J. A. WOTTON.

ELECTROMAGNETIC DEVICE.

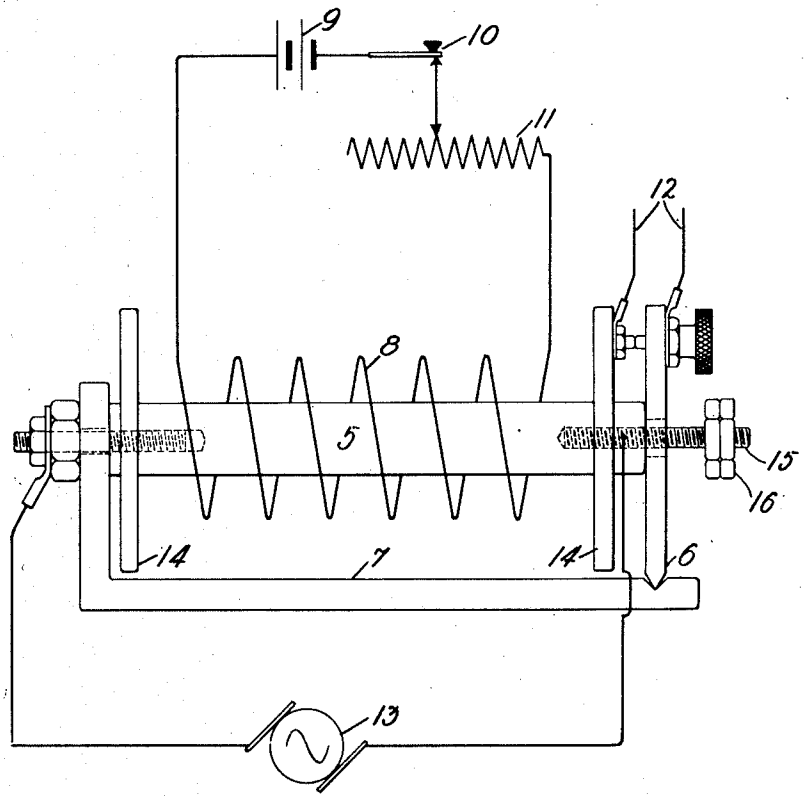
APPLICATION FILED AUG. 29, 1917.

1,367,727.

Patented Feb. 8, 1921.

2 SHEETS—SHEET 1.

Fig. 1.



Inventor:
James A. Wotton.
by J. H. Roberts Atty.

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2 SHEETS—SHEET 2.

Fig. 2.

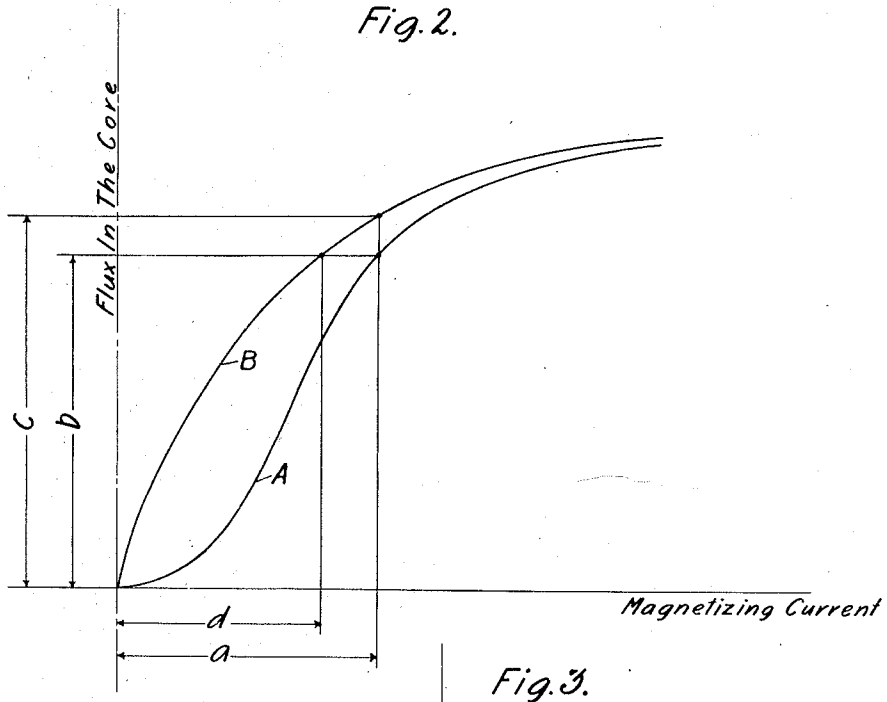
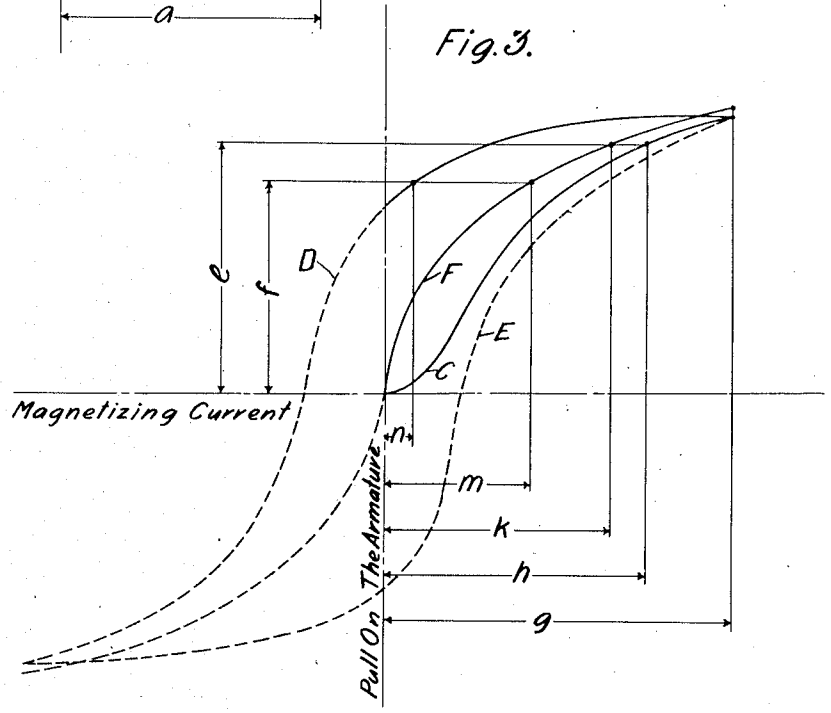


