

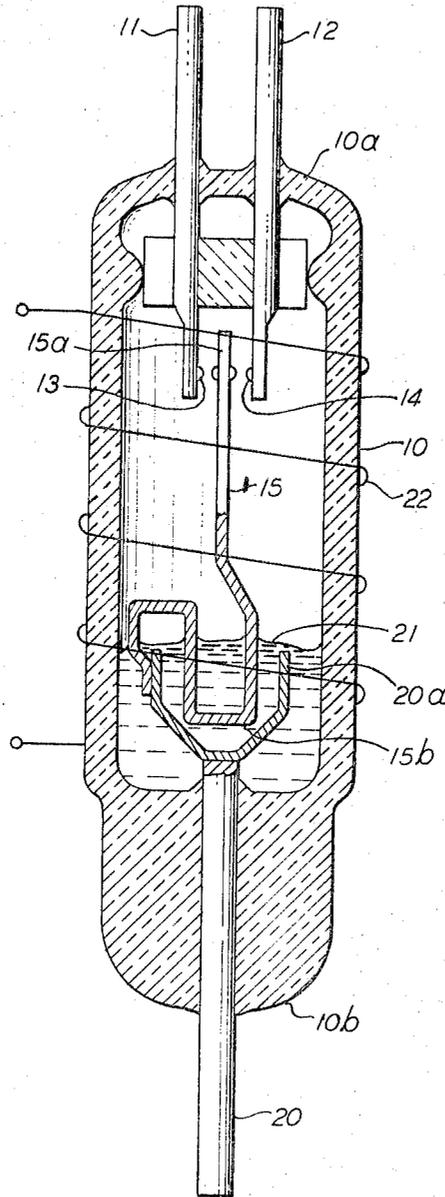
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M. BARLOW ETAL

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MERCURY CONTACT SWITCH HAVING AN ALLOY CONTACT

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INVENTORS **M. BARLOW**  
**P. J. PLANTING**  
BY *[Signature]*  
ATTORNEY

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**MERCURY CONTACT SWITCH HAVING  
AN ALLOY CONTACT**

Malcolm Barlow, Mountain View, and Peter J. Planting,  
Sunnyvale, Calif., assignors to Bell Telephone Labora-  
tories, Incorporated, Murray Hill, and Berkeley Heights,  
N.J., a corporation of New York

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**ABSTRACT OF THE DISCLOSURE**

A mercury switch is disclosed in which the contact sur-  
faces contain copper, platinum and nickel in various por-  
tions.

This invention relates to electric switches and particu-  
larly to those in which mercury is used on the contacting  
surfaces to improve switching performance.

It is broadly an object of this invention to improve the  
construction and operation of switches in which the con-  
tacts are wetted.

Switches of the kind under consideration are generally  
referred to as mercury switches. They take several forms  
and the ones disclosed in Patent 2,609,464, issued to  
J. T. L. Brown et al. and Patent 2,868,926, issued to C. E.  
Pollard, Jr., are typical.

Heretofore, the interacting contact surfaces in mer-  
cury switches have generally been made of a precious  
metal. For example, contacts surfaced with pure platinum  
have been widely used. Similarly, contacts surfaced with  
an alloy of platinum and nickel are also commonplace.

Contacts surfaced with either platinum alone or with  
an alloy of platinum and nickel, however, tend to stick  
within a short time after switching action begins. Specifi-  
cally, it has been found that when mercury and platinum  
meet in the switch, an amalgam forms at the interface.  
The amalgam disrupts the smoothness of the contact sur-  
faces, and the resulting roughness causes mechanical in-  
terlocking or sticking. Thus, amalgamation, the mecha-  
nism by which the desired wetting of the contact surfaces  
is produced, works too well and thereby creates other  
problems.

The addition of nickel to the platinum tends to inhibit  
amalgamation. However, if enough nickel is added to  
completely inhibit amalgamation, the contacts become so  
magnetic that switch operation is adversely affected. Con-  
sequently, while less severe where the contact surface is  
made of a platinum-nickel alloy, sticking nevertheless  
continues to be troublesome.

According to this invention, copper is added to the  
material used on the contact surfaces in order to inhibit  
sticking. For example, it has been found that when copper  
is added to platinum, the resulting alloy readily wets but  
amalgamates only slightly. Similarly, it has been found  
that by mixing copper with a platinum-nickel alloy, the  
new alloy readily wets but does not readily amalgamate.  
Furthermore, in the platinum-nickel-copper alloy, more  
nickel can be used than before without significantly affect-  
ing the magnetic characteristics of the contacts. Finally,  
it has been discovered that copper can be mixed with  
nickel alone to form a copper-nickel alloy which, when  
used as a contact surface, readily wets but neither amal-  
gamates significantly nor exhibits adverse magnetic char-  
acteristics.

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When taken with the drawing, the following detailed  
description will help one to a better understanding of this  
invention. The drawing shows a partial section view of an  
electromagnetically responsive switch made in accordance  
with this invention.

