

Campbell et al.

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- [56]
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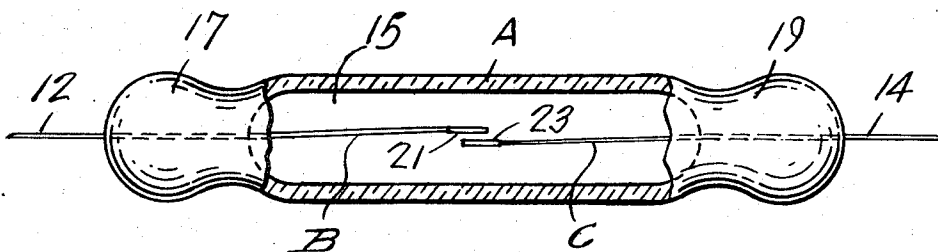
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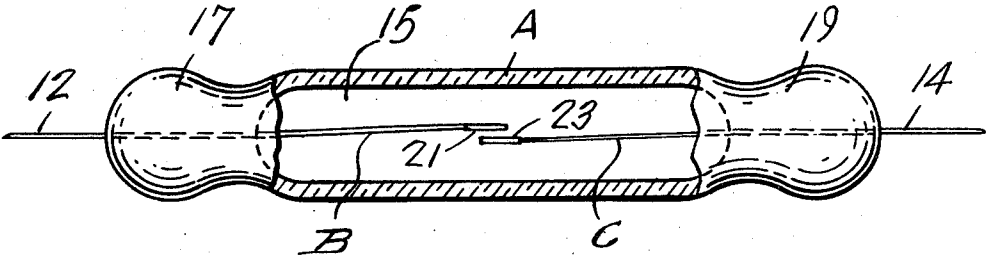
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[57] **ABSTRACT**

A reed for use in a reed-type switch comprising a body of magnetic material having a contacting surface essentially made up of a precious metal with some of the body material diffused therein, and an interface layer of an alloy of the precious metal and the body material between the body of magnetic material and the precious metal layer. The magnetic material is a glass-compatible nickel-iron alloy containing from about 0.125 to about 0.250 manganese by weight percent and having a resistivity not greater than about 225 ohms per circular mil foot.

6 Claims, 1 Drawing Figure





INVENTORS
David CAMPBELL
Reel Oscar CHAMBERLAND

Alan Searby
ATTORNEY

REED MATERIAL FOR SEALED CONTACT APPLICATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to switch devices and more particularly to reeds used in such devices.

2. Description of Prior Art

Canadian Pat. No. 790,708 Prival, July 23, 1968 (the disclosure of which is hereby incorporated by reference) discloses a typical reed-type switch having a reed of which the body is of magnetic material and which has a contacting surface of a precious metal and an interface layer of an alloy of the precious metal and magnetic material. The Prival patent and the article titled "Development of Reed Switches and Relays" by O. M. Hovgaard and E. O. Perreault, Bell System Technical Journal, Volume 34, Number 2, March 1955, pages 309 through 332, describe in detail the characteristics of the reed switch, its objectives, and some of its problems.

As discussed in the patent and in the article, reed switches have achieved wide acceptance in telephone, computing, and data transmission systems. However, the art is still striving to improve the properties of initial contact resistance and lifetime stability of the resistance. Many attempts have been made along these lines, for example, by trying various precious metals as contact materials and by varying the process of manufacture, but the success achieved has not been outstanding.

SUMMARY OF INVENTION

The applicants have now found that it is possible to decrease and improve the initial contact resistance, and at the same time to provide for increased stability throughout the life of the switch. This is accomplished, according to the invention, by using, as the body material of the reed, a glass-compatible substantially nickel-iron alloy containing an amount of manganese from about 0.1 to 0.3 (preferably from about 0.125 to about 0.25), and having a resistivity not greater than about 225 ohms per circular mil foot. Glass-compatible nickel-iron alloys preferred have a nickel content between about 51 and about 51.5 percent. Alloys having a resistivity not greater than about 225 ohms per circular mil foot presume toleration of small amounts of impurities, difficult to eliminate from any iron alloy. The required resistivity can be achieved by keeping these impurities within the following preferred bounds, a maximum of 0.015 carbon, a maximum of 0.1 cobalt plus silicon, a maximum of 0.005 chromium, and a maximum of 0.005 sulphur, not more than traces of say 0.005 percent titanium, phosphorus, aluminum, or copper.

None of these impurities are essential in the alloy, but their entire elimination or reduction below the levels stated is difficult and often impractical, since at the levels stated, they do not reduce the effectiveness of the contacts to a measurable degree.

BRIEF DESCRIPTION OF DRAWINGS

Having thus generally described the invention, it will be referred to in more detail by reference to the accompanying drawing, illustrating on an enlarged scale a reed-type switch embodying reeds according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring more particularly to the drawing, A represents a hermetically sealed cylindrical tube defining a chamber 15 containing a chemically inert gas under pressure greater than atmospheric. 12 and 14 are lead-in members which are sealed in bulbous end parts 17 and 19 of the tube A. The lead-in parts 12 and 14 preferably have a temperature coefficient of expansion equal to that of the glass. Reeds B and C have ends connected to the members 12 and 14 respectively and free ends which overlap and are slightly spaced apart. The reeds B and C and the members 12 and 14 may be made in one piece,

where the temperature coefficient of expansion of the reed material is equal to that of the glass.

