United States Patent

Zwobada et al.

[15] 3,638,150

[45] Jan. 25, 1972

[54] REED RELAY

[72] Inventors: Rene L. Zwobada, Orsay; Andre Jean Regeffe, Villemomble, both of France

[73] Assignee: International Standard Electric Corporation, New York, N.Y.

[22] Filed: June 19, 1970

[21] Appl. No.: 47,719

[30] Foreign Application Priority Data

June 25, 1969 France 6921308

[52] U.S. Cl. 335/153
[51] Int. Cl. H01h 51/27
[58] Field of Search 335/151–154

[56] References Cited

UNITED STATES PATENTS

3,075,059 1/1963 Blaha et al. 335/153

FOREIGN PATENTS OR APPLICATIONS

1,049,081 11/1966 Great Britain 335/153
870,906 6/1961 Great Britain 335/153

Primary Examiner—Bernard A. Gilheany
Assistant Examiner—R. N. Envall, Jr.
Attorney—C. Cornell Remsen, Jr., Walter J. Baum, Paul W. Hemminger, Charles L. Johnson, Jr., James B. Raden, Delbert P. Warner and Marvin M. Chaban

[57] ABSTRACT

A reed relay is provided in which the sealed envelope is a tube made of magnetic material instead of glass.

6 Claims, 9 Drawing Figures

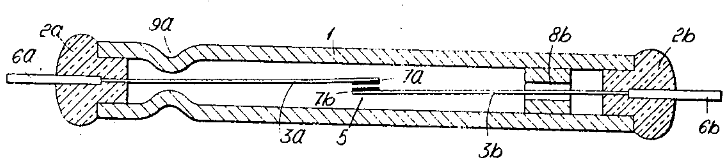
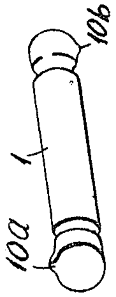


Fig.4.



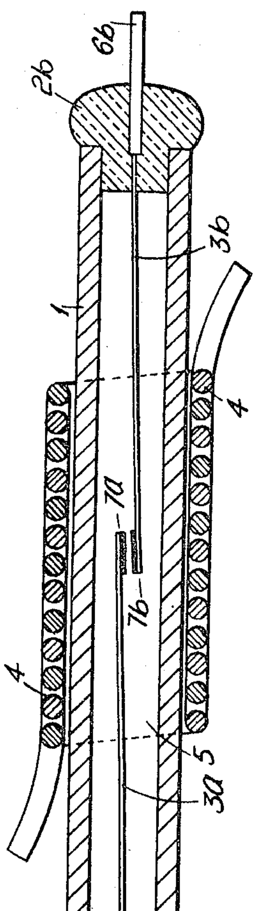


Fig.1.

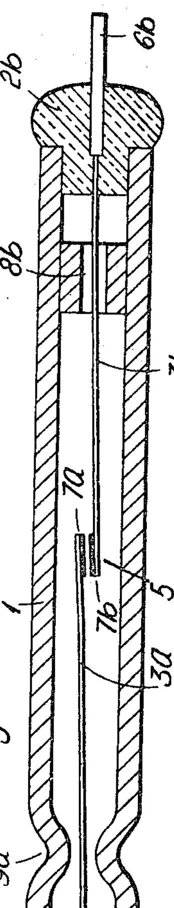


Fig.2.

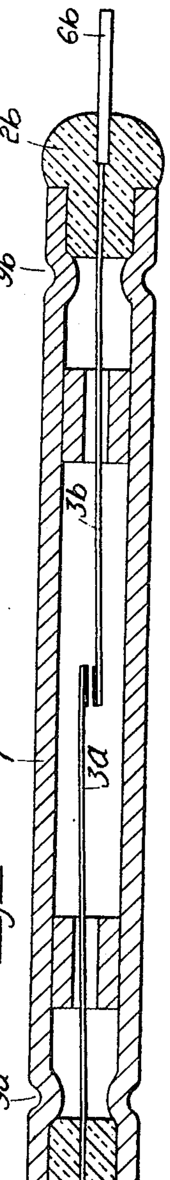


Fig.3.

