No. 847,877. PATENTED MAR. 19, 1907.

E. BACHELET.

ELECTRIC CURRENT INTERRUPTING AND VARYING APPARATUS.

APPLICATION FILED JAN. 9, 1906.

3 SHEETS—SHEET 1.

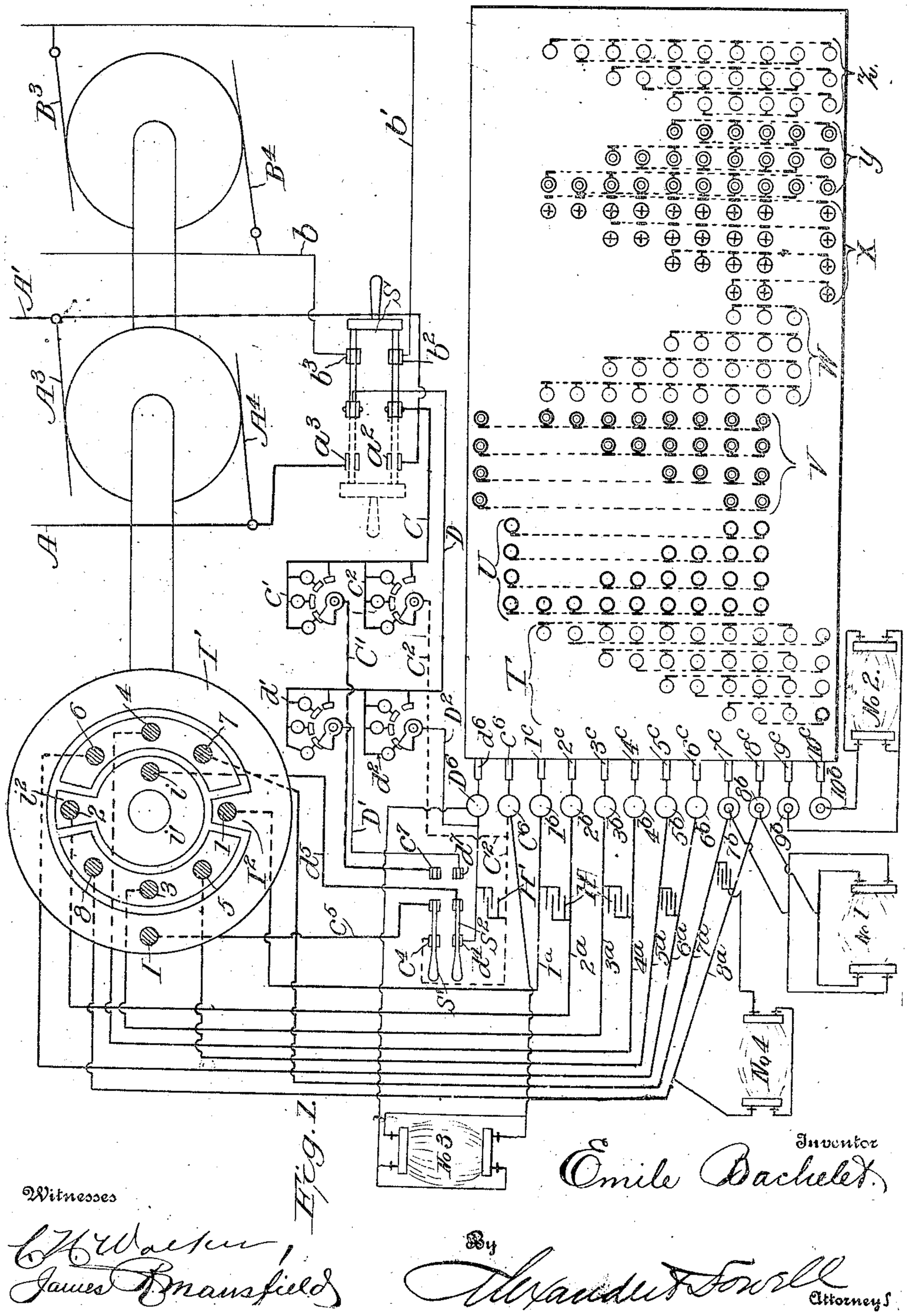

Fig. 1.

Witnesses

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3 SHEETS—SHEET 2.

Fig. 2.

