

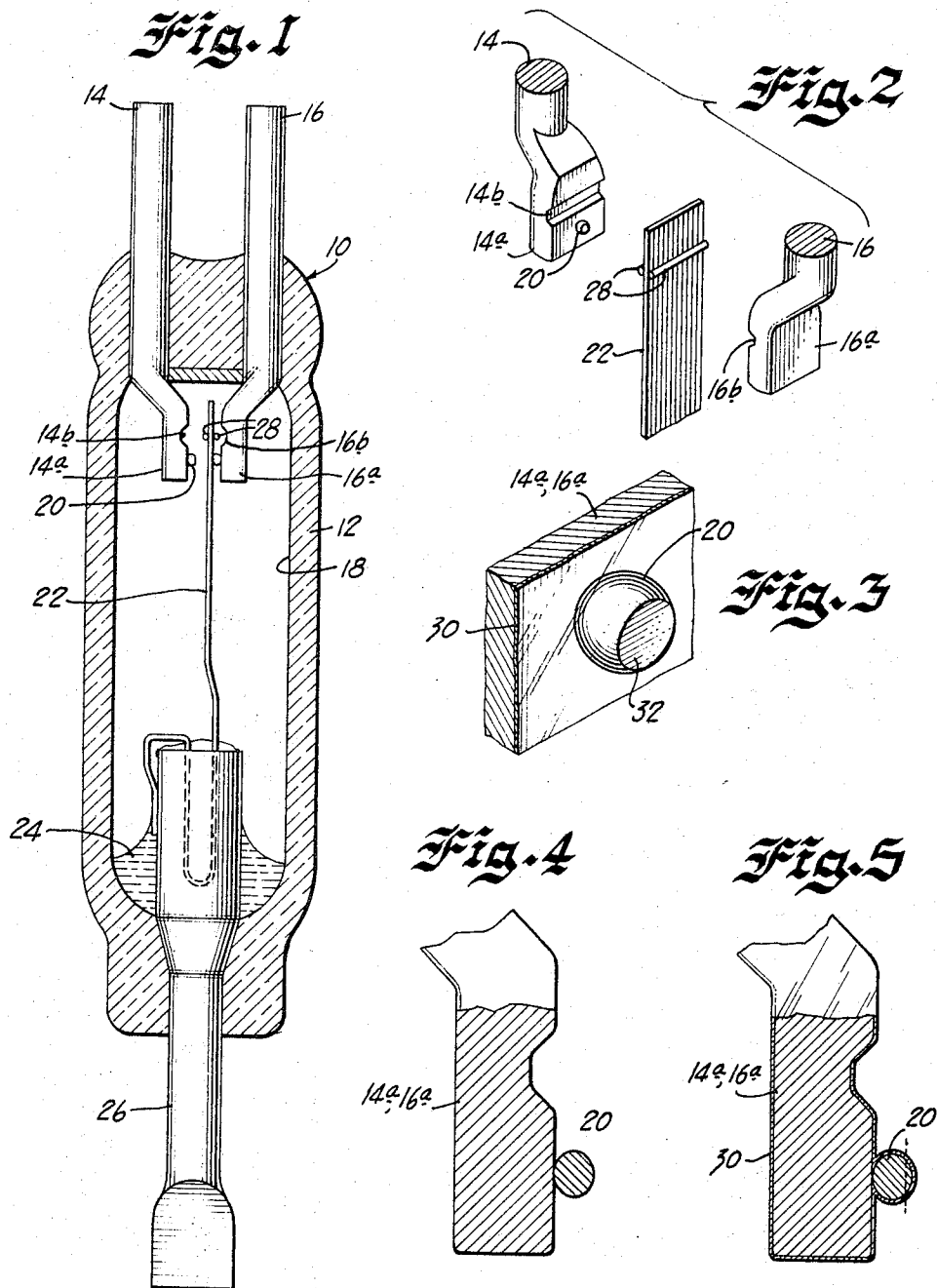
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SPHERICAL CONTACT STRUCTURE FOR SEALED MERCURY SWITCHES

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SPHERICAL CONTACT STRUCTURE FOR SEALED MERCURY SWITCHES

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This invention relates to sealed mercury switches and, more particularly, to an improved contact structure for a sealed mercury switch and a method of manufacturing this contact structure.

