No. 698,027. Patented Apr. 22, 1902.

E. C. KNAPP.

POLARIZED MAGNET.

(Application filed May 28, 1901.)

(No Model.)

FIG. 1

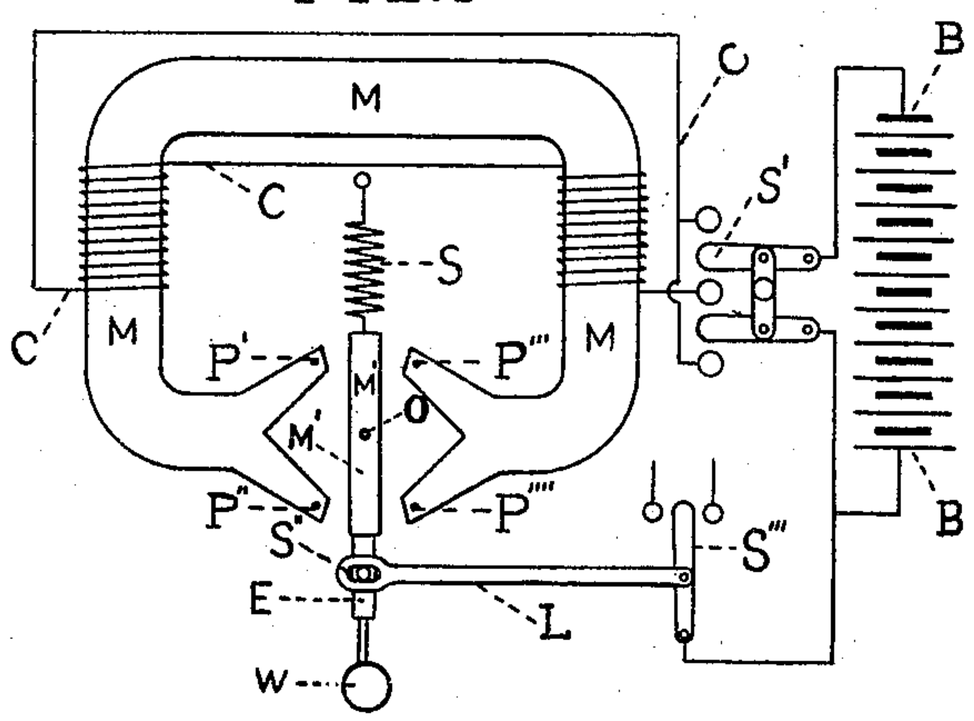


FIG. 2

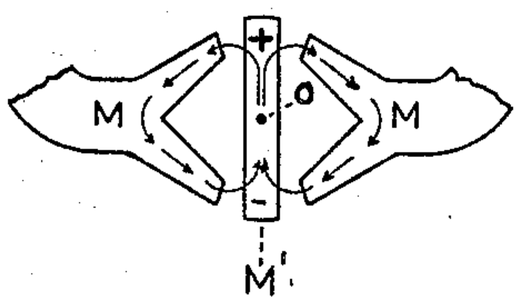


FIG. 3

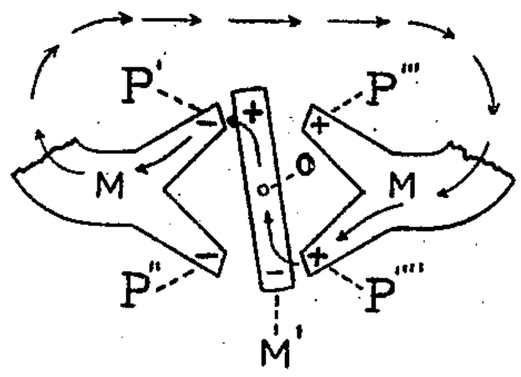


FIG. 4

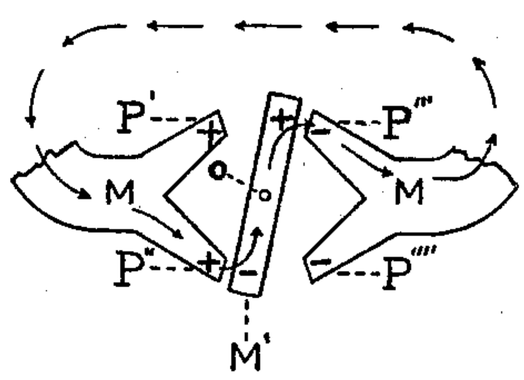


FIG. 5

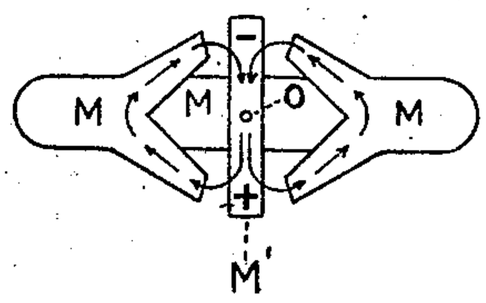


FIG. 6

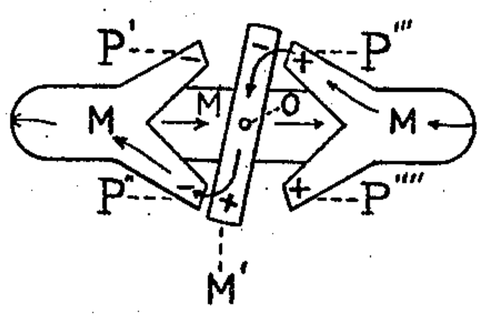


FIG. 7

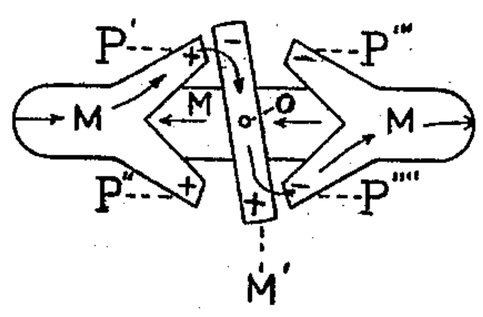


