

[54] REED RELAY

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N.J.**

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[52] U.S. Cl. 335/152

[51] Int. Cl. H01h 1/66, H01h 51/28

[58] **Field of Search** 335/151-154

3,539,956	11/1970	Andersen et al.....	335/154
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Primary Examiner—Roy N. Envall, Jr.
Attorney—Stephen W. Blore et al.

[57] **ABSTRACT**

A reed relay includes a hollow plastic bobbin having reed contacts extending therewithin and a coil wrapped therearound. The coil functions not only to provide the magnetic field for drawing the contacts together, but also closes off an aperture initially provided for contact adjustment, whereby the contact area is protected from the surrounding environment. In one embodiment the operating coil secures bobbin portions in engaged relation, while in another embodiment the apertured construction enables one-piece forming of the relay.

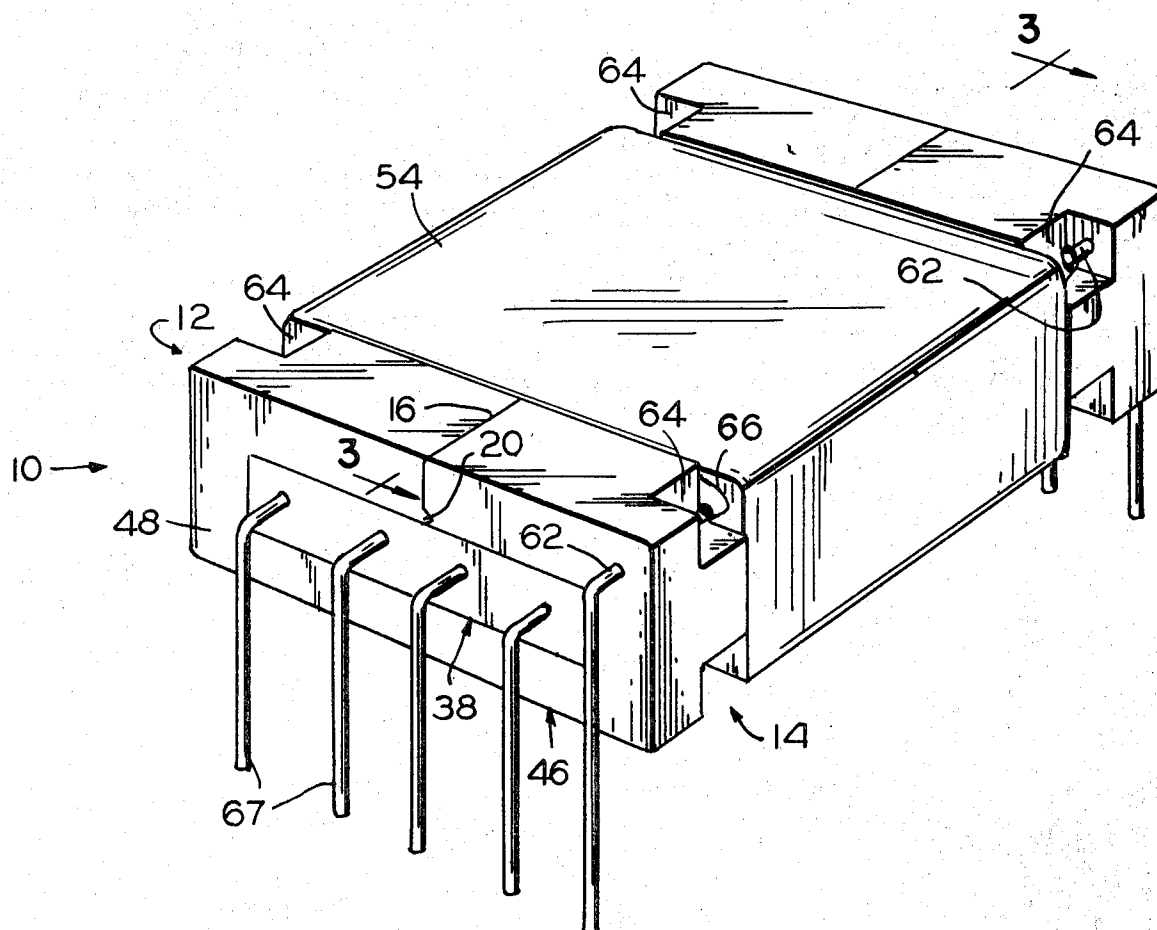
10 Claims, 16 Drawing Figures

[56]

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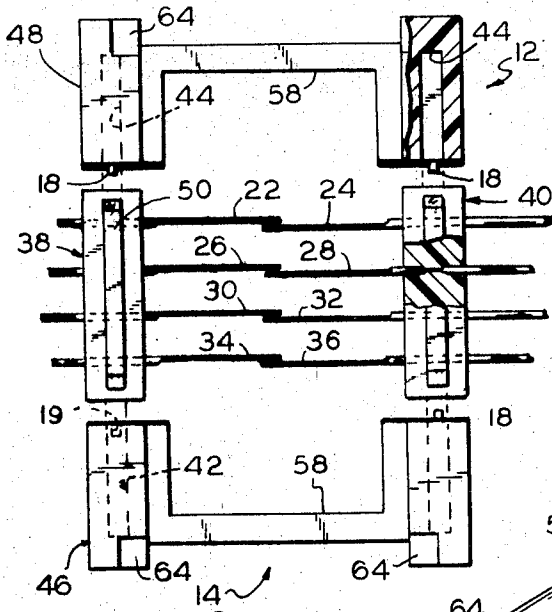


