May 1, 1962 W. B. ELLWOOD 3,032,628

CIRCUIT CONTROLLING DEVICE

Filed June 25, 1959

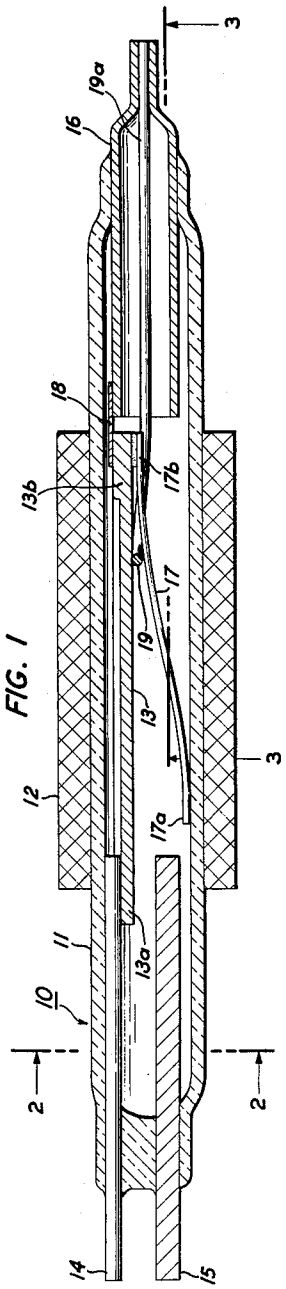

FIG. 1

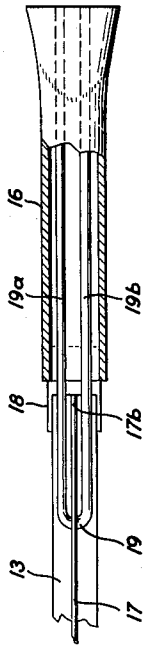

FIG. 3

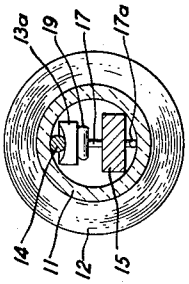

FIG. 2

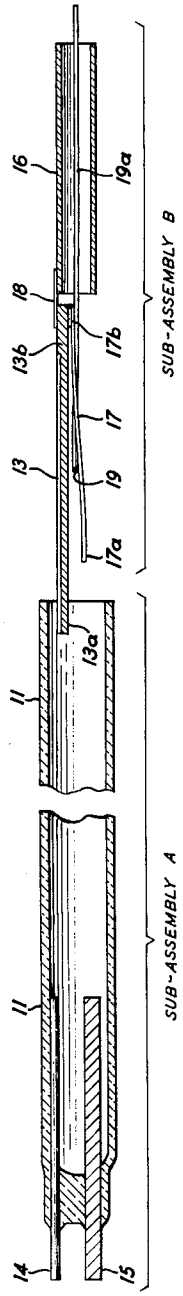

FIG. 4

INVENTOR
W. B. ELLWOOD
BY John C. Morris
ATTORNEY

United States Patent Office 3,032,628
Patented May 1, 1962

3,032,628

CIRCUIT CONTROLLING DEVICE

Walter B. Ellwood, New York, N.Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Filed June 25, 1959, Ser. No. 822,946
13 Claims. (Cl. 200—87)

This invention relates to hermetically encapsulated circuit controlling devices, generally; and, in particular, to switching devices having operating elements so arranged that adjustments may be made thereto after said elements are mounted within an envelope in which they are to be sealed.

In many instances it is desirable to enclose a switching device's operating elements within an envelope for the purpose of avoiding contamination of contact elements, fire hazard, etc. Although many advantages accrue from the use of hermetically encapsulated switching devices, many problems accompany the construction of such switching devices. Among these problems is the difficulty in achieving proper adjustments of the operating elements within the envelope. Since in switching devices of this type the envelope is ordinarily of glass and of relatively small bore, the difficulty of making and retaining proper adjustments is obvious. Moreover, assuming that parts may be assembled within the envelope in proper adjustment prior to sealing the envelope, there remains the hazard of maladjustment, particularly of metallic elements, due to the heat used in sealing the envelope.

