No. 745,508. PATENTED DEC. 1, 1903.

W. MEISSNER.

MEANS FOR PRODUCING ALTERNATING CURRENTS OF LOW PERIODICITY.

APPLICATION FILED APR. 1, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

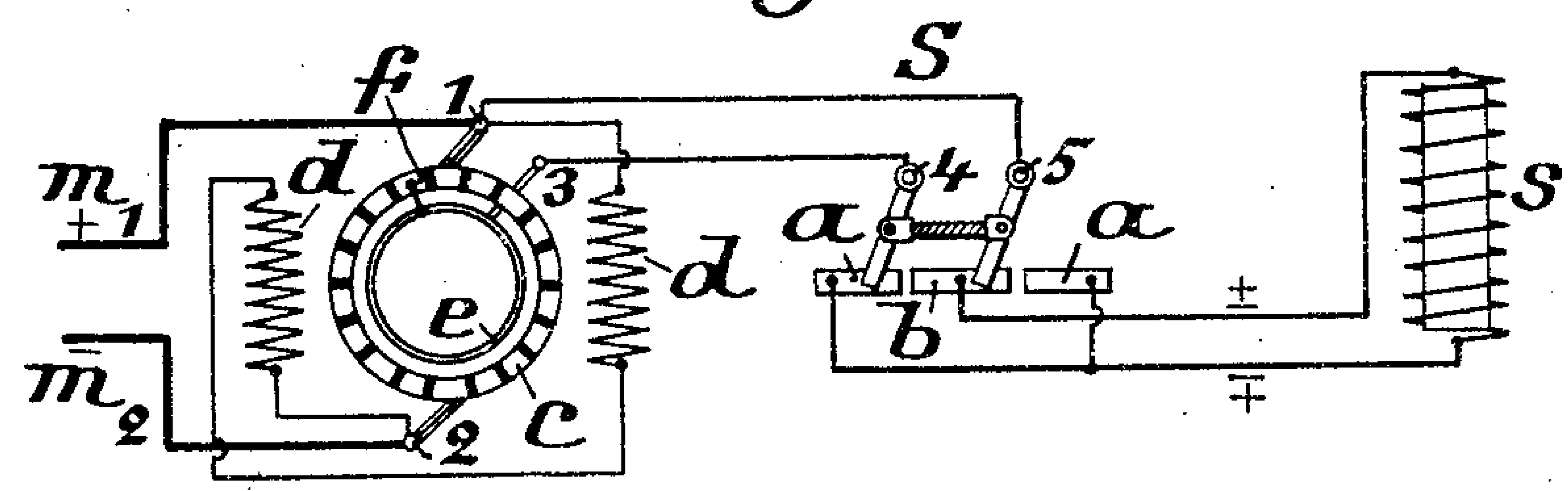


Fig. 2.

