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PROCESS OF PLACING A COPPER LAYER ON AN ALUMINUM ELECTRICAL CONNECTOR

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3,148,086

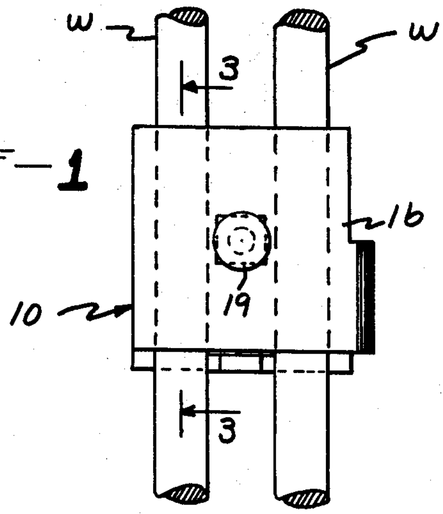

FIG-1

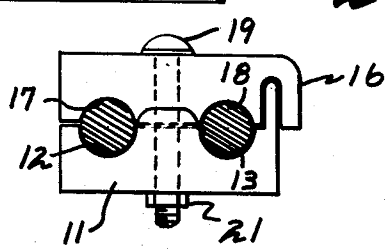

FIG-2

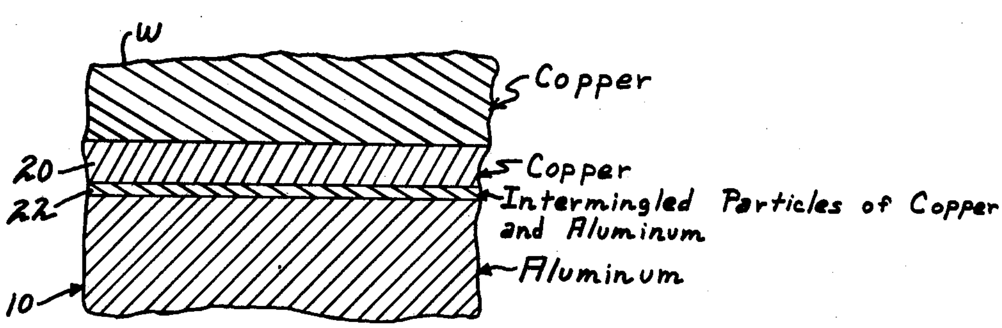

FIG-3

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PROCESS OF PLACING A COPPER LAYER ON AN ALUMINUM ELECTRICAL CONNECTOR

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This invention relates to aluminum electrical connectors and more particularly to aluminum electrical connectors for electrically connecting at least one copper surface thereto.

Heretofore it has been common to place copper inserts on aluminum electrical connectors when at least one copper wire has been connected to the connector. The copper insert has normally been soldered in position and this has required considerable labor as well as only providing a mechanical bond between the copper insert and the connector. In the use of a copper insert or sleeve on aluminum connectors, and particularly on the grooves of connectors, an aluminum oxide coating on the surface of the connector has inhibited the passage of electrical current from the copper sleeve or insert to the electrical connector. Resistance is thereby set up and heating of the connector takes place which oftentimes eventually loosens the copper sleeve from the aluminum since only a mechanical bond secures the sleeve or insert to the aluminum connector.

The present invention provides a process of applying a copper layer on an electrical aluminum connector by fusing the copper to the aluminum through heating both of the metals and thereby forming an intermediate layer of intermingled copper and aluminum particles of a thickness between .002 inch and .010 inch which is effective to withstand any of the conditions ordinarily exerted on the connector.

It is an object of this invention to provide a process of fusing a copper layer on the aluminum connector comprising heating the aluminum connector to a temperature of over 350° and spraying molten copper onto the connector with the copper being sprayed at a sufficient velocity so that the copper particles penetrate the hot aluminum and form an intermediate layer of mixed aluminum and copper particles between .002 and .010 inch in thickness with any zinc coating on the surface of the aluminum connector being burned off.

Apparatus showing a connector on which my process may be employed is shown in the accompanying drawing, forming a part of this application, in which:

FIG. 1 is a top plan view of an assembled connector showing a pair of wires being secured by the connector;

FIG. 2 is an end elevational view of the connector shown in FIG. 1; and,

FIG. 3 is an enlarged fragmentary sectional view taken generally along the line 3—3 of FIG. 1 and showing several layers of material.

