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ALLOYS

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This invention relates to contacting alloys and more particularly to copper-palladium alloys employed for contacts on electrical apparatus.

An object of this invention is to increase the efficiency and prolong the usefulness of contacts employed on electrical apparatus.

The contacts of electrical apparatus, especially relay contacts, are subjected to severe conditions in use. The minute sparking in the operation of the contacts of relays and other apparatus causes the building-up of the material on the contacts to render ultimately the relay inoperative. Various materials which withstand these severe conditions have been suggested. For example, E. F. Kingsbury in U. S. Patent No. 1,779,602 granted on October 28, 1930, has proposed the use of copper-palladium and other alloys for electrical contacts. The alloys of palladium-copper while possessing relative freedom from excessive oxidation and in general satisfactory as a contacting material are somewhat susceptible, as ordinarily prepared, to the building-up phenomena in which material is transferred from one contact to another.

The major factors which are correlated with the transferring of the material of one contact to that of another are the thermal and electric conductivity of the alloy. An alloy having a higher thermal and electric conductivity than that of another alloy comprising the same constituents is less prone to the transferring and building-up in needle-like fashion of the material of one contact on that of another.

In accordance with this invention copper-palladium alloys are prepared which have relatively high thermal and electrical conductivities and which are resistant to corrosion such as that caused by sulphur dioxide. Further, these alloys when employed for contacts on relays and other electrical apparatus manifest greater resistance to the transfer of metal from one contact to another.

Copper-palladium alloys, and more particularly alloys comprising 38 to 50 atomic per cent of palladium and the remainder chiefly copper exist in two extreme physical conditions, one, in which the atoms of the two elements are distributed at random, and the other in which the distribution is ordered. In the ordered condition, the two elements are in preferred positions with respect to each other, or more concretely, the elements are positioned so that an atom of one element is nearer the atom of the other element. The lattice structure of the ordered state is the body centered cube, while the lattice structure of the random state is the face centered cube. The copper-palladium alloys as usually prepared are in a random state, or in any case, are only partially ordered. Certain characteristics of copper-palladium alloys undergo profound changes when converted from the random to the ordered state. The electrical resistivity of an alloy comprising 47.2 atomic per cent palladium and 52.8 atomic per cent copper (60 per cent palladium and 40 per cent copper by weight) in the ordered condition is less than approximately one-tenth of that in its random state. The specific resistivity of the ordered alloy comprising 47.2 atomic per cent palladium and 52.8 atomic per cent copper is less than 4×10^{-6} ohm-cm. This resistivity is considerably less than that of palladium itself in spite of the fact that the alloy is almost in the center of the binary series. The ordered alloys are substantially harder than the corresponding alloys in the random state and the thermal conductivity is substantially greater in the ordered alloys. This greater hardness is of value when contacts are subjected to constant battering action such as that which obtains in high speed telegraph relays. The ordered structure of the alloys also has been found to result in decreased chemical corrosion on exposure to hydrogen sulphide and sulphur dioxide. The decreased resistivity, the increased thermal conductivity, hardness and resistance to corrosion contribute to make alloys of copper-palladium in the ordered state extremely desirable as contact alloys for relays and other electrical apparatus.

One method of preparing the copper-palladium alloy in the ordered state is to cold work the alloy and subsequently heat treat it within a temperature range of 275° C. to 450° C. The cold working may be effected by reducing the cross-sectional area of the alloy in the order of less than 50 per cent of that of the original. For example, an alloy comprising 50 per cent atomically of palladium and 50 atomic per cent of copper (62.7 per cent palladium and 37.3 per cent copper by weight) in the form of a wire .050 inch in diameter, is reduced to a diameter of .005 inch. This wire is then wound on a form, leads are welded on the wire for the determination of the resistance thereof and the form placed in a quartz tube which is maintained at a temperature of 280° C. This heat treatment may be performed in vacuum or in the presence of an inert gas which does not react with the copper-palladium alloy. The resistivity of the wire is determined from time to time in order to ascertain whether the transformation from the random state to the ordered state has been effected. A period of 15 to 30 minutes has been found satisfactory for this size of wire. Usually, the greater the degree of hard working prior to heating, the lesser time is required for the transformation. In any event the alloy is left in the furnace until the transformation is effected. As ascertained by resistance measurements, the specific resistivity for this particular alloy in the ordered state is 4.1×10^{-6} ohm-cm. After the transformation has been accomplished, the wire in the furnace is permitted to cool slowly therein to room temperature. With a wire .05 inch in diameter, the transformation from the random to the ordered state occurs in less than seven minutes at a temperature range of 290° C. to 330° C. Although the transformation is produced in this period, the alloy is preferably subjected to the heating for a longer time, such as 15 to 30 minutes. The transformation may also be ascertained by X-ray examination although the resistivity determination is more convenient.