United States Patent No. 2,868,926 discloses a sealed magnetic switch having a pair of pole pieces on which generally spherical contact members are mounted. A generally uniplanar magnetic armature having its opposite surfaces wetted by mercury is positioned within the sealed housing of the switch with an end portion disposed between contact members to be alternately movable into engagement therewith in response to applied magnetic fields. Although the pole pieces are treated so that they are not wettable with mercury, the spherical contact elements are formed of a material that is wettable by mercury so that mercury tends to form a body of generally spherical shape on the contact. As the armature is alternately moved into and out of engagement with the opposed contact members, a filament of mercury is drawn from the previously engaged contact to maintain circuit continuity for a period of around .25 millisecond after the armature engages the opposite contact member. Thus, the mercury switch shown in this patent provides a bridging action when the armature transfers from a position engaging one of the contact members to a position engaging the other contact member.

In many applications, this bridging action by which the armature and both of the pole pieces are electrically connected during the switch transfer interval cannot be tolerated. The construction shown in United States Patent No. 3,054,873 was evolved to provide a switch capable of providing a non-bridging action. In the construction shown in this patent, the spherical contact members are replaced by elongated bar contacts which are stamped or depressed in four spaced positions along the length of the contact bar to provide four recessed areas defining three upstanding lands or islands. The pole pieces with the bar contact members attached thereto are treated to render all of the outer surfaces non-wettable to mercury, and the outer surfaces of the lands are then polished or ground to remove the surface treatment so that these three areas are wettable with mercury supplied from the mercury coated armature. These three lands do not retain sufficient mercury to provide the bridging action.

However, it has been determined that during the stamping operation in which the contact bar is formed, the lands do not have uniplanar upper surfaces and do not provide the rectangular configuration desired. It appears that when the contacts are stamped from production tools, the three contact areas are generally oval and somewhat rounded, and the two end areas of the bars tend to be displaced downwardly so that all of the contact surfaces do not fall within a single plane. This means that it is difficult, if not impossible, to provide precisely the same exposed area wettable with mercury in successive switches produced from the same set of tools.

The total mercury wetted area on the contacts in non-bridging switches is a primary factor in determining the amount of current that can be safely switched by the device, and the rounded and somewhat oval configuration of the projecting islands or lands on the bar contacts tends to reduce the area below that desired. It has been observed that currents in excess of two amperes can

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cause complete liberation or vaporization of the mercury from the wetted surfaces during the transfer action of the armature. This complete liberation of the mercury wetting agent causes catastrophic failure of the switch by causing the armature to become welded to the contacts. This two ampere limitation on the current that can be switched by this non-bridging switch constitutes a severe limitation on its use in many applications in which the characteristics of the switch would be quite desirable. As an example, the contemporaneously filed application of Arthur J. Koda et al., Ser. No. 381,478, discloses an automobile distributor and ignition system in which it is necessary for the non-bridging mercury switch to be capable of reliably switching current in excess of four amperes over an operating life measured in terms of billions of operations.

Accordingly, one object of the present invention is to provide a new and improved sealed mercury switch.

Another object is to provide a new and improved method of manufacturing mercury switches and, more particularly, improved contact structures for non-bridging mercury switches capable of switching increased currents.

A further object is to provide a sealed mercury switch including a new and improved contact structure comprising a spherical contact member secured to a pole piece in which all of the surfaces except a generally uniplanar circular surface on one side of the sphere are treated to prevent wetting by mercury.

Another object is to provide a new and improved method of making contact structures for sealed mercury switches in which a spherical contact member is secured to a pole piece, the pole piece and contact member are treated to render them substantially non-wettable by mercury, and in which a circular surface is polished or ground on a surface of the contact member spaced from the pole piece to provide a mercury wettable surface of controlled area.