FIG. 2

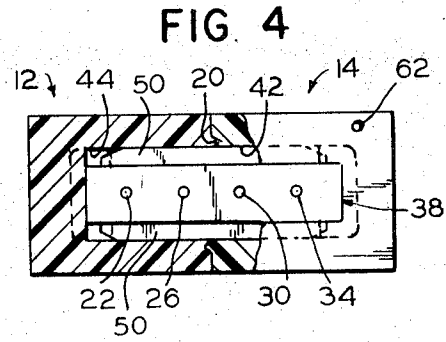


FIG. 4

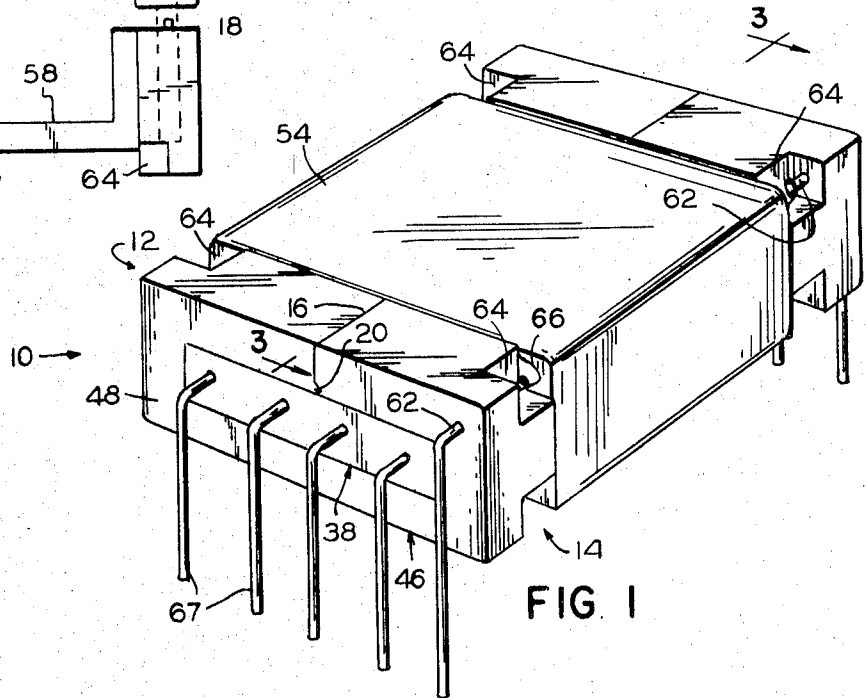


FIG. 1

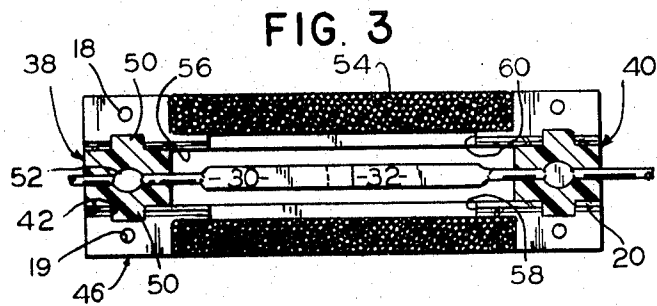


FIG. 3

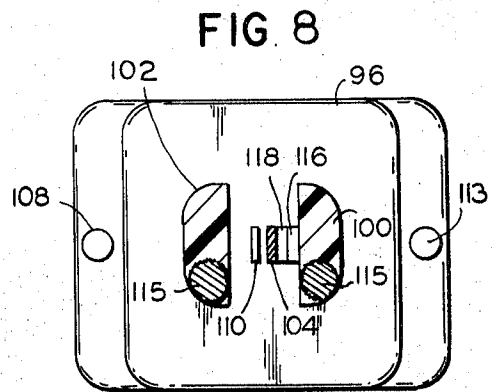
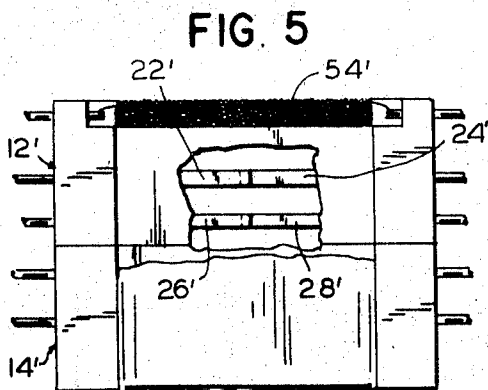
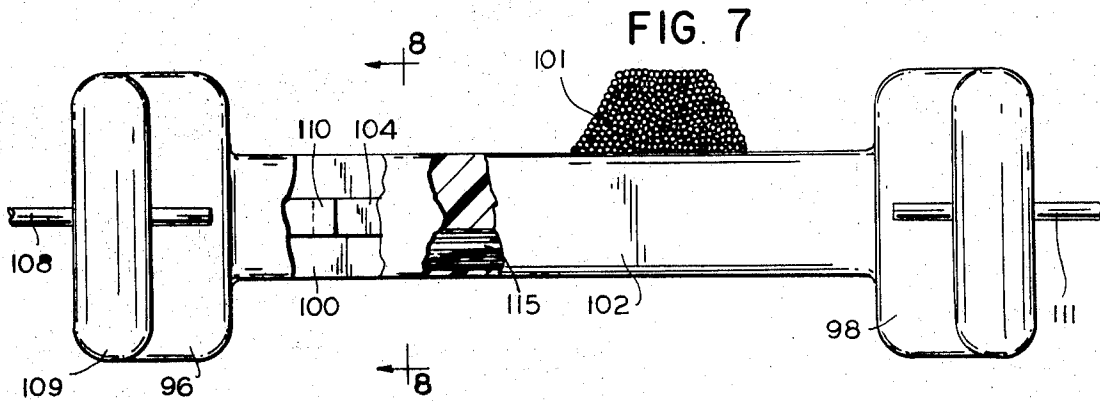
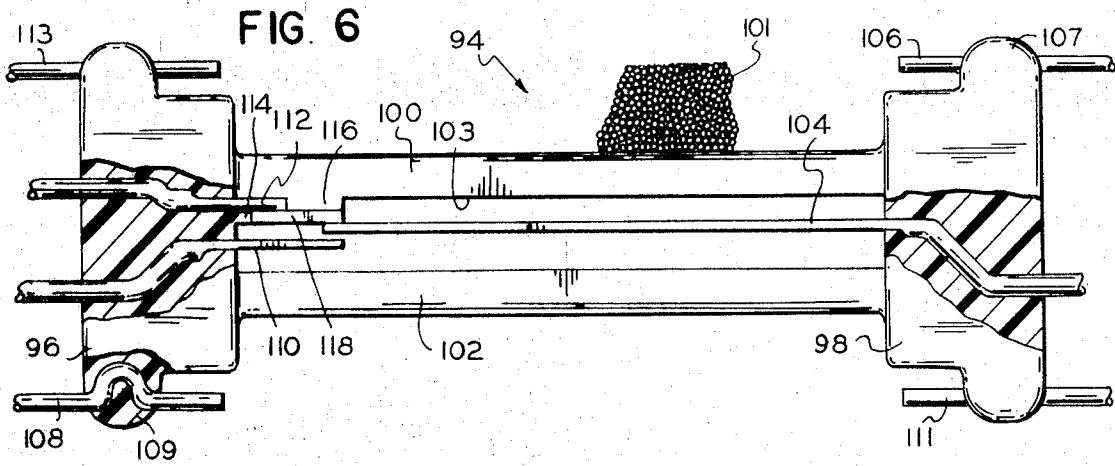