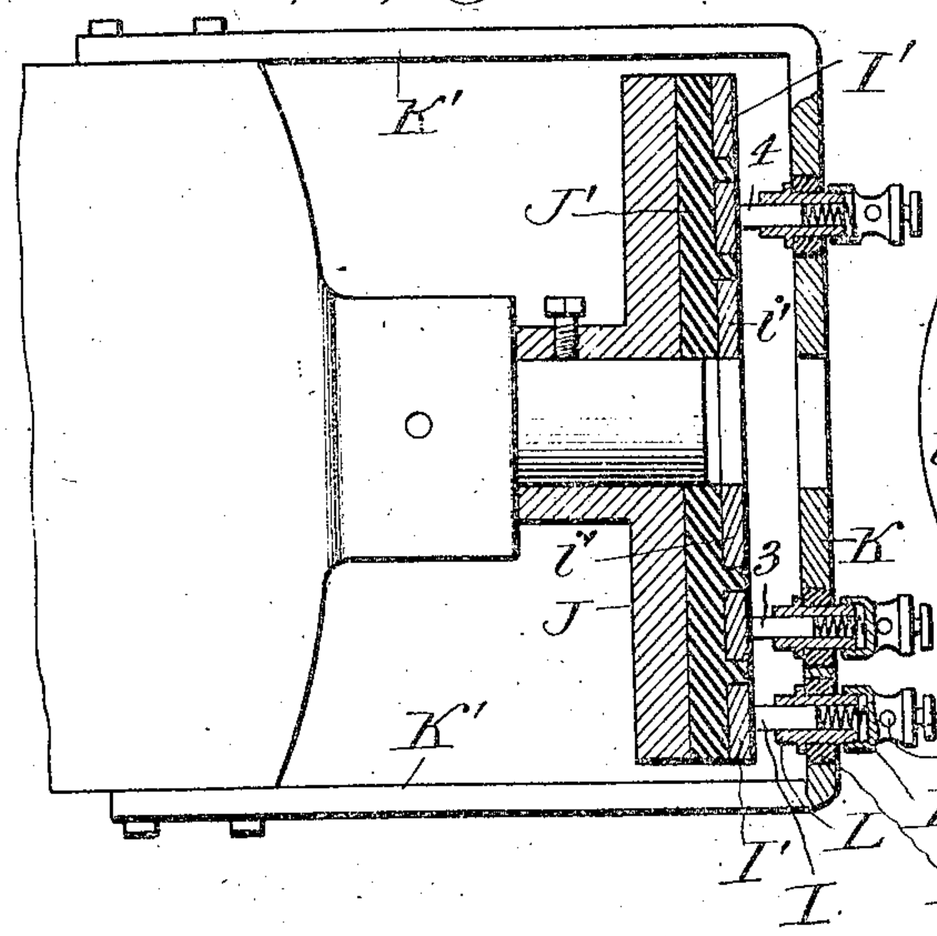


Fig. 3.

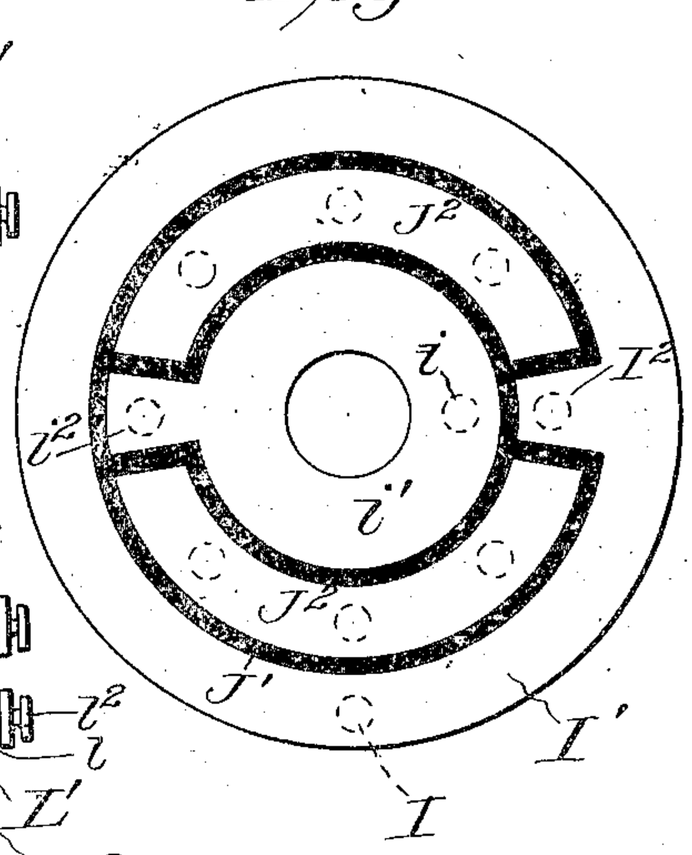


Fig. 4.

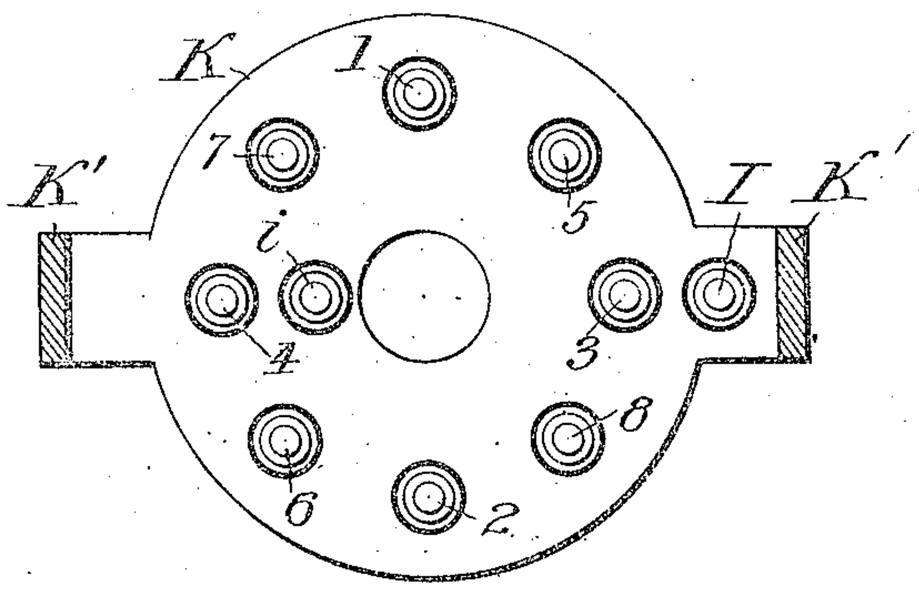
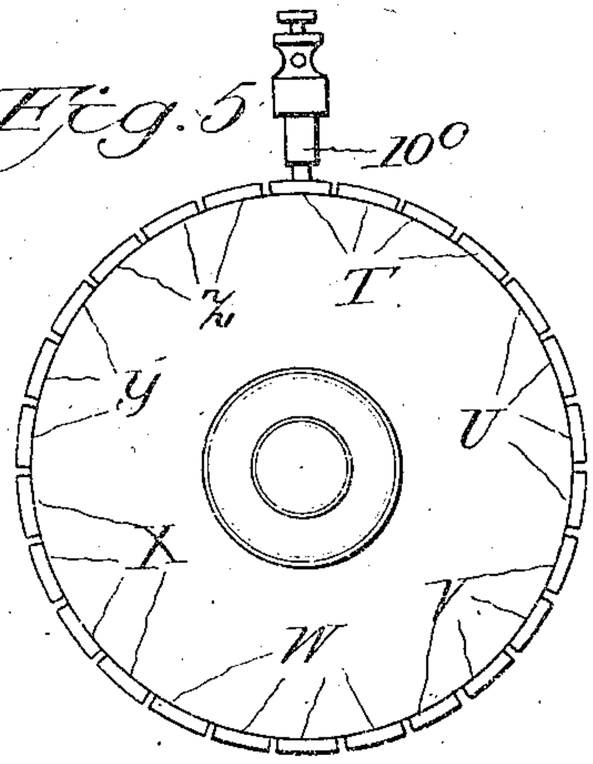


Fig. 5.