Therefore, the objects of this invention are, among others, the following: the improvement, structurally and functionally, of switching devices; the attainment of a switching device wherein the preset mensural and physical characteristics of its operating elements remain unchanged after the enclosure of those elements within a sealed envelope; the attainment of a switching device wherein the preset mensural and physical characteristics of its operating elements are unaffected by the application of heat in the encapsulation of those elements within a sealed envelope; the attainment of a switching device wherein operating elements, arranged within an envelope, are susceptible of being finally adjusted just prior to sealing the envelope; and, the achievement of the aforementioned objects with simple, reliable and economical means.

The invention, hereinafter described in terms of a specific embodiment, achieves the aforementioned objects by the provision of a switching device comprising: an envelope having an opening therein; operating elements arranged within the envelope; and, adjustment means for adjusting the operating elements, the adjustment means being connected with at least one of the operating elements and extending without the envelope, through the opening therein, whereby said elements are susceptible of being finally adjusted prior to sealing the envelope's opening. In order to prevent thermally induced stresses from affecting the adjustments of the operating elements while the envelope is being sealed, heat-flow retardation means are provided for limiting the amount of heat that can be conducted to the operating elements.

Therefore, one of the features of this invention is the provision of adjustment means, part of which are external to the circuit controller's envelope, for performing final adjustments on the operating elements, situated within the envelope, prior to sealing the envelope. Another feature of this invention is the provision of heat-flow retardation means for preventing maladjustments of the circuit controller's operating elements as a result of sealing the operating elements within the envelope by the application of heat thereto.

Other objects and features, as well as a fuller understanding of the invention, will become apparent by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view, in longitudinal section, of a magnetically operable switch in accordance with this invention;

FIG. 2 is a cross-sectional view of the switch, as taken along the line 2—2, shown in FIG. 1;

FIG. 3 is another sectional view of the switch, as taken along the line 3—3, as shown in FIG. 1; and

FIG. 4 is a sectional view of switch elements as in FIG. 1, partially assembled.

Referring now to the drawing, the magnetically operable switching device, or, relay, there illustrated, is comprised of the switch unit, designated, generally, by the reference character **10**, and the coil **12**, encompassing the switch unit. As is shown at FIG. 1, the switch unit **10** is comprised of: an envelope **11**; the electrodes **14**, **15** and **16**, each of which is sealed to, and protrudes through, the envelope; an armature **13** mounted within the envelope; a spring member **17**, connected with the armature; and, a separator **19** for spreading the armature and the spring member apart from each other.

A convenient way of constructing the switch unit **10** is suggested at FIG. 4. Two subassemblies, A and B, are illustrated there. Referring now to FIG. 4, the subassembly A is easily constructed by initially selecting a glass tube **11** having opposing open ends. The metallic electrodes **14** and **15** are, then, sealed to the glass tube at one end thereof so that each electrode is disposed partly within, and partly without, the envelope. In the specific embodiment illustrated in the accompanying drawing, the electrode **14** is a rod-like member of non-magnetizable material such as platinum or the like; the electrode **15** is a bar-like member of magnetizable material such as No. 52 Alloy (52 percent nickel and 48 percent iron) or the like.

In order to prepare the subassembly B, the reed-like armature **13** of magnetizable material is connected through a flexible hinge member **18** to the end of the tubular electrode **16**. The armature **13** has a free end **13***a* and a fixed end **13***b*; the armature's fixed end **13***b* being connected to the hinge member **18**.

A spring member **17**, having a free end **17***a*, is secured at its other end **17***b* to the fixed end **13***b* of the armature **13** by welding or another suitable process. A hairpin-like separator **19**, having legs **19***a* and **19***b*, is positioned with its bight portion between the armature **13** and the spring **17**.

As is illustrated at FIG. 4, the separator's legs **19***a* and **19***b* extend through, and beyond, the opening in the electrode **16**.

