No. 885,394. PATENTED APR. 21, 1908.

F. F. STRONG.

# APPARATUS FOR CONVERTING DIRECT CURRENT INTO ALTERNATING CURRENT.

APPLICATION FILED FEB. 16, 1906.

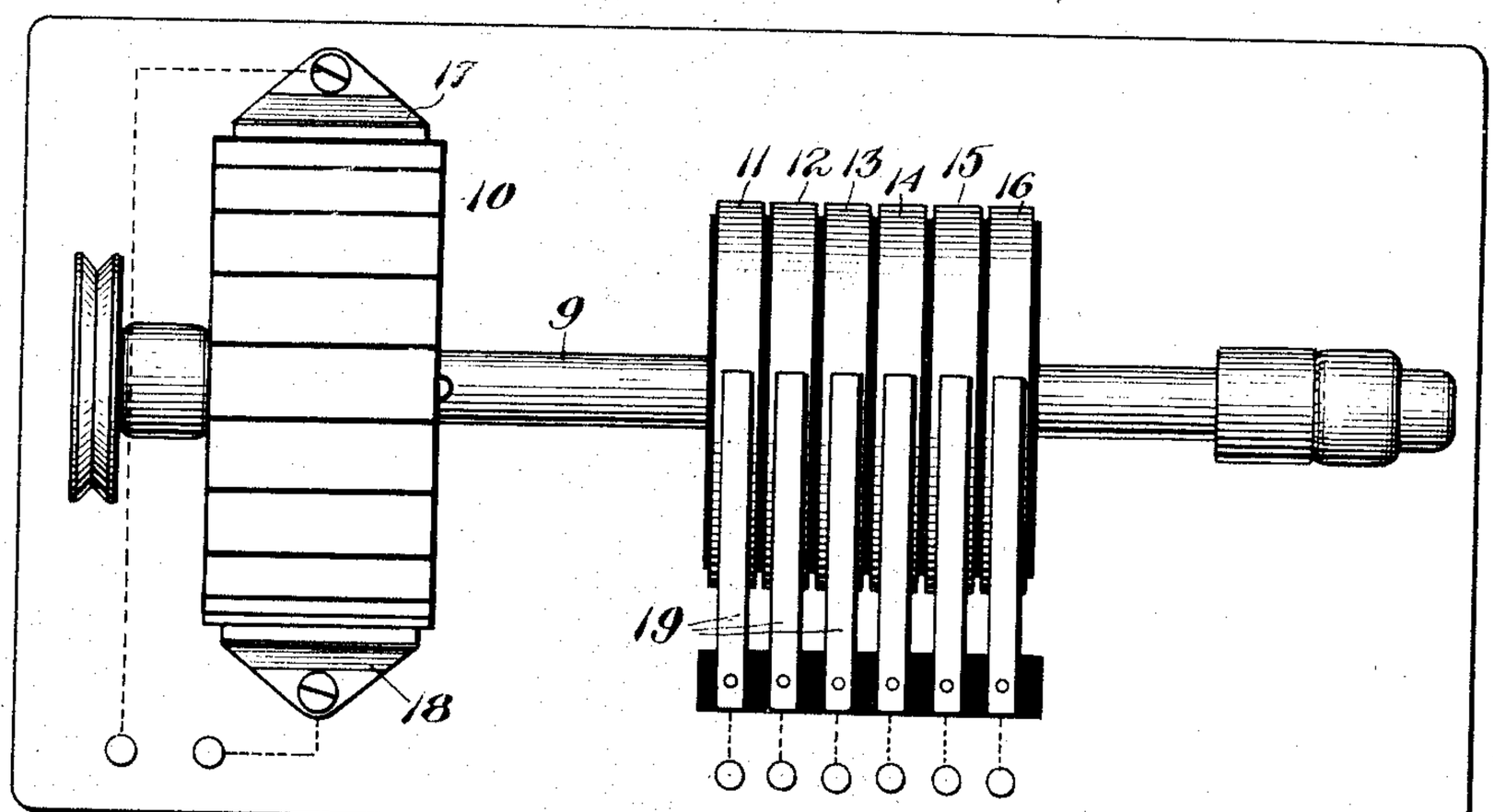



Fig. 1.

