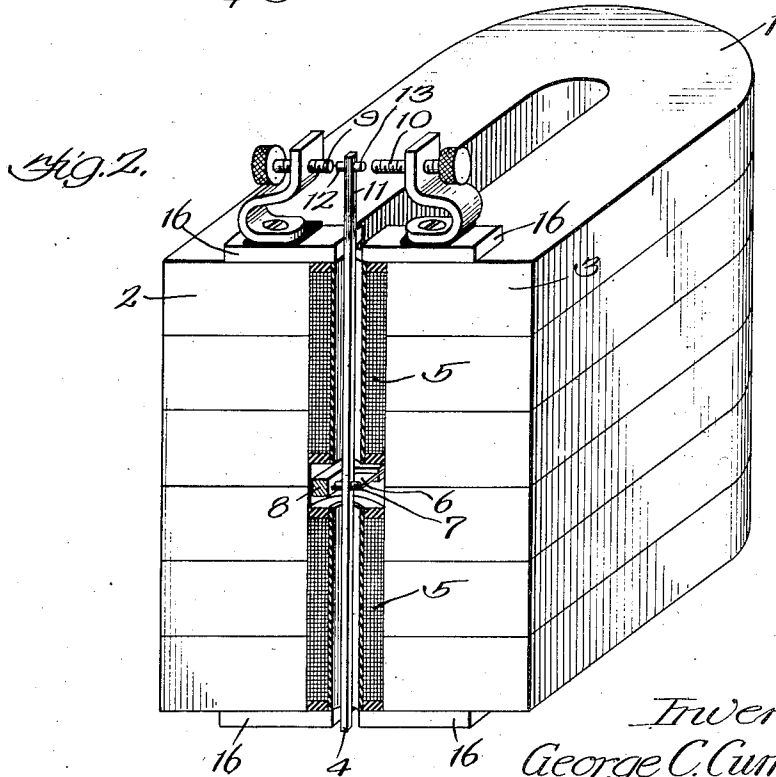
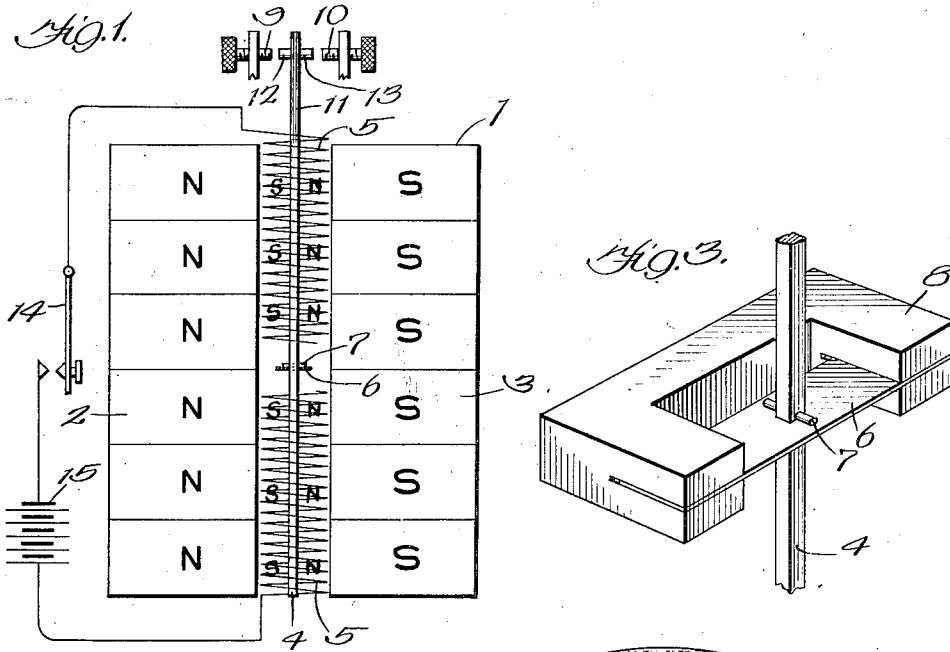


G. C. CUMMINGS.
ELECTROMAGNET.
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ELECTROMAGNET.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, GEORGE C. CUMMINGS, subject of King George of England, residing at East Orange, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Electromagnets, of which the following is a full, clear, concise, and exact description.

My invention, in one aspect, relates to electromagnets included in the class that embraces the polarized relay disclosed in the expired patent to Anderson, 267,966, of November 21, 1882.

The invention also relates to a novel armature mounting which is preferably employed in the magnet having the other characteristics of my invention.

The invention has for one of its objects the elimination of residual magnetism in the oscillating relay or magnet armature that is arranged along a face of a polar end of the magnet. In carrying out my invention this polar face is of a length that is a multiple of twice the width of the space between the axis of the armature and said polar face. This armature is threaded transversely of its length by the flux of a magnet, preferably a permanent magnet, substantially throughout all of the armature that is opposite said polar face. The armature is operable by means of an energizing circuit that includes a winding arranged, when the circuit is effective, to set up flux in said armature longitudinally thereof, the transverse flux of the aforesaid permanent magnet being of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing circuit is ineffective.