In accordance with these and many other objects, an embodiment of the present invention comprises a sealed mercury switch having an elongated glass housing in one end of which a pair of magnetic pole pieces are sealed in spaced apart and generally parallel relation. A magnetic armature carried on the other end of the housing is provided with an outer surface coated with mercury. A free end portion of the armature is disposed between the pole pieces and is alternately moved into engagement with two generally spherical contact members carried on the pole pieces by applied magnetic fields. The contact structure provided by the pole pieces and the spherical contact members is such that all of the surfaces adjacent the armature are treated to render them non-wettable with mercury, except for a generally circular area on these spherical contacts disposed adjacent the armature.

This improved contact structure is formed by securing the spherical contact element to the adjacent surface of a pole piece and then plating the joined contact member and pole piece with chromium which is subsequently sintered to render the outer surfaces of the contact member and the pole piece substantially incapable of being wetted by mercury. The surface of the spherical contact member to be disposed adjacent the armature is then polished or ground to remove the sintered chromium layer and to expose a generally circular area of contact material wettable with mercury. The exposed area of the contact member can be precisely controlled to insure the retention of sufficient mercury to prevent its complete liberation when switching substantially larger currents than can be switched by existing or prior non-bridging switches, while retaining the non-bridging characteristics of the switch. In fact, sealed mercury switches constructed in accordance with the present invention can reliably switch currents in excess of four amperes as contrasted

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with prior switches which are incapable of consistently switching currents in excess of two amperes over a reasonable period of time.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a sectional view of a mercury switch embodying the present invention;

FIG. 2 is an exploded perspective view of a contact structure embodying the present invention;

FIG. 3 is an enlarged sectional view of the contact member;

FIG. 4 is a fragmentary sectional view illustrating the contact structure at one point in its manufacture; and

FIG. 5 is a fragmentary sectional view of the improved contact structure at a subsequent point in its manufacture.

Referring now more specifically to FIG. 1 of the drawings, therein is illustrated a sealed magnetic switch which is indicated generally as 10 and which embodies the present invention. The sealed switch 10 includes an improved elongated cylindrical housing 12 formed of glass or other insulating material in the upper end of which a pair of similar magnetic terminals or pole pieces 14 and 16 are disposed. The inner ends or portions 14a and 16a of the pole pieces 14 and 16 are sealed within a cavity 18 defined by the housing 12 in positions generally parallel to and spaced from each other. Each of the offset portions 14a and 16a carries a generally spherical contact member 20 that is alternately engaged by an interposed and generally uniplanar end of a flexible magnetic armature 22, the lower end of which is supported in a pool of mercury 24 by a header or magnetic terminal construction 26 sealed in the opposite end of the dielectric housing 12.

The sealed mercury switch 10, which can also be rendered single-side-stable by mechanical or magnetic biasing means or rendered bistable by magnetic biasing means, is operated by the application of magnetic fields so that the armature 22 moves into alternate engagement with the contact members 20 on the pole pieces 14 and 16. The switch 10 is capable of interrupting current in excess of four amperes over an operating life measured in terms of billions of operations and provides the desired non-bridging action. In other words, the armature 22 when separating from a position engaging one of the contact members 20 does not remain electrically connected to this separated contact by a filament of mercury for a period of time long enough for this armature to engage the other one of the contacts 20. Interference with this type of contact action resulting from mercury displaced by movement of the armature 22 is prevented by a pair of troughs 14b and 16b formed in the offset ends 14a and 16a of the pole pieces cooperating with a pair of transversely extending bars 28 carried on the armature 22 in a position generally aligned with the troughs 14b and 16b and disposed above the points of contact between the armature 22 and the contact members 20.

The construction of the switch 10, with the exception of the improved contact structures including the pole pieces 14 and 16 and the contact members 20 and the method of manufacture thereof, is substantially identical to that shown and described in detail in United States Patent No. 3,054,873, and this sealed switch is manufactured in substantially the same manner except for the construction of the contact structure and the method of manufacture thereof. These changes in the contact structure and its method of formation are responsible for the more than twofold increase in the load current switching ability of the switch 10, as contrasted with prior non-bridging switches.