FIG 9

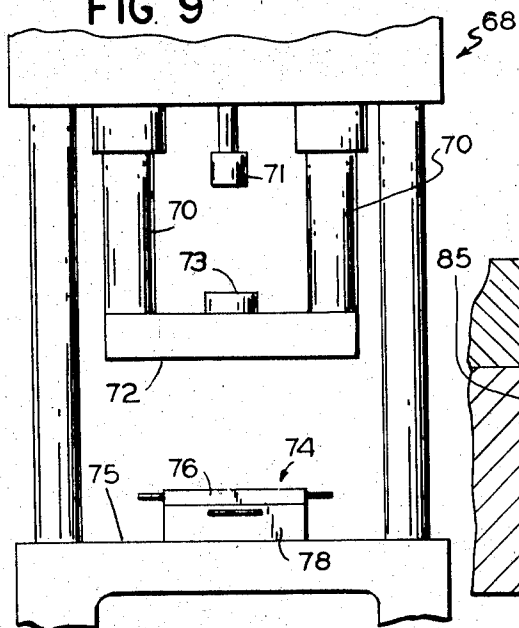


FIG 12

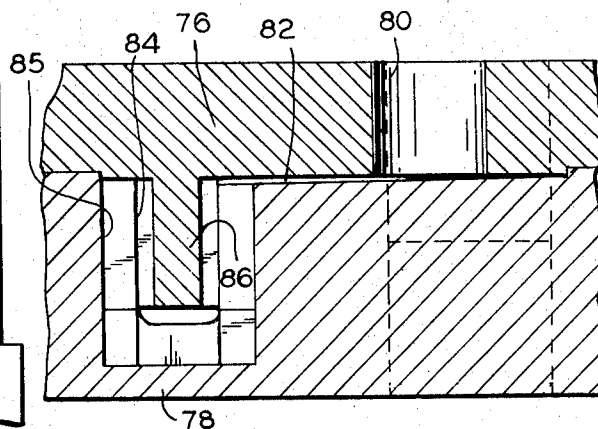


FIG 10

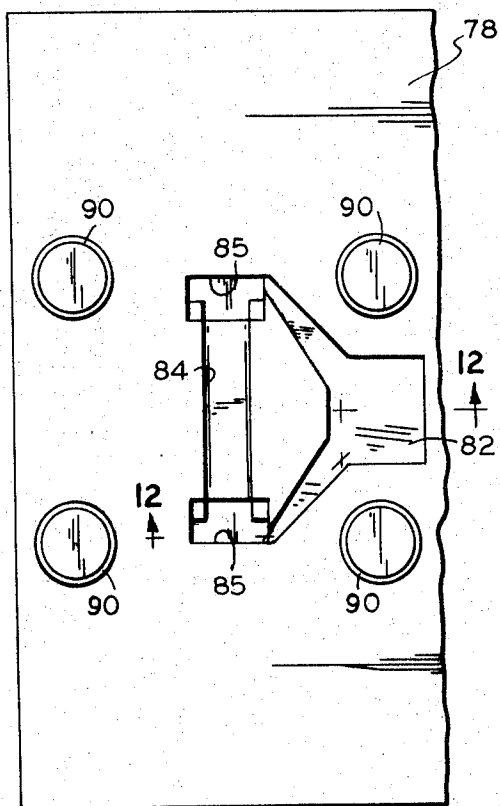
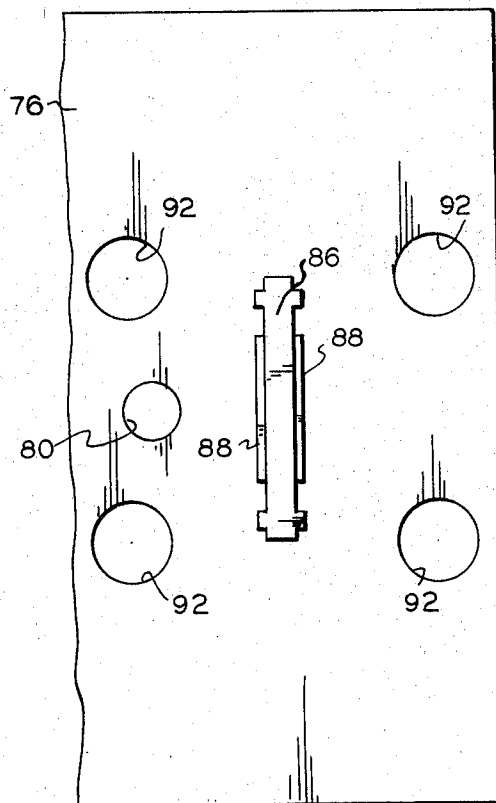


