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3,292,111

ELECTROSTRICTIVE RELAY

Filed April 29, 1965

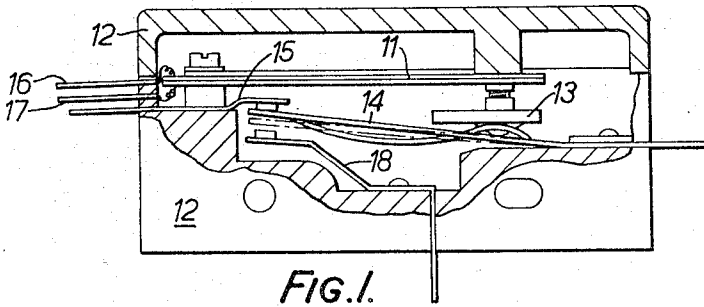


FIG. 1.

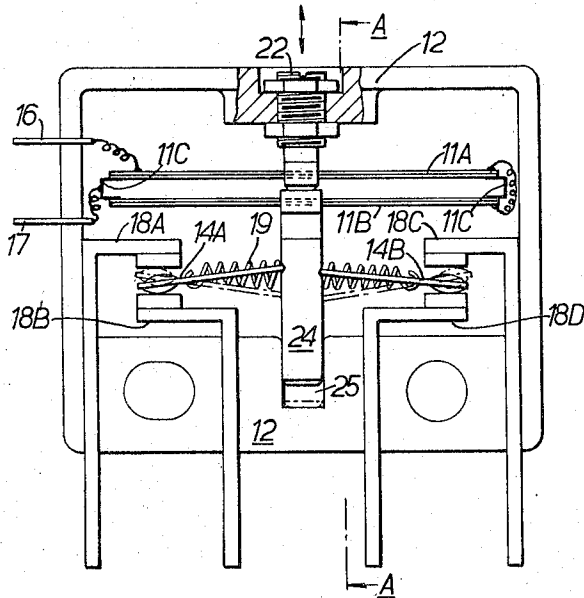


FIG. 2.

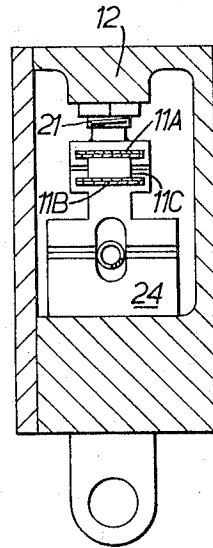


FIG. 3.

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ELECTROSTRICTIVE RELAY

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4 Claims. (Cl. 335-3)

The invention relates to electric relays. According to one aspect of the invention I provide an electric relay comprising a longitudinally extending member of a material exhibiting piezoelectric or electrostrictive properties having two electrodes arranged thereon that deformation of the member is caused, in use upon the application of an electric voltage between the electrodes and a slidably mounted member arranged to be moved by said deformation so as to directly cause actuation of at least one relay contact mechanically linked thereto.

The slidably mounted member may be in the form of a plunger and may be arranged to move in a direction parallel to the direction of greatest movement of said longitudinally extending member upon deformation thereof.

The longitudinally extending member may be in the form of bimorph or multi-morph element and there may be two such elements mechanically coupled such that the movement thereof which is imparted to the slidably mounted member is the sum of the greatest movements of the two members.

The relay contact(s) may be of the snap-action type which may have an overcenter spring associated therewith.

The foregoing and further features of the invention will become apparent from the following description of two preferred embodiments thereof with reference to the accompanying drawings in which:

FIGURE 1 shows a side elevational view, part cut away, of an electric relay;

FIGURE 2 shows a side elevational view, part cut away, of another electric relay;

FIGURE 3 shows a sectional view of the electric relay of FIGURE 2 along the line AA.

Referring firstly to FIGURE 1, there is shown a bimorph or multi-morph piezoelectric element 11 mounted as a cantilever in a relay body 12, which takes the form of either a moulding or an insulating material, or a metal case with insulated inserts to carry the element 11 and the relay contacts.

The free end of the element 11 rests on an insulating operating plunger 13, which is slidably mounted and which in turn rests on the operate point of the moving blade 14 of a conventional sensitive switch mechanism. The blade 14 carries a contact which normally rests against a fixed contact 15, or against an insulated stop.