FIG. 8

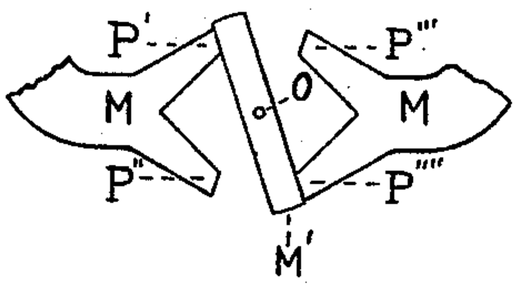


FIG. 9

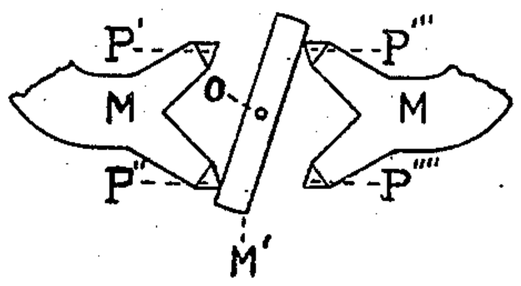
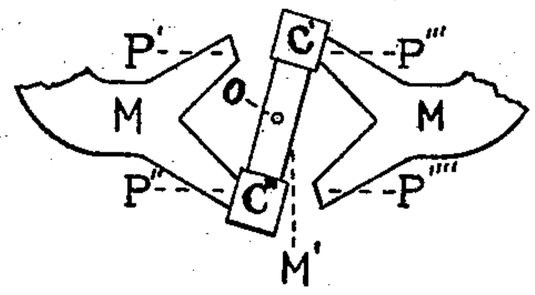


FIG. 10



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UNITED STATES PATENT OFFICE.

EDWIN C. KNAPP, OF SYRACUSE, NEW YORK.

POLARIZED MAGNET.

SPECIFICATION forming part of Letters Patent No. 698,027, dated April 22, 1902.

Application filed May 28, 1901. Serial No. 62,213. (No model.)

