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W. P. MASON ETAL

3,146,328

NON-STICKING ELECTRICAL CONTACTS

Filed Nov. 7, 1961

2 Sheets-Sheet 1

FIG. 1

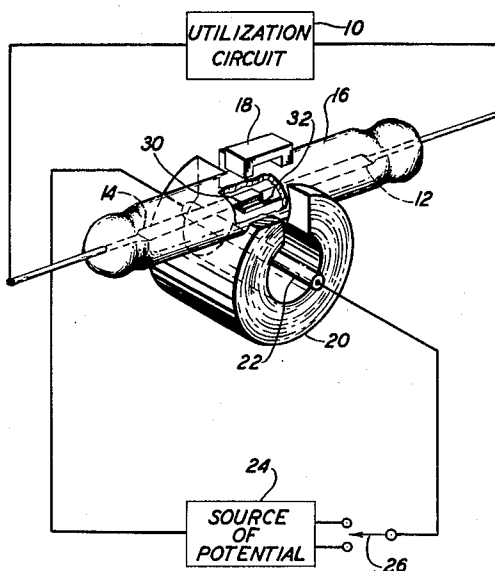
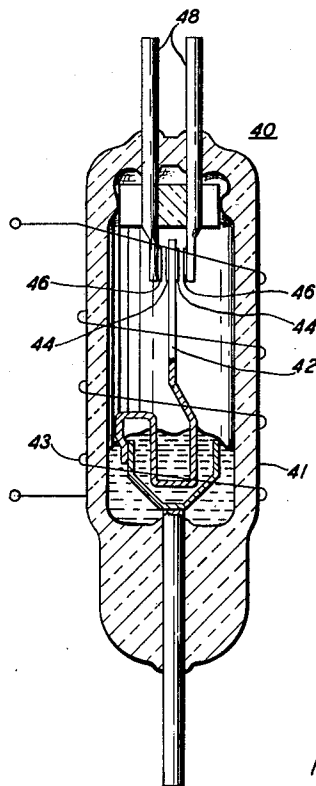