In the preferred embodiment of the invention the magnet that establishes the transverse flux has closely approached polar ends whose opposing faces are substantially parallel throughout a length that is a multiple of the width of the space between said parallel faces.

In magnets of the prior art the interpolar spaces were very wide and short. The flux produced by the permanent magnets of the prior art would not be permitted to exceed the most favorable magnetization points to prevent the magnets from becoming insensitive, a result that would follow excessive flux due to increased pressure of the arma-

tures upon their contact parts. This increased pressure must be offset by a force which is additive to the force required to be exerted by the operating current flux employed to move the armatures to their alternative positions. It has also been necessary to maintain large air gaps between the pole pieces and the armature so that the ratios between the distances traveled by the armatures to the distances between the armatures and the pole pieces should not be great enough to create undue contact pressure which would have to be overcome by the operating flux before effecting armature movement. The limitations heretofore present in the design of such magnets or relays have made it impossible to produce structures in which the permanent magnets would eliminate the residual magnetism, owing to the fact that only small portions of the armature lengths were subject to the transverse flux of the permanent magnets. When there is residual magnetism in the armature a force substantially equal thereto must be added to the force exerted by the operating flux.

In accordance with the remaining feature of my invention the armature is mounted upon a bar spring with which the armature is in rigid connection. This bar spring is preferably a strip metal spring secured at its ends to a suitable support. By means of such an armature mounting the armature may be held in mid position without engagement with either front or back contact.

I will explain my invention more fully by reference to the accompanying drawing showing the preferred embodiment thereof and in which Figure 1 is a view, somewhat diagrammatic, illustrating the preferred structure of my invention; Fig. 2 is a perspective view of a structure embracing the invention, parts being indicated in section; and Fig. 3 is a perspective view illustrating the preferred armature mounting.

Like parts are indicated by similar characters of reference throughout the different figures.

The magnet which I employ for effecting the transverse flux is desirably permanent and is preferably made up of a number of horseshoe magnet elements 1 having closely approached polar ends 2 and 3. The polar ends 2 of the magnet elements 1 are upon

one side of the interpolar gap and the polar ends 3 of the magnet elements 1 are upon the other side of the interpolar gap. The opposing faces of the polar ends of the compound magnet are substantially parallel throughout a length that is a multiple of the width of the space between said parallel faces. An oscillating armature 4 is located in and is disposed longitudinally of said space and is threaded transversely of its length by the flux of the permanent magnet substantially throughout all of the armature that is in said space. An energizing circuit is provided for the armature and includes a winding 5 arranged, when the circuit is effective, to set up flux in the armature longitudinally thereof, the transverse flux of the compound magnet being of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing circuit is ineffective. The mounting for the swinging armature is desirably in the form of a bar spring 6 which is preferably a strip metal spring permitting slight axial movement of the armature. This slight axial movement is the reciprocating lengthwise movement of the armature at the contact points where the structure is used for a relay. The armature is brought into rigid relation with said spring where connected therewith by means of a pin 7 rigidly secured to the armature and spring. The armature supporting spring is itself supported at its ends upon the non-magnetic support 8. The pin 7 is a strain equalizing pin that serves to distribute the torque of the spring evenly across the face of such spring which may be so arranged that its force is always such as to maintain or tend to maintain the armature in the center of the space between the contact screws or stops 9 and 10. Such spring force is adjusted so as nearly to but not quite offset the force, due to the permanent magnet flux, that tends to hold the armature against said stops. The armature is positioned to be subject to the actuating influence of the flux on both sides of the spring.

It will be observed that each polar end face of the permanent magnet is of a length that is a multiple of twice the width of the space between the axis of the armature and said face and while I prefer to employ two closely approached polar ends, I do not wish to be limited to this arrangement. It is preferable to make the width between the pole faces commensurate with the height of each individual one of the several permanent magnets comprising the structure because thereby the reluctance of the air gap between the faces insures a considerable percentage of the flux established by the permanent magnet passing directly across this gap rather than taking the longer and greater reluctance path out to the added

polar extensions or pole pieces. This result is secured by the dimensioning mentioned and also by increasing the strength of the permanent magnet as indicated to further insure an intense field across the gap between the pole faces at all points. The two together insure that the transverse flux shall be effective to eliminate residual magnetism.

In a very effective arrangement the distance between the poles is not more than one-sixth of the length of each polar face, such length being measured along the armature, and the strength of the permanent magnet should be ten or fifteen times that which is ordinarily present in a relay structure of the aforesaid Anderson type. By the arrangement herein disclosed an intense substantially equally distributed transverse field is established, neglecting reference to the leakage and fringe effects over the faces of the poles.

The armature 4 may be of soft iron, if desired, and preferably has a non-magnetic continuation 11 to carry contacts 12 and 13 when the structure is employed as a relay. The intense transverse magnetic field due to the combined permanent magnet effects the arrangement of the molecules of the armature in alinement with each other in the transverse directions followed by the permanent magnet flux whereby one long face of the armature is caused to be of one polarity and the face of the armature parallel to the aforesaid armature face is caused to be of the opposite polarity.

