

UNITED STATES PATENT OFFICE

2,640,020

FORMATION OF A SURFACE EASILY
WETTABLE BY MERCURY

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No Drawing. Application August 9, 1949,
Serial No. 109,420

4 Claims. (Cl. 204—34)

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This invention relates to a method of forming a surface of solid ferrous material to which mercury will readily adhere and more specifically to a method of treating the surface of a solid ferrous material and then coating it with a metal to create a surface easily wettable by mercury.

It has long been recognized that for certain purposes a mercury-coated surface is more advantageous than solid surfaces. This is particularly true in the case of contacts where opening and closing occurs many times. Because it is a fluid, a fresh surface is always presented for each contact closure, thus effectively preventing corrosion and wear of the contact point. On the other hand, solid contacts have certain advantages over mercury contacts inasmuch as solid contacts can be made of lighter material and can be made to move more rapidly than the mercury contacts. Furthermore, since the solid contacts maintain a constant shape it is easier to apply and regulate a motivating magnetic force.

The advantages of both the liquid mercury contact and the solid contact can be combined in one set of contacts if the solid contact can be coated with a film of mercury. This entails a process for conditioning the surface of the solid contact so that it will be easily wettable by mercury and such condition of wetness can be maintained at the contact point throughout a period of many openings and closures of the switch.

It is an object of this invention to provide a method for conditioning a ferrous element so that a thin coating of mercury will readily adhere to the surface of said element.

A further object is the formation of a mercury wetted surface that will not easily form amalgams.

The invention consists essentially of the steps of forming large crystals in the surface of the solid element by the process of annealing and then maintaining the element in the heated stage thus allowing the crystals to grow. Subsequently, the surface of the element is either etched or sandblasted to provide capillary grooves at the boundaries of the crystals formed therein. A thin coating of a suitable metal is then electroplated on this prepared surface and the resultant product is heated to provide fusion between the base metal and the electroplate. Finally, the plated element is dipped into a mercury bath.

In order to form capillary channels in the surface of an element made of an alloy of iron, hot crystals are formed in the alloy by a suitable heat treatment such as annealing and then the substance between the crystals which appear on the surface of the member is partially removed by etching or sandblasting. A suggested way or method of accomplishing this crystallization is as follows. For alloys comprising 45% Ni-55% Fe and 52% Ni-48% Fe satisfactory results have been obtained by heating the alloys with wet hy-

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drogen at a temperature of about 1,000° C. for 90 minutes. The metal is then cooled in a wet hydrogen atmosphere, the cooling time not being particularly critical. Times of 10 minutes to 2 hours have given satisfactory results. A hydrogen atmosphere is employed so as to minimize oxidation of the metal and keep it clean. The alloy used is then etched for about 7 minutes in a mixture of equal parts of concentrated (38 percent) hydrochloric acid and a saturated solution of copper sulfate. The solution is agitated during the etching process. Next the alloy is washed, first in distilled water, then in alcohol and then dried in air. On the resulting surface the crystals are easily visible, having dimensions ranging from .001 inch to .002 inch, and the channels between them well defined.

Instead of etching, sandblasting may be employed to form the channels between the crystals. In this case the alloy is subjected to a heat treatment and then sandblasted until the channels become well defined and then it may be washed in distilled water and subsequently dried. It should be noticed that modifications of the optimum time and temperatures given for the above-mentioned alloys will be required for alloys of a different chemical composition.

In order to provision the alloy element so that a thin coating of mercury will readily adhere to the surface of the element the element is next electroplated with a suitable metal. Such a metal must have certain physical and chemical properties. First, it must be easily wettable by mercury. Secondly, its solubility must be low enough so that the coating is not dissolved completely in the mercury, and thirdly it must be capable of being well bonded to the base metal, preferably with a diffused interface. Tests have indicated that platinum, rhodium, and nickel meet these three requirements. There may be others which would also give satisfactory results. Platinum appears to be the best of the three enumerated above because it is less soluble. However, under most conditions nickel appears to be quite adequate. Both nickel and platinum when coated to the element surface will stay wet in the contact area, apparently because some of it remains bonded to the base. Other materials such as copper which are more soluble in mercury than their amalgams always tend to dissolve completely and grains of solid amalgam are precipitated out of the solution. Tests have shown that a surface utilizing copper will not stay wet at the contact area or where it occurs.