FIG. 2



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FIG. 3
PRIOR ART

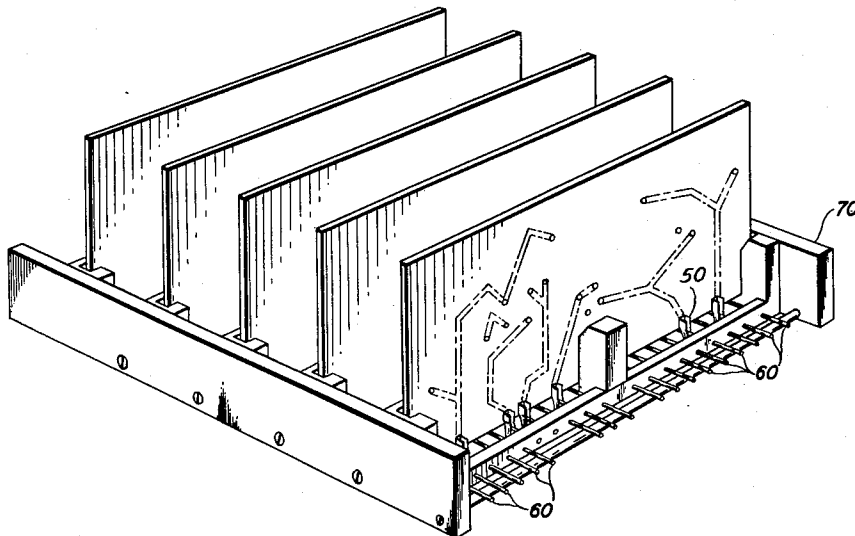


FIG. 4
PRIOR ART

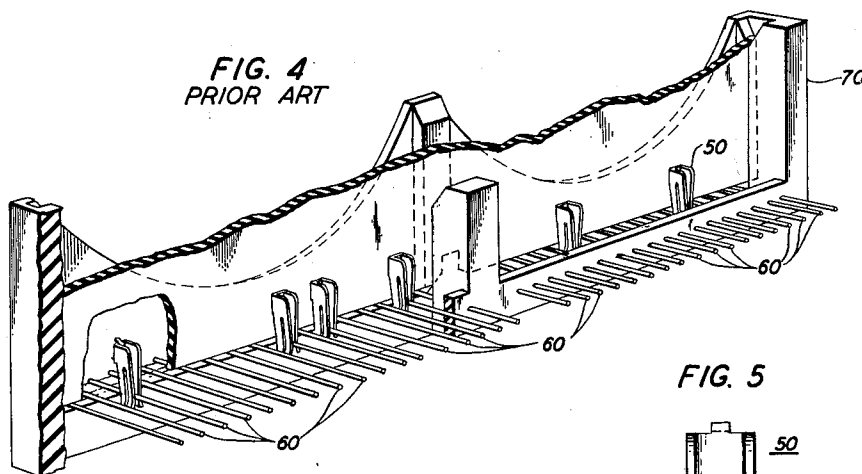
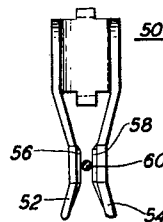


FIG. 5



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NON-STICKING ELECTRICAL CONTACTS

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1 Claim. (Cl. 200-166)

This invention relates to electrical contacts and more particularly to electrical contacts which will not tend to adhere or stick to each other.

Difficulties resulting from the adhesion or sticking of electrical contacts employed in making and breaking electrical circuit connections are frequently encountered with many prior art devices. These difficulties include not only the electrical malfunctioning of the connecting mechanisms but also the rapid mechanical deterioration of the contacting surfaces by abrasion, pitting and the like. In many instances adhesion between the contacting surfaces has resulted in the virtual welding together of appreciable portions of the two contacting surfaces. Subsequent separation of the members then frequently results in tearing pieces out of one or both surfaces.

In accordance with the present invention, such difficulties are substantially reduced by employing specific conductive materials for one or both of the contacting surfaces which have been found to have relatively very low coefficients of adhesion.

Accordingly, the present invention proposes the use of a metal selected from the group consisting of cadmium, cobalt, beryllium, titanium and zirconium. Metals of this group have low coefficients of adhesion and generally acceptable electrical characteristics. Preferably, for contact pairs one contacting surface is one of the above group of metals and the other is of a "noble" metal. Metals of the group consisting of gold, silver, ruthenium, rhodium, palladium, osmium, iridium and platinum are designated as "noble" metals by those skilled in the art. A number of these, particularly gold, silver, palladium and platinum, have been extensively used as electrical contacts since they have low electrical resistance and tend to be self-cleaning. In general, where a pair of contacts is to comprise one metal of the first group above-mentioned and one of the group designated "noble," they are preferably selected to be of approximately comparable hardness. For example, for a pair employing one contact of cobalt the noble metal contact can preferably be rhodium. This specific combination has been found to be very satisfactory, giving negligible sticking difficulty and low electrical resistance. As is well known in the art, "noble" metal contacts are in practice frequently alloys having appreciable percentages (for example, ten to fifteen percent) of base metals to increase their wear-resisting properties or otherwise improve their characteristics. For the purposes of the present invention, the noble metals specified may be of pure metal or of the conventional alloy forms normally employed for electrical contacts.

For switches employing mercury-wetted contacts, the present invention particularly recommends the further metal rhodium, since it does not form an amalgam with mercury. The sticking of mercury-wetted contacts has in many instances been found to have resulted from the formation of amalgams on the contacts. A second combination which has been found to have low electrical resistance and to be substantially free from sticking in devices employing mercury-wetted contacts is the pair comprising one contact of the noble metal ruthenium and the other contact of a platinum nickel alloy. The addition of a minor percentage (such as ten or twelve

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percent) of nickel in an alloy with platinum increases the facility with which it can be wetted with liquid mercury.

In general, cadmium, cobalt and rhenium are readily plated on the majority of other metals. Beryllium, titanium and zirconium must ordinarily be welded on other metals. Substantially all of the noble metals are readily plated on most other metals.

In the accompanying drawings, several differing types of electrical switching arrangements are illustrated and exemplify the application of the invention to such arrangements.