FIG 11



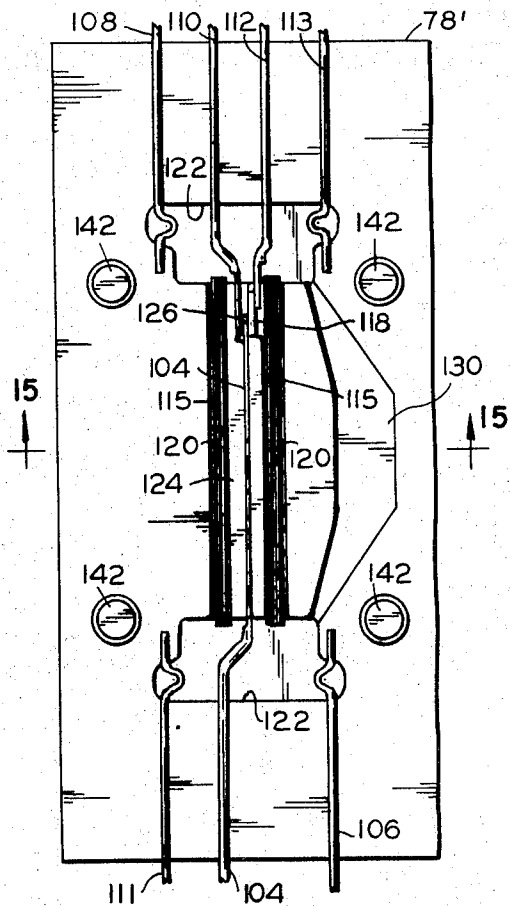


FIG. 13

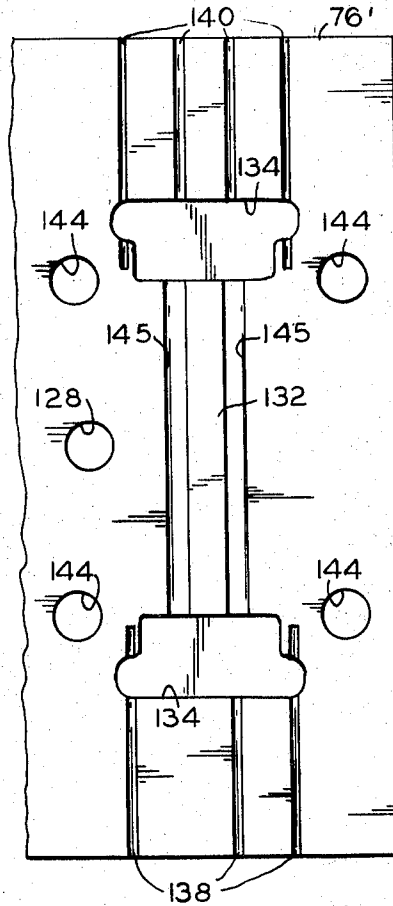


FIG. 14

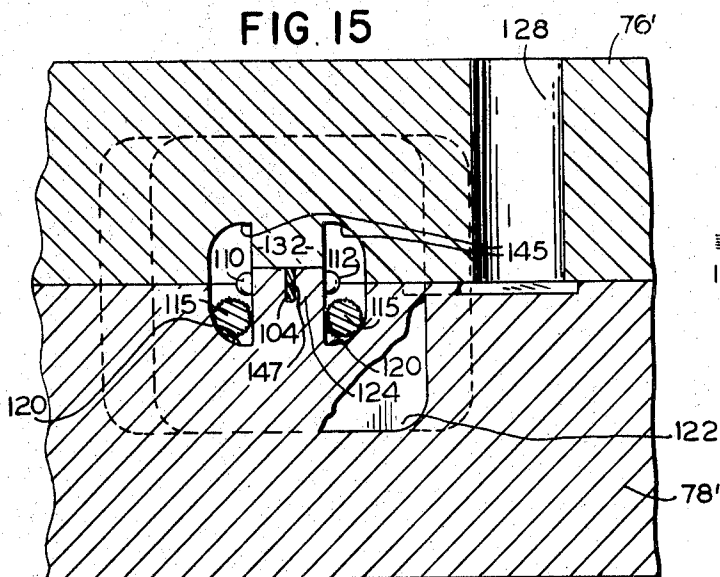


FIG. 15

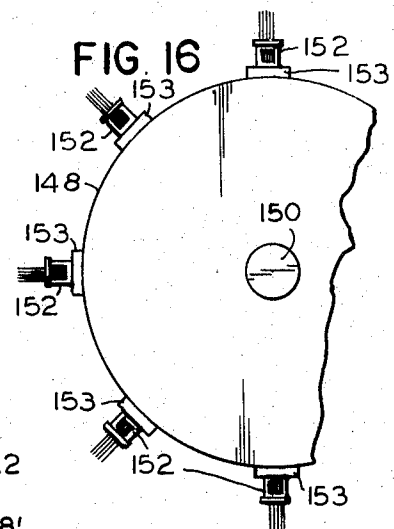


FIG. 16

1 REED RELAY

BACKGROUND OF THE INVENTION

Reed relays conventionally employ glass encapsulated, magnetically permeable contacts which "make" under the influence of a magnetic field produced by an operating coil wound therearound. This construction advantageously protects the contacts from the surrounding environment, but current carrying ability is liable to be limited since contact materials must be selected for sealing with glass. Furthermore, the conventional reed relay is relatively difficult and expensive to construct, and no adjustment of the contacts is afforded once the same are encapsulated.

