S^1 S^2. As the polarity of the latter poles changes with the direction of rotation, the external current supplied through the brushes B B to the mains H H has a constant direction independent of the direction of rotation.

It is not necessary to apply two different windings nor are even two commutators required; it is possible to connect both sets of brushes with a single commutator G. (Fig. 11.) Then not only a superposition of the fields and of the E. M. F.'s but also a superposition of the currents in the armature winding takes place. If the strength of the field n^1 n^2 s^1 s^2 is lower than that of field N^1 N^2 S^1 S^2 pole I of Fig. 11 will be a strong north pole, pole II a weak south pole, pole III a strong south pole, pole IV a weak north pole. Therefore the E. M. F.'s induced in the different quarters of the armature winding will differ from each other. For instance, the voltage of the left upper quarter may be 51 volts, the voltage of the right upper quarter 49, of the right lower quarter 51, of the left lower quarter 49 volts. The difference of two volts between the brushes *b b* will affect the equalizing current flowing through the winding F and continuing to produce the field N^1 N^2 S^1 S^2. The same effect can even be obtained without a special field winding F by making use of the armature reaction alone. If the armature brushes *b b* are short circuited as in Fig. 12 a current flows through the armature, generating a transverse field which, as desired, lies at right angles to the original field.

It is well known, that with an ordinary dynamo the armature reaction generates a field that is shifted by 90° against the primary field in the direction of rotation whereas with the motor it is shifted 90° against the direction of rotation.

Fig. 12 represents a two pole dynamo. The upper pole is divided in two parts I and II and the lower pole in two parts III and IV. By the battery Q the coils *f f* are supplied with current in such a way, that from the beginning I and II are north poles n^1 n^2

whereas III and IV are south poles s^1 s^2. The cross magnetizing reaction of the armature short circuited by the crossconnected brushes b b tends to weaken the field under the leading pole tips I and III and to strengthen it under the trailing tips II and IV. In other words, the reaction superposes in tip I an opposing polarity S^2, in tip II an assisting polarity N^1, in tip III an opposing N^2, in tip IV an assisting S^1. Now between the main brushes B B the superposed field N^1 N^2 S^1 S^2 generates a voltage and as during clockwise rotation the superposed field will be inversed to that during counter-clockwise rotation the potential of these brushes B B does not become reversed. The same effect can be obtained with any suitable armature winding and in various ways. For example: an external current always flowing in the same direction can also be obtained by short circuiting the brushes B^1 and B^4 and the brushes B^2 and B^3 as it is shown in Fig. 13. This is merely an imperfect method of carrying out the same inventive idea.

The arrangement of Fig. 11 as well as that of Fig. 12 gives an automatic regulation of the machine. In both cases the second magnetic field generated by the current of the auxiliary brushes b b is displaced with regard to the first by plus or minus 90 electrical degrees and the main current flowing through the main brushes B B generates by armature reaction a field, which is displaced through 0° or 180° as compared with the constant directed first magnetic field. That means the armature reaction of the current flowing through the main brushes B B will either assist or oppose the primary field. With such connection of windings as shown in Fig. 11 this armature reaction will strengthen the primary field. In the case of Fig. 12 it will oppose. It is self evident that each of these effects can be increased by arranging a special field winding traversed by the external current and that, on the other hand, any desired characteristic of the dynamo can be obtained by such a special winding.

The dynamo according to Fig. 12, the primary winding of which is separately excited, has such a characteristic that, when driven at constant speed, the voltage drops quickly if the main current rises. It is very eminently suited for parallel working with accumulators, if the velocity at which it is driven fluctuates. If, however, the machine is to be constructed for example for the transmission of power without accumulators, it is possible to make its voltage rising with rising main current or remaining constant like that of an ordinary compound machine, by arranging a main winding, traversed by the main current, to work in the same direction as the separate excited winding, the effect of which compensates or over-compensates the counter-action of the armature field. This arrangement is illustrated in Fig. 14, f^2 being the assisting coil traversed by the current of the main brushes B B.

It will be noticed that the machine, in some respects, possesses the qualities of a compensated machine. If the two upper pole pieces are not separated as in Fig. 12 the machine being built as shown in Fig. 15 with common pole pieces P P, the brushes B B will not spark, as perhaps might be expected, because the brushes are situated not in a neutral zone, but in a field n s which is displaced backward by 90° with regard to the main field N^1 N^2 S^1 S^2, so that it favorably influences the commutation. The poles n s work as commutation poles similar to such poles described in various patent specifications.

The arrangement shown in Fig. 15 renders it possible to build the magnetic system with very slight waste of material. The flux which induces the external voltage is generated by the short circuited armature winding and finds its way from the armature through the pole pieces back to the armature. The magnet limbs M and the magnet yoke J carry only a small flux, which must generate the short circuit current between b b and these can, therefore, have a very small cross section.

It is perfectly evident that the auxiliary or exciter brushes b b in Fig. 12, 14 and 15 halve the voltage between the main brushes B B. If, therefore, according to Fig. 16 a conductor h be connected with the short circuited exciter brushes b b whereas two other conductors H H are connected with the main brushes B B the three wires H h H with the lamps L L connected between them represent a three wire system directly fed by the dynamo.