The ordered condition in palladium-copper alloys may also be obtained by subjecting an unworked alloy to a heat treatment in an atmosphere of hydrogen. The preferred temperature range is the same as that in the case of cold worked alloys, i. e. 275 to 450° C. The hydrogen at the temperature of heat treatment is preferably not less than approximately atmospheric pressure (760 millimeters) at the temperature of heating. As an example of the transformation of an alloy in the random state to one in the ordered state, a wire of approximately .005 inch in diameter and comprising 47.2 atomic per cent palladium, and 52.8 per cent copper (60 per cent palladium and 40 per cent copper by weight) is heated for approximately 30 minutes in an atmosphere of hydrogen maintained at 760 millimeters pressure at a temperature of 280° C. The resistivity of the wire is ascertained from time to time in order to determine whether the transformation has been effected. The heating of the palladium-copper alloy is for a period sufficient to cause the transformation from the random to the ordered state. After the alloy is converted from the random to the ordered state it is permitted to cool slowly in the furnace to room temperature.

While two specific allows of copper-palladium have been employed in the specific examples, any other allow of copper-palladium, and more particularly, alloys comprising 38 to 50 per cent atomically of palladium (50.7 to 62.7 per cent palladium by weight) and the remainder chiefly copper, may be treated in like manner to change them from the random to the ordered state. The period of heating in each case is relatively short and can be easily ascertained by resistivity measurements.

While preferred embodiments of this invention have been described, various modifications therein may be made without departing from the scope of the appended claims.

What is claimed is:

1. The method of forming an improved contact alloy consisting of 50.7 to 62.7 per cent palladium by weight and 49.3 to 37.3 per cent copper by weight, said method comprising heating said alloy in an atmosphere of hydrogen to change the atomic relation of the said palladium and said copper from a random to an ordered state.

2. A method of forming a contact material consisting of 50.7 to 62.7 per cent palladium by weight and 49.3 to 37.3 per cent copper by weight, said method comprising heating said alloy at a temperature between 275° and 450° C. in an atmosphere of hydrogen to change said copper and said palladium from a random to an ordered stage.

3. A method of forming an improved contact material consisting of 50.7 to 62.7 per cent palladium by weight and 49.3 to 37.3 per cent copper by weight, said method comprising heating said allow at a temperature of approximately 280° C. in an atmosphere of hydrogen maintained at a pressure of not less than 760 mm. at the temperature of heating to effect the transformation of said copper and said palladium from a random to an ordered arrangement, and subsequently slowly cooling said alloy to room temperature.

4. A contact material consisting of 50.7 to 62.7 per cent palladium by weight and 49.3 to 37.3 per cent copper by weight, said allow being prepared by heating in an atmosphere of hydrogen at a temperature above 275° C. to convert said palladium and said copper from a random to an ordered state.

5. A contact material consisting of approximately 60 per cent palladium by weight and approximately 40 per cent copper by weight, said alloy being prepared by heating in an atmosphere of hydrogen at a temperature above 275° C. to convert said palladium and said copper from a random to an ordered state.

6. A contact material consisting of approximately 62.7 per cent palladium by weight and approximately 37.3 per cent copper by weight, said alloy being prepared by heating in an atmosphere of hydrogen at a temperature above 275° C. to convert said palladium and said copper from a random to an ordered state.

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