The armature **13**, the hinge member **18** and the electrode **16** may be fabricated from a material such as No. 52 Alloy or the like. The hinge member **18** has a thin cross-section to inhibit the conduction of heat from the electrode **16** to the armature **13** and to the spring member **17**. This heat is occasioned by the process of bonding the glass tube about the outer periphery of the tubular electrode **16**. As is illustrated in FIGS. 1, 2 and 3, one of the armature's longitudinal surfaces is curved. This curvature, as particularly illustrated in FIG. 2, is to provide a large contact area between the armature's free end **13***a* and the rod-like electrode **14** in order that a relatively low electrical resistance is achieved upon contact between the armature and the electrode.

The spring member **17** may be fabricated from a non-magnetizable material such as tungsten or the like. Although the spring member **17** is shown as a flexible rod in the accompanying drawing, it may be fashioned in other forms. For example, it may be fashioned as a reed-like member. The separator **19** may be fabricated from

a material such as No. 52 Alloy, or brass, or the like. Although the separator **19** is shown in hairpin-like form in the accompanying drawing, it may be fashioned in other forms. For example, it may be fashioned into a shape resembling a hook.

Having prepared the sub-assemblies A and B, the sub-assembly B is inserted through the opening in the glass tube **11** of the sub-assembly A. Thereafter, the glass tube is bonded to the outer periphery of the electrode **16**. As is indicated hereinbefore, the hinge member **18**, having a thin cross-section, prevents the conduction of a great quantity of the applied heat to the armature **13** and to the spring member **17**. Beneficially, the resilience of the spring member **17**, inter alia, is not changed.

Having connected the sub-assemblies A and B in the manner hereinbefore described, the separator **19** can be slidably positioned at a particular location, between the armature **13** and the spring member **17**, by manipulating the separator's legs **19***a* and **19***b* which protrude beyond the electrode **16** as shown at FIG. 4. As the separator **19** is pulled toward the armature's fixed end **13***b*, the armature's free end **13***a* is forced against the electrode **14** and the spring member's free end **17***a* is forced against the inner wall surface of the envelope **11**. In order to establish the proper armature and spring forces in relation to the ampere-turns requirements of the switch unit **10**, the separator **19** is slidably adjusted so that, at a predetermined magnitude of current through the coil **12**, the armature's free end **13***a* will break contact with the electrode **14** and make contact with the electrode **15**. When the location of the separator **19** has been thus established, the end of the tubular electrode **16** may be sealed as shown at FIGS. 1 and 3; the end of the electrode being crimped and welded thereby sealing the envelope **11** and, as a result, securing the separator's legs **19***a* and **19***b*. Again, the hinge member **18** prevents a great quantity of the heat, generated during the welding process, from being conducted to the armature **13** and to the spring member **17**. Therefore, the armature **13** and the spring member **17** are not subject to maladjustments due to thermally induced stress resulting from the welding process. As an alternative, the electrode **16** can be sealed by a cold-welding process.

The relay, as it is illustrated at FIG. 1 is in its unoperated, or, normal, status; i.e., in the absence of current flowing through the windings of the coil **12**, the armature's free end **13***a* is in contact with the electrode **14**. When current of sufficient magnitude flows through the windings of the coil **12**, the relay assumes an operated status, i.e., the armature's free end **13***a* breaks contact with the electrode **14** and makes contact with the electrode **15**. Advantageously, the spring member's free end **17***a*, being in contact with the inner wall surface of the envelope **11**, provides damping for the armature **13**. Whenever the armature's free end **13***a* moves from the electrode **14** to the electrode **15**, or from the electrode **15** back to the electrode **14**, the spring member's free end **17***a* slides along the envelope's inner wall surface. The resulting frictional force inhibits the armature's tendency to bounce.

Although the invention has been illustrated and described in terms of a specific embodiment, it is to be understood that the present disclosure has been made by way of example only and that many changes in the details of construction and the combination and arrangements of parts may be made without departing from the spirit and the scope of the invention as it is hereinafter claimed.