The illustrated switch comprises an envelope or housing  
10 which may be made of glass and which has two ends  
10a and 10b. Two spaced pole-piece terminals 11 and 12  
are sealed in the end 10a. Both terminals are made from  
a magnetic material such as 52 alloy. 52 alloy is a compo-  
sition consisting essentially of 52 percent nickel and 48  
percent iron. Further, the facing inner ends of each ter-  
minal 11 and 12 are provided with a contact 13 and 14,  
respectively. The composition of the contacts 13 and 14  
is described below in detail.

A metal tube 20 is sealed in the end 10b so as to extend  
into the housing 10. One part of the tube 20 is located  
within the envelope and has a flared or cup-like portion  
20a for holding an electrically conducting contact wet-  
ting liquid; viz, mercury 21. As illustrated, the mercury  
21 may be present in a quantity sufficient to fill part of  
the housing 10 and cover the cup-like portion 20a. Fur-  
thermore, the mercury 21 can be initially pure or it can  
contain additives such as copper or the like.

A reed or swinger 15 is secured to the cup 20a. It is  
made of a magnetic material such as 78.5 Permalloy. 78.5  
Permalloy is a composition consisting essentially of  
21.2 percent iron, 78.5 percent nickel and .3 percent man-  
ganese. One end of the swinger 15 terminates in a con-  
tacting portion 15a and the other end terminates in a  
looped portion 15b. The central portion of the swinger  
15 is adapted to transport the mercury 21 readily between  
the portions 15a and 15b. The looped portion 15b con-  
tacts the mercury 21 in the cup 20a and the contacting  
portions 15a is wetted by the mercury 21 transported by  
the central portion of the swinger 15. Finally, the contact  
portion 15a is disposed between the terminals 11 and 12  
in a position to readily engage the contacts 13 and 14.

An energizing coil 22, shown schematically in the draw-  
ing, surrounds the housing 10.

The theory of operation of mercury contact switches is  
well known to those skilled in the art and, accordingly,  
it is not discussed. For further information regarding the  
particular type of switch chosen to illustrate this inven-  
tion, reference is made to the previously noted Patents  
2,609,464 and 2,868,926. Generally, however, the swinger  
15 reciprocates between the contacts 13 and 14 in response  
to energization of the coil 22. Switching occurs when  
the swinger 15 engages one of the contacts through the  
mercury 21.

The contact 13, the contact 14, and, if desired, the por-  
tion of the swinger 15 which engages the contacts 13 and  
14, are preformed of an alloy before assembly in the  
switch. Specifically, they are preformed from an alloy  
which is substantially non-magnetic; which will not amal-  
gamate in bulk with the wetting agent (viz, the mercury  
21) and only slightly, if at all, on the surface; and which  
will form an advancing contact angle with the wetting  
agent of 20 degrees or less. For the purposes of this de-  
scription, an advancing contact angle is defined as the  
angle lying between a surface being wetted and a plane  
lying tangent to the leading edge of the medium which is  
wetting the surface.

In the particular embodiment described herein, the  
mercury 21 contains a small amount of copper, and the  
contacts 13 and 14 are preformed from an alloy consist-

ing of copper and platinum. More specifically, the alloy in the described embodiment consists of platinum and copper mixed in the atomic proportions PtCu<sub>3</sub>.

Switches having preformed contacts made of PtCu<sub>3</sub> have been tested for sticking and the results demonstrate that the problem of sticking has been drastically reduced. For example, four sample lots, each containing 10 relays equipped with contacts surfaced with PtCu<sub>3</sub>, were subjected to heating tests. The purpose of these heating tests was to force amalgamation between the mercury and the contact surfaces so as to intensify any sticking propensity. Specifically, three of the four lots were subjected to heat at 90 degrees centigrade for 16 hours. In two of the three lots, no sticking occurred whatsoever. In the third lot, only one of the 10 relays stuck. The stuck relay, however, was found to be defective for other reasons; i.e., its swinger was partially dry. The fourth lot was subjected to heat at 90 degrees centigrade for 92 hours and not a single relay stuck.

Next, two of the four lots were subjected to further tests. One was aged for 108 hours at 90 degrees centigrade with observations for sticking made at 32, 48 and 108 hours. This lot was then stored for six months at room temperature. No sticking of any kind occurred.

The remaining lot was heated for 92 hours at 90 degrees centigrade with no sticking observed at 32 and 92 hours. Thereafter, the relays were operated 60 times a second at about 200 percent normal power for 264 hours and then heated for 64 hours at 90 degrees centigrade. None of the relays stuck. The operating point for one relay, however, was substantially increased. By comparison, mercury switches having contacts made of platinum alone or an alloy of platinum and nickel exhibit a high incidence of sticking when subjected to tests of this kind.

At each observation point in the foregoing tests, the contacts were visually inspected for wetting. With the exception of those instances specified above, all of the contact surfaces were covered by the mercury.