Fig. 3.



Inventor:
James A. Wotton
by J. E. Roberts Atty

UNITED STATES PATENT OFFICE.

JAMES A. WOTTON, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTROMAGNETIC DEVICE.

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Application filed August 29, 1917. Serial No. 188,824.

To all whom it may concern:

Be it known that I, JAMES A. WOTTON, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electromagnetic Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to electromagnetic devices, and more particularly to electromagnetic circuit controlling devices or relays having retractable armatures.

In most cases where such devices are employed, it is desirable that they shall operate at substantially the smallest possible value of magnetizing force for a given structure, in order to minimize the energy losses therein. In other classes of service, it is desirable and important to reduce the difference between the operating and releasing currents in such devices to a minimum in order to improve the commercial range of operation.

The general object of this invention is to provide an electromagnetic device or relay such that for a given magnetic structure, a minimum value of magnetizing force will be required to actuate it, and wherein the releasing magnetizing force is only slightly below that required for its actuation.

Generally considered, an electromagnetically operated device embodying the present invention is characterized by the provision of means whereby the actuating flux path is subjected to auxiliary magnetization, for the purpose of decreasing the difference between the actuating and releasing current values of the device. More specifically considered, the invention is characterized by the provision of means whereby the actuating flux path of an electromagnetically-operated device is subjected to the auxiliary magnetization effect of alternating current. Still more specifically considered, as applied to an electromagnetically-operated device, the invention is characterized by the provision of means whereby alternating current is passed through the core of the electromagnetic structure for the purpose of magnetizing the actuating flux path.

This invention will be more clearly understood by reference to the drawings, in which Figure 1 is a schematic representation of an electromagnetic device or relay with its associated source of energizing current, showing one embodiment of this invention; Fig. 2 is a graphical representation showing the relation between the current in the energizing winding of the device of Fig. 1 and the flux produced thereby in the magnetic circuit under both the ordinary operating conditions and under the more exacting conditions satisfied by this invention; Fig. 3 shows graphically the relation between the current in the magnetizing winding of the device of Fig. 1 and the pull on the armature produced thereby under conditions similar to those of Fig. 2.

In Fig. 1 of the drawing, an electromagnetic device or relay is shown having a core 5, an armature 6, and a return magnetic path 7. An energizing winding 8 is supplied with current from a battery or other source of current 9, through a key 10, and a resistance 11, whereby the core is energized to attract the armature 6, to close a contact between conductors 12 of an auxiliary circuit. Upon the deënergization of the core 5, the armature 6 is retracted by the force of gravity to open the auxiliary circuit. A source of alternating current 13 of suitable amplitude and frequency is connected in series with the core 5, whereby alternating current is caused to pass lengthwise through the core. Non-magnetic members 14, 14 serve as terminal supports and spool heads for the winding 8, while the stud 15 and nuts 16 act as back-stop and adjusting means for the armature 6.

