United States Patent

Jones

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[54] SWITCH WITH HOUSING OF SEALED RIGID AND THERMAL PLASTIC MEMBERS

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[52] **U.S. Cl.** .....**200/168 G**, 335/151

[51] **Int. Cl.** **H01h 9/04**

[58] **Field of Search** .....200/166.1, 166 C, 168 G; 335/151, 154, 153, 202; 264/272; 29/627; 174/52.5, 52.6

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Primary Examiner—H. O. Jones

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[57] **ABSTRACT**

An electrical device having a rigid base member supporting electrical conductive elements and a thermal plastic member heat sealed thereto. A reed relay is described with blades mounted on a rigid ceramic base and hermetically sealed into a switching chamber by a thermal plastic cover member sealed at the periphery to the base member as by heating with a peripheral metal strip or sonic bonding. Localized deformation of the enclosure sets the gap of the contact blade. A blade is positioned in a slanted notch to spring bias the blade against another and the switching blade can be provided with a perforation filled with a precious metal contact material.

12 Claims, 10 Drawing Figures

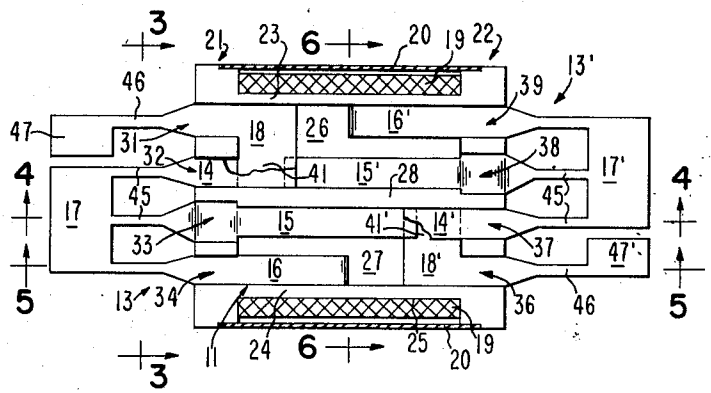


FIG. 1

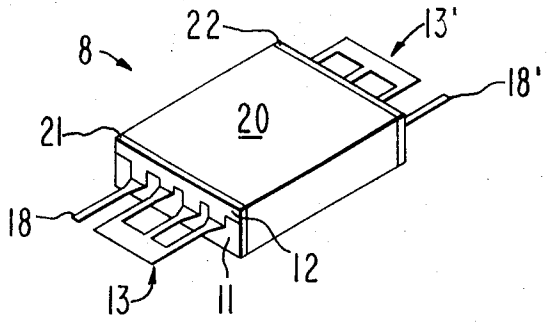


FIG. 2

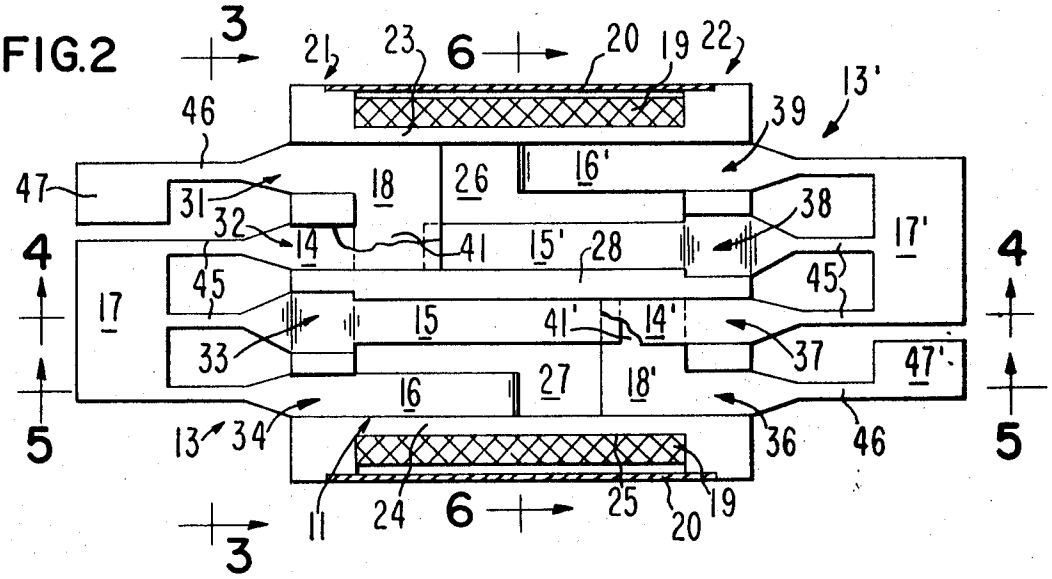


FIG. 4

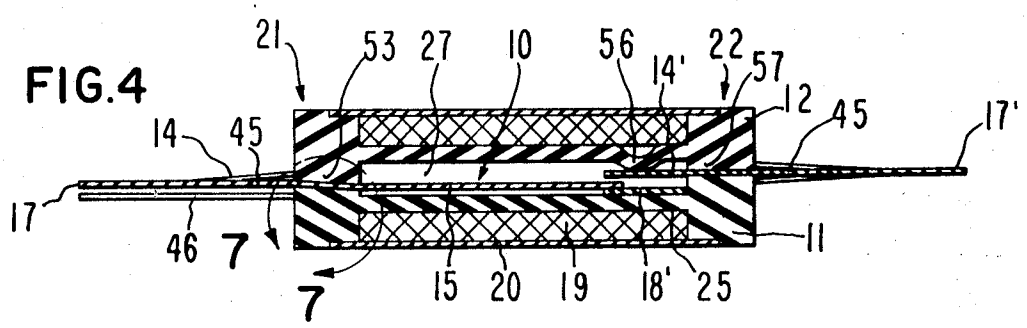
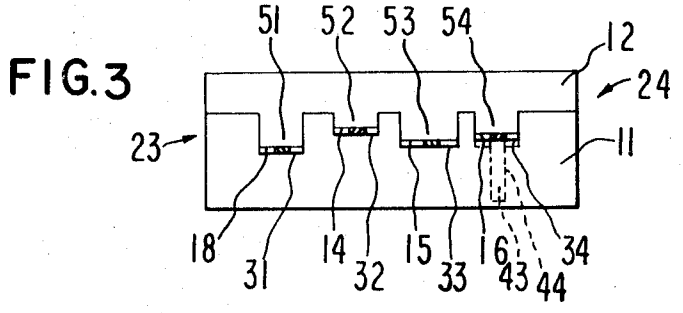


FIG. 3



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FIG. 5

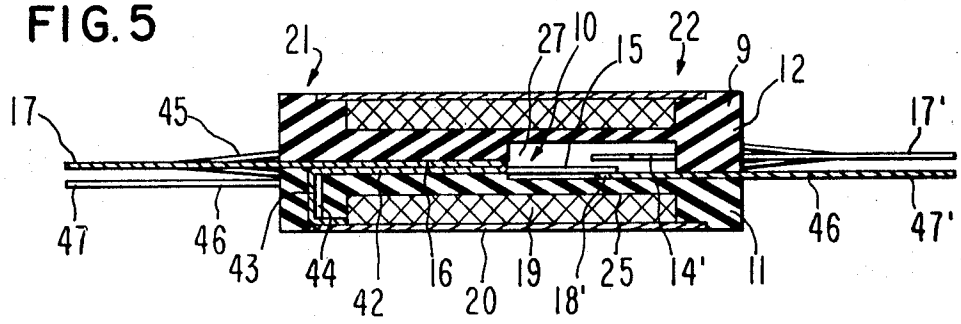


FIG. 6

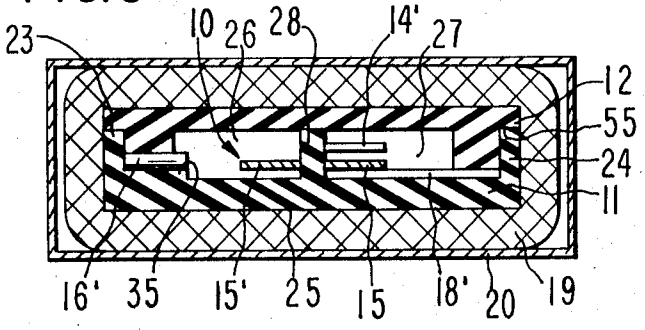
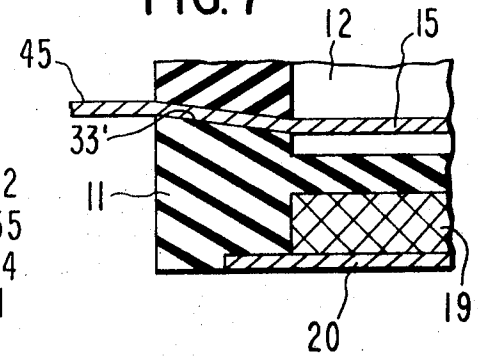


