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ELECTROMAGNETIC RELAY

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Fig. 1

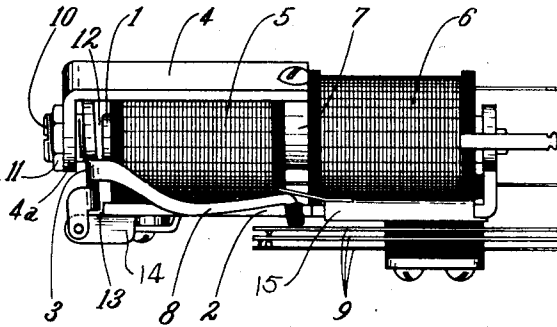


Fig. 2

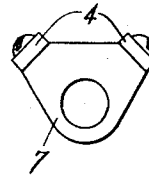
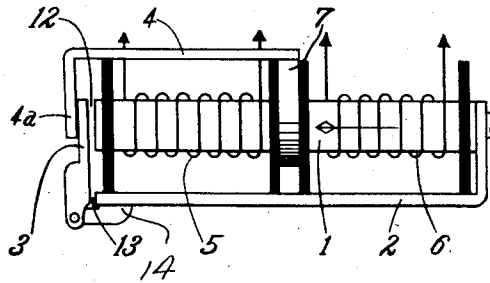


Fig. 3



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ELECTROMAGNETIC RELAY.

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This invention relates in general to electromagnetic relays, more particularly to electro-polarized relays, in which one winding of the relay is energized to magnetize the relay core, and in which the relay armature is operated only when the second winding of the relay is energized in such a direction that the magnetism produced by it assists that produced by the first winding; and the principal object of the invention is the production of a new and improved electro-polarized relay which can be cheaply constructed, and which may be operated over wider limits of voltage than it is possible to operate the relays of this type that have been constructed heretofore.

Electro-polarized relays have been constructed heretofore and put to a variety of uses, for example, they are made use of in the various telephone switching systems in common use, the relay being polarized when a trunk circuit is taken into use and operated when the called party signalled over that trunk responds to the call. Relays of this type, are usually provided with two windings, one of which is energized merely to polarize the relay core, that is to send a small amount of flux through the core in a given direction. The second winding of the relay is first energized in an opposite direction so that the flux it produces, opposes the flux produced by the polarizing winding, this latter winding being subsequently reversed, so that its flux assists that of the polarized winding, to operate the relay. In the design of relays of this type, it is intended that the polarizing winding shall not be of sufficient strength to operate the armature of the relay, this result being obtained heretofore only if the voltage impressed upon this winding is held within rather close limits. Furthermore, with relays of this type, it has been necessary to make the load upon the relay rather light, that is to provide only a few springs to be operated by the armature when it is attracted to the core, this being necessary since the polarizing winding must be maintained very weak to prevent a premature operation of the relay; and because of the limited ampere turn strength that it is possible to put into the second or operating winding of the relay in the circuit in

which it is commonly used. Accordingly in working out the object of my invention I have sought to provide a new and improved polarized relay whose polarizing winding may be stronger initially, and may be operated on a wider range of voltages without danger of prematurely operating the relay. Having accomplished this, I am able, with the usual strength of the second winding, to provide a relay that is sufficiently strong to operate all the springs that can be operated by a single wound straight acting relay of the same type.

Having devised an improved electro-polarized relay structure, I am able to employ that structure in a variety of useful devices. As a further object of my invention I arrange the structure to form a "trigger relay", that is a relay in which a large magnetic force is controlled by a very small magnetic force. By arranging the relay in accordance with this object of my invention, I have produced a structure containing a magnetizing winding which can be energized to any desired strength without operating the relay armature. A single impulse of current through the operating winding will cause the flux produced by the magnetizing winding to operate the armature, after which the armature is held in its operated position, by the magnetizing flux.

A further object of my invention is the production of an alternating current relay in which a large direct current flux is controlled by a small alternating current flux. In working out this object of my invention I employ the trigger relay structure mentioned above so adjusted that the application of alternating current to the operating winding will operate it.

Further objects of my invention not specifically mentioned here, will be apparent from the detailed description and claims which follow:

The drawings comprising Figs. 1 to 3, show sufficient details of the structure of the relay built up in accordance with the objects of my invention, to enable a clear understanding of it.