After plating, the material is heat treated in hydrogen to diffuse some of the electroplate into the base metal. This produces a good bond and removes the sharp interface between the two metals. The thickness of the plate and the length and temperature of the heat treatment depends on the material chosen for the coating. For

nickel, good results have been obtained with the plating .0005 inch thick followed by a heat treatment of 10 minutes at 800° C. in hydrogen.

The platinum-plated element is now dipped into a mercury bath which will completely wet the surface of the element and, due to the capillary action, will provide paths for the mercury to flow along the element to the contact point, thus continuously replenishing the contact areas with a fresh supply of mercury.

As an alternative to forming capillary paths in the surface of the base metal by crystallization and subsequent sandblasting or etching, the elements may have the channels coined in them by means of a press or a system of coining rollers. The material to be thus channeled is annealed at approximately 1,000° C. for half an hour in hydrogen, and it is then placed between the coining rollers and formed by the application of about 150,000 pounds per square inch. This produces parallel straight grooves about .002 inch with a spacing of 270 per inch. The coining method has an advantage over the crystallization method in that it provides a good control of channel size and the channels are more direct.

It is to be noted that the above-detailed description only describes a preferred embodiment of the invention and that certain changes can be made without departing from the scope or spirit of the invention.

What is claimed is:

1. The method of forming a liquid mercury contacting surface in an electric contact, whereby a continuously replenishable supply of fresh liquid mercury is made available at the contacting area through which an electric current is to be established and interrupted, which method comprises forming a capillary network in a ferrous metal contact base; electroplating said formed base with a metal easily wettable by mercury and not completely soluble in mercury, said metal being selected from the group consisting of platinum, rhodium and nickel, said metal being electroplated in such thickness as to leave said capillary network well defined in the exterior electroplated surface; heat treating said electroplated base to diffuse some of the electroplate into the ferrous metal base to produce a good bond while leaving said capillary network well defined in said exterior electroplated surface; and immersing said electroplated and diffused contact base having said well defined capillary network in its exterior surface into liquid mercury, to fill said network and to continuously replenish said contacting area with liquid mercury.

2. The method of forming a liquid mercury contacting surface in an electric contact, whereby a continuously replenishable supply of fresh liquid mercury is made available at the contacting area through which an electric current is to be established and interrupted, which method comprises annealing a ferrous metal contact base; coining a capillary network in said base; electroplating said coined base with a metal easily wettable by mercury and not completely soluble in mercury, said metal being selected from the group consisting of platinum, rhodium and nickel, said metal being electroplated in such thickness as to leave said capillary network well defined in the exterior electroplated surface; heat treating said electroplated base to diffuse some of the electroplate into the ferrous metal base to produce a good bond while leaving said capillary network well defined in said exterior electro-

plated surface; and immersing said electroplated and diffused contact base having said well defined capillary network in its exterior surface into liquid mercury, to fill said network and to continuously replenish said contacting area with liquid mercury.

3. The method of forming a liquid mercury contacting surface in an electric contact, whereby a continuously replenishable supply of fresh liquid mercury is made available at the contacting area through which an electric current is to be established and interrupted, which method comprises heat treating a ferrous metal contact base to form large crystals in the surface thereof; etching between said crystals to form a capillary network; electroplating said etched base with a metal easily wettable by mercury and not completely soluble in mercury, said metal being selected from the group consisting of platinum, rhodium and nickel, said metal being electroplated in such thickness as to leave said capillary network well defined in the exterior electroplated surface; heat treating said electroplated base to diffuse some of the electroplate into the ferrous metal base to produce a good bond while leaving said capillary network well defined in said exterior electroplated surface; and immersing said electroplated and diffused contact base having said well defined capillary network in its exterior surface into liquid mercury, to fill said network and to continuously replenish said contacting area with liquid mercury.

4. The method of forming a liquid mercury contacting surface in an electric contact, whereby a continuously replenishable supply of fresh liquid mercury is made available at the contacting area through which an electric current is to be established and interrupted, which method comprises heat treating a ferrous metal contact base to form large crystals in the surface thereof; sand blasting between said crystals to form a capillary network; electroplating said sand blasted base with a metal easily wettable by mercury and not completely soluble in mercury, said metal being selected from the group consisting of platinum, rhodium and nickel, said metal being electroplated in such thickness as to leave said capillary network well defined in the exterior electroplated surface; heat treating said electroplated base to diffuse some of the electroplate into the ferrous metal base to produce a good bond while leaving said capillary network well defined in said exterior electroplated surface; and immersing said electroplated and diffused contact base having said well defined capillary network in its exterior surface into liquid mercury, to fill said network and to continuously replenish said contacting area with liquid mercury.

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