FIG. 7



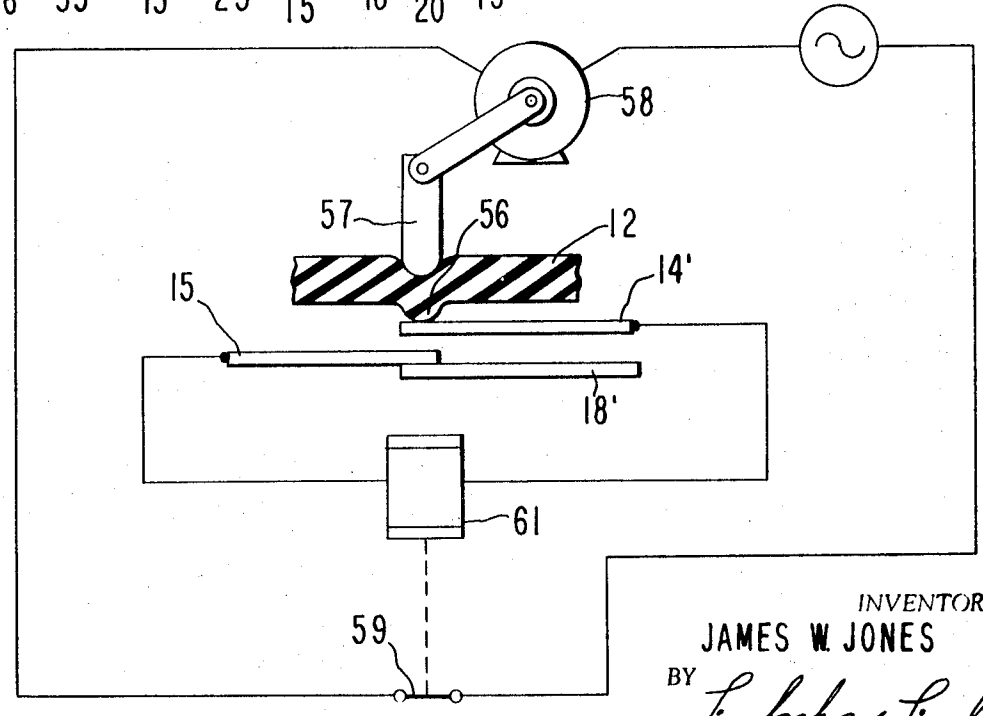


FIG. 8

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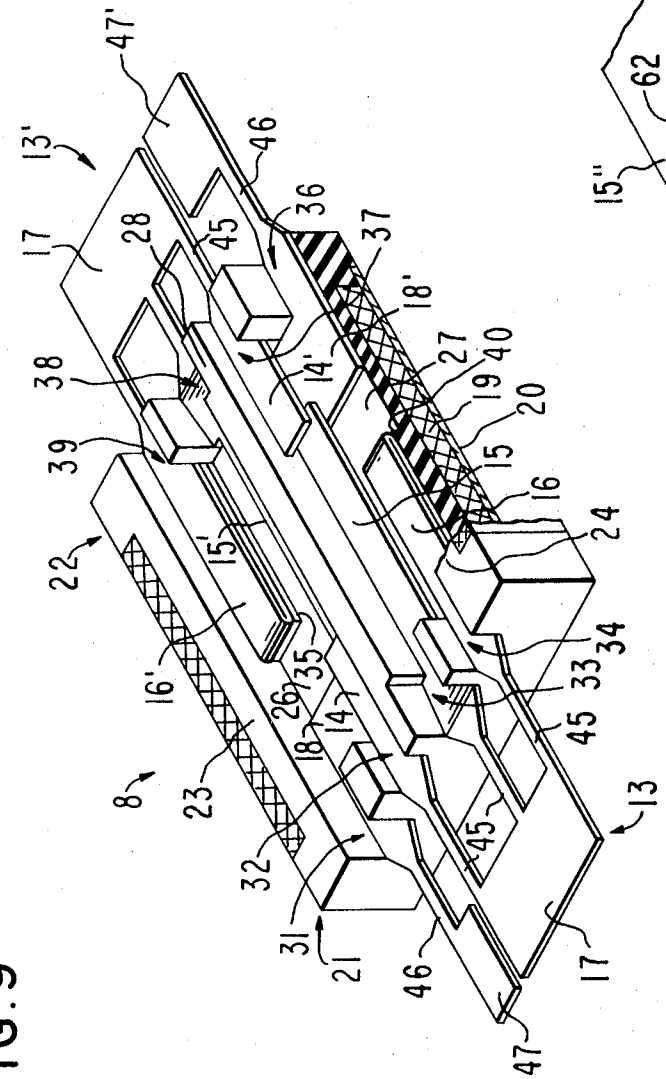


FIG. 9

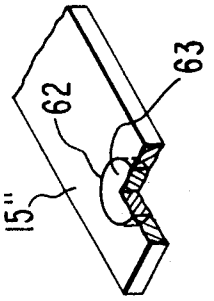


FIG. 10

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SWITCH WITH HOUSING OF SEALED RIGID AND THERMAL PLASTIC MEMBERS

The present invention relates in general to electrical or electronic components and more particularly, to a reed relay and method of making same.