SUMMARY OF THE INVENTION

According to the present invention, a hollow reed relay bobbin is formed of molded plastic and is preferably provided with a side aperture through which reed contacts may be adjusted. The operating coil is subsequently wound around the aforementioned bobbin and acts to seal off the contact area from the surrounding environment. In accordance with one embodiment, the bobbin comprises two plastic mating portions which are also held in substantially engaging relation by the aforementioned operating coil. In this embodiment, relay contacts are supported from plastic mounting means secured between the separate relay bobbin portions. In accordance with another embodiment, the relay bobbin is molded in substantially one operation in integral relation with the contacts, wherein the provision of side apertures not only facilitates adjustment of the relay contacts prior to the winding of the operating coil, but also facilitates the molding of the relay bobbin in one operation.

Relays according to the present invention have the advantage of selectably greater contact spacing and therefore greater current carrying ability as compared with the conventional reed relay, the contacts of the relay according to the present invention being formed of a more optimally permeable magnetic material. Thus the contacts can be more widely spaced and still be operable by a given actuating coil power input. Also, relays according to the present invention may be semiautomatically and economically formed in large quantities, greatly reducing both material and labor costs as compared with conventional reed relays. As hereinbefore indicated, contact spacing is readily adjustable leading to a lower rejection rate. The relays are, at the same time, suitably very small and lightweight, and are advantageously adaptable to printed circuit or integrated circuit apparatus.

Accordingly it is an object of the present invention to provide an improved reed relay of economical construction.

It is a further object of the present invention to provide an improved reed relay having selectable current switching/carrying and magnetic characteristics.

It is a further object of the present invention to provide an improved reed relay which may be semiautomatically produced.

It is a further object of the present invention to provide an improved reed relay adapted for contact spacing adjustment subsequent to molding of contacts in place.

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It is a further object of the present invention to provide a improved reed relay which may be formed in substantially one plastic molding operation.

The subject matter which we regard as our invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention, however, both as to organization and method of operation, together with further advantages and objects thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings wherein like reference characters refer to like elements.

DRAWINGS

- 15 FIG. 1 is a perspective view of a first embodiment of a reed relay according to the present invention;
- FIG. 2 is an exploded view of the FIG. 1 relay;
- FIG. 3 is a cross section of a reed relay according to the present invention, taken at 3—3 in FIG. 1;
- 20 FIG. 4 is an end view, partially broken away, of the relay according to the FIG. 1 embodiment;
- FIG. 5 is a side view, partially broken away, of a relay according to an alternative construction of the aforementioned embodiment;
- 25 FIG. 6 is a side view of a reed relay according to a second embodiment of the present invention, partially broken away in cross section;
- FIG. 7 is a bottom view, partially broken away, of the FIG. 6 relay;
- 30 FIG. 8 is a cross section taken at 8—8 in FIG. 7;
- FIG. 9 is a partially broken away front view of a transfer molding press employed in forming bobbins according to the present invention;
- 35 FIG. 10 is a top view, partially broken away, of a lower die part employed in forming a relay bobbin portion in accordance with the first mentioned embodiment;
- FIG. 11 is a bottom view, partially broken away, of a top die part employed in forming such relay bobbin portion;
- 40 FIG. 12 is a cross-sectional view showing the die parts in juxtaposition, and taken along line 12—12 in FIG. 10;
- FIG. 13 is a top view, partially broken away, of a lower die part employed in forming the relay bobbin according to the second embodiment of the invention;
- 45 FIG. 14 is a bottom view of a top die part employed in forming the last mentioned relay bobbin;
- FIG. 15 is a cross-sectional view taken at line 15—15 in FIG. 13 illustrating upper and lower die parts in juxtaposition; and
- 50 FIG. 16 is a top view, partially broken away, of a turret apparatus employed for holding bobbins during coil winding and soldering of coil leads.

DETAILED DESCRIPTION

- Referring to the drawings, and particularly to FIGS. 1 through 4 illustrating a first embodiment of a reed relay according to the present invention, such relay comprises a substantially rectangular bobbin 10 including a first portion 12 and a second portion 14 which meet along an axial parting line 16. The bobbin is quite small, typically about $\frac{3}{8} \times \frac{3}{8} \times \frac{1}{4}$ inch, and is formed of molded plastic material. FIG. 2, comprising an exploded view of the relay, more clearly depicts the initially separated portions of the relay bobbin, these portions being provided with pins 18 located at diagonally
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- 65

opposite corners of each bobbin portion for mating with aligned sockets 19 in the opposite bobbin portion. Also the portions are provided with an indexing groove configuration illustrated at 20 in FIG. 1.

The bobbin is hollow for receiving one or more pairs of reed contacts 22, 24; 26, 28; 30, 32; and 34, 36. Each contact is formed from magnetically permeable, electrically conductive metal and is molded into one of the plastic end support means, 38 or 40, slidably receivable within enlarged ends of the bobbin portions. Thus, support means 38 is cross-shaped in cross section, being provided with side tongues 50, as illustrated in FIG. 3, for sliding within mating grooves 42 at one end of the bobbin. Grooves 42 and 44 extend transversely of the relay within enlarged ends 46 and 48 of the respective bobbin portions, and are positioned in mating alignment when the bobbin is assembled as illustrated in FIGS. 3 and 4.