Inventor

R. ZWOBADA - A. J. REGEFFE

By D. O. Warner

Attorney

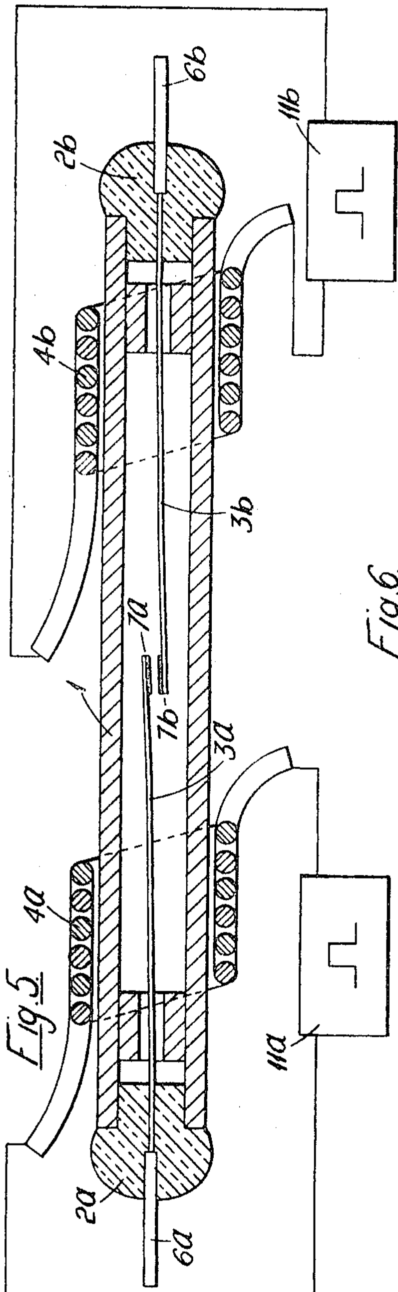

6b
2b
11b
4b
3b
7a
7b
3a
1
4a
11a
2a
6a

Fig.5

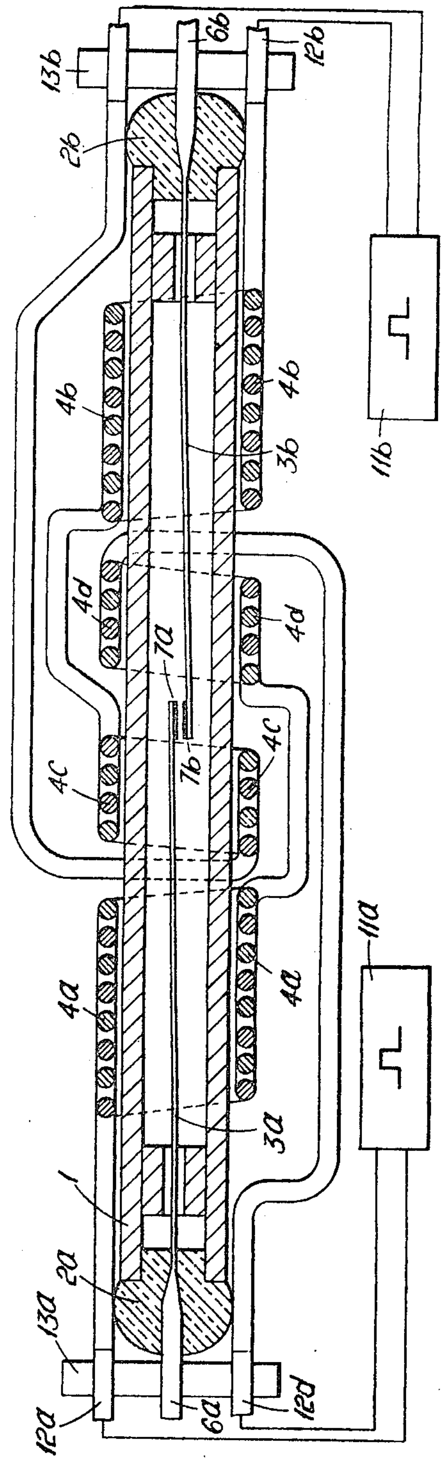

13b
6b
12b
2b
4b
4b
3b
11b
4d
4d
7a
7b
4c
4c
11a
4a
4a
3a
1
2a
13a
12a
6a
12d

Fig.6

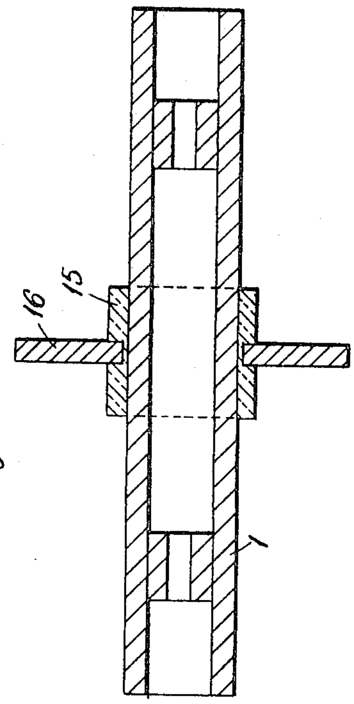


Fig.8

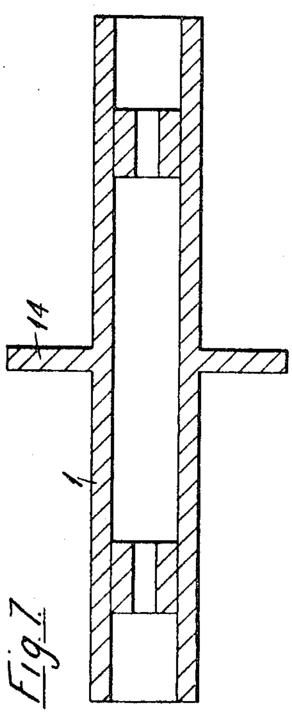


Fig.7

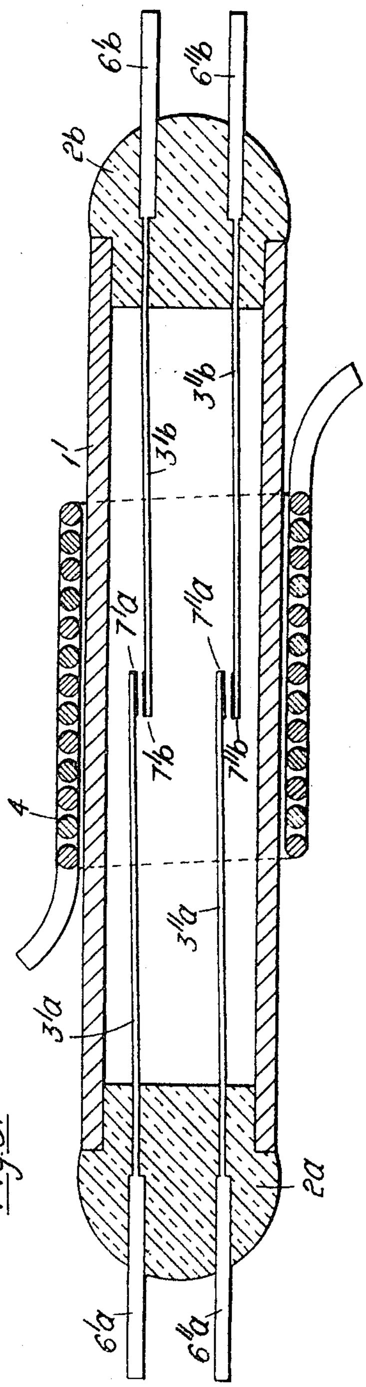


Fig.9

REED RELAY

The present invention relates to relays with contacts encased in a protective tube also known as sealed contact relays and more commonly known as reed relays.

A description of this type of relay was provided very early in the specification of French Pat. No. 852,275 filed by the applicant on Mar. 28, 1939 under the title: "Electric switching devices." These relays are basically made up of a glass cylindrical casing, in which are sealed, at both ends, reeds the outer prolongation of which serve as terminals and the inner ends of which serve as contacts. The reeds are elastic and magnetic and their ends are coated with a suitable metal to ensure good contact. The airtight casing can contain any inert gas, such as nitrogen or helium. One or several coils around the casing can be energized to close the contacts.

Apart from their corrosion-resistance properties, these relays are advantageous in that they operate rapidly. This accounts for their widespread use with digital computers and, in particular, as the main components of speech cross-points in telephone exchanges.

Moreover, in telephone exchanges, power is at a premium. This is why speech cross-points which only use power when they change states have been developed. We are referring to magnetically held sealed contact cross-points like the ones used in the ESS1 telephone system (Electronic Switching System No. 1) installed in the U.S.A. by Western Electric and in the Artemis automatic switching equipment installed by the applicant and described in the publication "Commutation et Electronique" No. 10, Oct. 1965, pages 80 to 89. These relays mainly comprise sealed contacts, reversible permanent magnets, which switch the magnetic stream in the contacts, and energizing coils. They are disadvantageous on the one hand, in that they constitute cumbersome assemblies and, on the other hand, their assembly is a long and therefore costly process. One aim of the invention is to provide for a less cumbersome and less expensive improved cross-point than previous ones. For the purpose of this description, the subassembly constituted by the sealed contacts in their casing will be termed sealed contacts.