Presently, dry reed relays that are being marketed consist of a reed switching element installed in a solenoid coil which is in turn installed into a container with suitable electrical terminations and/or leads for use by the customer. Thus, the conventional reed relay is an assembly of separate manufactured parts with a production cost relating to the cost of the several components as well as their assembly.

The object of the present invention is to provide a new electronic device that operates efficiently and trouble-free.

Another object of the present invention is to provide a method for manufacturing an electronic device quickly, accurately and economically.

Another object of the present invention is to provide a new reed switching device and method of making the same using a minimum of parts and wherein the device is reliable, subject to a long life, and resistant to shock and heat.

Another object of the present invention is to provide a new electrical device and method of making same wherein the relative position of certain elements thereof is accurately set after the device has been assembled.

Broadly stated, the present invention is directed to an electrical device formed with a rigid base member such as ceramic for supporting electrically conductive elements and a thermal plastic member heat sealed to the base member for establishing the environment of said electrical conductive elements. The term "thermal plastic" is used herein and in the accompanying claims to mean a thermoplastic or a thermosetting material. The rigid base member provides the structural support and means for accurately positioning the electrically conductive elements relative to one another and the thermal plastic member enables establishment of the desired environmental condition for the electrically conductive elements.

In one embodiment the invention is directed to a reed relay and the method of making same wherein switching reeds or blades are provided within the switching chamber of an enclosure wherein the thermal plastic member is heat sealed to the base member around a peripheral portion not only to seal the conductive elements in the enclosure but to fix the conductive elements in the desired location therefor positively established by the rigid base member.

This structure and method permit integrated manufacture of electrical devices such as relays while still permitting accurate control of parts location. This invention provides a versatile device with a minimum number of parts that are assured of proper assembly, and when assembled form a device that is rugged and not subject to shock and vibration and gives long life.

In accordance with another aspect of the present invention, the heat seal established between the ceramic base member and thermal plastic cover member is accomplished by conducting electric current along the sealing region to heat the thermal plastic member for establishing the seal with the ceramic base member. This method permits rapid heat sealing of the components of the electrical assembly when assembled without requiring transfer to a separate assembly region.

In accordance with another aspect of the present invention, the thermal plastic member of the assembly is deformed into contact with one of the electrical elements to move that element from a first position to a second position and hold the element in such second position for accurately controlling the relative position of said elements. This aspect of the invention enables assembly of the separate parts of the device with a minimum of assembly tools and precautions to maintain precise tolerances and critical spacings. The critical spacing can be achieved easily and automatically after the device has been assembled.

Thus, an electrical device is provided with accurately positioned electrical elements and the method of making same is accomplished efficiently and without danger of adversely affecting the integrity of the device previously assembled. The selection of a rigid base member and a flexible member heat sealed to the base member for environmental control enables the production of this device by this method with the desired accurately positioned elements.

In accordance with another aspect of the present invention, a device and method of making same of the last aforementioned aspect is accomplished by monitoring an electrical perameter of the circuit elements during deformation of the member and limiting the deformation when the electrical perameter reaches a desired character. With this method, not only the spacing of the circuit elements is determinative of the selected position for the elements, but also the variations in their operating properties are accounted for.

In accordance with still another aspect of the present invention, a reed relay of the type previously described is provided with notches in the rigid base member for receiving and positioning the relay blade and with at least one of the notches provided with a bottom surface lying in a plane that intersects another of the blades at an acute angle whereby a blade held in the one notch against the bottom surface thereof can be spring biased against the other blade. With this construction in a reed relay, maintained contact between the two blades is assured when the device is assembled and thereafter. This construction cooperates uniquely with the deformed portion of the thermal plastic member and technique of deformation for establishing the relative position of elements since the spring bias of one blade against the other can vary from device to device. The relative position of elements controlled by deformation of thermal plastic members can provide a gap spacing that varies from device to device but will always switch in response to a certain coil current.

In accordance with still another aspect of the present invention, a reed relay is provided in the form of a double pole double throw switch almost as easily manufactured as a single switch having a ceramic base member provided with two longitudinally extending channels and the blades forming the contacts extending into the channels through notches in the end of the ceramic base member and with the blades fixed in place and sealed within the recesses by a thermal plastic cover member and surrounded by the switch actuating coil. A magnetic gang blade assembly is provided at each end of the device including a normally open contact blade, a switching blade, and a coil blade which is connected to one end of the coil. Additionally, a nonmagnetic normally closed contact blade is provided at each end of the base member. This construction provides a switching blade assembly which can be assembled by automated machinery and includes a minimum number of parts for economic assembly. By providing specific notch sizes for certain blades the parts can be assembled in only one way thereby to prevent improper assembly.