Fig. 1, shows a completely assembled relay, comprising the core 1, the magnetic iron heel piece 2, polarizing winding 6, mag-

netic member 7, operating winding 5, magnetic iron back stop 4, the armature 3, non-magnetic armature pivoting lever 14, and armature lever 8 and its non-magnetic back stop 15.

Fig. 2, shows the detail of the magnetic iron member 7, to which is attached the magnetic iron back stop 4, comprising two legs or members joined together at one end to form the back stop 4^a of Fig. 1.

Fig. 3, is a schematic drawing of the relay, which will be of assistance in understanding its operation.

It will be noted that the relay I have shown is of the general type used in the Strowger automatic telephone system, such as is shown in Fig. 58, on page 56 of the second edition of the book Automatic Telephony by Smith & Campbell. These relays being compact and entirely self contained may be conveniently mounted in groups or singly as required. In constructing the relay shown in Fig. 1, I have in so far as possible, used the same parts as are used in the relays above referred to, so as to cheapen the cost of construction of my relay as much as possible.

Referring to Fig. 1, it will be noted that the relay consists of a core 1, with the windings 5 and 6 wound on opposite ends of the core and separated midway of the core by the magnetic member 7, which encircles the core at this point. Opposite one end of the core 1 is the armature 3, which is pivoted on one end of the magnetic heel piece 2, the other end of which is rigidly fastened to the opposite end of the core. This heel piece serves also as a mounting plate for the spring combination 9 and the non-magnetic armature lever back stop 15. Attached to two flat surfaces on the member 7, on the opposite side of the coil from the heel piece 2, are a pair of spaced magnetic members 4. These members are spaced apart from each other and are fastened to the member 7 by a pair of screws (see Fig. 2). The members extend parallel to each other and lengthwise of the core 1 to a point beyond the armature 3, at which point they extend down at right angles and form the magnetic back stop 4^a, which together with the adjusting screw 10 and nut 11 serves as a back stop for the armature 3. It will thus be seen that the back stop 4^a and the parallel members 4 comprise a unit structure consisting of the two prongs or extensions 4 joined together into a single piece to form the back stop 4^a.

Referring now to Fig. 3, it will be seen that if the polarizing winding 6 of the relay is energized so that the flux produced flows in the direction of the arrow, that flux will divide over two paths, the major part of the flux traversing the path including the magnetic member 7, both legs of the back stop

4, 4^a, through the small air gap, into the armature 3, through the secondary air gap 13, into the heel piece 2 and thence back into the core. The armature pivoting member 14 being non-magnetic, no flux will pass through it. A small portion of the flux produced by the winding 6 will traverse the core 1, through the main air gap 12, into the armature 3, through the secondary air gap 13 into the heel piece 2 and thence back into the core. Since this latter path has the main air gap 12 and the auxiliary air gap 13 included in it, it will be of high reluctance, and the flux flowing through it will be insufficient to operate the armature 3 to move it to the core, particularly so since the flux in the first of the above mentioned circuits, holds the armature 3 securely against the back stop 4^a. With the structure such as is shown in Fig. 1, the magnetic strength of the winding 6 may be as high as 1200 ampere turns without operating the armature 3, whereas in relays of this type such as shown in the above reference the ordinary ampere turn strength of the winding is but 600 ampere turns. If a circuit through the winding 5 of the relay is now closed in such a direction that the current flowing therein will produce a flux flowing in the opposite direction to that produced by the winding 6, the flux through the air gap 12 will be further reduced, and the flux flowing through the shunt path including the member 7, 4, 4^a and 3, will be increased proportionately. The strength of this second winding is immaterial, since the winding 6 alone, is unable to operate the armature of the relay. When the current direction in winding 5 is reversed, so that the flux produced therein assists that produced by the winding 6, the flux flowing through the shunt path circuit is decreased and the flux flowing through the air gap 12 is increased, so that the armature is attracted to the pole piece of the core 1 to eliminate the air gap 12, in the well known manner. After the armature has once been attracted to its operated position, the winding 6 is of sufficient strength to hold it there, even though the circuit through the winding 5 be opened. In this case the flux produced by the coil 6 traverses for the most part the path including the core 1, the armature 3, now adjacent thereto, the secondary air gap 13, the heel piece 2, and thence back into the core, while a small portion of the flux traverses the other path including the central member 7, the back stop 4 and 4^a, thence through a major air gap into the armature 3, through the auxiliary air gap 13, the heel piece 2, back into the core.