According to a feature of the invention, a reed relay comprising an airtight cylindrical casing comprising a remanent magnetic tube with insulating seals at its ends through which the contact reeds are threaded and around which the energizing coils are placed is provided for.

According to another characteristic of the invention, the tube is made of a ferromagnetic alloy with satisfactory remanent induction properties.

Compared with previous known relays, the relay of the invention is smaller, for the thickness of the glass cylinder no longer exists the magnet being located closer to the contact reeds, the gap is smaller.

According to another feature of the invention, the said gap can be made very small by effecting two constrictions in the magnetic tube and by placing the seals outside said constrictions so as to achieve the required electric installation.

Since the magnet is cylindrical, the flux is more concentrated and less leakage occurs. Therefore for a given contacts attraction field and for a given holding field, the flux of the cylindrical magnet can be weaker, i.e., the number of ampereturns required can be smaller, the number of coil turns can be lower thus permitting a reduction in volume of the relay. Finally, as leakage is low, the relays can be placed close to one another.

The aims and characteristics of the present invention will become clear from the following description of embodiment examples, said description being made with reference to the appended drawings in which;

FIG. 1 is a side view, partly in section, showing part of the contact relay device according to the invention.

FIG. 2 is a side view, partly in section, showing a specific embodiment example of sealed contact according to the invention.

FIG. 3 is a side view, partly in section, showing components of another specific embodiment example of a sealed contact according to the invention.

FIG. 4 is a drawing in perspective of specific embodiment example of the sealed contact casing.

FIG. 5 is a side view, partly in section, of a contact relay device incorporating the sealed contact of FIG. 2 and two energized coils.

FIG. 6 is a side view, partly in section, of a contact relay device incorporating the sealed contact of FIG. 2 and four energized coils.

FIG. 7 is a side view, partly in section, of a modification in the implementation of the sealed contact casing used in the devices in FIGS. 5 and 6.

FIG. 8 is a side view, partly in section, of another modification of the sealed casing.

FIG. 9 is a side view, partly in section, of a contact relay device according to the invention comprising two pairs of identical reeds placed in a single magnetic cylinder.

The contact relay device shown in FIG. 1 comprises:

- a remanent magnetic tube **1** forming a casing and made of ferromagnetic alloy of satisfactory remanence for instance steel, with a 0.6 to 0.7 carbon content, a 0.5 to 0.8 manganese content and a 0.6 to 0.7 silicon content;
- two insulating end seals **2***a* and **2***b* made for instance of two glass beads;
- two reeds **3***a* and **3***b* in highly permeable magnetic material which is also good electric conductor, said reeds being sealed in **2***a*and **2***b*;
- an energizing coil **4**.

The inside **5** of the casing constituted by **1**, **2***a* and **2***b* can be filled with a neutral gas such as nitrogen for example. The outer ends (projecting outside the casing), **6***a* and **6***b*, of reeds **3***a* and **3***b* form terminals whereas the inner ends, (inside the casing) **7***a* and **7***b*, are coated with suitable precious metal so as to ensure the high resistance and longlife of the contact.

The device shown in FIG. 1 operates as follows: the contact situated between ends **7***a* and **7***b* of reeds **3***a* and **3***b* being open, a current is set up in coil **4**, said current being such that the magnetomotive force applied allows for adequate magnetic induction of tube **1** (saturation); said tube then acquires longitudinal magnetization creating a north-south magnet the lines of force of which close themselves, in particular through reeds **3***a* and **3***b* and their ends **7***a* and **7***b*. Said ends are mutually attracted, and the contact closes; the current, in coil **4** can then be cut, the magnet constituted by tube **1**, provided the remanent induction is sufficient, holds the contact in a closed position. To release the relay, i.e., to open the contact, the magnetic field between ends **7***a* and **7***b* of reeds **3***a* and **3***b* must be suppressed; as soon as this field is suppressed the elasticity causes the reeds to move apart.