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3 SHEETS—SHEET 3.

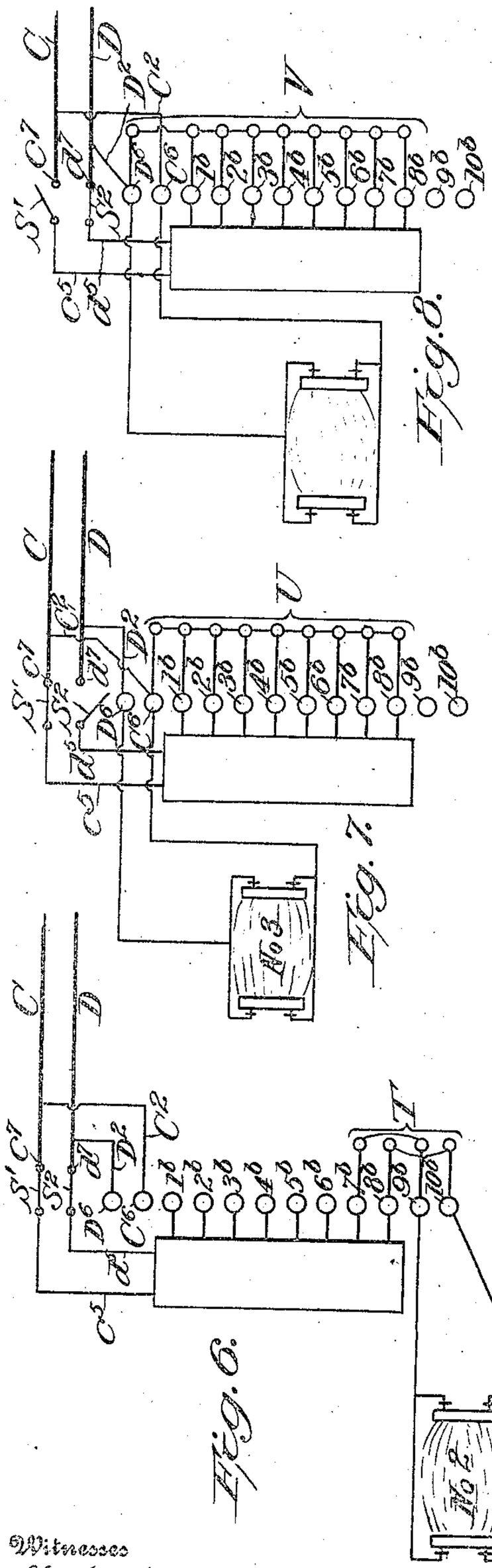

Fig. 8.

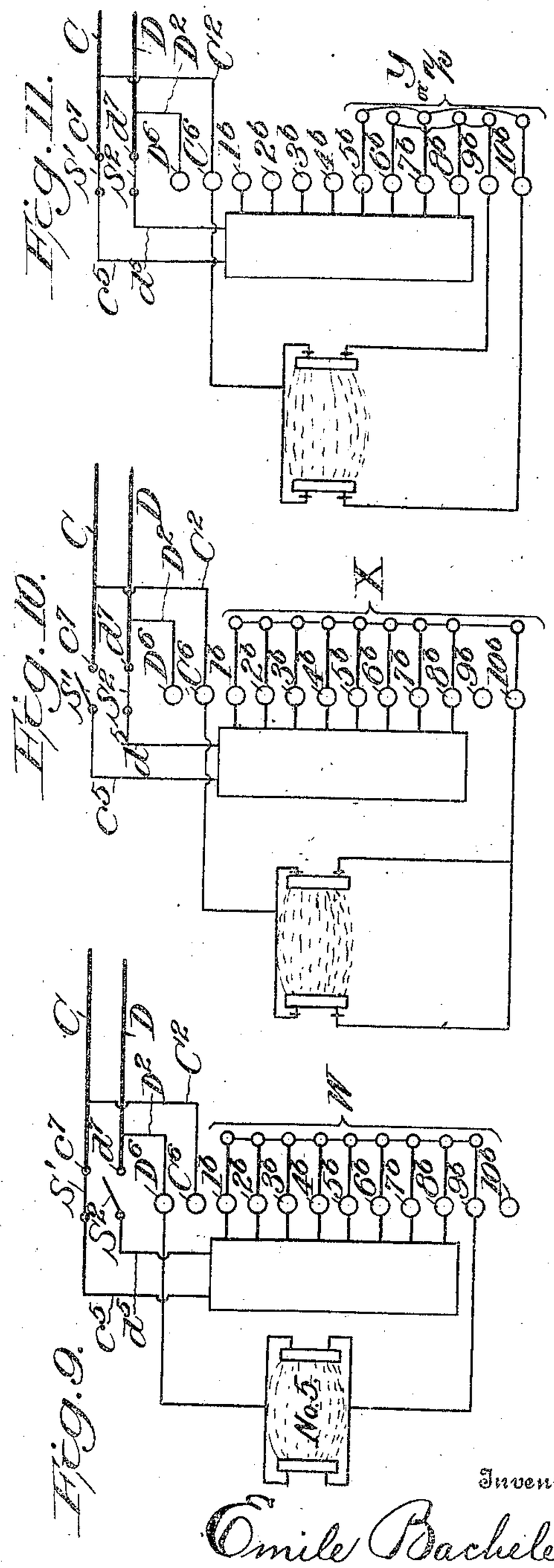

Fig. 11.

Fig. 7.

Fig. 10.

Fig. 6.

Fig. 9.

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UNITED STATES PATENT OFFICE.

EMILE BACHELET, OF NEW YORK, N. Y.

ELECTRIC-CURRENT INTERRUPTING AND VARYING APPARATUS.

No. 847,877. Specification of Letters Patent. Patented March 19, 1907.

Application filed January 9, 1906. Serial No. 295,213.

To all whom it may concern:

Be it known that I, EMILE BACHELET, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric-Current Interrupting and Varying Apparatus; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in electromagnetic apparatus, and particularly designed for use in connection with a magnetic-field-generating apparatus, for which Letters Patent of the United States No. 743,372 and No. 743,373 were granted to me on the 3d day of November, 1903.