In the relay described and in the relays tested, the contacts 13 and 14 were preformed from a combination consisting of a fused alloy of PtCu<sub>3</sub> and a base metal. With a fused alloy such as PtCu<sub>3</sub>, the contacts 13 and 14 are readily made by bonding a sheet of the fused alloy over the base metal and then stamping or cutting out contacts from the composite structure. The resulting contacts will have a base material adapted for joining to one of the terminals 11 or 12, and a contact surface adapted to engage the swinger 15 and be wetted by the mercury 21.

Other ways of making the contacts 13 and 14 are also feasible. For instance, they can be formed by sputtering or by electroplating the alloy metal over the base metal. Whichever method is used, however, the alloy metal overlay in the preformed contact should have a thickness on the order of 10 microns or greater.

While the embodiment described in the foregoing had contacts preformed from a copper-platinum alloy, the principles disclosed herein can be extended to other arrangements. For example, nickel is readily substituted for the platinum. In such a case, instead of copper-platinum, the preformed contact alloy consists of copper-nickel. The nickel substitution, moreover, need not be complete. For example, an alloy made of copper, platinum and nickel is particularly advantageous when the proportion of nickel present is 12 to 15 percent by weight. Thus, while an alloy consisting of platinum and copper is especially effective, other alloys containing copper will also create contact surfaces which wet easily and which do not stick.

Furthermore, the proportion of copper in the alloy can be varied. In the particular embodiment specifically described herein, platinum and copper are present in the proportions PtCu<sub>3</sub>. Other proportions, however, will also provide good results. For example, where absolute freedom from sticking is not of utmost importance, the proportion of copper in the alloy can be as low as 5 percent

by weight. Better reliability, however, is obtained when the percentage of copper is increased to the order of 55 percent by weight. Best reliability is obtained when the amount of copper in the alloy is just sufficient to chemically stabilize the interface between the contact and the wetting agent.

Similarly, when the alloy consists of copper and nickel, the amount of nickel can be varied. While the composition of the alloy can go as high as 70 percent nickel by weight before the alloy becomes magnetic in its operating range, best results are obtained when the amount of nickel is kept within 20 to 65 percent by weight.

In summary, a switching device containing contacts wetted by an electrically conducting agent has been disclosed in which the wetted contacts stay wet and sticking is substantially eliminated. It is to be understood, however, that the above described arrangements are merely illustrative of the application of the principles of this invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a sealed contact switching device containing a contact wettable by mercury, the combination comprising: a first contact having a contact surface preformed from an alloy consisting of copper and a metal selected from the group consisting of nickel, and an alloy of platinum and nickel; a second contact for engaging said first contact; and mercury wetting the contacting portions of said first and second contacts.
2. A combination in accordance with claim 1 wherein said first contact is a fused alloy consisting of copper and platinum and wherein the percentage of copper in said first contact ranges from 5 percent to 55 percent by weight.
3. A combination in accordance with claim 1 wherein said alloy consists of platinum and copper in the atomic proportions PtCu<sub>3</sub>.
4. In a switching device containing a contact wettable by an electrically conducting liquid sealed in a vessel, the combination comprising: mercury for wetting a first and second contact; said first contact having a contact surface wetted by said mercury, said contact surface being preformed from an alloy which is substantially non-magnetic, which is substantially free of amalgamation in said mercury, and which forms an advancing contact angle of less than 20 degrees when wet by said mercury; and said second contact having a contact surface wetted by said mercury and arranged to engage the contact surface on said first contact.
5. A combination in accordance with claim 4 wherein said alloy consists of copper and a metal selected from the group consisting of platinum, nickel and an alloy of platinum and nickel.
6. In a sealed contact switching device containing a contact wettable by mercury, the combination comprising: a first contact having a contact surface preformed from an alloy of platinum, nickel and copper wherein the percentage of copper in said first contact ranges from 5 percent to 55 percent by weight, and the percentage of nickel ranges from 12 to 15 percent by weight; a second contact for engaging said first contact; and mercury wetting the contacting portions of said first and second contacts.
7. In a sealed contact switching device containing a contact wettable by mercury, the combination comprising: a first contact having a contact surface preformed from an alloy of nickel and copper; a second contact for engaging said first contact; and mercury wetting the contacting portions of said first and second contacts.

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8. A combination in accordance with claim 7 wherein the percentage of nickel in said first contact ranges from 20 percent to 65 percent by weight.

9. In a sealed contact switching device containing a contact wettable by mercury, the combination comprising:  
 5 a first contact having a contact surface made of an alloy preformed from copper and at least one metal selected from the group consisting of platinum and nickel, the amount of nickel present being no more than 70 percent and the amount of copper being  
 10 between 5 percent and 55 percent by weight;  
 a second contact for engaging said first contact; and mercury wetting the contacting portions of said first and second contacts.

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10. A combination in accordance with claim 9 wherein said copper and said metal are fused to form said alloy.

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ROBERT K. SCHAEFER, *Primary Examiner.*

H. O. JONES, *Assistant Examiner.*