The free ends of the reeds are coated to provide them with cooperating contact surfaces 21 and 23 respectively, as is well understood in the art. The reeds are made of magnetic material, according to the invention, as is described elsewhere and the contact surfaces are coated on them as also described.

In operation the switch remains in the open position as shown in the drawing, until an associated electromagnet is energized, thereby producing an electromagnetic field which draws the two reed contacts together causing the switch to close. It is a feature of the present invention that the initial contact resistance properties are improved and the stability of the resistance throughout the life of the switch is improved over existing switches of the same general type.

Alloys of the types specified can be made by powder metallurgy or by vacuum-melt techniques, as is well known by those in the alloy art. Previously, in procuring of glass-compatible nickel-iron alloys for reed use, no special attention had been given to the amount of manganese present, with the exception that manganese was required to the extent necessary to capture sulphur which is inherently present in nickel-iron ore, usually at least 0.3 percent and often considerably higher.

The alloy used for the body of the reed comes in the form of wire having a size within a range governed by the size of the reeds to be made. Typical wire sizes are 0.022 and 0.051 inch in diameter. In making the switch, the wire is coined on a dye as well known in the art to form the reed.

After coining, the contact area of the reed is plated to the desired thickness with the rare metal by an electro-plating process. The reed is then treated in a reducing atmosphere, for example, hydrogen, at a temperature of within the range from about 800° to about 950° C. for a time within the range from about 5 minutes to about 1 hour. The heat treating brings out the desired magnetic properties and the diffusion of the body metal into the surface to achieve the desired contact composition. The temperature and time of heat treatment should be long enough to ensure proper development of magnetic properties and adequate diffusion. Over heat treatment or under heat treatment will cause deterioration of the surface contact composition and/or magnetic properties.

The glass tube is filled with a slightly reducing atmosphere, for example, nitrogen, and a minimum of half a per cent of hydrogen by volume.

The following examples are further illustrative of the invention in its preferred aspects.

EXAMPLE I

The following is an example of making a typical reed, according to the invention.

A coinable wire, having a diameter of 0.022 inch was selected of an alloy containing, by weight, about 51.425 percent nickel, about 0.25 percent manganese, 0.0028 carbon, 0.005 chromium, below 0.005 of each of aluminum, chromium, cobalt, magnesium, silicon, titanium, and copper, and sulphur less than 0.001. The tensile strength of the wire was 84,600 psi, expansion 10.28 inch per degree centigrade from 25° to 450° C. The wire was fed to the coining press, to form a reed of the type shown in the drawings. The coined reeds were then deburred and polished. Then, the reeds were placed in the electro-plating apparatus and alternate layers of gold, silver, and gold applied to approximate thicknesses of 14, 12, and 14 microinches, respectively. The resulting reeds were then heat-treated in an atmosphere of dry hydrogen at a temperature of about 860° C. for a time of about 8 minutes and then cooled rapidly.

The manufactured reeds were then assembled in glass tubes in an automatic infra red assembly machine to form switch units as shown in the drawing.

EXAMPLE II

A manufacturing procedure was carried out substantially as described in Example I with the exception that the wire was made from an alloy containing about 0.125 by weight manganese.

We claim:

1. A reed for use in a reed-type switch, comprising, a body of magnetic material provided with a contacting surface essentially made up of a precious metal with some of the body material diffused therein, and an interface layer of an alloy of the precious metal and the body material between the body of magnetic material and the precious metal layer, the improvement in which the magnetic material is a glass-compatible nickel-iron alloy containing from about 0.125 to about 0.250 manganese by weight percent and having a resistivity not greater than about 225 ohms per circular mil foot.
2. A reed, as defined in claim 1, in which the magnetic material contains from about 51.0 to about 51.5 nickel, from about 0.1 to about 0.3 manganese, a maximum of 0.015 carbon, a maximum of 0.1 cobalt plus silicon, a maximum of 0.005 chromium, a maximum of 0.005 sulphur, not more than traces of other metals, and the remainder iron.
3. A reed, as defined in claim 1 in which the contacting surface has a thin external layer of an alloy of gold and silver and an appreciably thicker layer of an alloy of gold, silver and the magnetic material, and the interface layer is an appreciably thicker layer of an alloy of gold, silver and the magnetic material.

4. A reed switch comprising a hermetically sealed cylindrical tube having a chemically inert gas therein, a pair of reeds of magnetic material extending within said tube and each defining a contacting surface disposed in overlapping relationship to one another in said tube, each said reed having a portion extending through and sealed in a respective end of said tube, said portion having a temperature coefficient of expansion equal to that of glass and providing connection to said reeds outside said tube, said contacting surface being essentially made up of a precious metal with some of the body material diffused therein, and an interface layer of an alloy of the precious metal and the body material between the body of magnetic material and the precious metal layer, said magnetic material being a glass-compatible nickel-iron alloy containing from about 0.125 to about 0.0250 manganese by weight percent and having a resistivity not greater than about 225 ohms per circular mil foot.

5. A reed switch as defined in claim 4 in which the magnetic material contains from about 51.0 to about 51.5 nickel, from about 0.1 to about 0.3 manganese, a maximum of 0.015 carbon, a maximum of 0.1 cobalt plus silicon, a maximum of 0.005 chromium, a maximum of 0.005 sulphur, not more than traces of other metals, and the remainder iron.

6. A reed switch as defined in claim 4 in which the contacting surface has a thin external layer of an alloy of gold and silver and an appreciably thicker layer of an alloy of gold, silver and the magnetic material, and the interface layer is an appreciably thicker layer of an alloy of gold, silver, and the magnetic material.

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