In accordance with still another aspect of the present invention, the switching blade assembly in accordance with the last mentioned aspect, includes on each blade exterior of the switching chamber, a portion of reduced thickness which serves as a heat choke to prevent conduction of undesired heat into the assembly.

In accordance with still another aspect of the present invention, a reed relay is provided with a perforated switching blade which is back filled at the perforation with a precious metal serving as the contact in a dual cantilevered beam mechanical switching device. This embodiment of the present invention enables mass production of reed relays which are assured of long accurate life.

Other objects and advantages of this invention will become apparent when reading the following description and referring to the accompanying drawing in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is an enlarged perspective view of a reed relay constructed in accordance with the present invention.

FIG. 2 is a plan view of the structure shown in FIG. 1 with the cover member removed and certain portions partially broken away.

FIG. 3 is an end elevational sectional view of the device shown in FIG. 2 taken along the line 3—3 in the direction of the arrows.

FIG. 4 is a longitudinal sectional view of the structure shown in FIG. 2 taken along the line 4—4 in the direction of the arrows,

FIG. 5 is a longitudinal sectional view of the structure shown in FIG. 2 taken along the line 5—5 in the direction of the arrows.

FIG. 6 is a transverse sectional view of the structure shown in FIG. 2 taken along the line 6—6 in the direction of the arrows.

FIG. 7 is an enlarged sectional view of the portion of the structure shown in FIG. 4 delineated by line 7—7.

FIG. 8 is a schematic view illustrating the manner of adjusting the relation of elements of the reed relay.

FIG. 9 is an enlarged perspective view of the structure shown in FIG. 2.

FIG. 10 is an enlarged perspective view of a blade showing another aspect of this invention.

As set forth above, the present invention is broadly directed to an electrical device having a rigid base member for supporting electrical circuit elements and a thermal plastic member heat sealed thereto. This invention can be used with electromechanical switches or relays, electronic components for circuits such as transistors, diodes and integrated circuits, and electrical components such as potentiometers, resistors, and capacitors. In these various embodiments electrical conductive elements are supported on a rigid base member and the thermal plastic member heat sealed to the base member for fixing the conductive elements in place and establishing the desired environment of the electrical conductive elements. For the sake of simplicity the invention will be described by way of illustration with respect to the accompanying drawings as utilized in a dry reed relay or reed switching device and the method of making same.

Referring now to the drawings with particular reference to FIGS. 1–6 and 9, there is shown a reed relay 8 which has a hermetically sealed envelope 9 containing a switching chamber 10 therein and comprising a base member 11 of a rigid dielectric material such as alumina ceramic which can be injection molded to the desired shape as described in greater detail below and a cover member 12 of a thermal plastic material such as nylon 30 percent glass filled and injection molded which can be heat sealed to the base member 11, subsequently deformed and fixed in deformed condition for controlling the spacing of electrical elements within the envelope 9 as described in greater detail below.

For electrical conductive elements the relay 8 includes a magnetic gang blade or reed assembly 13 such as of alloy 52 nickel-iron and including a "normally open" blade or reed 14, a "common," "swinging" or "switching" blade or reed 15 and a "coil" or solenoid lead blade 16 each with multilayered defused electrical contacts such as gold defused over nickel plate in a hydrogen furnace. Blades 14, 15 and 16 are all electrically connected together via a common connecting bar 17 outside the switching chamber 10 which bar 17 is trimmed off after the product is completed. Another electrically conductive element 18 is provided in the form of a nonmagnetic blade or reed serving as the "normally closed" blade or relay contact. This can be made of nickel/silver/copper alloy approximately 15 percent nickel, 17 percent silver and 65 percent copper gold plated at the contact region.

A coil or solenoid 19 formed, for example, of polyurethane insulated copper wire is wound around the envelope 9 intermediate at the ends thereof for providing the magnetic field to switch the relay 9, and a cover 20 such as stamped and formed Mu-metal is provided around the coil 19.

The base member 11, being a rigid dielectric, forms the structural support and aligning means for positioning the various blades while electrically insulating the blades from one another. In the particular embodiment illustrated, which is a double pole double throw relay switch, the base member which is an elongated flat member having first and second ends 21 and 22, respectively, and sides 23 and 24 includes a channel 25 located between the ends 21 and 22 and extending across the bottom surface and up the sides 23 and 24 to receive the windings of the coil 19. In the top surface and partially defining the switching chamber 10, the base member 11 is provided with first and second recesses 26 and 27 extending longitudinally from near the first end 21 to near the second end 22 and separated by a dividing rib 28. At each end of the base member a set of rectangular cross section notches is provided opening into the recesses 26 and 27.