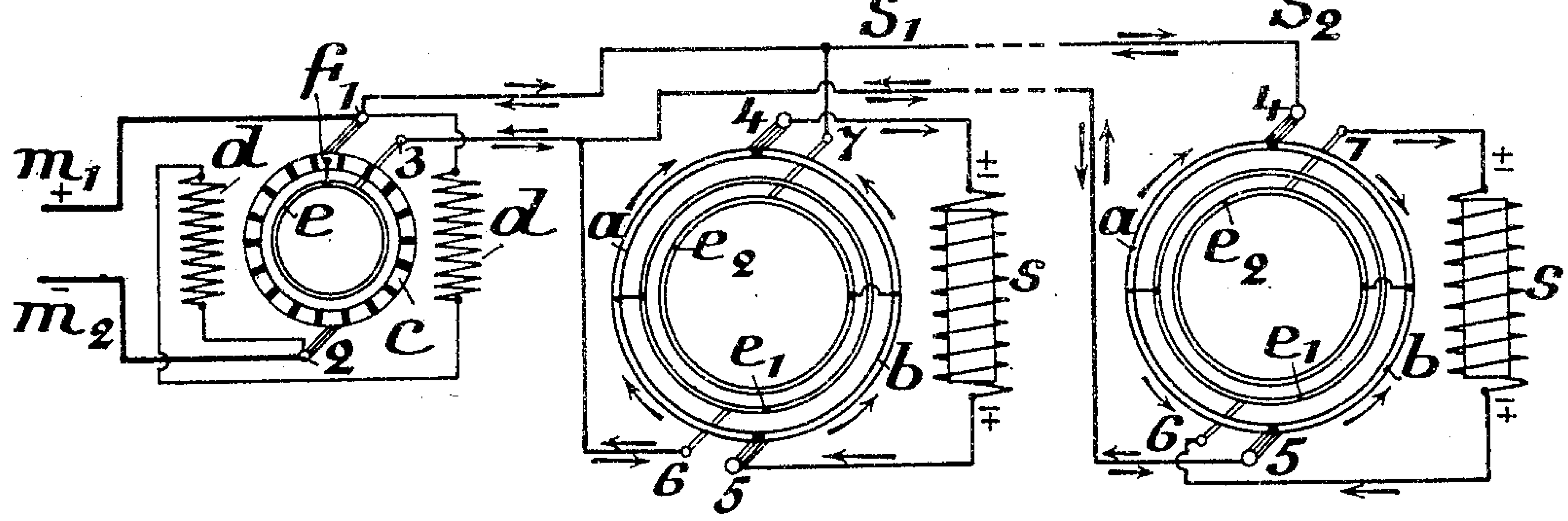
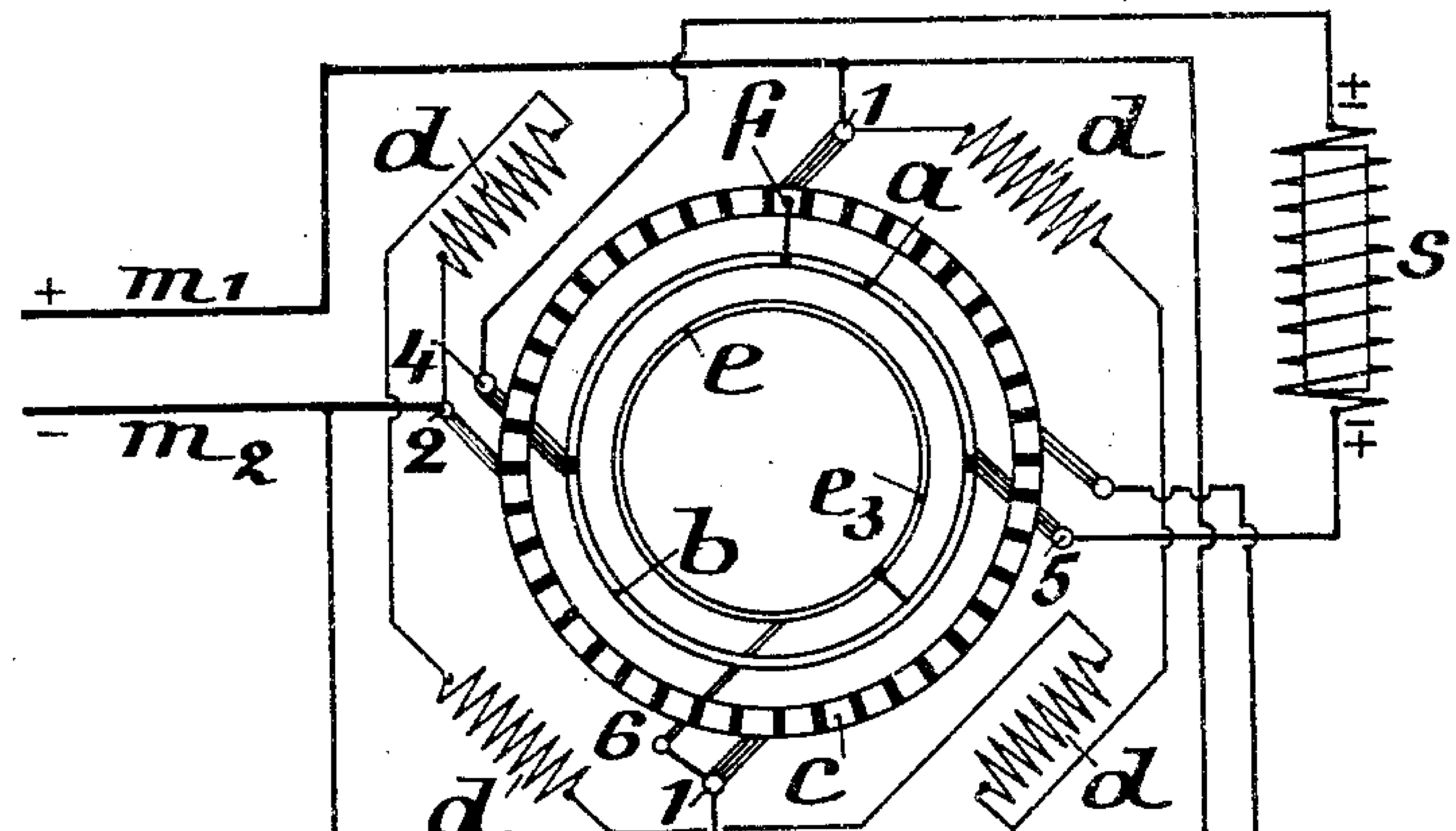


Fig. 3.



WITNESSES

[signatures]

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 4.