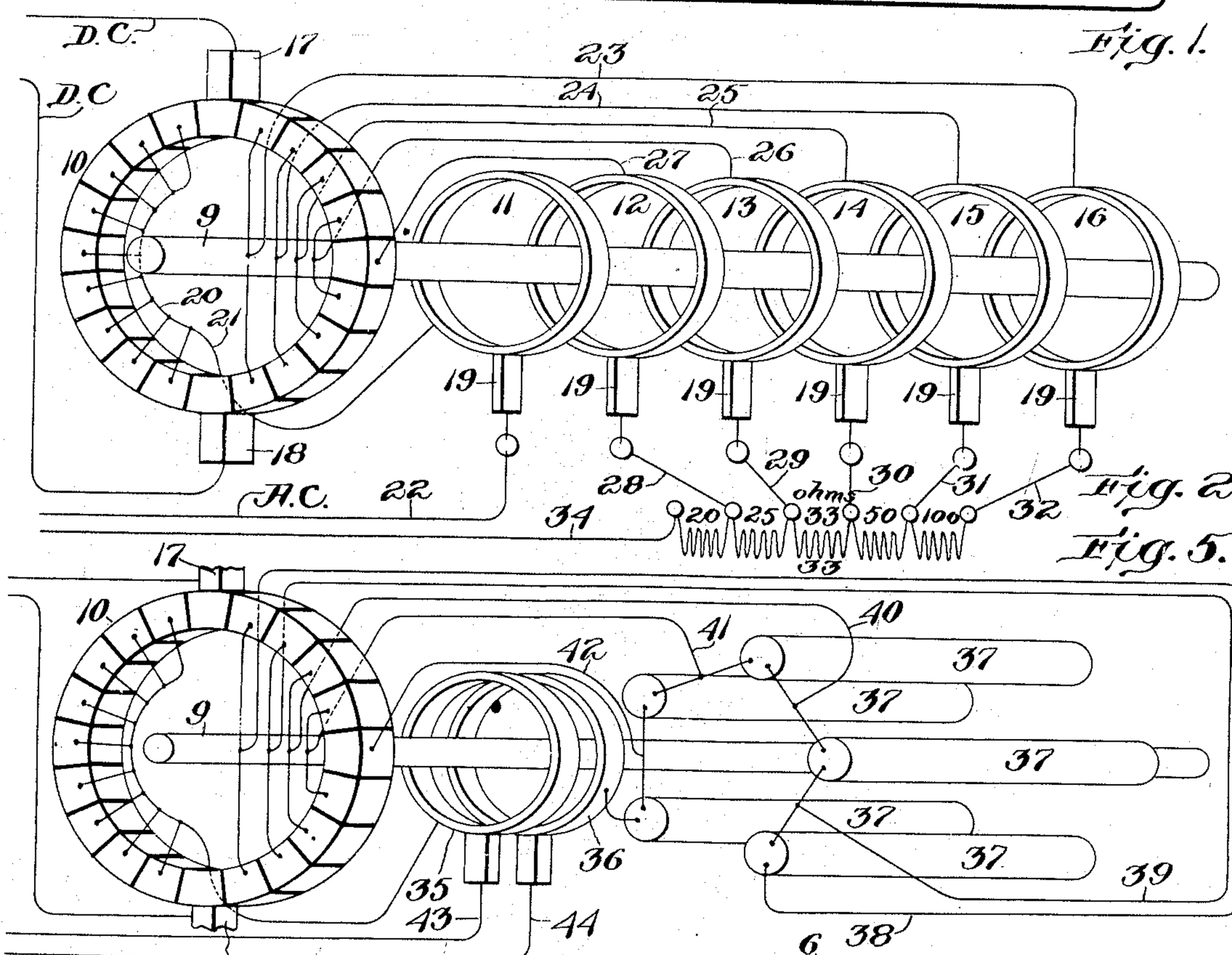



Fig. 2.

Fig. 5.