The first end 21 of the base member 11 is provided with notches 31, 32, 33, and 34 with notches 31 and 32 communicating with the first recess 26 and notches 33 and 34 communicating with the second recess 27. Similarly, at the second end 22 of the base member 11, notches 36 and 37 are provided communicating with the second recess 27 and aligned with notches 34 and 33, respectively, at the first end 21. Also, at the second end 22, notches 38 and 39 communicate with the first recess 26 and are respectively aligned with notches 32 and 31 at the first end. Notches 33 at the first end and 38 at the second end are slightly wider than the other notches to insure proper assembly of the blades in the notches.

While the present invention is adapted for providing various switching structures, the particular switch illustrated and economically manufacturable by reason of duplication of parts, is a double pole double throw reed relay with one gang blade assembly 13 provided at the first end 22 of the base member 11 with blades 14, 15 and 16 thereof positioned respectively in notches 32, 33 and 34. At the second end 23 of the base member 11, a second gang blade assembly 13' is provided with blades 14', 15' and 16' thereof located in notches 37, 38 and 39, respectively. Normally closed contact blades 18 and 18' are respectively provided in notches 31 and 36 at the first and second ends 22 and 23.

Ledges 35 and 34 are provided in recesses 26 and 27, respectively, adjacent the notches 39 and 34 for supporting respective coil blades 16' and 16 positioned therein.

Besides being enlarged, notches 33 and 38 are provided with bottom surfaces 33' and 38', respectively, which are sloped downwardly inwardly into the respective recesses so that these bottom surfaces lie in a plane which intersects the normally closed contact blades 18' and 18, respectively, projecting into recesses from the opposite end.

Normally closed contact blades 18 and 18' include enlarged portions 41 and 41' extending laterally within the respective recesses 26 and 27 beneath the adjacent normally open contact blades 14 and 14', respectively, so that at the enlarged portion 41 and 41' the blades 14 and 18 are superimposed as well as blades 14' and 18'.

The superimposed blades 14 and 18 and 14' and 18' have a length typically less than one-half of the length of the respective recesses 26 and 27 to provide a pair of spaced apart contacts between which the switching blades 15 and 15' can be moved. These latter blades 15 and 15' extend substantially the length of the recesses and are cantilevered from their supporting portion at notches 33 and 38, respectively, for movement between closed and open contact positions in response to magnetic fields established by the coil 19.

As illustrated in FIGS. 3 and 9, notches 32 and 37 through which normally open contacts 14 and 14' pass have a depth less than notches 31 and 36 through which normally closed contacts 18 and 18' pass to position the normally closed and normally open contacts in spaced apart to receive the switching blade therebetween. Notches 33 and 38 have a depth between that of notches 32 and 37 and that of notches 31 and 36.

The coil blades 16 and 16' include a length 42 that is doubled back on itself and provided with a tab 43 projecting transversely from the end thereof for passage through an aperture

43 in the base member 11 where the ends of the coil 19 are connected to the tabs 43.

Each of the blades of the gang blade assemblies 13 and 13' includes a portion 45 of reduced width between the blade portion in the notches and within the envelope 9 and the respective connecting bar portions 17 and 17' exteriorly of the envelope. Similarly, the nonmagnetic normally closed contact blades 18 and 18' include a portion 46 of reduced width between the blade portion in the notches and interiorly of the envelope and an exterior enlarged connection portion 47 to which a lead is attached. With this construction the reduced width portions 45 and 46 provide heat chokes for the blade assemblies so that appropriate leads can be soldered to the outside leads without substantial heat being conducted into the reed relay assembly which might have a deleterious effect on the assembly.

The cover member 12 provided over the top surface of the base member 11 for closing recesses 26 and 27 and defining the top of the hermetically sealed switching chamber 10 within envelope 9 is in the form of an extrusion molded, flat plate portion contacting the top surfaces of side members 24 and 25 and rib 28 and includes extensions 51–54 and 56–59 extending into notches 31–34 and 36–39, respectively, above the blades therein to establish a peripheral seal 55 between the cover and base members 11 and 12.

The peripheral seal 55 is established in one of several ways. In accordance with one embodiment of the present invention, an electric current carrying metal layer is selectively coated on either the base member 11, the cover member 12 or both around the peripheral seal and leads which can include one or more of the blades connected thereto for establishing current therein and generation of localized heat thereby heating the thermal plastic to establish a seal between the cover member 12 and the base member 11 and the respective blades as well as a seal between the metal blades and the ceramic base member.