For the sake of simplicity it has above been supposed that the primary field winding which influences the exciter brushes is fed from an accumulator battery or another external source of current. This is, however, absolutely unnecessary, and the exciting winding can be connected in any well known way with the main brushes, so that the machine works with self-excitation. This is illustrated in Figs. 17 and 18, in the former one the exciting coil f being connected in shunt, in the latter one in series to the outer circuit. The dynamo, in comparison with hitherto known machines, has the advantage that it always excites itself without reversing switches whichever the direction of rotation may be. If the machines discussed above run as motors they have analogous qualities, viz. once started in either direction, they continue to rotate in the same direction. The saving in the material which results from the excitation being produced by the armature is also existent in the case of motors. The starting can take place in any desired manner, for example by first disconnecting the auxiliary brushes b b and connecting them through a starting resistance, with an external source of current, so that the motor runs as a normal motor, and then gradually short circuiting the brushes b b and connecting the brushes B B with the external voltage. This is shown in Fig. 19. The dynamo with a magnet yoke J, limbs M, pole shoes P, an armature winding G, two brushes b^1 b^2 placed on the usual place and two brushes B^1 B^2 shifted about 90° is used as a motor. H^1 H^2 are the wires coming from the external source of current represented by the battery Q. The lever 11 of the starting resistance has contact pieces 12, 13 and 14, insulated from each other and from the lever. In the position shown the motor brushes B^1 B^2 b^1 b^2 are disconnected whereas the field coils f are excited from the line H^1 H^2. If the lever is moved in clockwise direction contact piece 12 will make contact between the copper bars 15 (connected with brush b^1 and copper bar 25) and 16 (connected with the conductor H^1) whereas piece 13 makes contact between the bar 17 (connected with conductor H^2) and the first terminal 18 of the resistance 18, 19, 20 the end of which is connected by the copper bar 24 with brush b^2. Contact piece 14 has no effect. The brushes B^1 B^2 are in no connection whatever to the conductors H^1 H^2 and the motor runs as a normal shunt motor at first in series with the resistance coils 18 19 and 19 20 that are gradually short circuited. If the lever is in its vertical position piece 14 makes contact between the bars 24 and 25 and short circuits the brushes b^1 b^2. Piece 12 has left the copper bar 15, piece 13 has left the starting resistance 18, 19, 20 connected respectively with the brushes b^1 b^2. Now piece 12 makes contact between the copper bar 16 and the bar 26 that is connected to the upper main brush B^1 whereas piece 13 makes contact between the copper bar 17 and the terminals of the second resistance 21, 22, 23 the end 23 of which is connected with the second main brush B^2. This resistance is gradually short circuited.

The different arrangements are shown in the drawings only by way of example. It is obvious that the construction can be modified in many ways. In particular as many poles may be employed as desired, and the magnetic system can be of any desired form.

It will be readily understood that one of the machines as above described, if it is so constructed that the original magnetic field is weakened when the main current increases, will be a very good primary machine for the electric lighting of railway carriages, it being driven from the carriage axle. The strength of current remains almost constant, being independent of the velocity within wide limits. The direction of the current remains the same for each direction of driving. It is only necessary to take care that when the train is moving with a very small velocity and when the train stops, the machine is disconnected from the accumulator battery. This can be effected in many well known ways.

What we claim and desire to secure by Letters Patent of the United States is:—

1. In an electric machine, the combination with means for creating two magnetic fields, of a single armature acted upon by both fields, the first field being excited in a constant direction and the second field being excited by a current produced by a rotating winding of the said armature, and current collecting devices connected with the armature to lead off to an external supply circuit the current generated in the armature by the said second field.

2. In an electric machine the combination with means for creating two magnetic fields of a single armature acted upon by both fields and commutator brushes for collecting separately the currents generated in the armature by the two fields, the first field being excited in a constant direction and influenced by a current derived from the brushes appertaining to the second field, the said second field being excited by a current produced by a rotating winding of the said armature.

3. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other, of a single armature acted upon by both fields, the first field being excited in a constant direction and the second field being excited by a current produced by a rotating winding of the said armature, and current collecting devices connected with the armature to lead off to an external supply circuit the current generated in the armature by the said second field.

4. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other, of a single armature acted upon by both fields and commutator brushes for said armature for collecting separately the currents generated in the armature by the two fields, the first field being excited in a constant direction by a suitable current and influenced by a current derived from the brushes appertaining to the second field, the second field being excited by a current produced by a rotating winding of the said armature.

5. In an electric machine the combination with means for creating two magnetic fields, of a single armature acted upon by both fields and commutator brushes therefor, the first field being excited in a constant direction by a suitable current and weakened by a current flowing through the brushes appertaining to the second field, the second field being excited by a current produced by a rotating winding of said armature.

6. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other, of a single armature acted upon by both fields and commutator brushes therefor, the first field being excited in a constant direction by a suitable current and weakened by a current flowing through the brushes appertaining to the second field, the second field being excited by a current produced by a rotating winding of the said armature.

