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MAGNETOSTRICTION RELAYS

2,945,105

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2 Sheets-Sheet 1

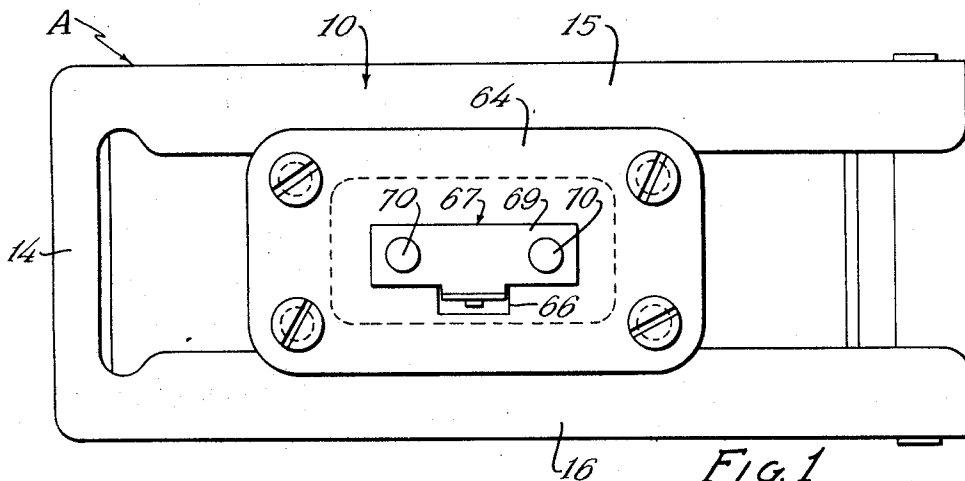


FIG. 1

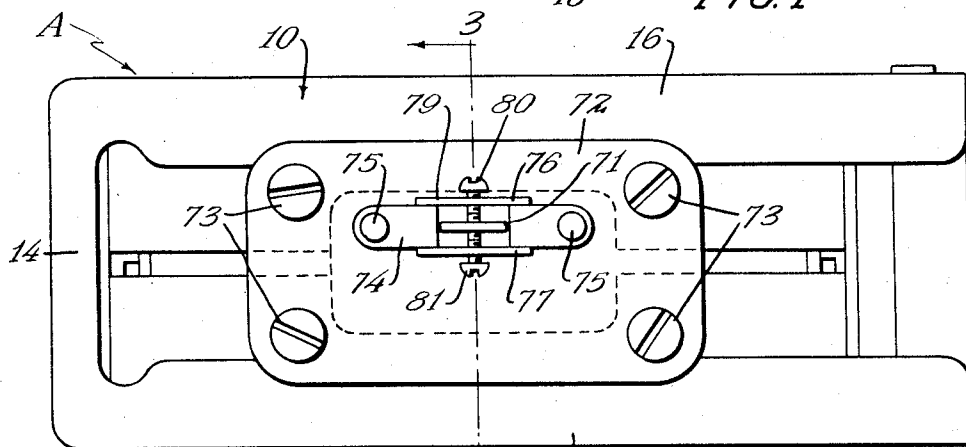


FIG. 2

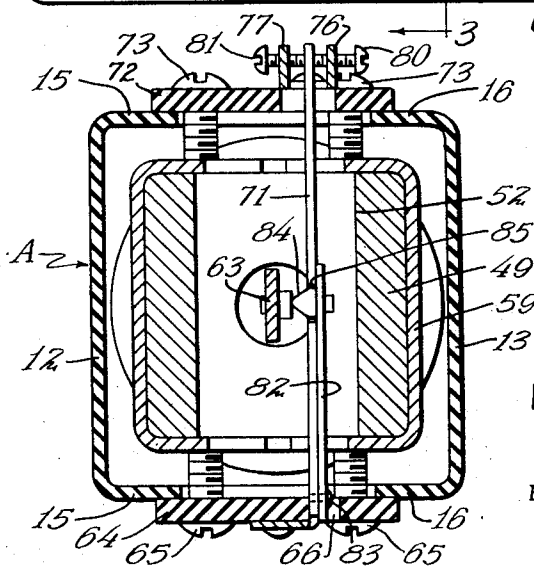


FIG. 3

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2 Sheets-Sheet 2

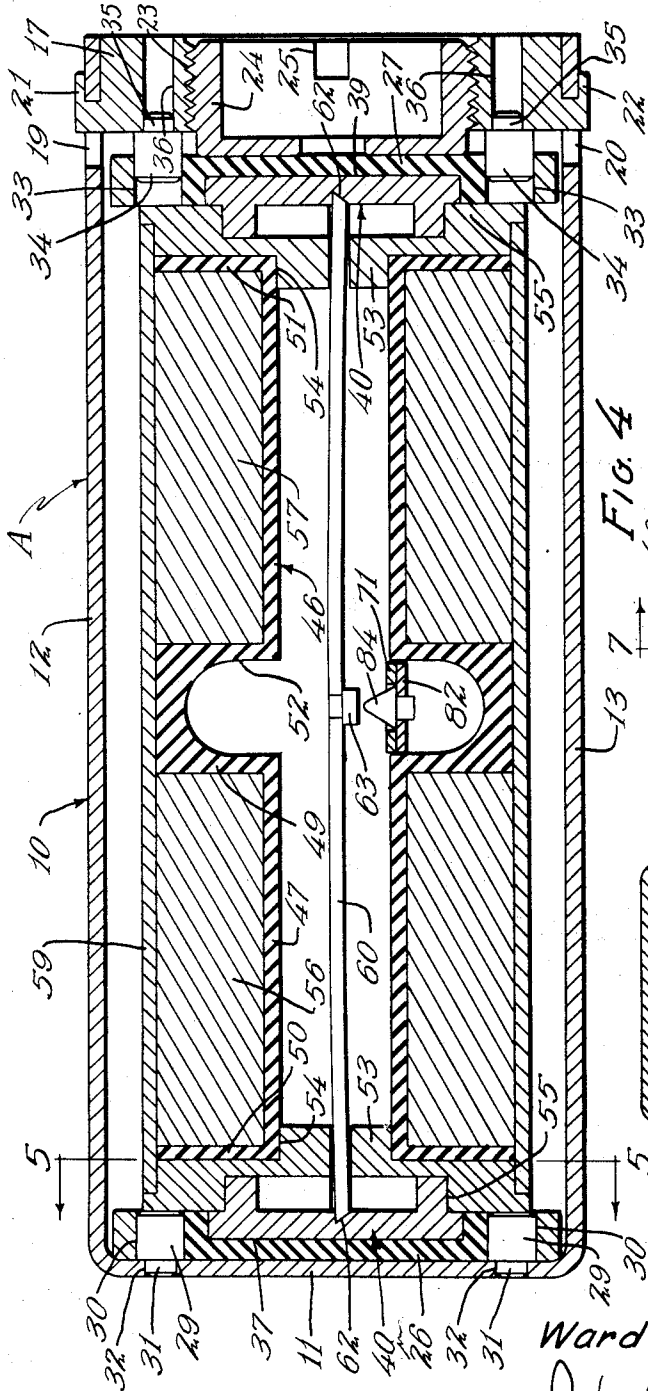


FIG. 4

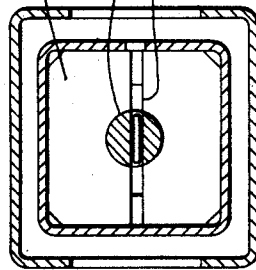


FIG. 5

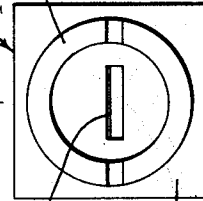


FIG. 6

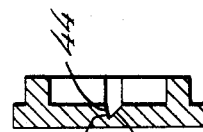


FIG. 7

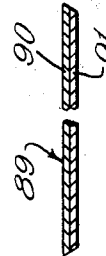


FIG. 8

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MAGNETOSTRICTION RELAYS

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4 Claims. (Cl. 200—87)

This invention relates to relays and, more specifically, to an improvement in magnetostriction relays and deals particularly with a relay which functions on a magnetostriction principle.

It has been known for some time that certain specific materials are unique from others, and that when these materials are subjected to a magnetic field a change in physical dimensions is experienced. These changes are usually designated as magnetostriction effects and take a number of well defined forms. This invention is more specifically concerned with one of these effects which takes the form of a change in length along the axis of the applied magnetic field. The volumetric and transverse changes occurring simultaneously with the changing length are of little importance.

Many materials exhibit magnetostriction properties to a greater or lesser degree but iron, nickel and cobalt alone, and in alloyed combination, show the most pronounced effects. Some of these materials expand lengthwise when undergoing the magnetostriction action and are known as positive magnetostriction materials, while others contract lengthwise and are known as negative magnetostriction materials. Fundamentally, this action is due to the orientation of the electron particles within the material which in most materials are distributed in a random fashion. Within limits, orientation of the particles in a material structure is largely produced by the action of mechanical cold rolling or working of the material which causes a grain orientation lengthwise with the material. One of the objects of this invention is to obtain negative and positive, or negative and neutral, or positive and neutral magnetostriction action of the relay actuating armature and frame, so that thermal compensation can be obtained by using similar materials for both structures with the axis of the major magnetostriction activity of each placed at right angles to each other. Other types of positive and negative magnetostriction materials can be used when the different thermal expansions can be compensated for by construction features.