The invention comprises a transformer, perferably a rotary transformer or dynamotor, adapted to transform a direct current into an alternating current or an alternating current into a direct current, and a double-pole double-throw switch by which either the supplied or derived current can be thrown into the two main conductors and of the machine. The two main conductors are branched, and in each branch is interposed a rheostat or resistance, preferably containing lamps, so that the amount of current passing through either branch can be regulated at the will of the operator.

Suitable electrical connections and switches are provided by which the main or derived current, direct or alternating, may be taken from either main conductor direct to the electroreceptive device which in the present instance is a therapeutic electromagnetic-field generator. A rotary interrupter is interposed in the circuit and is preferably attached to or directly driven by the rotary transformer or other electrical driving device at a constant uniform speed. Such interrupter is designed to produce a certain number of interruptions in the current for each rotation. In the example shown the interrupter is designed to make itself but two interruptions in the circuit at each rotation. As it is desirable in many instances to increase or lessen or vary the number of interruptions made in the current at a given time, the principal object of the invention is to enable this desired variation in the frequency of the interruptions to be accomplished without varying the speed of the interrupter and the transformer or motor by which the interrupter is driven, and to this end I provide in combination with the continuously uniformly driven interrupter what may be termed a "frequency-varying switch," which is interposed in the circuit between the interrupter and the electroreceptive device and by means of which and suitable electrical connections the current transmitted to the receptive device can be interrupted or broken a more or less number of times at the will of the operator by simply varying or shifting the position of the frequency-varying switch or "controller," as it may be termed, without changing the speed of the motor or interrupter and without increasing or varying the amount of power of current required to maintain a uniform speed of rotation of the interrupter.

Heretofore in order to vary the frequency of the interruptions of the current it has been necessary to change the speed of the interrupter either by increasing or diminishing the current applied to the motor by the introduction or cutting out of resistances in the main circuit, or by changing the power of the field, or using some device for increasing or diminishing induction in the apparatus. All of such devices are expensive in operation and wasteful of power, and the necessity for their use is avoided by my present invention, and the frequency of the current can be changed by simply shifting the frequency-varying switch to the desired position.

While the invention is generally adapted to any use or purpose in the arts in which the variations in interruptions of a current are desired, I particularly design it for use with my electromagnetic therapeutic apparatus, such as shown and described in my aforesaid Letters Patent, in which apparatus I employ two coacting electromagnets which are energized by the passage of an electric current and set up a vibrating magnetic field of force. I have found that it is desirable in treating different kinds of ailments with this apparatus to vary the strength and nature of the magnetic field. In treating some diseases a high-frequency powerful current is desired, and in others a low-frequency current is desired, and in some cases all positive impulses may be desired, and in others all negative impulses may be desired, and in still others a combination of both positive and negative impulses. By means of the apparatus shown in the drawings any desired kind and quality of current may be derived

from the main current supplied to the device.

In my above said patents a vibrating magnetic field is established by means of a coil or coils energized by an alternating current. As such currents are not always obtainable, it is desirable to provide means whereby a direct current can be changed into an alternating current, and this is most readily accomplished by means of a rotary transformer or dynamotor. The therapeutic effect of the magnetic field, I have found, depends upon the nature of the field, either positive or negative, or alternately positive and negative, and also upon the frequency of the magnetic waves or impulses, which depend upon the frequency of the undulations or interruptions in the electrical current by which the magnetic-field generators are energized; and therefore further subsidiary objects of the present invention, as used in connection with such apparatus, are to provide a compact, simple, and portable apparatus whereby, if necessary, a direct current can be transformed into an alternating current before the same is transmitted through the magnetic-field generators; to provide means whereby the current transmitted to the generators can be interrupted or broken, thereby producing the most powerful magnetic impulses; to provide means whereby the polarity of the current transmitted to the magnetic-field generators can be controlled, so that all positive impulses or all negative impulses or alternating positive and negative impulses can be transmitted to the magnetic-field generators; to enable the strength of the current transmitted to the generators to be regulated by cutting into or out of the circuit more or less resistance, preferably employing incandescent lights for this purpose, so that the operator can see the amount of resistance which is interposed in the circuit; to enable the magnetic-field generators to be energized by complex currents of electricity, such as a regular alternating current and a make-and-break current, transmitted simultaneously thereto through the same conductors, and to enable a number of electromagnetic generators to be simultaneously energized or operated with the same or with different characters of electric currents derived simultaneously from the apparatus.

I will now describe the invention in connection with the accompanying drawings, in which—

Figure 1 is a diagrammatical view of a complete apparatus, showing several magnetic-field generators connected therewith. Fig. 2 is an enlarged sectional view through the interrupter. Fig. 3 is an end view thereof. Fig. 4 is a view of the brush-carrier. Fig. 5 is a view of the frequency-varying switch. Figs. 6, 7, 8, 9, 10, and 11 are detail diagrams illustrating some of the various phases or changes in the electrical circuits which may be made in the apparatus.

I will first describe the apparatus illustrated in the drawings and then explain some of the various current variations which can be produced thereby.

Assuming that a direct current is supplied from the main-line wires A A′ to the brushes A^3 and A^4 of the rotary transformer, an alternating current will be supplied from the brushes B^3 B^4 to the conductors *b b′*. The wires A and A′ are electrically connected to the poles a^3 and a^2 of the single-pole double-throw switches S. The conductors *b* and *b′* are connected to the opposite poles b^3 b^2 of said switch and, as shown in full lines in Fig. 1, are therefore placed in communication with the main conductors C and D of the instrument.