The operating circuit of the magnet is inclusive of a winding 5 which is preferably subdivided into two coils arranged on opposite sides of the armature mounting spring 6. Any suitable form of circuit controlling switch is employed, a circuit closing switch 14 being shown in series relation with the winding 5 and a suitable source of current 15. When the switch 14 is closed, lines of force due to the winding 5 will be established in the armature, threading the same lengthwise. This longitudinal flux will cause a portion of the molecules of the armature to shift their position to occupy a direction at right angles to their previous position. This flux will cause the movement of the armature in one direction or the other depending upon the polarity of the battery and the direction of the winding 5. When the key 14 is released so as to be in open position the molecules of the armature which were disturbed by the longitudinal flux will assume their former positions transverse of the armature and parallel with the transverse flux of the permanent magnet which is at right angles to the length of the armature, such a shifting of the disturbed molecules to normal position being due to the intensity of the transverse flux of the perma-

nent magnet. All longitudinal flux, or residual magnetism, in the armature is thus effaced when the operating circuit of the magnet is opened.

5 In the preferred embodiment of the invention illustrated in Fig. 2 there are employed miniature polar extensions 16 that serve merely to concentrate locally very small portions of the transverse permanent
10 magnet flux adjacent the ends of the armature to correspond with the concentration of the operating flux at the armature extremities.

In the structure of the Anderson type the
15 forces which tend to move the armature and that result from the operating current flux are those exerted within the limitations of the polar extensions adjacent the extremities of the armature. In my structure the
20 forces tending to move the armature are not only existent within the limits of the polar extensions 16 but are strongly existent over the major portion of the length of the armature because of the tendency of the transverse permanent magnet field that supplies
25 a field of flux over the entire length of the armature to enable the weaker operating flux to become effective to move the armature, this weaker operating flux being effective throughout the major portion of the
30 armature length as well as at the armature extremities.

While I have herein shown and particularly described the preferred embodiment of
35 my invention I do not wish to be limited to the precise details of construction shown as changes may readily be made without departing from the spirit of my invention, but having thus described my invention I claim
40 as new and desire to secure by Letters Patent the following:

1. A magnet structure including a permanent magnet having closely approached
45 polar ends whose opposing faces are substantially parallel throughout a length that is a multiple of the width of the space between said parallel faces; an oscillating
armature in and disposed longitudinally of said space and threaded transversely of its
50 length by the flux of the permanent magnet substantially throughout all of the armature that is in said space; and an energizing circuit for said armature including a winding
55 arranged, when the circuit is effective, to set up flux in said armature longitudinally thereof, the transverse flux of the permanent magnet being of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing
60 ing circuit is ineffective.

2. A magnet structure including a magnet having closely approached polar ends whose opposing faces are substantially parallel
65 throughout a length that is a multiple of the width of the space between said

parallel faces; an oscillating armature in and disposed longitudinally of said space and threaded transversely of its length by the flux of the magnet substantially throughout all of the armature that is in
70 said space; and an energizing circuit for said armature including a winding arranged, when the circuit is effective, to set up flux in said armature longitudinally thereof, the transverse flux of the magnet
75 being of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing circuit is ineffective.

3. A magnet structure including a permanent magnet; an oscillating armature arranged along a face of a polar end of said
80 magnet, which face is of a length that is a multiple of twice the width of the space between the axis of the armature and said face, said armature being threaded transversely of its length by the flux of the permanent magnet substantially throughout all
85 of the armature that is opposite said polar face; and an energizing circuit for said armature including a winding arranged, when the circuit is effective, to set up flux in said armature longitudinally thereof, the transverse flux of the permanent magnet being
90 of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing circuit is ineffective.

4. A magnet structure including a magnet; an oscillating armature arranged along
100 a face of a polar end of said magnet, which face is of a length that is a multiple of twice the width of the space between the axis of the armature and said face, said armature being threaded transversely of its
105 length by the flux of the magnet substantially throughout all of the armature that is opposite said polar face; and an energizing circuit for said armature including a winding arranged, when the circuit is effective, to set up flux in said armature longitudinally thereof, the transverse flux of the magnet being of strength effective to eliminate longitudinal flux or residual magnetism in said armature when said energizing
110 circuit is ineffective.

5. An electro-magnet including a magnet winding; a swinging armature movable by the flux due to said winding; a bar spring
120 extending transversely of the armature and upon an intermediate portion of which the armature is mounted at an intermediate portion of the armature where the armature is in rigid connection with the spring, the armature being positioned to be subject to
125 the actuating influence of the flux on both sides of said spring; and a support for holding the ends of said spring in fixed relation.

6. An electro-magnet including a magnet winding; a swinging armature movable by
130

the flux due to said winding; a bar spring extending transversely of the armature and upon an intermediate portion of which the armature is mounted at an intermediate portion of the armature where the armature is in rigid connection with the spring, the armature being positioned to be subject to the actuating influence of the flux on both sides of said spring; and a support for said spring.

In witness whereof, I hereunto subscribe my name this 22nd day of April A. D., 1919.

GEORGE C. CUMMINGS.