A known means consists in feeding a current of decreasing force into coil **4** thus demagnetizing tube **1**. Other embodiment examples which make it possible to open and close the contact will be described hereafter.

FIG. 2 provides another embodiment example of a sealed contact according to the invention in which, in the vicinity of the ends of tube **1**, two constrictions, **8***a* and **8***b*, are made in the said tube. Said constrictions are designed to reduce the gaps between tube **1** and reeds **3***a* and **3***b*; the other components remaining in the same layout as in FIG. 1.

Constrictions **8***a* and **8***b* can be made as in **8***a* for instance, by pinching tube **1**, or as in **8***b* by adding a ring in the same material as tube **1** which is forcibly fitted into said tube.

FIG. 3 shows another embodiment example of a sealed contact in which the ends of tube **1** comprise grooves **9***a* and **9***b* designed to facilitate the locating of beads **2***a* and **2***b* during the sealing process. Naturally the placing of reeds **3***a* and **3***b* in the cylinder can be facilitated if the reed-bead unit is prepared beforehand.

FIG. 4 shows a tube **1** the ends of which have notches **10***a* and **10***b* opening outwards, the notches being diametrically opposite to one another so that the reed-bead units—the beads being round except for a small projection on one side—can be threaded without error into the ends of **1**.

FIG. 5 shows a relay device according to **2** in which tube **1** is surrounded by two coils **4***a* and **4***b* placed on either side of the center of tube 1. In the absence of a control flux, ends 7*a* and 7*b* of reeds 3*a* and 3*b* are held in separate positions thanks to the elasticity of the reeds themselves: the contact is open.

The closing of the contact is effected by simultaneously energizing in the same direction coils 4*a* and 4*b* by means for example of sending pulses of current produced by separate sources 11*a* and 11*b*. As was explained above, the applied magnetomotive force which is the sum of the magnetomotive forces corresponding to sources 11*a* and 11*b*, causes the magnetic induction of tube 1; said tube becoming longitudinally magnetized thus generating an induction flux along reeds 3*a* and 3*b* which come into contact.

The sources of energizing current 11*a* and 11*b* can be short pulses, it suffices that their amplitude be great enough to provide the magnetization power needed to produce suitable remanent induction. This induction is stored in tube 1 and the contact can therefore be closed after the disappearance of the energizing current pulses and in the same way be maintained without a holding current being required for either of coils 4*a* and 4*b*.

The releasing of the relay, i.e., the separation of ends 7*a* and 7*b* of reeds 3*a* and 3*b*, can be achieved by suppressing the magnetization of tube 1 or at least by diminishing said magnetization considerably; to do this, coil 4*b* for example is energized from source 11*b* by a pulse of current of opposite direction to that which caused, as described above, the closing of the contact, but of a smaller amplitude.

Another process to achieve the resetting of the relay consists in energizing, as already indicated, coils 4*a* and 4*b* from sources 11*a* and 11*b* by short pulses of current, but in this case with pulses which act in opposition, i.e., pulses of opposite polarities.

It can be assumed that inside tube 1, before the application of said pulses, the magnetic charges are so distributed that the left part of said tube for instance corresponds to a South Pole and, conversely, that the right-hand part of said tube bears opposite charges and corresponds to the North Pole; there is therefore a neutral zone in the center of tube 1 where the charges cancel one another out thus it is as if said tube comprised two coupled magnets. The magnetomotive force set up by source 11*a* is assumed to be sufficient to saturate the magnetization of the left part of tube 1; similarly, the magnetomotive force set up by source 11*b* is assumed to be sufficient to saturate the magnetization of the right part of tube 1.

The two saturated magnetizations are in opposite directions so that when energization via sources 11*a* and 11*b* ceases, the two halves of tube 1 are characterized by remanent inductions of the same quantity but in opposite directions; in other words the ends of tube 1, bearing magnetic charges of the same sign, have the same polarity; the resulting induction in reeds 3*a*, 3*b* is practically nil and the reeds move apart.

FIG. 6 shows a relay device comprising a sealed contact, which basically corresponds to the one shown in FIG. 2, in which tube 1 is surrounded by four coils 4*a*, 4*b*, 4*c* and 4*d*.

Coils 4*a* and 4*c* surround the left-hand part of tube 1; coils 4*b* and 4*d* surround the right-hand part.

Coils 4*a* and 4*b*, on the one hand, are wound in a given direction, coils 4*c* and 4*d*, on the other hand, are wound in the opposite direction.