7. In an electric machine the combination with means for creating two magnetic fields having each the same number of poles displaced relatively to each other by an angle of ninety electrical degrees, of a single armature acted upon by both fields and commutator brushes therefor, the first field being excited in a constant direction and the second field being excited by a current derived from the brushes appertaining to the first field.

8. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other, of a single armature acted upon by both fields and having a short circuited winding, the first field being excited in a constant direction and the second field being excited by a current flowing in the said short circuited winding of the said armature.

9. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other of a single armature acted upon by both fields, two sets of commutator brushes for said armature, a cross connection for the set of brushes corresponding to the first field, the first field being excited in a constant direction and the second field being excited by a current in a winding of the armature short circuited through said cross connection between the brushes corresponding to the first field.

10. In an electric machine the combination of a field magnet, an armature provided with a commutator, commutator brushes and connections short circuiting the armature on a line displaced through an angle of ninety electrical degrees from the medial line of primary field magnetization, and a second set of brushes displaced through an angle of ninety electrical degrees from the first set, together with an external circuit connected to said second set of brushes.

11. In an electric machine the combination with means for creating two magnetic fields having poles of the same pitch displaced relatively to each other of a single armature acted upon by both fields, two sets of commutator brushes for said armature, a cross connection for the set of brushes corresponding to the first field, the first field being excited in a constant direction and the second field being excited by a current in a winding of the armature short circuited through said cross connection between the brushes corresponding to the first field, together with a three-wire system of distribution, the neutral point of which system is connected to one of said last mentioned brushes.

12. In electric machines the combination with two magnetic fields having poles of the same pitch displaced relatively to each other of a single armature acted upon by both fields, the first field being excited in constant direction and the second field produced by the current of an armature winding short circuited through a cross connection of the set of brushes corresponding to the first field, said connection being the neutral point for a three wire system, substantially as described.

13. In electric machines the combination of a field magnet an armature provided with a commutator, commutator brushes and connections short circuiting the armature on a line displaced ninety electrical degrees from the line of field magnetization and connected with the neutral wire of a three wire system and a second set of brushes displaced ninety electrical degrees from the first set and connected to the external wires of a three wire system, substantially as described.

14. A direct current dynamo electric machine having an armature, means for creating in the armature two magnetic fluxes, one of which is of constant direction and the other of which reverses when the direction of rotation of the armature is reversed, and current collecting devices connected with the armature to lead off to an external supply circuit the current generated in the armature by the said reversing flux, whereby the generator is enabled to produce a useful external current of constant direction regardless of the direction of rotation of the armature.

15. In an electric machine, a field magnet, a winding therefor, an armature provided with a commutator and brushes, connections whereby the current induced in the armature

by the field flux produces a second magnetization at an angle to that of the field, and connections whereby the current induced in the armature by the second magnetization is supplied to an external circuit.

16. In an electric machine, a field magnet, a winding therefor, an armature provided with a commutator and brushes, connections whereby the current induced in the armature by the field flux produces a second magnetization at an angle to that of the field, and connections whereby the current induced in the armature by the second magnetization is supplied to an external circuit and opposes the magnetizing effect of the current in the field winding.

17. In an electric machine, a field magnet, a winding therefor, an armature provided with a commutator and brushes, connections whereby the current induced in the armature by the field flux produces a second magnetization at an angle to that of the field, and connections to an external circuit at points on the armature equi-potential with respect to the field flux.

18. In an electric machine, a field magnet, a winding therefor, an armature provided with a commutator and brushes, and connections for connecting in a local closed circuit points on the armature winding on a line displaced substantially ninety electric degrees from the line of field magnetization, and brushes and connections for connecting to an external circuit points on the armature on a line substantially parallel to the field magnetization.

19. In an electric machine having a magnetic field, an armature in inductive relation to said field, whereby the rotation of the armature generates an electromotive force, and brushes and connections whereby a working current due to said electromotive force is supplied to an external circuit and creates in the armature a second magnetic field displaced from the first field, and additional brushes and connections through which the electromotive force induced in the armature by the second field becomes effective to reduce the first named field.

20. In a dynamo-electric machine, an armature provided with a commutator, two sets of commutator brushes, displaced from each other by approximately ninety electrical degrees, a field winding producing a magnetization in line with one set of brushes and thereby inducing a voltage between the second set of brushes, connections for said second set of brushes for producing a second magnetization in line with said second set whereby a voltage is induced between the first set of brushes, and connections for the first set of brushes for reducing the magnetizing effect of said field winding.

21. In a dynamo-electric machine, an armature provided with a commutator, two sets of commutator brushes displaced from each other, connections from one of said sets of brushes to an external circuit, a field winding producing a magnetization in line with said set of brushes, the current flowing through said connections to said external circuit producing in said armature a magnetomotive force in opposition to that of said field winding, and connections for including the other set of brushes in a local circuit.

In testimony whereof we have hereunto set out hands in presence of two subscribing witnesses.

HEINRICH ROSENBERG.
EMANUEL ROSENBERG.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.