The conductors C and D are branched. One branch C^2 of the conductor C leads to one of the binding-posts C^6 of the frequency-varying switch hereinafter described, and one branch D^2 of the conductor D is connected to the binding-post D^6 of said frequency-varying switch. Suitable rheostats or resistances, preferably lamps, are interposed in the branches C^2 and D^2, as indicated at c^2 and d^2. By means of this connection any electrical receptive device may be connected with the posts C^6 and D^6, and the alternating current derived from the transformer can be delivered thereto when the switch S is in the position shown in full lines in Fig. 1, or if the switch S be turned to the position shown in dotted lines in Fig. 1 a direct current could be sent to said receptive device. The branch C^2 of the conductor C is furthermore electrically connected, as shown in Fig. 1, to one of the poles c^4 of the single-pole double-throw switch S′, by which it is electrically connected, through wire c^5, with the brush I, which contacts with one of the commutator-plates I′ of the current-interrupter hereinafter referred to. The branch D^2 of the conductor D is similarly electrically connected to one of the poles d^4 of the single-pole double-throw switch S^2, by which it can be electrically connected by a wire d^5 with a brush *i*, which contacts with the second commutator-segment *i′* of the current-interrupter. The commutator-plates I′ and *i′* are therefore of opposite polarity; but said commutator-plates are always insulated from each other.

The construction of interrupter.—This interrupter is preferably constructed as shown more particularly in Figs. 2, 3, and 4. It comprises a metal disk J, preferably keyed on the shaft of the rotary transformer, so as to be driven at uniform speed therewith. To the face of this disk are secured the commutator-plates I′ and *i′*, which are preferably concentric, as shown in Fig. 2. These plates I′ and *i′* are electrically insulated from each other and from the disk J by means of a plate

J′, of any suitable insulating material, which is secured to the disk J in any suitable manner. The plate I′ is provided with an inwardly-projecting radial extension I^2, and the plate i' is provided with an outwardly-extending projection i^2 diametrically opposite the projection I^2. The face of the insulating-plate J′ between these projections may be protected by metal plates J^2, which are, however, insulated from the disk J and from both the plates I′ and i'. Opposite the plates I′ and i' and arranged in a concentric series around the axis thereof are a series of brushes 1, 2, 3, 4, 5, 6, 7, and 8, the brushes 1 and 2, 3 and 4, 5 and 6, and 7 and 8 being arranged in pairs diametrically opposite each other. The adjacent brushes are placed so far apart that the projections I^2 or i^2 on the commutator-plates I′ and i' will leave one brush before they contact with another. The brushes are preferably constructed as shown in Fig. 2, being supported in a fixed annular plate K, attached to a suitable part of the framing by arms K′. I preferably employ carbon brushes which are retained in tubular brush-holders L, provided with adjustable screw-caps L′ and with non-conducting bushings L^2, which are fitted in openings in the plate K. The caps L′ may be provided with apertures l and thumb-screws l^2 for the purpose of securing the conductor-wires thereto. Each brush is electrically connected by the wires 1^a, 2^a, 3^a, 4^a, 5^a, 6^a, 7^a, and 8^a, respectively, to contact-pieces 1^b, 2^b, 3^b, 4^b, 5^b, 6^b, 7^b, and 8^b, respectively, of the frequency-varying switch, and said switch is also provided in line with two additional contacts 9^b and 10^b, to which one or both terminals of the electroreceptive device may be connected, as hereinafter explained. Preferably the binding-posts D^6 and C^6 and contact-pieces 1^b, 2^b, 3^b, 4^b, 5^b, 6^b, 7^b, 8^b, 9^b, and 10^b are arranged in alinement beside the frequency-varying switch, which switch is preferably constructed in the form of a cylinder or controller, the surface of which cylinder is shown laid out in the diagrammatical view of Fig. 1 and is provided with twelve annular series of contacts adapted to contact, respectively, with the binding-posts D^6 and C^6 and the contact-pieces 1^b, 2^b, 3^b, 4^b, 5^b, 6^b, 7^b, 8^b, 9^b, and 10^b, and which contacts may be brought into electrical communication with said binding-posts by means of brushes d^6 and c^6, 1^c, 2^c, 3^c, 4^c, 5^c, 6^c, 7^c, 8^c, 9^c, and 10^c, as shown. In order to make plain the operation of this interrupter and the frequency-varying switch, we will assume that the commutator-plates I′ and i' are in constant electrical connection with the conductors D and C, as shown in Fig. 1, and an electroreceptive device No. 1, (which may be an electromagnetic-field generator, as described in my aforesaid patent,) has its opposite terminals connected by suitable plugs with the posts 7^b and 8^b, respectively. Under such conditions at each revolution of the interrupter the projections I^2 and i^2 of the plates I′ and i' simultaneously contact twice with the brushes 7 and 8, which are in electrical connection, by means of wires 7^a and 8^a, with the binding-posts 7^b and 8^b and through the latter with the receptive device. Consequently each time the circuit is closed by the interrupter a current is transmitted from the conductor C through the interrupter to the receptive device, back through the interrupter to the other conductor D. This current is broken twice for each rotation of the interrupter, as the projections I^2 and i^2 will contact with brushes 7 and 8 twice during each rotation. Obviously other electroreceptive devices can be put in circuit with the interrupter by connecting their terminals with the pairs of binding-posts 1^b and 2^b, 3^b and 4^b, 5^b and 6^b. In other words, as many as four electroreceptive devices could be operated in this manner from the interrupter and each receptive device be energized twice for each rotation of the interrupter without varying or increasing the current. This connection would give but one uniform interruption of current, assuming that the interrupter rotates at uniform speed, as it is intended to do.

In order to increase the number of interruptions, it is obvious that ordinarily it would be impossible to vary the number of interruptions in the current produced by the interrupter in a given time unless the speed of the interrupter was varied; but as varying of speed is undesirable both on account of the uncertainty and on account especially of the waste in power involved in this change of speed I provide what I term herein a "frequency-varying switch," by means of which without changing the speed of the interrupter or the number of contact-points thereon I am enabled to increase the number of interruptions in the current transmitted to the electroreceptive device. For this purpose the terminals of the electroreceptive device may be connected in several ways, one of which is as follows: Taking magnetic-field generator No. 2, for example, its opposite terminals may be plugged to the binding-posts 9^b and 10^b, as shown in diagram in Fig. 1. In the position shown in said figure, however, these connections remain as above described, with the frequency-varying switches as shown in Fig. 1, with all contacts open, so that no current will pass through, the magnetic generator No. 2; but as soon as the switch is moved so as to cause the brushes 9^b and 10^b to come into contact with one of the annular series of contacts thereon the current will be established through the electroreceptive device No. 2. Before explaining the passage of this current it is desirable to understand the arrangement of the contacts on this frequency-varying switch.