The element 11 is appropriately polarized so that, when a suitable voltage is applied between the terminals 16 and 17, connected via leads to the upper and lower conducting surfaces of element 11, the element bends in a direction which causes the operating plunger 13 to press on the blade 14 of the switch, and to move it out of contact with the fixed contact 15 (or insulated stop) and into contact with a fixed contact 18 (or insulated stop).

The arrangement of the fixed contacts or stops can be made to result in a change-over, break or make contact as required.

Referring now to FIGURES 2 and 3, there is shown two bimorph or multi-morph elements 11a and 11b joined together by metal stirrups 11c soldered at the two facing conducting layers on the two elements 11a and 11b. The stirrups 11c also serve as an electrical connection to the

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two conducting layers and one is connected by a flexible lead to terminal 17.

The outer conducting layer of element 11a is electrically connected to the outer conducting layer of element 11b by a flexible wire, and the outer layer of element 11a is connected to terminal 16.

The upper element 11a is fixed at its centre in a bracket 22 attached rigidly to the frame 12 of the relay. The position of the bracket 22 in the direction of the arrow is freely adjustable by a suitable arrangement, such as, for example, screws and nuts illustrated.

The upper end of an insulating operating plunger 24 is attached to the center of the lower element 11b, the lower end of the plunger 24 being free to slide in a guiding slot 25 in the relay body 12.

Two contact blades 14a and 14b are held in close contact with the plunger 24 by an overcenter tensile spring 19 attached at each hook end thereof to the blades 14a and 14b. The spring 19 passes freely through a slot in the plunger and slots in the contact blades and the inner end of each blade is shaped to a knife edge and pivots in a corresponding V notch in the plunger 24. The outer end of each blade 14a and 14b, forming or carrying a suitable electrical contact, normally rests in contact with the fixed contacts 18b and 18d or with suitable stops formed in the body if a "make only" switch is required.

The two elements 11a and 11b are appropriately polarized so that when a suitable voltage is applied between the terminals 16 and 17 the elements bend in opposing directions, the outer ends of element 11a bending downwards in FIGURE 2 and the outer ends of element 11b bending upwards in FIGURE 2. Thus the plunger 24 is caused to move axially downwards by twice the movement achieved individually by the free ends of either element 11a and 11b. This carries the pivot points of the contact blades forward until the center line of tension spring 19 passes above instead of below the first points. The two contact blades 14a and 14b then snap upwards until their free ends contact the fixed contacts 18a and 18c respectively (or corresponding stops set in the body moulding).

The elongate structure comprising elements 11a and 11b in FIGURES 2 and 3 may be modified to provide greater movement or pressure by building up pairs of elements of the form illustrated with adjacent pairs being coupled together by attaching a lower pair to the one above by the center point of the upper element. Alternatively, each of elements 11a and 11b in FIGURES 2 and 3 may be replaced by a stack of any number of elements.

In either of the above described embodiments the relay contacts return to the original position when the voltage is removed from across the bimorph or multi-morph elements and the terminals thereof are short circuited or when a reverse voltage is applied thereto. If the voltage is reduced to zero, but the terminals are not shorted, then the relay will return to its normal position after a time delay which can be controlled by a suitable resistance connected between the terminals, it being realised that the actuator is effectively a capacitor rather than an inductor, as in electromagnetic relays, and one of its advantages is that it can be operated by a very small current building up a charge in the relay over a comparatively long period, or by a larger current applied over a very short period.

What I claim is:

1. An electrostrictive relay including a plurality of electrostrictive bending elements defining an elongate structure, means coupling the electrostrictive bending elements together, actuating means fixedly secured to one of said elements, contact means arranged to be operated in response to predetermined linear movement of said ac-

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tuating means, means restraining another of said elements against displacement thereof as a whole so that bending of said another element in response to the energization thereof is imparted to said one element and is added to the movement thereof produced in response to its own energization.

2. An electrostrictive relay as claimed in claim 1, in which the actuating means comprises a slidably mounted plunger connected to the center of the said one element, and comprises a pair of pivoted contact arms extending from said plunger in directions transverse to the direction of bending of the elements, and spring means associated with said contact arms and effective to cause snap operation of the contact means by over center movement in response to a predetermined actuating movement of the plunger.

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3. An electrostrictive relay as claimed in claim 1, in which the relay contacts are of the snap-action type.

4. An electrostrictive relay as claimed in claim 3, in which the contacts have an over-center spring associated therewith.

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