Alternatively, a seal is provided between the base and cover members 11 and 12 and between these members and the blades by application of sonic vibration to the members at the peripheral seal.

As will be appreciated from the description above and with reference to FIGS. 4 and 7, the switching blades 15 and 15' are bent downwardly against the bottom surfaces 33' and 38' of notches 33 and 38 as the base and cover members are sealed together. This bending action on switching blades 15 and 15' spring biases the remote contact ends of these blades against the normally closed contact blades 18 and 18'. Since the switching blades 15 and 15' are formed of magnetic material while the normally closed contact blades are formed of nonmagnetic material, conduction of electrical current between the leads 16 and 16' in coil 19 establishes a magnetic field within the envelope 9 whereby the switching blades 15 and 15', being magnetic, are caused to switch into contact with magnetic normally open contact blades 14' and 14, respectively.

It will be appreciated from the above that the envelope 9 of the relay 8 with the respective blades assembled and sealed therewithin can easily be formed by first laying out the base member 11, placing the normally closed contact blades 18 and 18' in the respective notches 31 and 36, placing the gang blade assemblies 13 and 13' in the respective notches at the opposite ends of the base member, placing the cover member 12 on top of the assembled base member and blades, and heat sealing the cover member 12 to the base member 11.

At this stage of the assembly, due to variations in the characteristics of the different materials establishing the spring action of the various blades and the magnetic force required to change the blade from the spring biased, normally closed contact position to the normally open contact position, the spacing between the normally open and normally closed contact blades typically only approximates the optimum spacing. In accordance with another aspect of the present invention, the assembled electronic device in the form just described can be operated on to set the gap spacing between the normally open and normally closed contact blades for operation with the appropriate operating coil current.

Thus, with reference to FIG. 8, either a current is established between gang blade assemblies 13 and 13' via coil blades 16 and 16' and through a coil 19 that can be wound on the envelope 9 leaving access to the cover member 12 over the normally open contact blade to set up the appropriate magnetic field between switching blades 15 and normally open contact blades 14 or a standard field is established in this region. Then a portion 56 of the cover member 12 is deformed such as by a heated probe 57 driven thereagainst in the vicinity of the normally open contact blade 14' by a drive mechanism schematically illustrated as a motor 58. As the heated probe 57 depresses the portion 56 of cover member 12, the portion 56 moves into contact with normally open contact blade 14' and begins to move that blade 14' closer to normally closed contact blade 18'. When the normally open contact blade 14' has moved to a position at which switching blade 15 switches to normally open contact blade 14' by reason of the specific characteristics of this blade assembly and magnetic field, movement of probe 57 is halted such as by a switch in the circuit driving motor 58 and opened by a relay connected between blades 15 and 14. Simultaneously, the deformed portion 56 is fixed such as by cooling the probe 57.

By setting the spacing between the normally closed and normally open contacts after the assembly has been completely sealed and in response to electrical reaction parameter of the switching assembly, the switch is adjusted for optimum performance. This method of assembly and a switch produced thereby produce a highly reliable long-life switching assembly produceable with high efficiency and repeatability.

A typical area size for a reed relay of a type described and illustrated is that of a trading stamp.

While the present invention has been described as particularly applicable to a double pole double throw switch, it will be appreciated that the structure of the relay and method of manufacture are equally applicable to switches for reed relays with different contact configuration. Thus, the envelope could include a single recess and provide a double pole single throw, single pole single throw or other desired configuration as well as multiple recesses for other desired switching configurations.

Also, while the invention has been described with the normally open blade, swinging blade, and coil blade of each gang blade assembly electrically connected together, it will be appreciated that the blades can be isolated from one another such as simply by cutting off the connecting bar 17.

Additionally, while the invention has been described with reference to the illustrated embodiment as utilizing a single base member and a single cover member so that a minimum number of parts are utilized, either of these members could be replaced by two or more members. For example, the cover member could be formed as two members, the first of which includes projecting portions into the notches of the base and the second of which is simply a flat slab cover member and wherein all the members are sealed together at one time.

In accordance with still another aspect of the present invention, as illustrated in FIG. 10, extra long-life contacts can be provided for the reed relay assembly previously described by producing a perforation or cutout portion 62 in the switching blade 15'' and filling this cutout portion with a precious metal 63 such as platinum which would then serve as the making and breaking contact. In the case of the double pole relay described above and illustrated, this metal contact 63 provides the switching contact to both of the poles.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

I claim:

1. An electrical device comprising, in combination, a rigid ceramic base member for supporting electrical conductive elements and a thermal plastic member heat sealed directly to said base member for establishing the environment of said electrical conductive elements, said members defining a chamber and heat sealed together in a region surrounding said chamber,

said electrical conductive elements including at least a pair of switching blades projecting through said region into said chamber, the relative position of said blades within said chamber being changeable to open and close an electrical circuit.