The contact support means 38 and 40 receive a generally cylindrical contact cross section, flattened as at 52 to prevent turning thereof. The operating portions of the contacts centrally located in the relay are, of course, flattened to flex and make connection with one another, under the influence of a magnetic field provided by coil 54 wound around the central part of the relay bobbin between the enlarged ends. Coil 54, in addition to providing the magnetic field for causing attraction between pairs of reed contacts, also functions for holding the initially separated portions of the relay bobbin together.

The bobbin is provided with a central cavity 56 into which the contacts longitudinally extend from the support means 38 and 40, and within which the respective contact pairs are adapted to make connection under the influence of the magnetic field produced by coil 54. The bobbin portions are also provided with apertures or windows 58 and 60 on respective sides thereof, opening from the central cavity 56 to the outside environment during initial construction of the relay. Through these windows, the contact pairs can be adjusted for achieving proper contact spacing thereof after assembly of support means 38 and 40 within bobbin portions 12 and 14 and closure of the last mentioned bobbin portions in abutting relation.

It will be noted that the support means 38 and 40 not only carry the contacts but also form an integral part of the relay bobbin, strengthening the bobbin structurally, while closing off the ends of cavity 56, thereby in part protecting the contacts from the outside environment. Moreover, after the contacts have been adjusted through windows 58 and 60, winding 54 is wound thereover for closing off these windows and the cavity 56 from the sides, for completing a protective enclosure for the contacts.

The slidably receivable support means 38 and 40 each carry four contacts in the particular embodiment illustrated, but it will be appreciated a lesser or greater number of contacts may be molded into such end support means for any given relay. The construction is quite flexible in that the same bobbin portions, accommodating a particular operating coil, can be employed for various selected combinations of relay contacts premolded into selected different end support means 38 and 40. It will be appreciated the remaining end support means 40 closes the enlarged opposite end of the relay bobbin in a structurally identical manner to that described above.

Additional coil connecting leads 62 are suitably molded into the enlarged ends of the relay bobbin portions, e.g., enlarged end 46 in FIG. 1. Additional leads 62 extend from ends of the bobbin at outside corners thereof into molded recesses 64, at which location a pigtail lead 66 forming the winding end of coil 54 may be soldered onto a lead 62. Recesses 64 are conveniently formed at all four corners of each end of the relay, but the leads 62 are molded or otherwise inserted into the enlarged ends of the relay bobbin portions only at selected corners where it is most convenient for making connection to the relay coil.

FIGS. 9 through 12 illustrate a molding process for forming the bobbin of the relay illustrated in FIGS. 1 through 4. A conventional transfer molding press 68 includes first rams 70 adapted to move downwardly and hold cross member 72 against book mold 74 placed upon platform 75. A quantity of plastic material, e.g., thermosetting plastic material, is placed within chamber 73 and plunger 71 is actuated downwardly at high pressure forcing the plastic material through an aperture 80 in top die part 76 of the book mold. Plastic material is forced into recess 82 and from there into the cavity 84, 85 defining the shape of the outside of one of the bobbin portions. End cavities 85 define the enlarged ends of the bobbin portions while cavity 84 extending therebetween defines the narrower central portion of the bobbin. A male member 86 extending downwardly from the upper die part 76 provides the central cavity for the bobbin as well as the slots for the enlarged end portions, with extensions 88 forming the aforementioned windows 58 and 60. The relay bobbin portion thus formed represents half of the complete bobbin, i.e., either bobbin portion 12 or 14 in FIG. 1, which are substantially identical. Pins 18 and sockets 19 may be provided in the same molding operation, or the bobbin portions may be drilled and the pins appropriately inserted. Only a portion of the mold is illustrated in FIGS. 10, 11 and 12, it being understood that a plurality of bobbin portions may be formed at the same time in the same mold if desired.

The book mold die parts are aligned by means of pins 90 extending from the upper die part and having a mating relation with holes 92 in the lower die part. In the instance of the particular example as illustrated in FIGS. 9-12, the coil is suitable connected separately to connection means other than those passing through the bobbin. The contact support means 38 and 40 are suitably formed of substantially the same plastic material as employed for the bobbin by a similar method and apparatus in a manner which will be apparent to those skilled in the art.

After the bobbin portions are thus molded, they are assembled in the manner illustrated in FIGS. 1 through 4, and the contacts may be adjusted through windows 58 and 60 by bending the contacts slightly to provide the proper spacing therebetween. A plurality of relay bobbins of the type illustrated in FIGS. 1 to 4 may be placed on a turret apparatus illustrated in FIG. 16 by inserting the same in chucks 153 for winding of the coils 54, followed by soldering of the end leads 66. In a given instance, bobbins 152 are supported by turret 148 and coils are wound around the same from ends thereof by fly-winding apparatus (not shown) or other appropriate apparatus. After a bobbin is provided in this manner with a coil, the turret 148 is rotated on vertical spindle 150 and the coil end leads are soldered.

Alternatively, the relay bobbins may be attached to sides of a turret rotatable about a horizontal axis for coil winding on one side followed by rotation of the turret for coil lead soldering on the opposite side of the turret axis.

The relay coil may then be wrapped with a layer of protective tape and positioned in a jig (not shown) suitable for bending the outer contact lead ends in a downward direction as illustrated at 67 in FIG. 1, adapting the relay for mounting onto a circuit board or the like. The same jig may be suitably adapted for testing the relay by energization of the coil 54 and testing pull in and drop out of the respective contact pairs.

An alternative construction is illustrated in FIG. 5, this relay being substantially identical with the one illustrated in FIGS. 1 through 4 except for the absence of side windows and a difference in the direction of flexure of the contact pairs. The contact pairs flex in the direction of the narrowest relay dimension, or side-wise of the relay. This construction is sometimes suitable for placing a large number of contacts in close proximity, but has the disadvantage of permitting substantially no adjustment or spacing of the contacts after assembly of the bobbin. The relay parts of the FIG. 5 embodiment are referred to employing primed reference numerals wherein these parts correspond to those of the FIG. 1-FIG. 4 embodiment referred to employing corresponding unprimed reference numerals.