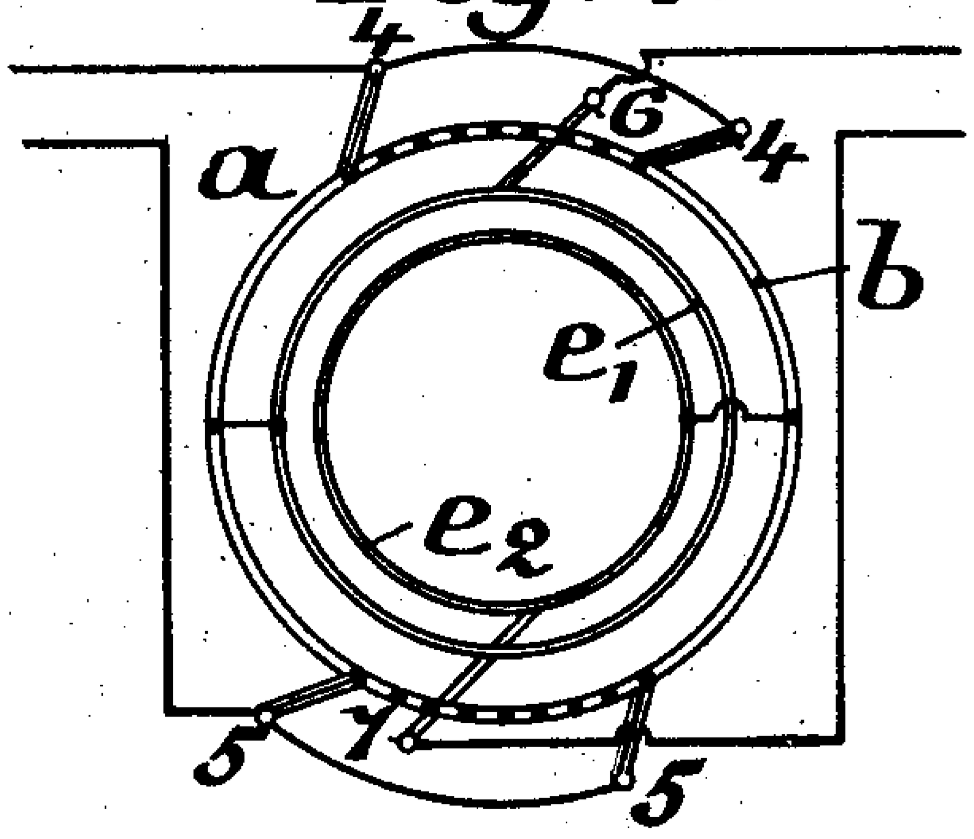


Fig. 5.

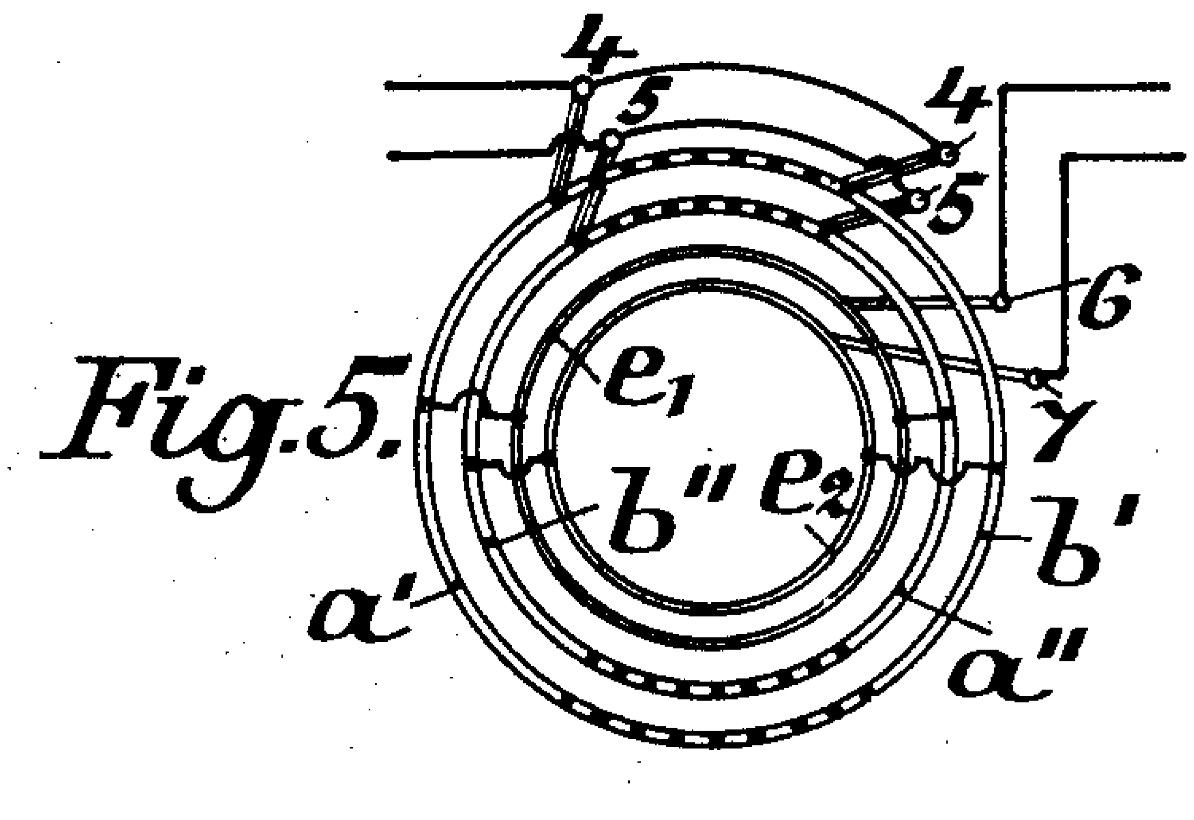


Fig. 6.