2. The device of claim 1 wherein said thermal plastic member is formed of glass filled nylon.

3. A reed switch comprising, in combination,

a hermetically sealed envelope defining a reed switching chamber,

at least a pair of switching blades projecting through said envelope and positioned at least partially in superimposed relation within said envelope,

said envelope including

a ceramic base portion and a plastic sealing cover portion,

said portions sealed to each other and to said blades, and

means for establishing relative movement of said blades within said envelope between an open contact position and a closed contact position.

4. The reed switch of claim 3 wherein

said plastic sealing portion is deformed into contact with one of said blades to move said blade from one position when said portions are heat sealed together to a different selected position for establishing a desired relative position between said blades.

5. The reed switch of claim 3 wherein at least one of said blades includes a portion removed entirely therethrough and filled with a precious metal for establishing the contact with the other blade to open and close said circuit.

6. A reed switch comprising, in combination,

a hermetically sealed envelope defining a reed switching chamber,

at least a pair of switching blades projecting through said envelope and positioned at least partially in superimposed relation within said envelope,

said envelope including a flat rigid dielectric base portion having notches for receiving and confining portions of said blades spaced from the inner ends thereof,

a thermosetting plastic cover portion with said portions sealed to each other and to said blades, and

means for establishing relative movement of said blades within said envelope between an open contact position and a closed contact position.

7. A reed switch comprising, in combination,

a flat ceramic base member having a plurality of recesses therein defining blade receiving portions and notches around the periphery communicating with said recesses;

a plastic cover member constructed to close said recesses and said notches,

said members having cooperating peripheral sealing surfaces establishing a hermetic seal, at least a pair of reed blades projecting into said recesses through said seal at said notches, said members sealed to each other and to said blades; and

means for providing relative movement of said blades between an open contact position and a closed contact position.

8. The reed switch of claim 7 wherein

in said base member the bottom surface of one of said notches lies in a plane that intersects one of said blades at an acute angle

whereby a blade held by said cover member in said one notch against said bottom surface is spring biased against said one blade.

9. An electrical device comprising, in combination,

a rigid ceramic base member for supporting electrical conductive elements and a thermal plastic member heat sealed to said base member for establishing the environment of said electrical conductive elements,

said members defining a chamber and heat sealed together in a region surrounding said chamber,

said electrical conductive elements including at least a pair of switching blades projecting through said region into said chamber, the relative position of said blades within said chamber being changeable to open and close an electrical circuit, and at least one of said blades including a portion thereof located within said chamber removed entirely therethrough and filled with a precious metal for establishing the contact with the other blade to open and close said circuit.

10. An electrical device comprising, in combination,

a rigid ceramic base member for supporting electrical conductive elements and a thermal plastic member heat sealed to said base member for establishing the environment of said electrical conductive elements, said members defining a chamber and heat sealed together in a region surrounding said chamber,

said electrical conductive elements including at least a pair of switching blades projecting through said region into said chamber,

the relative position of said blades within said chamber being changeable to open and close an electrical circuit,

said one of said members including a notch therein at said region receiving and positioning one of said blades with the bottom surface of said notch lying in a plane that intersects the other of said blades at an acute angle

whereby said one blade is held against said bottom surface of said notch of said one member by said other member and spring biased against said other blade.

11. An electrical device comprising, in combination,

a rigid ceramic base member for supporting electrical conductive elements and a thermal plastic member heat sealed to said base member for establishing the environment of said electrical conductive elements, said members defining a chamber and heat sealed together in a region surrounding said chamber,

said electrical conductive elements including at least a pair of switching blades projecting through said region into said chamber,

the relative position of said blades within said chamber being changeable to open and close an electrical circuit,

said thermal plastic member being deformed into contact with one of said blades to move said one blade from one position when said members are heat sealed together to a different selected position for establishing a desired relative position between said blades.

12. An electrical device comprising, in combination,

a rigid ceramic base member for supporting electrical conductive elements and a thermal plastic member heat sealed to said base member for establishing the environment of said electrical conductive elements, said members defining a chamber and heat sealed together in a region surrounding said chamber,

said electrical conductive elements including at least a pair of switching blades projecting through said region into said chamber,

said relative position of said blades within said chamber being changeable to open and close an electrical circuit,

each of said blades including outside said chamber a portion of reduced mass between the portion extending into said chamber and a portion exterior thereof for making electrical connection thereto.

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