The effect of an alternating current passing through the core upon the magnetic characteristics thereof will be more clearly understood by reference to Fig. 2. Graph A is the magnetization curve obtained by passing successively increasing values of current through the winding 8 of the relay of Fig. 1, and measuring the corresponding values of magnetic flux in the core. Graph B is a similar magnetization curve obtained from the same core, while alternating current from the source 13 is passing therethrough. This characteristic behavior of magnetic material is discussed by Professor Ewing in his book on the "*Magnetic Induction in Iron and Other Metals.*" The effect of the phenomenon represented by the magnetization curves of Fig. 2 is that a given current value *a* will normally produce a value of flux *b*, while a larger flux value, represented by *c*, will result if an alternating current is

passing through the magnetic material of the core. Or, viewing it from another angle, a smaller value of current *d*, when alternating current is flowing, will produce the same amount of flux *b* as is normally produced by a current of value *a*.

Referring now to Fig. 3, the curve C corresponds to the initial magnetization curve A of Fig. 2. D and E are successive branches of a curve similar to the well-known magnetization loop obtained by cyclic magnetization of magnetic material. F corresponds to the magnetization curve B of Fig. 2, and furthermore represents the two branches of the magnetization loop which have become merged into one, due to the alternating current passing through the core. Only those parts of these curves which indicate the actual pull on the armature when the relay is in use are shown in full lines. The remaining portions, represented by dotted lines, are shown merely for clearness of description.

Let it be assumed that a pull on the armature represented by *e* is necessary to attract it from its retracted position, while a pull *f* is required to hold it in actuated position. If no alternating current is passing through the core, a value of direct current *h* would be required to actuate the armature; the maximum value attained by the current as determined by the battery 9, and resistance 11 being represented by *g*. Upon opening the circuit at key 10 or upon increasing the value of the resistance 11, in series with the battery 9, the current will fall and the armature will remain attracted until the current has reached the value *n*, whereupon the pull is reduced to the releasing value *f*, allowing the armature to fall back into retracted position. The corresponding current values required when the alternating current is passing through the core, are *k*, *g* and *m*.

It is, therefore, clear that while the maximum energizing current, determined by operating conditions, may be the same in either case, the armature will first be attracted by a substantially smaller value of energizing current, when alternating current is flowing and will be retracted, on the other hand, at a substantially higher value. The margin of operation, which in either case is determined by the ratio of releasing current to operating current is substantially higher when the alternating current is passing through the core, as shown by the ratio of *m* to *k* as compared with *n* to *h*.

There would be in practice a slight discontinuity in the curves of Fig. 3 at the point where the armature changes from its retracted position to its actuated position, and vice versa, due to the consequent change in reluctance of the magnetic circuit; but for the purpose of simplicity such slight discontinuity has not been shown.

It is obvious that many modifications of the exact structure shown in Fig. 1 of the drawing may be made, all of which come within the scope of this invention. Currents having other characteristics than those described may be used to actuate the armature and means other than those described may be used to produce auxiliary magnetization of the actuating flux path.

What is claimed is:

1. The method of decreasing the difference between the actuating and releasing operating current values of an electromagnetically operated device which consists in auxiliarly magnetizing the magnetic circuit during the application of the operating current.

2. The method of decreasing the difference between the actuating and the releasing current values of a direct current electromagnetically-operated device, which consists in magnetizing the magnetic circuit by means of alternating current during the application of the direct current.

3. In an electromagnetically-operated device, an energizing winding, a magnetic circuit therefor including a retractable armature coöperating therewith, means for supplying operating current to said winding, and means for simultaneously producing auxiliary magnetization of the magnetic circuit.

4. In an electromagnetically-operated device, an energizing winding, a magnetic circuit therefor including a retractable armature coöperating therewith, means for supplying operating current to said winding, and means for simultaneously producing auxiliary magnetization of the magnetic circuit by means of alternating current.

5. In a direct current electromagnetically-operated device, an energizing winding, a magnetic circuit therefor including a retractable armature coöperating therewith, means for supplying direct current to said energizing winding, and means for simultaneously magnetizing the magnetic circuit by means of alternating current.

6. In a direct current electromagnetically-operated device, an energizing winding, a magnetic circuit therefor including a core and an armature coöperating therewith, means for supplying direct current to said energizing winding, and means for simultaneously passing alternating current through said core for the purpose of magnetizing the magnetic circuit.

In witness whereof, I hereunto subscribe my name this 23rd day of August A. D., 1917.

JAMES A. WOTTON.