By referring to Fig. 1 it will be seen that there are seven different groups of contacts vertically disposed on said cylinder. The first group of contacts contains four vertical rows of contact-points. In each of these rows every alternate contact-point is electrically connected. The lower contact-point in each row contacts with the brush 10^c, the second contacts with the brush 9^c, and the third contacts with the brush 8^c, and so on up the row. If now the frequency-varying switch be moved so as to bring all the first row of contact-points in the first group T in contact with the brushes 7^c, 8^c, 9^c, and 10^c, (see diagram, Fig. 6,) the current will flow from the interrupter through the binding-post 7^b and brush 7^c and the contacts in the first row of series T, to brush 9^c, to post 9^b, to the receptive device No. 2, and return through post 10^b, brush 10^c and suitable contacts in the first row of series W to brush 8^c, and thence back to the variator. In this position the receptive device No. 2 would receive the same current as receptive device No. 1 and with the same number of interruptions—to wit, two for each rotation of the interrupter. If the frequency-variator be moved over to bring the second row of contacts in series T into contact with the brushes in operative position, the current will not only flow through the brushes 7^c and 8^c, as described, but the circuit will also be closed through the brushes 5^c and 6^c, the interrupter, and receptive device No. 2, so that additional interrupted currents or impulses will be received by receptive device No. 2 whenever the projections I^2 and i^2 on the interrupter contact with the brushes 5 and 6. When this second series of contacts is in position, the receptive device No. 2 will be energized four times for each rotation of the interrupter without increasing its speed, and thus if the third row of series T be brought into position the receptive device No. 2 will be energized six times, and if the fourth row be brought into position the receptive device will be energized eight times for each rotation of the interrupter without having to increase the speed of the interrupter or changing the current. Thus by simply moving the frequency-varying switch the number of impulses transmitted to the receptive device electrically connected with the contact-points 9^b and 10^b can be varied from two to eight for each revolution of the interrupter without varying the speed of the interrupter or the speed of the motor or changing the intensity of the current, and this provision of means for changing the frequency of impulses transmitted from the device without changing the source of electricity and the interrupter operating at uniform speed I believe to be entirely novel and forms one of the principal features of my present invention. The other series of contact-points on the frequency-varying switch have practically the same mode of operation or effect as the series already described, but are designed to be used in connection with the different polarities and characters of current and will be hereinafter referred to.

Transmitting continuous and interrupted currents through the same receptive device.—In some cases it is desirable to transmit an uninterrupted and an interrupted current through the same receptive device. This can be accomplished as follows: The receptive device (indicated as No. 3) may be electrically connected to the posts D^6 and C^6. Assuming that an alternating current is being furnished to the main conductors C and D, it is obvious that such current will pass from post C^6 to the receptive device No. 3 and return thence to the plug D^6 and in this manner complete the circuit, the receptive device No. 3 being continuously and regularly energized by said current. In order to supply in addition an interrupted current to said receptive device, the interrupter is put in circuit with conductors C and D by branch conductors C′ and D′, as indicated in Fig. 1, current-regulating devices or rheostats, preferably lamps, being interposed in the branch circuits C′ and D′, as illustrated at c' and d'. The branches C′ and D′ are connected with the poles c^7 and d^7 of the single-pole double-throw switches S′ and S^2, respectively, and when a receptive device, as No. 3, is connected to the posts C^6 and D^6, as described, the switches S′ and S^2 are opened, so as to break contact with the posts C^4 and D^4, and one of these switches S′ and S^2 is closed against the other pole c^7 or d^7.

We will assume that the switch S′ is closed against the post c^7 and the switch S^2 left open. The branch current will then flow through the conductors C′ and D′, switch S′, and wire C^5 to the commutator I′, and as the interrupter rotates of course the electrical connection is established temporarily between the commutators I′ and i' with the several binding-posts 1^b, 2^b, 3^b, 4^b, 5^b, 6^b, 7^b, and 8^b. (See diagram Fig. 7.) Then the second series of contact-points U of the frequency-varying switch are brought into play. If the switch is turned so that the first vertical row of the second series of points be brought into contact with the binding-posts C^6 to 8^b, inclusive, (see diagram Fig. 7,) a complete circuit will be established from the interrupter through the binding-posts and contacts in series U with the post C^6, and thence from the post C^6 to the receptive device No. 3 and back to the post D^6, and thence out of the machine, thus completing the interrupted circuit through the receptive device No. 3 simultaneously with the continuous circuit therethrough due to the direct connection between the main branches C^3 and D^3 with the posts C^6 and D^6, as above described.

With the set of contacts shown in series U, I can obtain from two to eight interruptions of the current transmitted through the receptive device No. 3 without changing the speed of the interrupter and without varying the current directly transmitted through the interrupter from the branches D^2 and C^2.

The polarity of the interrupted current transmitted through the receptive device No. 3 simultaneously with the continuous current can be changed by opening the switch S′ entirely and closing the switch S^2, so as to place it against the post d^7. (See diagram Fig. 8.) This cuts the branch C′ out of circuit, but places the branch C^2 in circuit with the interrupter. In this case the third series V of contact-points of the frequency-varying switch would be used for the interrupted current and the same number of changes in interruptions produced, as is obvious. In this third series of contact-points instead of contact being made with the brush of binding-post C^6 the contacts are made with the brush of binding-post D^6.

In some cases it is desirable to use the direct current instead of the alternating current, and this can be readily done by throwing the main switch S so as to cut out the connections between the conductors C and D and the alternating-current wires *b* and *b′* and put the conductors C and D into connection with the wires A and A′, this position of the switch S being indicated in dotted lines in Fig. 1. In this position the direct current will be supplied to the main conductors C and D. If it be desired to interrupt this direct current, it can be done in various ways by the apparatus shown and when applied to my electromagnetic field-generator I find it is frequently desirable to energize the magnets by an interrupted current of one polarity.