To all whom it may concern:

Be it known that I, EDWIN C. KNAPP, a citizen of the United States, residing at Syracuse, in the county of Onondaga and State of New York, have invented a new and useful Polarized Magnet, of which the following is a specification.

In the construction of automatically-controlled machinery it is often desirable or necessary to use a magnet which shall be sensitive to change in either the amount or direction of a magnetizing-current. Such a magnet, known as a "polarized" magnet, is the subject of this specification.

A polarized magnet consists of two magnets (of which one at least must be an electromagnet) so placed that each acts as an armature for the other. Then if adjacent poles of the two magnets be of opposite polarity they attract each other and if of the same polarity they repel. In either case reversing the polarity of either magnet alone reverses the direction of magnetic forces acting. If one magnet be held stationary while the other is allowed to move, its motion becomes available to manipulate any device as desired in accordance with changes of the magnetizing-current and consequent magnetic forces of the electromagnet changing polarity. When the adjacent poles of the two magnets are of the same polarity, each opposes the other in its magnetic flux, and with the usual construction the polarity of the weaker magnet is in danger of being reversed by the superior magnetism of the stronger, thus reversing the direction of motion from that desired. Also with such construction said magnets tend to separate, thus lengthening the magnetic circuit, increasing its reluctance, and consequently greatly reducing the strength of magnetic forces acting.

The objects of my invention are to avoid the possibility of reversal of polarity of the weaker magnet by the stronger and to obtain a construction in which any change of relative position of the two magnets due to magnetic action shall shorten the magnetic circuit, reduce its reluctance, and thus strengthen the magnetic forces acting regardless of the polarity of magnetization or the direction of motion of the movable magnet caused thereby; also, to obtain a device which shall be sensitive to slight magnetic charges both as regards amount and direction, positive and forcible in its movements, and symmetrical in its magnetic field, thus relieving the pivot of the movable magnet of all magnetic forces.

In the accompanying drawings, which form a part of this specification, Figure 1 shows, in elevation and diagram, the complete apparatus. Figs. 2, 3, 4, 5, 6, and 7 show the different positions taken by the movable magnet with reference to the fixed one due to magnetic polarities, as indicated by the positive and negative signs at the magnet-poles. Also by the lines of arrows these figures show the path of magnetic flux corresponding to each case. Figs. 8 and 9 show the magnetic circuit completed in iron by a swing of the movable magnet in either direction. Fig. 10 shows actual contact of magnetic metal prevented by stops c' c'', as described later, while Fig. 9 shows actual but imperfect contact, as described later.

Referring more especially to Fig. 1, M is the core of an electromagnet having each extremity divided or forked into two branches, making in all four branches P′, P″, P‴, and P⁗, which become magnet-poles when the core M is magnetically excited. Of these poles, P′ and P″ at one end of core M are always of the same polarity, while P‴ and P⁗ at the other end are of the opposite polarity. Which pair is positive and which negative is determined by the direction of magnetization of core M. All four poles P′, P″, P‴, and P⁗ are located in the same plane at the corners of a rectangle, the two positive and the two negative poles forming or making opposite sides of said rectangle, as shown in Figs. 3, 4, 6, and 7. Upon an axis O, passing through the center of said rectangle and perpendicular to the plane thereof, is pivotally mounted the movable magnet M′, which has poles of opposite polarity, one at or near each extremity, and is so mounted upon axis O, passing through the region of its neutral zone, that each pole lies between one positive and one negative pole of those of magnet M outlining said rectangle. For reasons more fully explained hereinafter it becomes impossible with this arrangement for the electromagnet M to reverse the original polarity of

magnet M′, however powerful the former or weak the latter may be.

As shown in Figs. 1, 2, and 5, magnet M′ is in the central position, with its poles lying midway between those of electromagnet M, where it may be lightly held by a spring, as *s*, or a weight, as *w*, or both together, as desired. Electromagnet M is magnetized with either polarity or demagnetized at will by means most readily available. Magnet M′ may be magnetized once for all and its polarity never changed. It is best, therefore, made a "permanent" magnet, in which case it may be made very light and sensitive. In Fig. 1 means to magnetize, demagnetize, and reverse electromagnet M are shown, consisting of a battery B, pole-changing switch *s*′, and magnetizing-circuit *c*.