A preferred embodiment of a relay according to the present invention is illustrated in FIGS. 6 through 8, and is a little smaller than the first mentioned embodiment in exterior size. In the instance of this preferred embodiment, the relay bobbin is substantially one piece in form, and is molded in integral relation with the contacts thereof, in substantially one step. The relay bobbin 94, formed of molded plastic material, includes enlarged ends 96 and 98 with contacts 110 and 112 being molded into enlarged end 96, while contact 104 is integrally molded with enlarged end 98. Longitudinal legs 100 and 102, which are integral with the enlarged ends, extend between said ends in spaced relation with each other for defining a central cavity 103 therebetween into which the contacts 104, 110 and 112 are disposed in a direction longitudinal or axial of the relay. Knurled rods 115 are suitably embedded longitudinally within legs 100 and 102, for the length thereof, to provide reinforcement for the legs. As in the case of the previously mentioned contacts, contacts 104 and 110 are formed on a conductive material of optimal magnetic permeability (in a particular instance comprising No. 52 nickel-iron alloy manufactured by Magnetics, Inc., Butler, Massachusetts). The thermosetting plastic material for either embodiment is suitably Furane 409 manufactured by Furane, Fairfield, New Jersey.

The relay construction of FIGS. 6-8 is adapted for providing both normally open and normally closed relay operation. Contact 116 is supplied with an additional contact part 118 which is suitably welded to contact 112 or integrally formed with contact 112, while being disposed between shoulder 114 of enlarged end 96 and shoulder 116 of longitudinal leg 100. This contact part 118 is disposed in normally contacting relation with contact 104. Contact part 118, as well as contact 112, if desired, is suitably formed of a nonmagnetically permeable material, whereby the magnetization of contacts 104 and 110, by energization of coil 101,

produces attraction and connection between contacts 104 and 110.

The enlarged end portions of the relay of FIGS. 6-8 are provided with end shoulders 109 and 107 through which coil leads 106, 108, 111 and 113 extend in molded relation. As can be seen in the FIG. 6 cross section, these leads as well as the aforementioned contacts are appropriately bent to prevent movement or turning of the contact or lead after manufacture of the relay. The relay of FIGS. 6-8 facilitates ready adjustment of the contacts through the side windows provided between legs 100 and 102 in the manner described in connection with the previous embodiment. Thus, the flattened central contact portions, within cavity 103, can be bent to ensure the proper spacing. It will be appreciated only two leads need be embedded in shoulders 107 and 109, as desired, for making connection with the relay coil 101 subsequently would around longitudinal legs 100 and 102 in a manner similar to that described in connection with the previous embodiment, e.g., on a turret device. While a normally open and normally closed contact configuration is illustrated in the embodiment of FIGS. 6, 7 and 8, it will be further appreciated by those skilled in the art that other contact configurations are also possible. It is found the one-piece molded relay embodiment requires less contact adjustment than the embodiment of FIGS. 1 through 4.

Molding apparatus for forming the relay of FIGS. 6 through 8 in substantially one operation is illustrated in FIGS. 13 through 15, depicting a top die part 76' and a bottom die part 78' of a book mold similar to the one illustrated in FIGS. 9 through 12. Die part 78' is supplied with end cavities 122 for forming the lower half of the enlarged end portions of the bobbin, and longitudinal cavities 120 which form the lower half of the longitudinal legs of the bobbin and into which knurled rods 115 are placed. An upwardly extending male member 124 is provided with a slot 147 for receiving the flattened portion of contact 104 while the bent portion of this contact extends across a cavity 122. Contact 104 is further received in a slot extending across the upper face of the die part beyond cavity 122. Similarly, contact 110 and contact 112, joined to part 118, are disposed in slots in the upwardly extending male member 124, while contacts 110 and 112 extend to slots in the upper face of the die part 78' beyond the remaining cavity 122. Likewise, leads 106, 108, 111 and 113 are received in face slots in the die part and extend across cavities 122 as shown. It will be noted that contacts 104 and 110 meet in a central cavity 126 in male member 124, but this cavity is employed solely for spacing purposes and is blocked from receiving any of the plastic material transferred within the book mold by the press.

Upper die part 76' includes a central male member 132 which extends downwardly in abutting relation with male member 124 along a parting line disposed upwardly from the parting line between other portions of the die parts, by a distance of one-half the width of the contacts. The male member 132 separates a pair of cavities 145 adapted for forming the upper part of the longitudinal legs of the bobbin, these cavities joining cavities 134 adapted for forming the top of the enlarged bobbin ends. The face of die part 76' is provided with slots 138 and 140 receiving the respective contacts and leads 104, 106, 111, 108, 110, 112 and 113.

The lower die part 78' includes pins 142 matingly received in holes 144 in the upper die part 76', the upper die part being further provided with an aperture 128 through which plastic material is forced into recess 130 communicating with the aforementioned cavities. It will be seen that as plastic material is thus transferred into these cavities by a press as illustrated at 68 in FIG. 9, the relay bobbin construction illustrated in FIGS. 6 through 8 is formed in substantially one operation, integrally with the contacts thereof, after which the contact spacing can be adjusted from the side as desired. It will be seen that the side opening construction not only facilitates contact adjustment, but also makes possible the one-step forming process. It is understood the addition of contact 112 and portion 118 is to provide a normally closed contact arrangement and is not required if only normally open contacts are desired. Also the die parts may be employed to form a plurality of bobbins at the same time instead of one as in the illustrated example.