All-positive impulses.—In case I desire to obtain only interrupted positive impulses in the magnetic field the electrical connections are made, using the series W of contact-points on the switch. The direct current is transmitted through the conductors C and C′, switch S′, and wire c^5 to the interrupter and passes thence to the several binding-posts 1^b to 8^b, inclusive. The opposite terminals of the receptive device should be electrically connected in this instance to the binding-posts 9^b and D^6. (See diagram Fig. 9.) Then the frequency-varying switch is shifted to bring one of the vertical rows of contacts in series W into the circuit, and the course of the current will be as follows: The positive current passes from the conductors C and C′ to the switch S′, wire c^5 to the interrupter, and from the latter through the binding-posts 1^b to 8^b and through the row of contacts in series W to the binding-post 9^b, thence through the receptive device No. 5, Fig. 9, to the binding-post D^6, which is in electrical connection with the other conductor D, thus closing the circuit and obtaining only positive impulses (four to eight in number) in the receptive device, according to which row of contacts in the series W are used.

All-negative impulses.—It is sometimes desirable to obtain all-negative impulses. In this case the switch S′ is opened. The switch S^2 is closed against the post d^7, so that the negative current passes from conductor D through branch D′, switch 7^2, wire d^5 to the interrupter, and thence to the several contact-posts 1^b to 8^b, inclusive. The receptive device in this case should have its terminals connected with the binding-posts 10^b and C^6. The frequency-varying switch is then shifted so as to bring one of the vertical rows of contact-points of the series X into operative position, and the circuit will then be as follows, (see diagram Fig. 10) from conductor D through branch D′, switch S^2, wire d^5 to the interrupter, thence to the binding-post 1^a to 8^a, thence through the row of contacts in series X of frequency-varying switch to the binding-post 10^b, thence through the receptive device to the post C^6 and branch C^2 to the conductor C, thus completing the circuit, the number of interruptions of the current depending upon which row of contacts in series X is in operative position, only negative impulses being transmitted through the receptive device.

Reciprocating field.—In some cases when using the device in connection with my electrotherapeutic device it is desirable to obtain a reciprocating all-positive or all-negative field—that is, a field with but one polarity and in which the waves are thrown off first from on side of the field and then from the other side. This is particularly desirable in my electrotherapeutic apparatus patented to me, as above referred to, wherein two magnets are employed at opposite sides or ends of the field, and by energizing these magnets in alternation only positive or only negative currents can be obtained and the desired reciprocating of the all-positive or all-negative field. To accomplish this, the magnets must be connected independently and not in series or multiple.

All-negative reciprocating field.—To obtain an all-negative reciprocating field, for example, each of the magnets of the electromagnetic field-generating apparatus should have one terminal connected to the binding-post C^6, and the other terminals of the magnets are respectively connected to the binding-posts 9^b and 10^b. The switch S′ being open and the switch S^2 being closed against the post d^7, the frequency-varying switch is shifted so as to bring one of the vertical rows of contacts in the series Y into operative position. With this arrangement (see diagram Fig. 11) the current will flow from the conductor D to branch D′, switch S^2, and wire d^5 to the interrupter, thence to the binding-posts 1^b to 8^b,

respectively, thence through a row of contacts in the series Y to the binding-posts 9^b and 10^b, respectively, and thence through the respective magnets back to the binding-post C^6, thus completing the circuit through each magnet. It will be observed that the series of contacts in each row of series Y are connected alternately to the two lowermost contacts, and therefore the impulses sent alternately will be transmitted alternately through the posts 9^b and 10^b to the respective magnets.

All-positive reciprocating field.—To obtain an all-positive reciprocating field, the switch S^2 is open and the switch S′ is closed againts the post c^7, so as to be connected to the conductor C through branch C′, switch S′, and wire c^5 to the interrupter, from which the current will be transmitted to the posts 1^b to 8^b, respectively. In this case one terminal of each magnet in the electroreceptive device is connected to the binding-post D^6, and the other terminals of the magnets are connected, respectively, to the binding-posts 9^b and 10^b. The frequency-varying switch can be shifted so as to bring one of the rows of contacts in the series marked Z into operation, whereupon the current will flow from conductor C, switch S, wire c^5, the interrupter to the posts 1^b to 8^b, through a row of contacts in the series Z, through the binding-posts 9^b and 10^b, through the magnets of the receptive device back to the binding-post D^6, thence to the conductor D, and the magnets will be energized in alternation with only positive currents.

I have indicated in the drawings two duplicate sets of contacts Y and Z; but it is obvious that one set of said contacts could be used for both the all-positive and the all-negative reciprocating fields.

Preferably I provide condensers, as shown at H, between each pair of conductors 1^a and 2^a, 3^a and 4^a, 5^a and 6^a, and 7^a and 8^a for the purpose of taking care of the counter electromotive force resulting from the action of the conductor. A condenser may also be interposed between the branch conductors D^2 and C^2, as indicated at H′. I also find it practicable to use an electromagnetic generator in connection with these condensers, one receptive device so connected being indicated as No. 4 in Fig. 1 of the drawings.

From the foregoing it will be readily seen that by means of this apparatus I am able to produce a great variety of currents and to interrupt the current delivered to the receptive device a greater or less number of times by means of the frequency-varying switch without changing the speed of rotation of the interrupter itself or the motor.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination of a uniformly-operating interrupter, an electroreceptive device, and means for amplifying or changing the number of interruptions transmitted from the interrupter.

2. The combination of a uniformly-operating rotary current-interrupter, an electroreceptive device, and means for amplifying or changing the number of interruptions transmitted from the interrupter to said device.

3. In combination, an electroreceptive device, a source of electrical energy, a uniformly-operating interrupter interposed in the circuit between the electrical supply and the receptive device, and means interposed in the circuit between the interrupter and the electroreceptive device for varying the number of interruptions without varying the speed or regularity of operation of the interrupter itself.

4. In combination, a receptive device, an interrupter, means for operating the interrupter at uniform speed, electrical connections between the interrupter and the source of electrical supply and between the interrupter and the electroreceptive device, and means interposed in the circuit between the interrupter and the electroreceptive device whereby the number of interruptions transmitted to the receptive device may be increased or diminished without varying the speed of the interrupter.

5. In combination, a receptive device, a rotary interrupter, means for driving the interrupter at uniform speed, electrical connections between the interrupter and the source of electrical supply and between the interrupter and the electroreceptive device, and a frequency-varying switch interposed in the circuit between the interrupter and the electroreceptive device whereby the number of interruptions transmitted to the receptive device may be increased or diminished.