Coils 4*a* and 4*b* have the same number of turns N_1 which is a higher number, for instance twice as high, as the number of turns of coils 4*c* or 4*d*, characterized by N_2 turns. Coils 4*a* and 4*d*, on the one hand, and coils 4*c* and 4*b*, on the other hand, are connected in series. The free ends of the assembly in series of 4*a* and 4*d*, emerge on the left of the device shown in FIG. 6 by prongs 12*a* and 12*d*; similarly the free ends of the assembly in series 4*c* and 4*b* emerge on the right of the device shown in FIG. 6 by prongs 12*c* and 12*b*. Ends 6*a* and 6*b* of reeds 3*a* and 3*b* also serve as prongs.

The three prongs 6*a*, 12*a* and 12*d*, on the one hand, the three prongs 6*b*, 12*c* and 12*b*, on the other hand, are held in position using known methods by rigid insulating parts respectively shown in schematic form by 13*a* and 13*b*: they can be solid with the body of tube 1.

The assembly constituted in this way can then be plugged onto a base provided for beforehand and set out, for instance, on printed circuits; prongs 6*a*, 12*a* and 12*d* are plugged onto a first printed circuit, prongs 6*b*, 12*c* and 12*b* onto a second printed circuit.

In a modification of the device according to the invention but not shown in the drawing, the outputs of coils 4*d* and 4*b* as well as the output of reed 3*b*, are extended and brought round the outside of the device into the proximity of coils 4*a* and 4*c* and of output prong 6*a* of reed 3*a*; the six outputs thus placed close to one another are equipped with prongs 6*a* and 6*b* corresponding to the contact reeds of prongs 12*a* and 12*d*, corresponding to coils in series 4*a* and 4*d*; and with prongs 12*c* and 12*b* corresponding to coils in series 4*c* and 4*b*; these six prongs are held in position by a single rigid insulating part; the arrangement of the prongs can be such that the operation of plugging onto a base, provided for prior to assembly, can be performed without any risk of error as regards connecting.

The device shown in FIG. 6 operates as follows: when the coils assembled in series 4*a* and 4*d* (or 4*c* and 4*b*) are energized from sources 11*a* (or 11*b*) each coil 4*d* (or 4*c*) develops a magnetomotive force E_2 proportional to N_2 sufficient to saturate tube 1 in a given direction, whereas the coil associated with an inverted winding—i.e., respectively 4*a* or 4*b*—develops a magnetomotive force E_1 proportional to N_1, in the opposite direction. E_1 is greater than E_2 for approximately:

$$E_1=\frac{N_1}{N_2}E_2$$

A pulse of current applied at one of the assemblies of coils in series 4*a* and 4*d* for instance—if we imagine that tube 1 is separated into a left-hand part and a right-hand part on which opposite magnetomotive forces respectively act, said forces being generated by coils 4*a* and 4*d*—creates saturated magnetizations of opposite direction on the two parts of tube 1.

Thus polarities of the same sign stand at the ends of the said tube the two parts of which are crossed by appreciably equal inductions but in opposite directions: once the pulse has been suppressed, the remanent inductions are also in opposite directions and the total induction which travels through reeds 3*a* and 3*b* becomes very low. Consequently if ends 7*a* and 7*b* of said reeds were in contact, they would move apart and if they stood apart they would remain so.

When current pulses of the same direction, yielded by sources 11*a* and 11*b* are simultaneously applied to the two assemblies of coils in series 4*a*–4*d* and 4*c*–4*b*, there stand on the left-hand part and on the right-hand part of tube 1 equal magnetomotive forces proportional to (N_1-N_2) and of the same direction; they have a cumulative effect and it is as if a magnetomotive force E_3 proportional to $2\ (N_1-N_2)$ acting on the whole of tube 1 brought about magnetization saturation with poles of opposite signs appearing at its ends; once the pulse has been suppressed, the remanent induction flux travelling longitudinally, and in the same direction, through reeds 3*a*and 3*b*, causes the ends 7*a* and 7*b* which bear opposite sign magnetic charges to move together; the contact closes.

The relay device shown in FIG. 6 can be used to advantages in the matrices of cross-points in centralized control switching systems. In such systems, one of the pairs of coils in series 4*a*–4*d* for instance, is assembled in series with corresponding coils or the relay constituting one of the rows of the matrix; the other pair of coils in series 4*c*–4*b*, is assembled in series with the corresponding coils of the relays constituting one of the columns of the matrix.