Having thus described my invention, it will be apparent to one skilled in the art that there are many uses to which it may be put. For example in Fig. 67, one page 70 of the book Automatic Telephony, above

referred to, is shown a circuit of an impulse repeater, which employs a polarized relay such as I have just described. That relay designated as BBR, is energized through its polarizing winding when the repeater is taken into use, the circuit through the operating winding being in opposition at the time. After a certain cycle of operation has taken place and the party to whom the connection is being extended has responded to the call, the current through the second winding of the relay will be reversed in the well known manner, whereupon the relay BBR will energize and at its upper motion close a circuit for the reversing relay, Rev. Rly., shown immediately to the left. This operation is explained in detail in the pages of the text, beginning with the paragraph headed Repeater Circuits appearing upon page 70. If the relay of my invention were employed in such a circuit as is shown in Fig. 7, it would be unnecessary to use the reversing relay in addition to the polarized relay BBR, since it would be possible to put all of the springs now on the reversing relay directly upon the polarized relay BBR, that relay being of sufficient strength to properly operate them.

From the foregoing general description, it is apparent that I have constructed a new and useful polarized relay, and it will be apparent to the ones skilled in the art that the structure of my polarized relay can be put to a number of useful purposes. For example, I may employ the relay as an alternating current relay, by energizing the polarizing winding on direct current, and including the operating winding 5 in a circuit upon which is impressed alternating current. During the portion of the cycle of the alternating current in which the flux produced thereby is assisting the flux of the polarizing winding, the relay will snap up, and once it is in its energized position will be maintained by the polarizing winding. By a suitable circuit arrangement, the polarizing winding can be under the control of a local circuit, which control is started by the application of alternating current to the winding 5.

Another modification of the relay permits its use in a circuit wherein the relay is energized over the operating winding 5 in much the same manner as in the case of the straight polarized relay, and by the inclusion of springs on the relay in the circuit of the polarizing winding 6, the relay is released directly under the control of the winding 5. That is, once the relay is in its energized position, a very small current in the winding 5 is sufficient to maintain the relay operated, and if the polarizing winding is opened by the springs mentioned above, the relay can be released by simply opening the circuit of the winding 5.

Another use to which the relay can be put by simply putting it into the proper adjustment, is that of a snap up relay, that is, a relay in which a comparatively large operating flux is controlled by a relatively small control flux. If the polarizing winding 6 is energized upon direct current, and the armature back stop screw 10 adjusted so as to put the armature 3 in such a position that the flux traversing the main air gap 12 is almost sufficient to attract the armature, a very small current flowing through the winding 5 in such a direction as to assist the flux produced by the winding 6, will cause the relay to snap up. In a test made on relays of this type, I was able to operate the relay by applying only two ampere turn strength to the winding 5, the relay then being maintained energized by the polarizing winding 6.

The structure of my relay permits its use in circuits wherein the relay is initially operated by passing direct current through the winding 5. When the polarizing winding 6 is energized in such a direction that the flux it produces opposes the initial flux, the armature retracts, and can again be operated by reversing the current flow through it.

The foregoing description of the construction and uses of the relays of my invention are made merely by way of example, and I do not wish to be limited by the specific disclosure, as there are many modifications and adaptations which will be apparent to one skilled in the art, which can be made without departing from the scope of my invention.

Having described my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims:

What is claimed is:

1. An electromagnetic relay comprising a magnetic iron heel piece having a magnetic iron core mounted thereon, an armature movably attached to said heel piece and having a portion adjacent to one end of said core, a magnetic iron projection disposed on said core midway between said armature end and the point of attachment of said core and heel piece, a magnetic iron backstop attached to said projection and engaging said armature, magnetizing means on said core between said projection and heel piece, the major portion of the flux produced thereby traversing a path consisting of a part of said core, said back stop, armature and heel piece without operating said armature, and a second magnetizing means on said core between said projection and armature, said second means cooperating with said first to operate said armature.