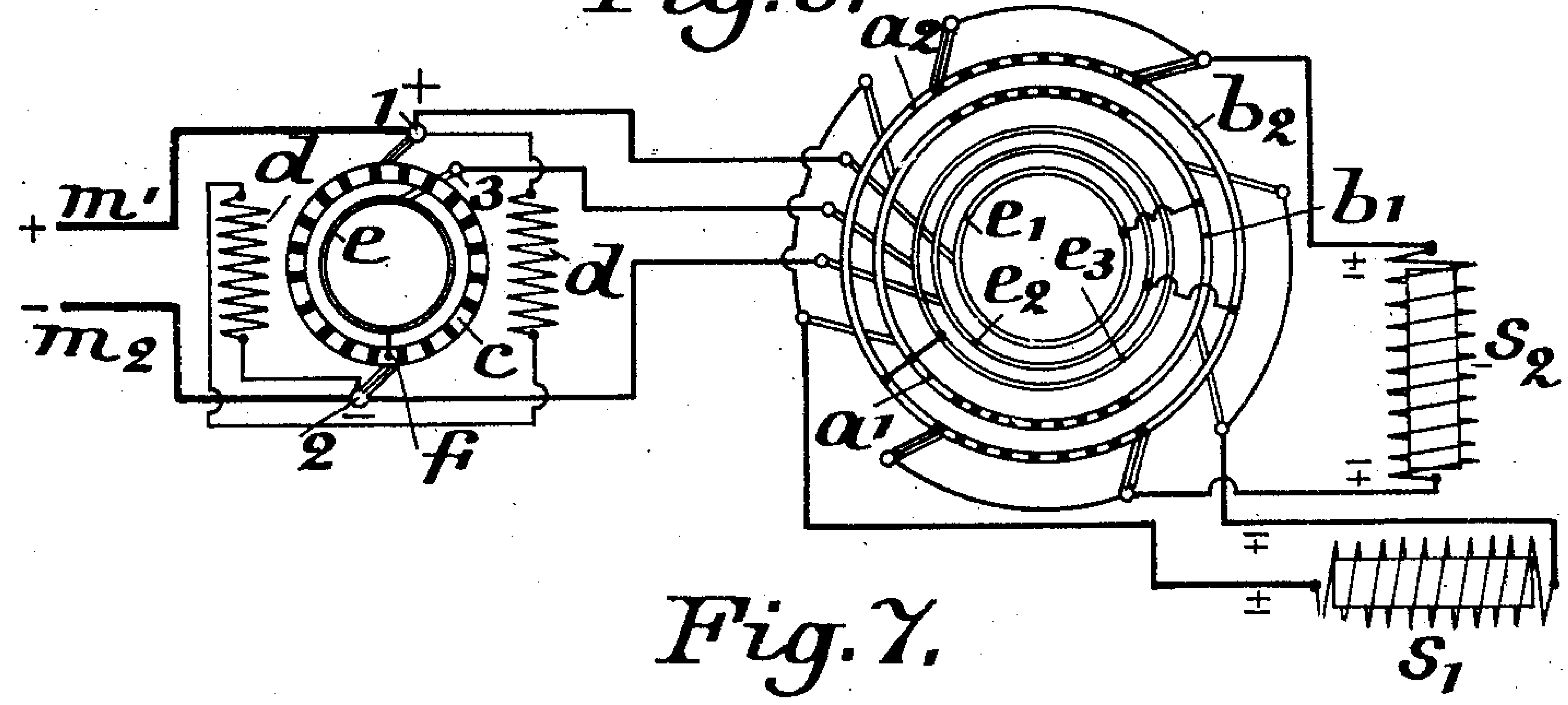
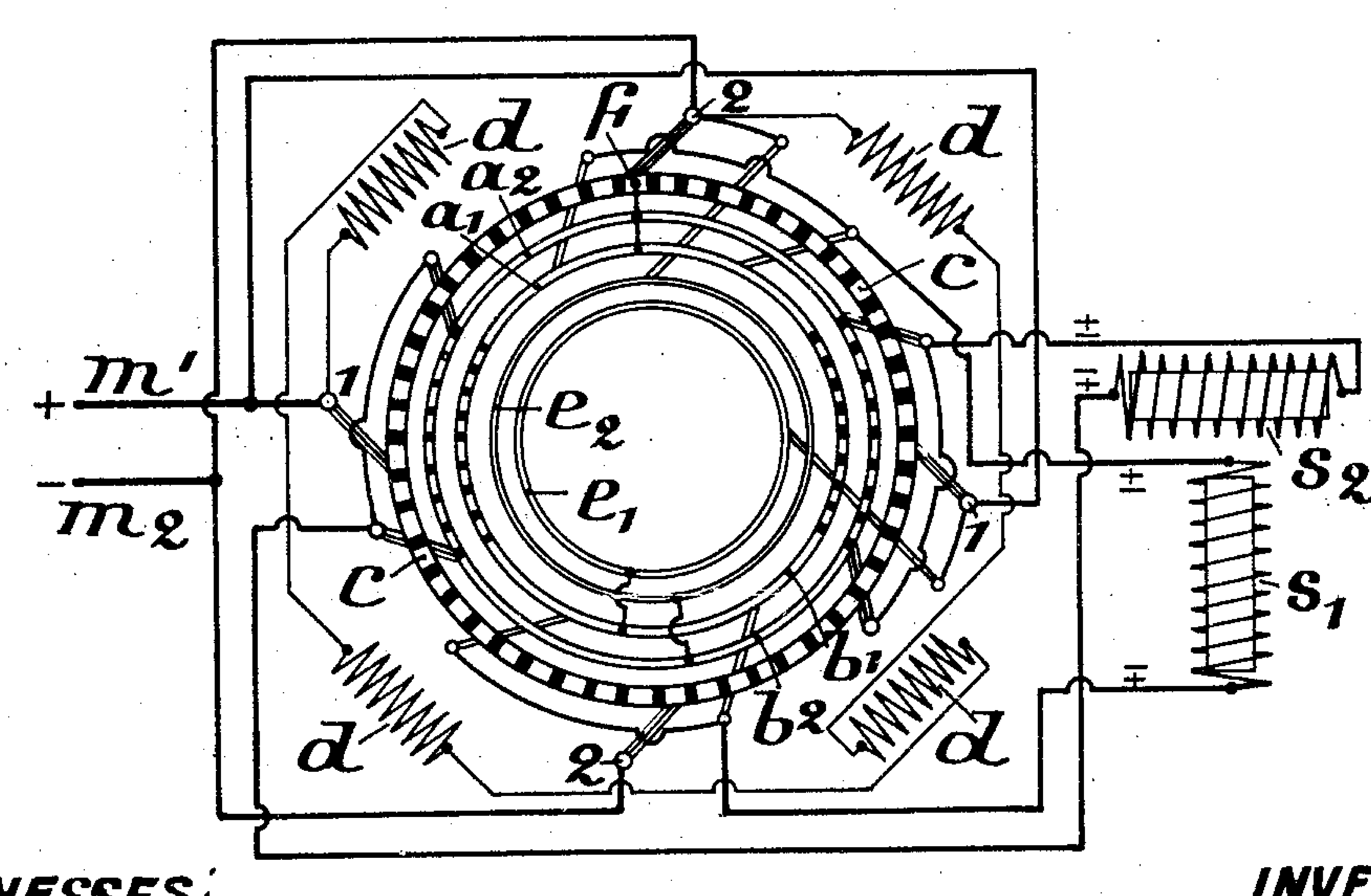