When M is demagnetized, M′ under the influence of weight or spring takes its central position, as shown in Figs. 1, 2, and 5. Let M be magnetized a slight amount and M′ is at once deflected to one of the positions shown in Figs. 3, 4, 6, or 7, according to which case the polarity of magnets corresponds. If magnet M′ be originally magnetized with polarity as shown in Fig. 2, then when under the magnetic influence of electromagnet M it will take one of the positions shown in Figs. 3 or 4. If originally magnetized as in Fig. 5, it takes a position shown in Figs. 6 or 7. In any case the direction of magnetic flux through magnet M′ remains the same as originally magnetized, as shown by the arrows in Figs. 2, 3, and 4 or Figs. 5, 6, or 7, and with it unites the magnetic flux of electromagnet M, reinforcing and intensifying but never opposing it. Also any displacement of magnet M′ from its central position reduces the length of path of the united magnetic flux, reduces the air-gaps therein, and consequently greatly reduces the reluctance of the magnetic circuit and correspondingly increases the magnetic flux and forces causing such displacement. This process may continue until the air-gaps are closed and the magnetic circuit becomes complete in the iron, as shown in Figs. 8 and 9. In fact, as shown in Fig. 8, the reluctance may be so reduced as to cause the magnets to still adhere after the magnetizing-current has been discontinued. To avoid this action, the pole-faces are cut away, as in Fig. 9, thus reducing the area of contact to any amount desired, or stops may be provided to arrest the movement of M′ at a point short of actual contact. Such stops, consisting of a non-magnetic covering for the magnet-poles, are shown at *c*′ *c*″, Fig. 10.

That displacement of magnet M′ may take place under the least amount of magnetic influence it is best to allow some lost motion in the connections through which the motion of M′ is transmitted to the device which it is to operate. In Fig. 1 provision for this is made by the slot *s*″ in the link L, through which extension E of magnet M′ operates the switch *s*‴. Slot *s*″ permits M′ to move an amount which insures for it a strong magnetic attractive force before it is called upon to overcome any resisting frictional forces of switch *s*‴.

It should be noted that the peculiar mode of operation here described is a result of the arrangement with relation to one another of the several magnet-poles and the axis upon which the moving magnet swings, in which arrangement lies the principal part of the invention herein set forth. While these relative positions of magnet-poles are retained either magnet may be made the reversible electromagnet and either the swinging magnet, making in all four combinations, which will be evident to one versed in the art, without in any way affecting the mode of operation or tending to reverse the magnetism in the magnet not intentionally reversed.

Referring again to Figs. 2, 3, 4, 5, 6, and 7, each figure represents the relative positions of the two magnets and the path and direction of magnetic flux corresponding to the polarities of magnets as there indicated, regardless of which is the reversible magnet and which the moving one.

Making the reversible magnet the heavy, stationary, and forked one, while the swinging magnet is a light, simple, and preferably a permanent one, is considered best practice for usual cases, though exceptional conditions might arise making it advantageous to use one of the other forms.

Having thus fully described my invention and its mode of operation, what I claim as my invention, and desire to secure by Letters Patent, is—

1. A polarized magnetic device comprising a magnet having its two ends branched or forked each into a pair of magnetic poles of the same polarity but each of said pairs being of opposite polarity, all four poles so formed lying in the same plane and each of said pairs forming, or marking, opposite sides of a rectangle therein; a second magnet itself having two poles of opposite polarity, each of which is located at or near one extremity thereof and between a positive and a negative pole of those of said first magnet forming said rectangle; an axis passing through the geometrical center of said rectangle and perpendicular to the plane thereof upon which axis one of said magnets is pivotally mounted; and means to control the magnetic excitation of one of said magnets.