In manufacturing the contact structure for the sealed switch 10, a ball or sphere, composed, for example, of 85% platinum and 15% nickel, is welded to the ends 14a, 16a (FIG. 4) of the magnetic terminals or pole pieces

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14, 16. Incident to this welding operation, the ball or contact 20, in one embodiment of the construction, is slightly flattened to provide a height of .0075 inch. The assembled pole pieces 14, 16 and the contact members 20 are then plated with a material that is not wetted with mercury, such as chromium, to provide a layer 30 (FIG. 5) completely covering the surfaces of the pole piece portions 14a, 16a and the contacts 20 that are exposed to mercury from the armature 22. The layer 30 of material, such as chromium, which is preferably applied by a plating operation can be sintered following the plating operation.

In this condition, the contact structure can not be wetted by mercury and is incapable of providing the desired mercury wetting contact action. The contact structures are then placed in a fixture or jig in which the generally spherical though somewhat flattened outer surface of the contact member 20 is polished or ground to provide a generally uniplanar and circular contact surface 32 illustrated in FIG. 3 of the drawings. The degree of grinding or polishing is illustrated by the dashed line in FIG. 5. During this operation, the sintered layer of chromium 30 is removed to expose the nickel-platinum material forming the contact member 20 which can be wetted with mercury. In switches 10 constructed in accordance with the present invention, the height of the contact 20 above the adjacent surface of the pole piece portions 14a, 16a, is around .0065 inch and provides a generally circular wetted surface 32 having a diameter on the order of .010-.012 inch.

By the use of gauge blocks and because of the spherical geometry of the contact member 20, it is possible to precisely control the area of the exposed surface 32 that is wetted by mercury so as to be able to provide the quantity of mercury necessary for switching relatively large currents while retaining the non-bridging action desired in the switch 10. Because all of the remaining surfaces of the contact member 20 and the adjacent surfaces of the pole piece portions 14a and 16a are covered with the layer 30 of material that cannot be wetted by mercury, there is no possibility for fillets or globules of mercury to be formed adjacent the contact member 20 which would interfere with the desired non-bridging action. Thus, the unit 10 can switch currents twice as large as prior switches.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. A sealed non-bridging switch comprising a housing, a pair of magnetic pole pieces sealed in one end of the housing, an armature disposed in the housing and having a generally uniplanar end portion coated with mercury on both sides and disposed between the pole pieces, a generally spherical contact member secured to each of the pole pieces in a position adjacent the end portion of the armature, the two contact members being disposed generally opposite each other, a generally flat surface formed on each of the spherical contact members adjacent the armature end portion, each of said flat surfaces being wettable with mercury and carrying a layer of mercury, and a layer of material that is not wettable with mercury covering the adjacent surfaces of the pole pieces and all of the exposed surfaces of the contact members except the flat surfaces so that the mercury on the flat surfaces and the end portion provide mercury wetted contacting means, the layers of material and the spherical contact members preventing the accumulation of sufficient mercury to permit the bridging of the two contact members when the armature is transferred between the contact members.

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2. A sealed non-bridging switch comprising a housing, a pair of contact supports spaced from each other and sealed in one end of the housing, a magnetic armature disposed in the housing and having a generally uniplanar end portion coated with mercury on both sides and disposed between the contact supports, a generally spherical contact secured to each of the contact supports in a position adjacent the end portion of the armature, the two contacts being disposed generally opposite each other, and a generally flat and circular surface formed on each of the spherical contacts adjacent and facing the armature end portion, each of said flat surfaces being wettable with mercury and carrying a layer of mercury, the adjacent surfaces of the contact supports and all of the exposed surfaces of the contacts except the flat surfaces comprising

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a material incapable of being wetted with mercury to prevent the retention of mercury that would bridge the contacts when the armature transfers between the contacts.

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