Fig. 7.



WITNESSES:

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UNITED STATES PATENT OFFICE.

WALDEMAR MEISSNER, OF CHARLOTTENBURG, GERMANY.

MEANS FOR PRODUCING ALTERNATING CURRENTS OF LOW PERIODICITY.

SPECIFICATION forming part of Letters Patent No. 745,508, dated December 1, 1903.

Application filed April 1, 1903. Serial No. 150,509. (No model.)

To all whom it may concern:

Be it known that I, WALDEMAR MEISSNER, engineer, a subject of the German Emperor, residing at 25 and 26 Joachimsthalerstrasse, Charlottenburg, near Berlin, Germany, have invented certain new and useful Improvements in Means for Producing Alternating Currents of Low Periodicity; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention refers to means for generating alternating currents of very low periodicity, such as are especially used in electromagnetic reciprocating machines, and more especially in concussion rock-drills.

The invention consists in a continuous-current dynamo provided with a special commutator by means of which a pulsating current is generated in the external circuit and of means for converting the pulsating current thus obtained into an alternating current.

Of the accompanying drawings, Figure 1 is a diagram illustrating the principle upon which my invention is based. Fig. 2 is a diagrammatical illustration of means for executing the invention; Fig. 3, a diagrammatical illustration of a specific embodiment of the invention, and Figs. 4 to 6 diagrammatical illustrations of various modification of specific means for carrying out the invention.

The same reference-symbols apply to like parts in all the figures.