2. A polarized magnetic device comprising a magnet having its two ends branched or forked each into a pair of magnetic poles of the same polarity but each of said pairs being of opposite polarity, all four poles so formed lying in the same plane and each of said pairs forming or marking opposite sides of a quadrilateral figure therein; a second magnet itself having two poles of opposite polarity each of which is located at or near one extremity thereof and between a positive and a negative pole of those of said first magnet forming said quadrilateral figure; an axis passing

through the center of gravity of said quadrilateral figure and perpendicular to the plane thereof upon which axis one of said magnets is pivotally mounted; and means to control the magnetic excitation of one of said magnets.

3. A polarized magnetic device comprising an electromagnet having its two ends branched or forked each into a pair of magnetic poles of the same polarity but each of said pairs being of opposite polarity, all four poles so formed lying in the same plane and each of said pairs forming or marking opposite sides of a rectangle therein; a permanent magnet having two poles of opposite polarity each of which is located at or near one extremity and between a positive and a negative pole of those of said electromagnet forming said rectangle; an axis passing through the geometrical center of said rectangle and perpendicular to the plane thereof upon which axis said permanent magnet is pivotally mounted; and means to control the magnetic excitation of said electromagnet.

4. A polarized magnetic device comprising an electromagnet having its two ends branched or forked each into a pair of magnetic poles of the same polarity but each of said pairs being of opposite polarity, all four poles so formed lying in the same plane and each of said pairs forming or marking opposite sides of a quadrilateral figure therein; a permanent magnet having two poles of opposite polarity each of which is located at or near one extremity and between a positive and a negative pole of those of said electromagnet forming said quadrilateral figure; an axis passing through the center of gravity of said quadrilateral figure and perpendicular to the plane thereof upon which said permanent magnet is pivotally mounted; and means to control the magnetic excitation of said electromagnet.

5. A polarized magnetic device comprising two magnets, one at least of which is subject to the direct influence of a magnetizing-coil adapted to reverse its polarity, the first of said magnets having its extremities branched or forked each into two magnetic poles all lying in the same plane and marking the corners of a rectangle therein, the second magnet having two poles of opposite polarity located each at or near an extremity thereof, and between a positive and a negative pole of those of said first magnet outlining said rectangle; an axis passing through the geometrical center of said rectangle and perpendicular to the plane thereof upon which one of said magnets is pivotally mounted and adapted to swing in such a manner as to place its magnetic lines in continuation with those of the other magnet thus forming through both magnets from end to end a single continuous magnetic circuit whose direction in either magnet is unchanged by a reversal in the other.

6. A polarized magnetic device comprising an electromagnet having its two ends forked each into two branches of equal magnetic reluctance, terminating in a pair of magnetic poles of the same polarity, but each of said pairs being of opposite polarity, all four poles so formed lying in the same plane and each of said pairs forming or marking opposite sides of a quadrilateral figure therein; a permanent magnet having two poles of opposite polarity each of which is located at or near one extremity and between a positive and a negative pole of those of said electromagnet forming said quadrilateral figure; an axis passing through the center of gravity of said quadrilateral figure and perpendicular to the plane thereof upon which said permanent magnet is pivotally mounted; and means to control the magnetic excitation of said electromagnet.

7. A polarized magnetic device comprising two magnets, one at least of which is subject to the direct influence of a magnetizing-coil adapted to reverse its polarity, the first of said magnets having its extremities divided each into two branches of equal magnetic reluctance, each branch terminating in a magnet-pole and all poles so formed lying in the same plane and making the corners of a rectangle therein, the second magnet having two poles of opposite polarity located each at or near an extremity thereof and between a positive and a negative pole of those of said first magnet outlining said rectangle; an axis passing through the geometrical center of said rectangle and perpendicular to the plane thereof upon which one of said magnets is pivotally mounted and adapted to swing in such a manner as to place its magnetic lines in continuation with those of the other magnet thus forming through both magnets from end to end a single continuous magnetic circuit whose direction in either magnet is unchanged by a reversal in the other.

Signed at Schenectady, in the county of Schenectady and State of New York, this 11th day of May, 1901.

EDWIN C. KNAPP.

Witnesses:
WM. F. FITZGERALD,
N. AMNEUS.