What is claimed is:

1. A circuit controlling device comprising an envelope having an aperture through a wall portion thereof, a first electrode, including a cavity therein, fitted into said aperture thereby sealing the envelope, a magnetizable second electrode sealed through another wall portion of the envelope, an armature situated within the envelope and

mounted on the first electrode, spring means within the envelope for biasing the armature to any one of a plurality of first positions, each of the first positions being distant from the second electrode, adjustment means associated with the spring means for biasing the armature to a selected position among the first positions, part of said adjustment means being secured within the cavity to the first electrode, and magnetic means, outside of the envelope, operable for moving the armature from the selected position into contact with the second electrode.

2. A circuit controlling device comprising a non-magnetizable envelope, a non-magnetizable first electrode protruding through the envelope, a magnetizable second electrode protruding through the envelope, a third electrode, including a cavity therein, protruding through the envelope, a magnetizable reed, including a fixed end and a free end, arranged within the envelope, connection means for fastening the reed's fixed end to the third electrode, a leaf spring having a fixed end joined to the reed's fixed end and a free end extending toward the first and second electrodes, adjustable spacer means positioned between the reed and the spring for biasing the reed's free end against the first electrode and the spring's free end against the envelope's wall, said spacer means having an extension portion disposed within the third electrode's cavity and secured thereat, and a coil, outside the envelope, operable for moving the reed's free end into contact with the second electrode.

3. A circuit controlling device as defined in claim 2 wherein the connection means is a thin reed member having low thermal conductivity.

4. A circuit controlling device comprising an envelope having a duct protruding through a portion thereof and defining an opening in the envelope's wall, said duct being adaptable of being closed thereby sealing the opening in the envelope's wall, actuating means situated outside the envelope, a movable member mounted within the envelope, said movable member being normally located at a first position and movable therefrom, upon operation of the actuating means, to a second position, biasing means situated within the envelope for biasing the movable member to the first position, and adjustment means for adjusting the biasing means; part of said adjustment means extending outside the envelope through the duct whereby the biasing means is capable of being adjusted from outside the envelope prior to closing the duct thereby securing the adjustment means.

5. A circuit controlling device comprising an envelope, a duct member protruding through the envelope and having an extending portion disposed outside of the envelope, said duct member including an aperture therethrough defining a passage between space inside the envelope and space outside the envelope, the extending portion of said duct member being adaptable of being deformed in order to seal the envelope's inside space from the space outside the envelope, actuating means situated outside the envelope, a movable member mounted within the envelope, said movable member being normally situated at a first position and movable therefrom, upon energization of the actuating means, to a second position, biasing means situated within the envelope for biasing the movable member to said first position, and adjustment means for adjusting the biasing means; part of said adjustment means extending through said duct member's aperture to the space outside the envelope whereby said biasing means is finally adjusted from outside the envelope prior to deforming said duct member's extending portion thereby sealing the envelope and securing the adjustment means.

6. A circuit controlling device comprising an envelope, first and second electrodes of non-magnetizable and magnetizable material, respectively, sealed through a portion of the envelope, a third electrode, including a cavity therein, sealed through another portion of the envelope, an armature, within the envelope, having a hinge and secured to the third electrode and a free end disposed between the

first and second electrodes, an armature biasing spring having a hinge end thereof secured to the armature's hinge end and a free end thereof extending toward the armature's free end, adjustable spacer means having a portion between the armature and the biasing spring for spreading them apart and another portion extending into the third electrode's cavity and secured thereat, whereby said spacer means forces the armature's free end against the first electrode and forces the biasing spring's free end against the envelope's wall, and magnetic means outside of the envelope operable for moving the armature's free end into contact with the second electrode.

7. A circuit controlling device comprising an envelope having an inner wall surface, a magnetizable reed situated within the envelope, the reed having a fixed end and a free end, a reed-like spring member having a fixed end and a free end, the reed's fixed end and the spring member's fixed end being joined together, mounting means for supporting the reed's fixed end, a separator located between the reed and the spring member for spreading the reed's free end apart from the spring member's free end, the reed's free end being moved to a first position and the spring member's free end being moved into contact with the envelope's inner wall surface, and magnetic means, outside of the envelope, operable for moving the reed to a second position.