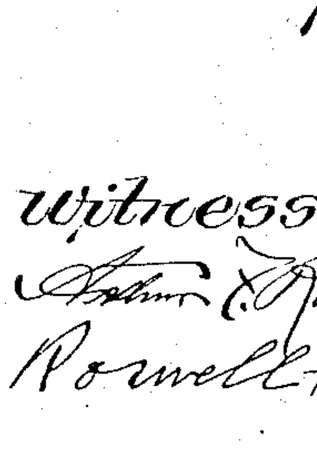
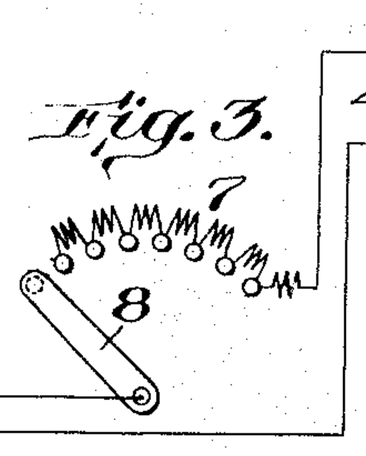




Fig. 3.



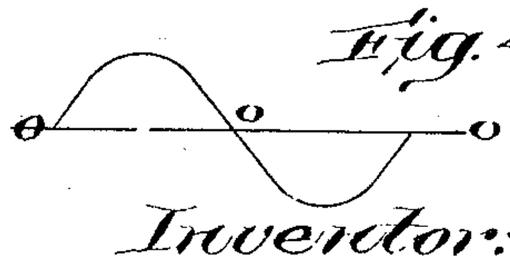



Fig. 4.

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# UNITED STATES PATENT OFFICE.

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## APPARATUS FOR CONVERTING DIRECT CURRENT INTO ALTERNATING CURRENT.

No. 885,394. Specification of Letters Patent. Patented April 21, 1908.

Application filed February 16, 1906. Serial No. 301,346.

*To all whom it may concern:*

Be it known that I, FREDERICK F. STRONG, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Apparatus for Converting Direct Current into Alternating Current, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to the conversion of direct electric current into alternating current, and is especially useful for the operation of high frequency apparatus or an induction motor or the like, my invention residing, broadly stated, in causing the required undulations by gradually cutting in ohmic resistance and then gradually cutting it out again, and as the wave reaches the neutral point reversing the direction of the current.

My invention also includes mechanism for carrying out the above method automatically.

Further details of my invention and the various advantages thereof will be better understood by reference to the accompanying drawings in which I have illustrated my invention.

In the drawings, Figure 1 is a plan view of one form of mechanism for carrying out my invention; Fig. 2 is an isometric view of the various parts of the apparatus of Fig. 1, showing the relations of parts and the wiring; Fig. 3 is a diagrammatic view illustrating the principle of my invention embodied in a hand apparatus; Fig. 4 is a diagrammatic view of a sinusoidal wave, referred to in explaining my invention; and Fig. 5 is an isometric view of a modified embodiment of the invention.

Referring to Fig. 3, for convenience in explaining my invention, it will be understood that 1 indicates a usual source of direct current (which, for purposes of explanation, will be considered of 100 volts) from which wires 2, 3 lead to a double-throw switch 4 connected to the main wires 5, 6, a suitable series resistance 7 being interposed in the wire 3 operated by a contact arm 8. Preferably the resistance is so arranged that, in accordance with Ohm's law, there will be a difference of one ampere between the successive contacts, as, for example, commencing at the right Fig. 3 the successive contacts of the rheostat will represent 10, 15, 20, 25, 33⅓, 50 and 100 ohms respectively. Let it now be supposed that the lever 8 is on the zero contact, the resistance being infinite, and is moved gradually over to the right, thereby cutting out ohmic resistance from the direct current circuit. Having reached the contact on extreme right so that all but the last resistance is cut out, the lever is shifted gradually back to the left, thereby re-introducing said resistance gradually, and just as the lever reaches the extreme left position the double-throw switch 4 is operated to reverse the current in the wires 5, 6, whereupon the operation is repeated exactly the same until the lever again comes to its full line position Fig. 3, when the switch 4 is shifted back again. The result of this operation is that an alternating current is produced, substantially as shown in Fig. 4, in which the wave begins at the neutral line (*i. e.* as the lever 8 begins to move from left to right) and gradually increases (as the resistance is cut out) until it reaches the apex of the curve (when the lever 8 is at the extreme right position) and then gradually descends (as the rheostat lever is swung back to the left) until it reaches the zero line again (when the lever 8 has reached its original position at the left) and then passes below the neutral line (as the switch 4 is shifted) and again increases (as the resistance is again being cut out) until it reaches maximum (by the arrival of the lever 8 at its extreme right position) and then gradually decreases until it reaches the neutral line again (by the arrival of the lever 8 at its original left-hand position, ready for the second reversal of the switch 4). By this means I produce an alternating current simply by properly manipulating ohmic resistance and reversing the current at the proper moment. This entirely eliminates the objectionable features which have accompanied the use of inductive resistance for this purpose as in the usual type of rotary converter, permits the resistance to be outside of the rotary device if desired, and does away with all danger of heating and burning out. It is self-limiting as to the amount of current to be delivered on the alternating side of the circuit, and is self protecting in that it cannot be destructively overtaxed.