The more usual magnetostriction relays, such as those of the bi-metal type (U.S. Patent 2,782,280) lack the ability to withstand any substantial external shock or vibration, while those of the resonant type (U.S. Patent 2,120,985) will not operate in, on or off service at the low frequency of 1 c.p.m.

An object of the present invention lies in the use of these principles and characteristics to provide a means of actuating a relay contact or similar device. A feature of the present invention resides in the provision of a relay embodying a frame supporting one or more magnetic coils and containing a strip of either positive or negative magnetostriction material affected in length by the magnetism of the coil or coils or any similarly controlled magnetic field. In a preferred form of construction, the elongated strip of material is confined in a slightly arched position between the ends of a frame. The contact point is provided at the center of the strip which forms the armature of the device. A second fixed contact is sup-

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ported adjoining the first and is arranged either in normally open or normally closed relation to the armature contact. When the coils are energized to provide a magnetic field, the change in length of the armature causes the normally open contacts to close or the normally closed contacts to open.

A feature of the present invention resides in the fact that the supporting frame may be constructed of a material similar to that of the armature but opposite in magnetostriction action and, accordingly, the frame serves the purpose of compensating for variations in temperature. By making the supporting frame of a material similar in analysis to that for the armature but with a major magnetostriction activity at right angles to each other, the expansion and contraction of the frame will be similar to the expansion and contraction of the armature, thus compensating for temperature variations.

These and other objects and novel features of the present invention will be more clearly and fully set forth, in the following specification and claims.

In the drawings forming a part of the specification:

Figure 1 is a side elevational view of one side of the relay.

Figure 2 is a side elevational view of the opposite side of the relay from that illustrated in Figure 1, the relay being inverted from the position shown in Figure 1.

Figure 3 is a cross sectional view through the relay, the position of the section being indicated by the line 3—3 of Figure 2.

Figure 4 is a longitudinal sectional view through the relay showing the general arrangement of parts therein.

Figure 5 is a sectional view through an end of the relay, the position of the section being indicated by the line 5—5 of Figure 4.

Figure 6 is a front elevational view of one of the armature supports.

Figure 7 is a cross sectional view through the armature support, the position of the section being indicated by the line 7—7 of Figure 6.

Figure 8 is an enlarged sectional view through a modified form of armature.

The magnetostriction relay is indicated in general by the letter A and is shown as being generally rectangular in form. Obviously, the specific form or shape is not of utmost importance although the form illustrated has been found to have advantages. The relay is mainly contained in a frame 10 which is preferably formed of the same material as the armature which will be later described. The frame 10 includes an end panel 11, and opposed parallel panels 12 and 13 which are at right angles to the end panel 11. The end panel 11 is provided with right angularly turned flanges 14 on opposite sides thereof thus forming a generally channel shaped end. The panels 12 and 13 also include right angularly turned reinforcing flanges 15 and 16 respectively extending throughout the length of the panel. Thus, the three closed sides of the frame 10 are all generally channel shaped in form.

The normally open end of the frame 10 is provided with a cap 17 which fits snugly between the parallel panels 12 and 13 of the frame and between the flanges 15 and 16 on these panels. The panels 12 and 13 are provided with transversely elongated slots 19 and 20 therein which are of sufficient size to receive a pair of elongated hook shaped projections 21 and 22 on opposite sides of the plug 17. The plug 17 is provided with an internally threaded axial aperture 23 extending therethrough. An externally threaded adjustment plug 24 is threaded into the aperture 23 and includes opposed slots 25 designed to accommodate a suitable tool for rotating the plug 24 in adjusting the same.

The relay assembly is supported between a pair of

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insulating discs 26 and 27, the left of which in Figure 4 lies inwardly of the end panel 11 of the frame and the right hand of which lies inwardly of the plug 17. The insulated disc 26 is held in position by suitable pins, one pair of pins 29 being positioned in apertures 30 arranged in diametrically opposed relation in the insulator disc. The pins 29 are provided with projections 31 which are staked in apertures 32 in the end panel 11. The insulator disc 27 is similarly provided with a pair of diametrically opposed apertures 33 which accommodate pins 34 having reduced diameter ends 35 which are staked in suitable apertures 36 in the plug 17. The pins which have been described also prevent the rotation of the insulators which may be formed of ceramic material which is of importance due to the fact that each insulator disc is provided with a rectangular recess which supports the armature fulcrum members. The disc 26 is provided with a central rectangular recess 37 while the disc 27 is provided with a similar recess 39.