Referring at first to Fig. 1, *c* is meant to represent the commutator of an ordinary continuous-current dynamo, and *d d* the field-windings of the same. The number of field-windings *d* in the divers figures indicates the number of poles the dynamo is meant to be provided with. *e* is a slip-ring supposed to be mounted on the armature-shaft of the dynamo and conductively connected to one of the bars *f* of the commutator *c*. 1, 2, and 3 are contact-brushes of the usual description, of which two—viz., 1 and 2—slide on the surface of the commutator *c*, and the third, 3, slides on the surface of the ring *e*, so that the latter is continuously in electrical connection with the bar *f*. S is a pole-changing device consisting of three contact-pieces *a b a*, of which the first and last are conductively connected with each other, and of two contact-arms 4 and 5, mounted on suitable pivots and mechanically coupled, so as to move in unison, as indicated in the drawings, but electrically insulated from each other. *s* is a translating device. The principle upon which my present invention is based will now be explained with reference to this diagram. When the commutator-bar *f* registers with the brush 1, the potential difference between brushes 1 and 3 will be zero. Then as bar *f* advances toward brush 2, the potential difference will increase and will reach a maximum value when *f* registers with brush 2. It will then begin to decrease and will again become zero when *f* registers with 1, and then the same play will be repeated. Thus a pulsating current will be generated in the translating device *s*, the periodicity of which for a two-pole generator, as indicated in Fig. 1, will be equal to the number of revolutions of the generator in this sense, that the current will pass from one maximum to the next in the same time in which the generator completes one revolution. Now if the pole-changing device S is operated by any suitable mechanism, (not shown in the diagram,) which mechanism is adapted to perform one reversal of the current every time said current becomes zero, this pulsating current will be converted into an alternating current completing one full period in the same time in which the generator completes two full revolutions.

In Fig. 2 I have diagrammatically illustrated specific means for accomplishing the conversion of the pulsating current into an alternating current. The generator is the same as in Fig. 1; but there are shown two pole-changing devices S′ and S². It should be understood, however, that these two devices are not intended to be used simultaneously, but rather represent different modifications of the electrical connections adapted to bring about the desired result. The pole-changing device consists of a pair of slip-rings e' e^2 and a pair of brushes 6 and 7, mounted to slide on these contact-rings, respectively. Besides these slip-rings the device is provided with a third ring, consisting of two segments *a* and *b*, conductively connected to the slip-rings e' and e^2, respectively. Finally two brushes 4 and 5 are provided, sliding on the slip-ring a b. In the case of S′ the translating device s is inserted between the brushes 4 and 5, and brush 7 is connected to brush 1 of the generator and brush 6 to brush 3 of the generator. In the case illustrated with reference to S^2 the translating device is inserted between the brushes 6 and 7, and brush 4 is connected to brush 1 of the generator and brush 5 to brush 3 of the generator. It will be evident that after every half-revolution of this pole-changing device has been completed—that is, every time the brushes 4 and 5 register with the insulating portions of the circumference of the slip-ring which separates the segments a and b—a reversal of the current flowing in the circuit of the translating device will be effected. Consequently in order to establish synchronism between the pole-changing devices S′ and S^2 and the generator, the revolution of the generator-shaft should be transmitted to the shaft of the pole-changing device by a gearing which makes the ratio of the two revolutions as two to one. It will be noted that the devices S′ and S^2 are in all respects equivalents of the device S. (Shown in Fig. 1.) It will also be noted that either way of connecting up these pole-changing devices with the generator and the translating device will have the same effect upon the latter. When there is no self-induction in the translating device and the pole-changing device is mounted in such a way that the brushes 4 and 5 register with the insulating-pieces separating the segments a and b at the same moment that the bar f in the commutator of the generator registers with the brush 1, the current in the whole system will be naught during the reversal of the current; but when self-induction obtains in s there will be established a difference of phase between the current and the electromotive force generated, and the consequence will be that at the moment of reversal a current of definite strength will be flowing in the circuit, and this current would tend to create sparking at the brushes 4 and 5, with all the deleterious results following therefrom. In order to obviate this difficulty, I make the brushes 4 and 5 so broad with relation to the insulating-pieces in the circumference of the pole-changing device a b that at the moment of reversal the segments a and b are short-circuited. Consequently at this moment no pressure can obtain between the two segments a and b, and the reversal will take place without sparking.

As I have hereinbefore said, the ratio of speed of the shaft of the pole-changing device with reference to the speed of the generator-shaft should be as two is to one in this case; but this rule can be more generally expressed by stating that if the number of poles in the generator is $2p$ this ratio should be as p is to two, and it will be seen that for p equal to two or for a four-pole generator this ratio is one. This means that the pole-changing device can be directly coupled with the shaft of the generator, or, in fact, be mounted upon it. A modification of my present invention embodying this result is diagrammatically shown in Fig. 3. Instead of two field-windings d d four are provided, corresponding to the four poles of the dynamo; likewise, instead of one brush 1 there are two. On the other hand, the two slip-rings e' and e^2 are replaced by the single slip-ring e^3, which is connected to the segment b, and the segment a is connected to the bar f. The other connections strictly correspond to the case shown in Fig. 2 with reference to S′, and the action of the whole arrangement will readily be understood with the help of the foregoing explanation.