8. A method of making a sealed circuit controller comprising the steps of sealing two electrodes in parallel spaced relation through one end of an envelope, securing one end of a magnetic armature to a tubular electrode by means of a flexible hinge, bonding one end of an elongated spring to the hinge end of the armature, placing a bight portion of an adjustment member between the armature and the spring with the remainder of the adjustment member extending through the tubular electrode, inserting the armature and the parts assembled thereto into the envelope so that a portion of the armature is disposed between the two electrodes, bonding the envelope to the tubular electrode, placing the envelope within the core area of a coil, energizing the coil while positioning the adjustment member's bight portion to a position of satisfactory controller operation, and simultaneously sealing the envelope and securing the adjustment member by sealing an end of the tubular electrode thereto.

9. A method of making a switching device comprising the steps of assembling a magnetically movable member with a biasing means, adjustable for positioning the movable member at any of a plurality of positions, placing the movable member and part of the biasing means within an envelope having an opening therein, adjusting the biasing means from outside the envelope to set the movable member at a predetermined position, sealing the envelope's opening thereby securing the biasing means, and placing said envelope, movable member and biasing means within the influence of a magnetic field producing means.

10. A method of making a switching device comprising the steps of placing operating elements, including an adjustment member, within an envelope having an opening in a wall portion thereof, said adjustment member extending without the envelope through said opening, manipulating said adjustment member from without the envelope to adjust the operating elements within said envelope, and sealing the opening in said envelope's wall portion thereby securing the adjustment member.

11. A method of making a switching device comprising the steps of assembling a movable member with adjustment means for positioning the movable member, placing the movable member and part of the adjustment means within an envelope having an opening therein, manipulating the adjustment means from without the envelope to set the movable member at a predetermined position, and sealing the envelope's opening thereby securing the adjustment means.

12. A method of making a switching device comprising the steps of assembling a non-magnetizable first electrode and a magnetizable second electrode within a nonmagnetizable envelope in spaced-apart relationship, said first and second electrode protruding through a wall portion of the envelope, said envelope having an opening in another wall portion thereof, preparing a subassembly including a magnetizable reed, having a fixed end and a free end, a leaf spring, having a fixed end and a free end, a third electrode, having an aperture therethrough, and a spacer having a bight portion and an extension portion, said reed's fixed end being joined to the third electrode, said spring's fixed end being joined to the reed's fixed end, said spring's free end extending toward the reed's free end, said spacer's bight portion being situated between the reed and the spring and said spacer's extension portion passing through the third electrode's aperture, placing the subassembly into the envelope's opening so that the reed's free end is disposed between the first and second electrodes, bonding the envelope about the third electrode, manipulating the spacer's extension portion from outside the envelope to position the bight portion thereby forcing the reed's free end against the first electrode and forcing the spring's free end against the envelope's wall, and sealing the third electrode thereby securing the spacer's extension portion.

13. The method of making a magnetically operable, spring biased, sealed switch that comprises sealing a magnetizable electrode and a nonmagnetizable electrode in parallel spaced relation through one end of an insulating envelope, making a subassembly comprising a tube, a magnetizable armature, a flexible hinge, a spring and an adjusting-biasing member by securing the armature to one end of the tube by means of the hinge, securing one end of the spring to the hinge end of the armature, wedging a bent-over end of the adjusting-biasing member between the armature and the spring with an elongated portion of this member extending through the tube, inserting the subassembly into the envelope so that the free end of the armature is between the inner ends of the electrodes, sealing the tube to the envelope with a portion of said tube extending therefrom, applying a magnetic field to the magnetizable elements, manipulating the adjusting-biasing member by means of its elongated portion to place the bent-over portion in a position to properly bias the armature and spring for satisfactory switch operation, and closing the extending end of the tube on to said elongated portion to secure the adjusting-biasing member and to seal the envelope.

References Cited in the file of this patent

UNITED STATES PATENTS

2,406,021	Little	Aug. 20, 1940
2,457,218	Ferrell	Dec. 28, 1948
2,491,907	Reifel et al.	Dec. 20, 1949
2,506,414	Ellwood	May 2, 1950
2,527,475	Bates	Oct. 24, 1950
2,653,199	Brown et al.	Sept. 22, 1953
2,921,161	Scata et al.	Jan. 12, 1960