Referring now to Figs. 1 and 2 where I have shown a preferred mechanical embodiment of my invention, it will be seen that I have provided on a shaft 9 a commutator 10 and a series of collector rings 11—16. The com-

mutator is provided with opposite contact brushes 17, 18 for supplying direct current (of 100 volts, for instance) and each collector ring has a brush 19. The commutator is divided into a series of similar segments which are represented largely diagrammatically in Fig. 2, all the segments on one side of the commutator being connected in suitable manner as indicated at 20, and thence connected by a wire 21 to the ring 11 whose brush 19 connects to one wire 22 of the main line circuit. The remaining segments of the commutator 10 are connected in pairs by wires 23, 24, 25 and 26 which connect respectively with the rings 16, 15, 14 and 13, the ring 12 being connected by a wire 27 to the middle segment of the commutator. From the brushes 19 of the respective collector rings 12—16 are conductor wires 28—32 leading to a rheostat 33 whose resistance is indicated in ohms in Fig. 2, the opposite main wire therefrom being indicated at 34. The wires 32, 34 are connected in circuit with any high frequency mechanism or other apparatus which requires this kind of alternating current.

From the above description it will readily be understood that as the commutator rotates it will cause the current wave to rise and fall, will then reverse the current and cause the same undulation in the opposite direction, repeating this effect at each rotation.

In Fig. 5, I have shown a modified construction in which the resistance, instead of being stationary as in the preferred construction Figs. 1 and 2, is rotary with the rest of the device. The commutator 10 is constructed the same as before and on its shaft is mounted two collector rings 35, 36 and a series of resistances 37, herein shown as five in number, connected to the commutator by wires 38, 39, 40, 41, 42 in the same manner as previously described. The only difference between these two embodiments is that in my preferred construction the resistance is stationary, the current being taken from rotary collector rings by means of the brushes 19, whereas in the modified construction Fig. 5 the resistance rotates with the rest of the device and hence there are no corresponding collector rings and brushes but simply the two collector rings 35, 36 for the main wires 43, 44.

I prefer to arrange the apparatus so that there will always be some resistance left in the series (*e. g.* 20 ohms in a 500 watt converter) to protect the translating device. In both instances the ohmic resistance is separate from the rest of the apparatus in the sense that it is between the commutator and the translating device and is not dependent in any way upon the motor or other means employed for rotating the apparatus. It will be understood that the gradations of rise and fall may be varied practically without limit to suit individual preferences or to accommodate the apparatus to any given work.

While I have illustrated three different means of carrying out my method, I do not intend to limit myself thereto, the main requirement being to provide means for gradually cutting out the ohmic resistance from the direct current circuit and then for gradually introducing said ohmic resistance into said circuit up to infinity, then reversing the direction of the current while the infinite resistance is in circuit and then gradually cutting out the resistance again, and, when it is nearly all cut out, gradually introducing it again, reversing the direction of the current and so on, repeating this cycle of operations continuously, thus producing in effect the desired cycles of alternating current. By suitably speeding the motor or other means employed in rotating the device, an alternating current of any desirable frequency may be produced, the advantage of this being that the same device may be used at will to furnish current for a 60 cycle induction motor or for one of 133 cycles, etc.

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

An electric apparatus for converting direct current into alternating current, comprising a rotary commutator, its brushes and feed wires for delivering direct current thereto, and an outgoing circuit including collector rings, brushes and circuit wires for conveying current from said commutator, and a plurality of resistances in series interposed in said outgoing circuit, said commutator having segments coöperating with said brushes to cut out the feed current at predetermined intervals, and segments connected with the rheostat for gradually cutting out the resistance from said outgoing circuit and gradually restoring said resistance to said outgoing circuit in the interval between said predetermined intervals, and means for reversing the feed current at said predetermined intervals.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

FREDERICK F. STRONG.

Witnesses:
GEO. H. MAXWELL,
M. A. JONES.