From the foregoing, moreover, it will be understood that in order to obtain the desired synchronism between the generator-shaft and the pole-changing device it is only necessary that one reversal should take place every time the bar f of the commutator c registers with one of the brushes 1. On the other hand, a reversal takes place every time the brushes 4 and 5 register with the insulating-pieces separating the segments a and b on the circumference of the pole-changing device. It follows that it will be possible to vary the actual speed of the pole-changing device independently of the speed of the generator if the number of segments a and b on the circumference of the pole-changing device is increased and corresponding segments are interconnected. If instead of giving the ring of the pole-changing device two segments, it is formed of four, six, &c., segments, evidently a reversal does not take place after every half-revolution, but rather after every fourth, sixth, &c., part of a revolution, and in order to obtain synchronism the speed of the pole-changing device must be varied accordingly. If the number of pairs of segments a and b be called n and the number of poles of the generator $2p$ as above, the ratio obtaining between the speeds of the generator and the pole-changing device would be $2n:p$ for synchronism, and this value being dependent upon the value of n besides that of p it is evident that it can be made equal to 1 for any value of p that is divisible by 2 by giving n the value $\frac{p}{2}$. It is therefore possible to use a direct coupling between the generator-shaft and the pole-changing device not only in a four-pole machine, but likewise in an eight, twelve, &c. pole machine.

In all cases the number of periods of the alternating current obtained in the unit of time is half that of an alternating current that would be generated by the same machine when directly used as an alternator by providing it with two slip-rings.

Referring now to Fig. 4, it will be seen that it is in all general features a repetition of the pole-changing device S^2 in Fig. 2, the only difference being that instead of simple insulating-pieces being arranged for separating the segments a and b a number of pieces are provided, which may be formed of insulating material, but which, however, I prefer to form of metal pieces separated from each other by insulating material. With such insulating devices in order to short-circuit the segments a and b at the moment of reversal the brushes 4 and 5 are made in pairs, the single members of each pair being placed at circumferential distances corresponding to the circumferential length of the insulating device separating the conductive segments. This arrangement I have found advantageous in all cases in which the tension of the current to be generated is not quite small. Practical experience has shown that with ordinary insulating-segments, as indicated in the foregoing figures, the apparatus acts satisfactorily for a short time; but soon a film of metal forms on the surface of the insulating-segments and violent sparking is the consequence. On the other hand, by applying the insulating device, consisting of metal pieces separated by pieces of insulating material, this difficulty is absolutely avoided. I find, moreover, that it is not so important to increase the circumferential length of the insulated pieces as it is to increase the number of them in order to obviate sparking. It will be readily seen that the effect of this arrangement is exactly the same as the effect of that described with reference to the foregoing figures, if only the condition be fulfilled that the conductive segments are not shorter than the distance of the members of each pair of brushes 4 and 5. It is therefore possible to increase the total length of the insulated segments up to one-quarter of the total circumference for each insulating device, and by this disposition the maximum of security against sparking is obtained.

Fig. 5 shows another modification of the pole-changing device. It is evident from the foregoing that in order to obtain the desired reversal with the described arrangements the brushes or pairs of brushes 4 and 5 must be placed exactly opposite each other; but if instead of using one two-pole-changing device I use two one-pole-changing devices I will evidently be free to place the brushes at any part of the circumference if the segments of the slip-rings are arranged accordingly. Thus, for instance, the brushes may be placed in immediate vicinity of each other, as in Fig. 5, and in some cases I prefer this arrangement, because when sparking occurs in consequence of a faulty adjustment of the brushes they can be controlled more easily when both are located at the same side of the pole-changing device.

The above-described arrangement can with proper modifications also be employed for producing polyphase alternating currents instead of single-phase currents, and the simplest case is obtained in the production of two currents removed by one-quarter of a period from each other. Such currents can be produced from the generator, as above described, by providing it with two slip-rings e, each of which is connected to a bar of the commutator c, such bars being chosen as are removed by one hundred and eighty degrees from each other. I prefer, however, to use the arrangement illustrated in Fig. 6, in which only one slip-ring e is provided, and the two currents are taken from brushes 1 and 3 and 2 and 3, respectively. The corresponding pole-changing device is shown in proper connection with this arrangement in Fig. 6.

Fig. 7 shows this modification applied to the case of a four-pole machine, as in Fig. 3. Both figures will be readily understood without being explained in detail. It will suffice to say that in both cases the reversal of the current issuing from the negative pole of the generator takes place at the moment illustrated in the figure, and after one-quarter of a revolution of the pole-changing device the other current removed by one-quarter of a period will be reversed. In the figure two translating devices s' and s^2 are shown corresponding to the two currents, and the difference of phase in both is indicated by their relative angular position.

As will be seen by persons conversant with the art the same method can be employed for obtaining three or more polyphase currents; but it will be observed that by adjusting the brushes 1 2, &c., at angular distances of one hundred and twenty degrees from each other a difference of phase of only sixty degrees is obtained, so that it will be necessary to arrange the connections accordingly. In all cases it will be necessary to employ separate pole-changing devices for each current; but it is evident that these devices may be mounted on the same shaft.