2. An electromagnetic relay containing a core and a heel piece, an armature movably

attached to said heel piece, a main air gap between said core and armature and an auxiliary air gap between said armature and core, said auxiliary air gap having an appreciably lower reluctance than said main gap, a magnetic iron back stop attached to said core away from said main air gap and so shaped as to form a rest against which said armature normally rests, a magnetizing winding disposed upon the heel end of said core, the flux produced thereby traversing two parallel magnetic paths dividing into parts inversely proportional to the reluctance of said paths, means for reducing the reluctance of the high reluctance path by shortening said main air gap which is included therein without materially changing the reluctance of said low path, and means on the armature end of said core operable at will to increase the flux flow across said main air gap to operate said armature to eliminate said air gaps.

3. An electromagnet relay comprising an L shaped magnetic iron heel piece, a cylindrical magnetic iron core attached to one leg of said heel piece and substantially parallel to the other, an armature hinged to the free end of said heel piece and having a portion adjacent to the pole of said core, a projection on said core between said pole and heel piece, a magnetic iron back stop attached to said projection and having a portion against which said armature normally rests, a magnetizing winding on said core between said projection and heel piece the flux produced thereby traversing a low reluctance path comprising the heel end of said core, said projection and back stop, said armature and heel piece, and an operating winding on the armature end of said core, said latter winding cooperating with said magnetizing winding to move said armature to said pole.

4. An electro-magnet comprising a magnetic core, a pole piece projecting from the core at a point intermediate its ends and extending to one end of said core to form an air gap therewith, a second pole piece projecting from the other end of said core, an armature pivoted on the end of said second pole piece and movable in said air gap, windings on the core on opposite sides of said first pole piece, one of said windings adapted to produce a flux over a path including said pole pieces, core and armature to maintain said armature in normal position, and the other of said windings adapted to produce a flux over said path and render said armature operative.

5. An electro-magnet comprising a magnetic core, a pole piece projecting from the core at a point intermediate its ends, a second pole piece projecting from one end of said core, an armature pivoted on the end of said second pole and movable in an air gap between the end of said first pole piece and

the other end of said core, windings on said core on opposite sides of said first pole piece, one of said windings adapted to produce a flux over a path excluding said air gap and maintain said armature in normal position and the other of said windings adapted to produce a flux over a path including said air gap and operate said armature.

6. In an electro-magnetic relay, a core having two windings thereon, a heel piece attached to one end of said core and extending parallel therewith, an armature pivoted at the end of said heel piece and in operative relation with the opposite end of said core, a pole piece attached intermediate said core and between said windings and extending to said opposite end of the core to form a back stop for said armature, one of said windings adapted to produce a flux so that said armature is maintained in normal position, and the other winding adapted to produce a flux to operate said armature.

7. In combination, an electro-magnet having a heel piece parallel to the core and attached to one end thereof and an armature for forming a series magnetic circuit, parallel magnetic members parallel to said core and heel piece but on the opposite side of the core from the heel piece, another magnetic circuit differing from the first and including a portion of the core and said members, said magnetic members spaced apart sufficiently to enable another electro-magnet to be mounted in close proximity to the first and parallel thereto.

8. In combination, an electro-magnet having a core with two windings thereon, a magnetic heel piece attached to one end of said core and extending parallel therewith, an armature on the end of the heel piece, all forming a series magnetic circuit, parallel magnetic members attached intermediate the core and extending parallel to the core and on the opposite side of the core from the heel piece, all forming another magnetic circuit, said magnetic members spaced apart to enable another electro-magnet to be mounted adjacent and parallel thereto.

9. In an electro-polarized relay, a core, a winding on each end of the core, a magnetic heel piece, attached to one end of the core and extending parallel therewith to the opposite end of the core, a pole piece attached intermediate the core between said windings and having a portion extending parallel to the core and on the opposite side thereof from the heel piece, the end of the pole piece being bent at right angles and extending opposite the end of the core, and an armature pivoted at the end of said heel piece and adapted to move in a space between the end of said pole piece and said core.

10. In an electro-polarized relay, a core, a winding on each end of said core, a magnetic heel piece attached to one end of said core

and extending parallel therewith to the opposite end, a pole piece having two legs attached intermediate the core and between said windings, said legs extending parallel to the core on the opposite side of the core from the heel piece and joined together and bent at right angles opposite the end of the core, and an armature pivoted at the end of said heel piece and having its movement limited by the end of the pole piece, where the two legs are joined together, and the end of the core. 10

In witness whereof, I hereunto subscribe my name this 17th day of June, A. D. 1926.

HAROLD C. PYE.