The armature fulcrums at opposite ends of the armature are identical and will be described by similar numbers. As indicated in Figures 6 and 7 of the drawings these fulcrums 40 include a rectangular base plate 41 of proper size to fit in the insulator recesses 37 and 39 and the base plate 41 is provided with a ring shaped flange 42 projecting axially therefrom. A generally rectangular pocket 43 is provided near the center of each base plate 41. As indicated in Figure 7 of the drawings, the pocket is preferably generally wedge shaped in form including a slightly inclined upper wall 44 and a downwardly slanting lower wall 45.

A bobbin 46 is centrally mounted within the frame 12 and is preferably formed of nylon or other suitable insulating material. The bobbin 46 includes a generally cylindrical core 47 having a rectangular thick center flange 49 and a pair of relatively thinner rectangular end flanges 50 and 51. Magnetic coils are wound upon the cylindrical core 47 between the center flange and each end flange thus providing a double coil. A passage 52 extends through the central flange 49 from one side of the flange to the other to provide access to the interior of the core 47 intermediate the ends thereof.

The bobbin 46 is supported by a pair of similar end plugs 53 which include a central boss 54 of proper diameter to fit within the core 47 and to act as a support therefor. Each plug 53 is also provided with a ring shaped flange 55 projecting therefrom in a direction opposite the boss 54. This flange 55 encircles the ring shaped flange 42 of the armature fulcrums 40 so as to support the core 47 in coaxial relation to the armature fulcrums. The plugs 53 are preferably made of iron or similar magnetic material which cooperates with the magnetic coils 56 and 57 which are wound upon the bobbin core 47.

A generally rectangular sleeve 59 encircles the flanges 49, 50 and 51 of the bobbin and encircles a portion of the circular flange 55 of each end plug 53. The sleeve 59 is also of magnetic material such as iron and combines with the end plugs 53 to form a magnetic path when the coils 56 and 57 are energized. The fulcrums 40 are preferably formed of hardened steel and are in contact with the end plugs 53 through the encircling shoulders 55 of the end plugs.

As is indicated in Figure 5 of the drawings, each end plug 53 is provided with a transversely elongated slot extending through the body of the plug near the center thereof. These slots are somewhat wider than the dimensions of the armature 60, the slot or aperture being identified in Figure 5 by the numeral 61. The armature 60 comprises an elongated strip of magnetostriction material and is shown as being rectangular in cross section. The ends 62 of the armature 60 are cut off on a dihedral plane at an acute angle to one surface of the armature blade. As an example, the end surfaces of the armature blade 60 are about 30° from a plane normal to the blade

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axis. The surfaces 44 and 45 of the pockets 43 in the fulcrums 40 are at a somewhat greater dihedral angle, the surface 44 being on a plane at a dihedral angle of about 5° from horizontal and the surface 45 is on a plane at a dihedral angle of perhaps 31° with a horizontal plane. Thus, the armature is confined by the pockets 43 but the fulcrums are actually along a knife edge at the opposite extremities of the armature blade.

The armature blade 60 is provided with a central contact 63 projecting from one surface thereof. With reference now to Figures 1 and 3 of the drawings, it will be noted that an insulation plate 64 is mounted outwardly of the frame 10 at the center of the frame and overlying one end of the transverse passage 52 through the central flange 49 of the bobbin 46. Mounting screws 65 extend between the flanges 15 and 16 of one side of the frame 10 and are threaded into the sleeve 59. The insulation plate 64 is provided with a generally rectangular aperture 66 extending therethrough. A mounting plate 67 includes a mounting plate 69 overlying the outer surface of the insulation block 64 and secured thereto by fastening means 70. The mounting blade also includes an elongated blade member 71 which is bent at right angles to the mounting plate 69 and extends through the aperture 66 and through the passage 52 in the bobbin flange 49 in the manner best illustrated in Figure 3 of the drawings.