In the embodiment examples described heretofore and, in particular in those illustrated by FIGS. 5 and 6, it was assumed that the devices could be imagined as being two magnetically independent parts. Now this is ideally true only, for in practice the induction lines which in the case of the opening of the contacts emerge in opposite directions from the ends of tube 1 (FIG. 5 or 6) are not channeled and are looped via illdefined paths; in some applications if required a magnetic shunt can be provided which is placed at the center of tube 1, on the outer side, and which reduces the effective air reluctance by shunting the various magnetic parts and, consequently reduces the residual induction which travels through reeds 3*a* and 3*b* (FIG. 5 and 6) thus promoting the opening of the contact.

This magnetic shunt can be advantageously implemented by modifying as shown in FIG. 7 the outside shape of remanent magnetic tube 1; this modification entails fitting a fairly thin disk 14 of suitable diameter in the middle of the tube. Disk 14 can possibly be equipped with notches to accommodate the wires of the windings.

Moreover, this magnetic shunt can be implemented without modifying the shape of the remanent magnetic tube 1, by slipping on the said tube around its middle, as shown in FIG. 8, a ring component 15 bearing a highly permeable disk in magnetic material 16.

In some applications of cross-point matrices, several contacts enclosed in a single protective tube are associated and used for a single cross-point.

FIG. 9 is a schematic diagram of a device according to the invention which, enclosed in a single cylindrical casing 1′ in remanent magnetic material groups two pairs of contact reeds respectively 3′*a*, 3′*b* and 3″*a*, 3″*b* in highly permeable elastic magnetic material which is also a good conductor of electricity.

Reeds 3′*a* and 3″*a* are sealed in insulating member 2*a*; reeds 3′*b* and 3″*b* are sealed in insulating member 2*b*. The ends outside the casing, 6′*a* and 6″*a*, of reeds 3′*a* and 3″*a* operate as terminals whereas their inner ends (i.e., inside the casing), 7′*a* and 7″*a* are coated with suitable precious metals; similarly, the ends outside the casing, 6′*b* and 6″*b*, of reeds 3′*b* and 3″*b* operate as terminals whereas the ends inside the casing, 7′*b* and 7″*b* are coated with suitable precious metals.

The section of the cylindrical casing 1′ can be circular, elliptical or any other shape according to the specific use to which it is to be put.

Said cylindrical casing can obviously be modified as in the layouts shown in FIGS. 2, 3, 4, 7 or 8.

Similarly, it is obvious that multiple sealed contacts like those shown in FIG. 9 can be energized using the same methods and the same associated energizing coils as the single sealed contacts used in the relay devices already described with reference to FIGS. 5 and 6.

Although the principles of the present invention have been described hereinabove with a reference to a particular example of embodiment, it will be clearly understood that the said description has been only made by way of example and does not limit the scope of the invention.

We claim:

1. A contact relay device encased in a protective tube comprising an impervious cylindrical case, a plurality of contact reeds, means sealing said contact reeds through opposite ends of the case to provide extensions outside the case and ends inside the case which operate as contacts, said reeds being elastic and magnetic, the inner ends of said reeds including coatings of suitable contact metal, at least one energizing coil for said reeds wound around said case, said case being formed by a tube made of remanent magnetic material, said tube being closed at its ends by insulating seals through which said reeds are extended, and said tube including in the vicinity of each of its ends an airgap formed by a constriction along a certain length of the inner diameter of said tube.

2. A device according to claim 1, in which the remanent magnetic material used for said tube is a ferromagnetic alloy.

3. A device according to claim 1, in which said insulating seals, through which said reeds are extended to close the ends of said tube, are formed by beads of insulating material such as glass, each one of said beads being accommodated at an end of said tube in a volume defined by the inner wall and the constriction in the inner diameter of said tube.

4. A device according to claim 1, in which said tube has, at each end, a notch on the outside, the notch at one end being diametrically opposite to the notch at the other end, said notches being used to accommodate small projections on corresponding insulating sealing parts.

5. A device according to claim 1, in which said tube is equipped in its middle with a magnetic shunt directed towards the outside and formed of a projection of said tube shaped like a flat ring.

6. A device according to claim 1, in which said tube has in its middle a magnetic shunt formed by a flat ring of highly permeable magnetic material, said ring being adapted to be slid along said tube.

* * * * *