In FIG. 1, one form of a "dry reed" type of switching mechanism is shown;

In FIG. 2, one form of a switching mechanism employing mercury-wetted contacts is shown;

In FIG. 3, one form of a printed circuit assemblage is shown; and

In FIGS. 4 and 5 details of the assemblage of FIG. 3 of particular interest in connection with the application of the principles of the present invention are shown.

In more detail, in FIG. 1 a switching mechanism of a general type disclosed and claimed in applicant W. P. Mason's copending application Serial No. 847,235 filed October 19, 1959, which matured as Patent No. 3,008,020, granted November 7, 1961 is shown to an enlarged scale. Insofar as it is pertinent, this copending application is incorporated by reference as an integral portion of the disclosure of the present application.

As described in the aforementioned copending sole application, the arrangement of FIG. 1 includes a reed-type, magnetically-operable, switching mechanism comprising a sealed glass envelope 16, five-eighths of an inch long and one-eighth of an inch in diameter, into which are sealed reeds 12 and 14 supported by being embedded in the right and left end seals, respectively, of envelope 16, as shown, so that their free ends are held in close proximity though not in physical contact.

Reeds 12 and 14 are of magnetic material so that when subjected to a suitably directed magnetic field they will be drawn together to make physical and electrical contact and thus close a circuit which includes utilization circuit 10, as shown. Reeds 12 and 14 are sufficiently resilient that they will return to their original positions when the magnetic field, including the remanent magnetic field, is appropriately reduced, as above described, thus opening the circuit including utilization circuit 10.

The toroidal C-shaped yoke 20, with its gap uppermost, is recessed transversely with respect to the gap at the top so that the cylindrical tube 16 can be assembled in the transverse recess with the free ends of reeds 12, 14 in the gap of yoke 20 as shown. Yoke 20 is of a bistable magnetic material such as a ferrite in which remanent polarization is readily established by passing a very short pulse of direct current through conductor 22, which conductor passes through the central opening in yoke 20. The polarity of the polarization will of course be reversed if the direction of the pulse in conductor 22 is reversed. The material of yoke 20 is chosen so that a suitable degree of remanent polarization to hold the reeds 12 and 14 in contact will be established by an extremely short pulse of the appropriate polarity. The contacts may, accordingly, be operated by a pulse having a duration of one microsecond or less.

A source of potential 24 controlled through single pole, double throw switch 26 can furnish momentary direct-current pulses of either polarity and of appropriate magnitude to conductor 22.

As shown in FIG. 1, a portion of the glass tube 16 and a portion of the yoke 20 are broken away to expose the adjacent ends of reeds 12 and 14 so that the character of the structure can be more readily perceived. It is to

be understood however that in use a complete yoke and complete tube are employed.

A small permanent magnet 18 is employed immediately above the gap in yoke 20, as shown, and is polarized in such a direction that it tends to aid a direct-current pulse of appropriate polarity in establishing sufficient remanent polarization of yoke 20 as required to hold reeds 12 and 14 in contact, that is, in the closed position. The strength of magnet 18 is however insufficient to establish an operated or closed condition of the switch unless aided by the pulse. A similar direct-current pulse, but of opposite polarity, will sufficiently reduce the remanent polarization of yoke 20 so that the resilience of reeds 12, 14 will cause them to separate.

In accordance with the present invention the surfaces at the free ends of reeds 12 and 14 which establish electrical contact are covered, for example, the upper one with a contacting surface 30 of a metal selected from the group consisting of cadmium, cobalt, beryllium, titanium and zirconium and the lower with a contacting surface 32 of a noble metal from the group consisting of gold, silver, ruthenium, rhodium, palladium, osmium, iridium and platinum.

Since metals of the first group have very low coefficients of adhesion and metals of the second group have excellent conductive and self-cleaning properties, switches employing the above prescribed contact pairs will not weld together, stick nor tend to prematurely wear, pit, or otherwise deteriorate. Alternatively, both end surfaces of reeds 12 and 14 can be covered by a metal of the first group where minimum contact resistance and self-cleaning properties are not of primary importance.

In FIG. 2 an improved switching mechanism of a type which employs mercury-wetted contacts is shown to an enlarged scale. With the exception of the right and left pairs of contacts 44 and 46, assembly 40 of FIG. 2 can be precisely as described in Patent 2,868,926 granted January 13, 1959, to C. E. Pollard, assignor to applicants' assignee. The description of Patent 2,868,926 pertinent to assembly 40 is hereby incorporated by reference and made an integral portion of the present application.