6. In an electrical apparatus, the combination of a transformer for changing the current, an electroreceptive device through which the transmitted current is conducted, an interrupter interposed between the transformer and the receptive device, and means whereby the number of interruptions in the current transmitted to the receptive device may be varied without varying the interrupter.

7. In an electrical apparatus, the combination of a transformer for changing the current, an electroreceptive device through which the transmitted current is conducted, an interrupter interposed between the transformer and the receptive device, means for operating the interrupter at uniform speed, and a frequency-varying switch whereby the number of interruptions in the current transmitted to the receptive device may be varied without varying the speed of the interrupter or the current.

8. In combination, a source of electrical energy, an interrupter, a receptive device, means for transmitting one current direct through the receptive device, and means for directing another current through the interrupter to the receptive device.

9. In combination, a source of electrical energy, a uniformly-operating interrupter, a receptive device, means for transmitting part of the current direct through the receptive device, and means for directing another branch of the current through the interrupter to the receptive device.

10. In combination, a source of electrical energy, an interrupter, a receptive device, means for transmitting a current direct through the receptive device, means for directing another current through the interrupter to the receptive device, and means for amplifying the number of interruptions transmitted from the interrupter to the receptive device.

11. In combination, a source of electrical energy, a uniformly-operating interrupter, a receptive device, means for transmitting part of the current direct through the receptive device, a means for directing another branch of the current through the interrupter to the receptive device, and means for amplifying the number of interruptions transmitted from the interrupter to the receptive device.

12. In combination, an electroreceptive device, a source of electrical energy, an interrupter interposed in the circuit between the electrical supply and the receptive device, a means for transmitting current direct from the source of energy to the receptive device, means for sending a current to the receptive device through the interrupter, and means interposed in the circuit between the interrupter and the receptive device for varying the number of interruptions without varying the speed of operation of the interrupter.

13. In combination, a transformer, an interrupter, an electroreceptive device and means interposed in the circuit between the interrupter and the electroreceptive device for varying the number of interruptions without varying the speed of operation of the interrupter.

14. The combination of a source of electrical energy, a transformer, an interrupter, electrical connections between the transformer and interrupter, an electroreceptive device, and means interposed between the interrupter and electroreceptive device for varying the number of interruptions of the current transmitted to the receptive device from the interrupter, without varying the speed of the interrupter or varying the current.

15. In combination, an interrupter, a receptive device, means for transmitting current from the interrupter to the receptive device, means for varying the polarity of the current transmitted from the interrupter to the receptive device, and means for varying the number of interruptions of the current transmitted from the interrupter without changing the speed of the latter.

16. The combination of a transformer, an interrupter, electrical connections between the transformer and interrupter, whereby either a direct or alternating current may be supplied to said interrupter, a receptive device adapted to be connected in circuit with the interrupter, and means for varying the number of interruptions transmitted to the receptive device without varying the speed of the interrupter.

17. The combination of a transformer, an interrupter, electrical connections between the transformer and interrupter, whereby either a direct or alternating current may be supplied to said interrupter, a receptive device adapted to be connected in circuit with the interrupter, and means for varying the number of interruptions transmitted to the receptive device without varying the speed of the interrupter.

18. The combination of a rotary transformer, an interrupter, electrical connections between the transformer and interrupter, whereby either a direct or alternating current may be supplied to said interrupter, a receptive device adapted to be connected in circuit with the interrupter, means for varying the number of interruptions transmitted to the receptive device without varying the speed of the interrupter, and means whereby the polarity of the current transmitted to the interrupter may be varied, substantially as described.

19. The combination with an interrupter in an electrical circuit, of a frequency-varying switch in said circuit provided with a series of contacts, whereby the number of interruptions produced by the interrupter can be amplified between the interrupter and receptive device.

20. The combination of an interrupter, a series of brushes contacting therewith, and a series of binding-posts electrically connected with said brushes; with a frequency-varying switch having a series of contacts adapted to be brought into the electric circuit to vary the number of interruptions transmitted to the electroreceptive device.

21. The combination of an interrupter, an electroreceptive device, a frequency-varying switch interposed in the circuit between the interrupter and the receptive device, and provided with a series of contacts whereby the number of interruptions produced by the interrupter can be changed or amplified between the interrupter and receptive device by shifting the switch.

22. In combination, an interrupter, a

series of brushes contacting therewith and a series of binding-posts electrically connected with said brushes; with an electroreceptive device and a frequency-varying switch having a series of contacts which may be brought into operative relation with said binding-posts to vary the number of interruptions transmitted to the electroreceptive device.

23. In combination, a transformer, an interrupter operated at uniform speed, electrical connection between said transformer and the interrupter, an electroreceptive device, and a frequency-varying switch interposed in the circuit between the interrupter and the electroreceptive device, whereby the number of interruptions of the current transmitted through the interrupter to the receptive device can be varied or amplified without changing the speed of the interrupter.

24. In combination, a transformer, an interrupter operated at uniform speed, electrical connection between said transformer and the interrupter, an electroreceptive device, and a frequency-varying switch interposed in the circuit between the interrupter and the electroreceptive device, whereby the number of interruptions of the current transmitted through the interrupter to the receptive device can be amplified without changing the speed of the interrupter, and means whereby the polarity of the current can be varied.

25. In combination, a rotary transformer, an interrupter operated thereby at uniform speed, electrical connection between said transformer and the interrupter, whereby either direct or alternating currents can be transmitted to said interrupter, an electroreceptive device, and a frequency-varying switch interposed in the circuit between the interrupter and the electroreceptive device, whereby the number of interruptions of the current transmitted through the interrupter to the receptive device can be varied or amplified without changing the speed of the interrupter.

26. In combination, a rotary transformer, an interrupter operated thereby at uniform speed, electrical connection between said transformer and the interrupter, whereby either direct or alternating currents can be transmitted to said interrupter, an electroreceptive device, and a frequency-varying switch interposed in the circuit between the interrupter and the electroreceptive device, whereby the number of interruptions of the current transmitted through the interrupter to the receptive device can be varied or amplified without changing the speed of the interrupter, and means whereby the polarity of the current can be varied.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

EMILE BACHELET.

In presence of—
I. M. TITUS,
S. F. SAHM.