After the bobbin is thus formed, operating coil 101 can be wound about legs 100 and 102 by fly-winding apparatus or the like, e.g., in combination with a turret arrangement as hereinbefore described, for closing off the cavity 103 and protecting the operating contacts therewithin. The end leads of the coil are connected to selected of the aforementioned leads which extend through shoulders 107 and 109, after which a length of protective tape may be wrapped about the coil. The end leads of the relay may be bent down and the relay tested, as hereinbefore described with respect to the previous embodiment, adapting the relay for operation on a circuit board or the like.

The relay construction according to the present invention has numerous advantages. Not only is the reed relay according to the present invention readily adjustable after formation of the bobbin, but also the relay is economical in construction in both material and labor costs. Moreover, the relay is substantially sealed off from the external environment when the operating coil is wound therearound. The relay is quite small and is suitably adapted for use on printed circuit boards and the like. Furthermore, the contact spacing is readily selectable, adapting the relay for current carrying ability several times that of the conventional reed relay. This is in part due to the ability to utilize contacts of optimal magnetic permeability, enabling contact operation for a given actuating coil power input at wider contact spacing, without the limitation of having to select a contact material for its glass sealing characteristics. Operation characteristics are comparable to those of an electromechanical relay, while retaining the contact protection of a reed relay at a fraction of the cost thereof.

While we have shown and described several embodiments of our invention, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from our invention in its broader aspects. We therefore intend the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.

We claim:

1. A reed relay comprising:

a plastic hollow bobbin comprising two mating pieces adapted for interfitting relation along a line substantially longitudinal of said bobbin,

an energizing coil wound around said bobbin constraining engagement of the two pieces of said bobbin along said line,

a first contact mounting means, initially separate from said bobbin, received between pieces of said bobbin proximate a first end of said bobbin,

a second contact mounting means, initially separate from said bobbin, received between pieces of said bobbin proximate the second end of said bobbin,

and reed contacts formed of magnetically permeable material carried respectively and separately by said mounting means and disposed longitudinally within said hollow bobbin in spaced proximity from one another, wherein energization of said coil is adapted to produce magnetic attraction and operation of said contacts.

2. A reed relay comprising:

a plastic hollow bobbin comprising two mating pieces adapted for interfitting relation along a line substantially longitudinal of said bobbin,

an energizing coil wound around said bobbin constraining engagement of the two pieces of said bobbin along said line,

each of said pieces having laterally directed slots proximate ends of said bobbin which mate with slots on the remaining piece when the pieces are thus engaged,

a first contact mounting means slidably received in the mating slots proximate a first end of said bobbin,

a second contact mounting means slidably received in the mating slots proximate the second end of said bobbin,

and reed contacts formed of magnetically permeable material carried respectively by said mounting means and disposed longitudinally within said hollow bobbin in spaced proximity from one another, wherein energization of said coil is adapted to produce magnetic attraction and operation of said contacts.

3. The apparatus according to claim 2 wherein said hollow bobbin is provided with at least one side aperture in a wall of said bobbin substantially parallel with the direction of movement of said contacts for providing adjustment access prior to placement of said coil on said bobbin.

4. The apparatus according to claim 2 wherein said contact mounting means are molded plastic receiving said contacts.

5. A reed relay comprising:

a one-piece molded plastic bobbin having end portions through which contacts extend in secured relation to said bobbin, and a central portion comprising at least first and second longitudinal legs defining a central cavity therebetween into which said contacts extend in a direction axial of said relay, said legs defining openings on either side of said cavity, said contacts being embedded in said end portions for support thereby and having operative portions substantially exposed to the interior of said central cavity,

and an operating coil wound around said legs and adapted to bring about operation of said contacts.

6. The apparatus according to claim 5 wherein said coil substantially closes said openings for preventing exposure of said contacts.

7. The apparatus according to claim 5 wherein said contacts include normally open and normally closed contacts, said normally closed contacts including a further member extending from one of said contacts, in contacting relation with one of the remaining of said contacts.

8. The apparatus according to claim 5 wherein said openings face in directions substantially perpendicular to the direction of movement of said contacts for providing access for contact adjustment prior to placement of said coil on said bobbin.

9. A reed relay comprising:

at least two contacts formed of magnetically permeable material,

a one-piece molded plastic bobbin comprising end portions through which said contacts extend and a central hollow portion adapted to receive said contacts for contact operation, said contacts being supported by said end portions wherein portions of said contacts are embedded in said end portions while other portions of said contacts where said contacts are adjacent one another for contact operation are substantially exposed to said central hollow portion of said bobbin, said central hollow por-

tion being provided with apertures at the sides thereof extending substantially between said end portions,

and an operating coil wound around said central portion of said bobbin between said end portions for bringing about operation of said contacts.

10. A reed relay comprising:

at least a pair of magnetizable reed contacts,

a molded plastic bobbin having end portions through which the respective reed contacts extend, and having a central hollow portion within which said reed contacts are adapted to operate, said contacts being supported by said end portions wherein portions of said contacts are embedded in said end portions while other portions of said contacts are substantially exposed to said central hollow portion of said bobbin, said central portion being provided with a side aperture for providing initial access to said contacts in a direction permitting adjustment of said contacts during manufacture of said relay, and an operating coil for said relay wound around said central portion and substantially closing off said aperture for protection of said contacts.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,760,311 Dated September 18, 1973

Inventor(s) Robert A. Zimet et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 59, "reel" should be --reed--.

Column 2, line 10, "conjunction" should be --connection--.

Column 5, line 12, "be" should be --by--.

Column 5, line 50, "on" should be --of--.

Column 6, line 18, "would" should be --wound--.

Column 7, line 59, "out" should be --our--.

Signed and sealed this 2nd day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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(SEAL)

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