As described in the Pollard patent, a glass envelope 41 encloses the switching mechanism and serves to support, by an arrangement described in detail in the patent, the armature 42, intermediate the fixed conductive members 48 in the respective positions shown so that direct-current energy applied to winding 43 will deflect armature 42 to the right for one polarity or to the left for the opposite polarity, respectively, thus closing the right or left pairs of contacts 44, 46, respectively. As described in the Pollard patent, sufficient mercury is drawn upwardly along armature 42 by capillary action so that both contacts 44 are maintained with a complete covering of liquid mercury, that is, they are mercury-wetted. Contacts 46 become mercury-wetted by contact with their respective associated contacts 44 in normal operation of the switch.

In accordance with the teachings of the present invention, for each pair of contacts 44, 46 one of the contacts should be of a metal selected from the group consisting of rhenium, cadmium, cobalt, beryllium, titanium and zirconium and the other should be of a noble metal as defined hereinabove. Of the first-mentioned group of metals, rhenium is preferable where, as in the present instance, mercury-wetted contacts are employed, since, as mentioned above, rhenium does not form an amalgam with mercury and has a low coefficient of adhesion. Alternatively, both contacts may be of a metal selected from the first-mentioned group and again the metal rhenium is preferable for the reason stated above. A further very

satisfactory, non-sticking, low electrical resistance contact combination when mercury-wetted contacts are used has been found, as mentioned above, to comprise one contact of ruthenium paired with a contact of a platinum nickel alloy.

In FIG. 3, an over-all assembly of the type disclosed and claimed in United States Patent 2,832,013 granted April 22, 1958, to L. Pedersen and A. J. Wier, assignors to applicants' assignee, is shown. This is designated in the joint patent as a "printed wire circuit card interconnection apparatus." The designation is obviously succinctly descriptive of the assembly. A detailed description is, of course, given in the patent.

In FIG. 4 a partial cross-sectional showing of the connections of a representative card of the assembly of FIG. 3 to the wires of the frame is shown to a somewhat larger scale. In FIG. 5 the details of an individual connecting clip are shown to a still larger scale.

Except for the provision of special contacting surfaces 56 and 58 for the connecting clip prongs 52 and 54, respectively, as shown in FIG. 5 of the present application, which will be described in more detail hereinafter, the apparatus may be precisely as described in the above-mentioned joint patent. FIGS. 3, 4 and 5 of the drawings of the present application are, with the above noted exception, substantially identical with FIGS. 1, 3 and 4, respectively, of the joint patent. The disclosure of the joint patent pertinent to the present application is accordingly incorporated by reference and made an integral part of the disclosure of the present application.

In FIG. 5, the connecting clip 50 may be precisely identical with that shown in FIG. 4 of the above-mentioned joint patent to Pedersen and Wier except that the bifurcated contacting fingers 52 and 54 of the clip 50 are equipped on their inner surfaces with metal layers 56 and 58, as shown, which serve to make mechanical and electrical contact with an associated predetermined interconnecting wire 60 of the rack assembly 70 of FIG. 3 for the purposes set forth in detail in the above-mentioned joint patent.

In accordance with the present invention, metal layers 56 and 58 are of a metal selected from the group which consists of cadmium, cobalt, beryllium, titanium and zirconium. Wire 60 may be coated with a metal from this group or alternatively and preferably, it may be coated with a noble metal selected from the group consisting of gold, silver, ruthenium, rhodium, palladium, osmium, iridium and platinum. Numerous other forms of assemblies employing "plug-in" apparatus units are well known in the art and can obviously employ the teachings of the present invention to advantage.

Numerous and varied other switching arrangements will readily occur to those skilled in the art fully within the spirit and scope of the present invention. No attempt to cover all such arrangements has been made, the above disclosed arrangements being fairly illustrative but obviously not restrictive with respect to the application of the principles of the invention.

What is claimed is:

Switching means in which an electrical circuit is opened and closed by separating and bringing together, respectively, two metallic members, one of said members being of cobalt and the other of rhodium.

References Cited in the file of this patent

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