With reference now to Figures 2 and 3 of the drawings it will be noted that the frame 10 is provided with an insulation plate 72 on the side of the frame opposite the plate or block 64. The insulation plate 72 is secured to the sleeve 59 by means of bolts 73 which extend between the flanges 15 and 16 of the frame sides 12 and 13. A bracket 74 is secured to the surface of the insulation plate 72 by fastening means 75 and this bracket includes a pair of spaced parallel flanges 76 and 77 which project outwardly from the insulation plate 72 and at substantially right angles thereto. The plate 72 is provided with an aperture 79 extending therethrough which is in opposed relation to the aperture 66 in the plate 64. The mounting blade 71 extends between the flanges 76 and 77. Adjustment screws 80 and 81 extend through the flanges 76 and 77 and engage against the end of the mounting blade 71 to adjust the position thereof. The blade 71 is preferably weakened at the point of bend between the mounting plate 69 and the blade 71 to permit the position of the blade to be adjusted.

A thin flexible switch blade 82 is secured at 83 to the mounting blade 71 at a point near the connection of this mounting blade and its anchoring or mounting plate 69. The blade 82 is provided with a contact 84 thereupon which extends through an aperture 85 in the mounting blade 71. The contact 84 is engageable with the contact 63 on the armature 60.

While the material of which the armature 60 is somewhat of a matter of choice, in a typical example the armature was made of a material known as "A nickel." As was previously described, the frame 10 is made of a similar material. The purpose of this arrangement is to permit temperature compensation as variations in length of the armature due to changes in temperature will also cause corresponding changes in dimensions of the frame in which the armature is supported.

It will be noted from Figure 4 of the drawings that the armature 60 is slightly bowed in a downward direction as viewed in Figure 4 of the drawings and is confined between the two fulcrums 40. The distance between these fulcrums may be adjusted by operation of the threaded adjustment plug 24. In the particular arrangement illustrated, the relay is of a normally closed type and the circuit will open when the coils 56 and 57 are subjected to electrical current. The coils may be energized either by a direct current or by alternating current. When operated by direct current, the contact points 63 and 84 will separate each time the current is applied

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due to a contraction in the length of the armature 60 under such conditions. Contraction of the armature 60 acts to decrease the arcuation or curve of the armature so that the contact 63 mounted thereupon will raise slightly as indicated in Figure 4, thus opening a circuit from the armature 60 to the contact point 84. As soon as the current is interrupted, the armature will resume its normal length and the circuit will again be closed. Where the coils are energized by alternating current, the frequency of operation of the opening and closing of the contact points 63 and 84 will depend upon the frequency of the current. For example, an alternating current of two thousand cycles per second will open the normally closed circuit between the contacts 63 and 84 two thousand times per second. The contact point 84 is mounted upon an independent thin blade 82 in order to simplify the adjustment between the contacts. In the specific relay disclosed, using "A nickel" as the material for forming the armature, and using an armature having a total length of slightly less than two inches, the contact 63 was found to move a distance of .0025 inch each time the coils were energized. Thus, in small relays the current between the contacts must be maintained below a value which will cause arcing between the points. However, the relays are not limited as to size and obviously a greater degree of movement is obtained by a longer armature. The current consumption of the relay coil is extremely small and the relays are durable and may be given rugged use. Furthermore, due to the construction employed, the relays may be suspended in almost any position as the moving parts are virtually unaffected by gravity or similar forces.

Figure 8 of the drawings illustrates a modified form of armature 89 in which the strip is laminated of two layers of similar material such as "A nickel" indicated at 90 and 91. The grain orientation or temper of one layer is such as to provide positive magnetostriction action while the grain orientation or temper of the other layer is such as to provide negative magnetostriction action. As a result while the same material is used for both layers, the magnetostriction action is greatly increased or accentuated.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in magnetostriction relays, and while I have endeavored to set forth the best embodiment there-

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of, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A magnetostriction relay including an armature comprising an elongated strip of a material capable of varying in dimension when subjected to a magnetic field, a coil encircling said armature, a sleeve of magnetic material encircling said coil, end members of magnetic material at the ends of said sleeve and at the ends of said armature including fulcrums between which said armature is pivotally supported, means for adjusting the distance between said end members, said end members holding said armature under longitudinal compression in a slightly arcuate position, a contact on said armature intermediate the ends thereof, said armature varying in the degree of arcuation when said coils are energized, said contact being movable from a first position when said coil is energized to a second position when said coil is deenergized, and a second contact engageable with the first mentioned contact in one of said positions and disengaged from the first said contact in the other of said positions.
2. The construction described in claim 1 and including a frame encircling said sleeve, and means on said frame comprising the means for adjusting the distance between said end members.
3. The construction described in claim 2 and in which said frame is constructed of a material having similar expansion and contraction properties when subjected to variations in temperature as said armature, and being of substantially equal length as said armature.
4. The construction described in claim 1 and including a frame member connecting said end members, said frame being formed of a material having similar thermo-expansion and contraction properties to said armature and being electrically insulated therefrom.

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