The generator may be driven either mechanically or electrically, and for this latter purpose the mains m' and m^2 are shown on all the drawings. Moreover, in all the figures I have shown the field of the generator in a shunt connection; but series windings might also be employed, if desirable, either by using the continuous current of one of the mains m' or m^2 or also the pulsatory current generated by the dynamo itself. If two polyphase currents be generated, as in the cases of Figs. 6 and 7, both currents should be superposed for feeding a field-winding connected in series. Assuming the curve shapes of the currents to be true sines, the sum of both currents would in this case be a true continuous current.

Returning now to Fig. 2 and assuming that the translating device s contains an appreciable amount of self-induction an appreciable difference of phase between the current generated and the terminal electromotive force of the generator will be established. Consequently, since reversal is effected at the moment in which the terminal electromotive force of the generator becomes naught, a current of definite intensity will still be flowing in the circuit. It is to be remarked that at the moment of reversal, which is shown in the drawings, the brushes 4 and 5 are not only short-circuited by the segments *a* and *b*, but also by the circuit formed by the brushes 1 and 3 and the slip-ring *e* and bar *f*. The long arrows disposed along the different branches of the circuit are meant to represent the direction of the current flowing in that branch at the moment before the brushes 4 and 5 are short-circuited—that is, when brush 4 touches segment *a* only and brush 5 touches segment *b* only. The short arrows indicate the direction of the current in the respective parts of the circuit at the moment immediately following the commutation. It is to be noted that in consequence of the difference of phase between the current and the electromotive force a reversion of the current only takes place in that part of the circuit which is represented by the brushes 1 and 3, slip-ring *e*, and bar *f*. At the moment of commutation the part of the current flowing in the segments *s* and *b* will be transferred to this branch, and there will be no sparking, provided this branch be free from self-induction. It is evident that this condition can be practically fulfilled in all cases, and consequently sparking can be effectually avoided, though the translating device *s* may contain any amount of self-induction.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. Means for producing alternating currents of low periodicity of any number of phases which means consist in the combination, with a continuous-current dynamo, of a pole-changing device inserted between the brushes and one bar of the commutator of said dynamo and means for operating the said pole-changing device in synchronism with the commutator of said dynamo, substantially as and for the purpose described.

2. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring mounted on the armature-shaft and connected to one of the bars of the commutator of said dynamo, a brush mounted to slide on said slip-ring, a circuit formed between said brush and a brush of the dynamo, a pole-changing device inserted in said circuit, and means for operating said pole-changing device in synchronism with the armature of said dynamo, substantially as and for the purpose described.

3. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring divided into segments, such segments being in electrical communication with the brushes and with one bar of the commutator of the dynamo, respectively, and means for rotating the slip-ring in synchronism with the commutator of the dynamo, substantially as and for the purpose set forth.

4. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring consisting of segments, such segments being in electrical communication with the brushes and with one of the commutator-bars, respectively, of the said dynamo, the segments of the slip-ring being separated from each other by a plurality of insulated pieces, and means for rotating the said slip-ring in synchronism with the said dynamo, substantially as and for the purpose described.

5. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring formed of segments, such segments being in electrical communication with the brushes and with one commutator-bar, respectively, of the said dynamo and being separated from each other by insulating devices, each device comprising a plurality of insulated pieces, of pairs of brushes coöperating with said slip-ring the members of each pair being removed from each other by the angular length of each insulating device and being conductively connected with each other, and means for rotating said slip-ring in synchronism with the commutator of the said dynamo, substantially as and for the purpose set forth.

6. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring formed of a plurality of pairs of segments, means for electrically connecting said pairs of segments alternately to a bar of the commutator and to the brushes of the said dynamo, and means for rotating said slip-ring in synchronism with the commutator of said dynamo, substantially as and for the purpose described.

7. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo having p pairs of poles, of a slip-ring formed of $2n$ segments in electrical communication with one commutator-bar and with the brushes of said dynamo, respectively, and means for rotating said slip-ring with a speed of $2n : p$ multiplied by the speed of said commutator of said dynamo, substantially as and for the purpose described.

8. Means for producing alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo having p pairs of poles, of a slip-ring formed of pairs of segments alternately connected electrically to the brushes and one commutator-bar of said dynamo, respectively, the number of said pairs of segments being equal to $p : 2$ and said slip-ring being mounted upon and adapted to rotate with the commutator-shaft of said dynamo, substantially as and for the purpose set forth.

9. Means for producing polyphase alternating currents of low periodicity which means consist in the combination, with a continuous-current dynamo, of a slip-ring for each current of separate phase, such slip-rings consisting of segments alternately connected electrically to respective brushes and to a commutator-bar of said dynamo, and means for rotating said slip-rings in synchronism with the commutator of said dynamo, substantially as and for the purpose described.

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

WALDEMAR MEISSNER.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.