It is highly desirable to remove the aluminum oxides from the connector to be coated before my process is applied as the fusing of copper is hindered by the presence of aluminum oxides. Aluminum oxide has a melting point of around 3600° F. against a melting point of 1220° F. for aluminum and 1980° F. for copper. To remove any aluminum oxides from the connector before my process is applied, it is desirable to subject the connector to a mild alkaline cleaning. Next, the connector is put through an acid pickling process and then, it is placed in a solution of sodium zincate. A thin coating of zinc is deposited over the aluminum and inhibits the forming of new oxides on the aluminum surface to which copper is to be applied. The zinc coating has a melting point of around 790° F.

Referring to the drawing, a clamp type electrical connector is shown for the purpose of illustration, it being

understood that my process may be employed on other types of aluminum electrical connectors. When the term "aluminum" is employed in the claims and specification to describe the connector it is understood that this term includes aluminum alloyed with other metals. The connector is indicated generally by the numeral 10 and comprises a base clamping part 11 having grooves 12 and 13 therein adapted to receive electrical wire. An upper part is indicated generally by the numeral 16 and has a pair of complementary portions 17 and 18 therein which coact with grooves 12 and 13 in base portion 11. A bolt 19 connects portions 11 and 16 in clamping position on wires W. Bolt 19 has a nut 21 thereon to pull connector parts 11 and 16 together in clamping relation on wires W. At least one of wires W is formed of copper while normally the other wire W is formed of aluminum.

In the process of fusing copper to the aluminum connector, the aluminum connector 10 is first heated to a temperature of around 500° F. preferably. Temperatures between 350° F. and 900° F. will work satisfactorily. Before the connector loses its temperature, it is sprayed with molten copper entrained in a stream of gaseous material. In spraying the copper a copper wire is fed to a metalizing gun which atomizes the wire into a stream of molten copper particles. The particles are uniformly heated and the rate of spray is well controlled by the metalizing gun. The copper wire is melted by a combination of gases at a uniform rate of speed. The gases comprise oxygen combined with one of the following: acetylene, propane, butane, or hydrogen. Also, natural or manufactured gas may be combined with the oxygen. The gases are balanced along with compressed air that is also used to atomize the molten copper, and a neutral flame neither oxidizing or carbonizing is formed in which the copper wire is atomized. The molten particles of copper are entrained in a stream of oxygen free air formed from the compressed air, and the oxygen mixture which stream is at a temperature in excess of 4000° F. The blast of hot air and the finely divided superheated copper particles vaporize the zinc coating on the aluminum connector and the molten particles of the atomized copper impinge against the aluminum connector and penetrate it to a depth between .002 inch to .010 inch. The metalizing gun is held about 4 inches from the surface of the connector to which the copper is to be fused and the copper particles move at a maximum velocity of around 225 feet per second.

An intermediate layer 22 as shown in FIG. 3 is formed beneath the surface of the aluminum connector composed of mixed particles of copper and aluminum and of a thickness of between .002 inch and .010 inch corresponding to the penetration of the copper particles.

An outer layer 20 of copper is formed of any thickness from .020 inch and is built up on intermediate layer 22 above the surface of the aluminum connector. A thickness of around .030 inch for outer layer 20 has been found to be preferable. Thus, particles of copper and aluminum are fused in intermediate layer 21 so as to secure in permanent fashion outer layer 20 of copper which will contact a copper wire W. An outer layer 20 of at least .020 inch in thickness provides a non-porous copper coating the surface of which is hard and slightly rough. This roughness is desirable as it will cause the copper wire to be gripped tightly in the connector. The percentage of copper in the intermediate layer is variable but it increases from its innermost penetration of the aluminum outwardly to the surface of the connector. After the connector has been sprayed with copper, it is cooled rapidly in water or a mist which keeps the oxidizing of the surface of the copper at a minimum during cooling.

The connector is usually sprayed only on the portions thereof which would contact the copper wires or surfaces since it is desirable to maintain a good contact between the copper wires and the aluminum connector without having any interfering aluminum oxides on the surface of the connector to interfere with the electrical current being conducted from one wire to another wire through the connector.

From the foregoing it will be understood that I have provided a process for applying a copper layer on an electrical aluminum connector by heating the aluminum connector and then spraying the copper onto the surface of the connector. By removing the oxides and zincating the connector, then heating the connector and spraying the copper particles at a sufficient velocity, the copper particles penetrate the surface of the connector and form an intermediate layer of intermingled copper and aluminum particles between .002 inch and .010 inch thereby fusing the copper and aluminum. The copper layer may be provided in a minimum of time and any outer zinc coating on the connector is burned off by the hot air or other gases in which the molten copper particles are entrained when the copper is sprayed onto the connector.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. The process of fusing a copper layer on an aluminum electrical connector comprising zincating the surface of the aluminum connector to remove any aluminum oxides from the surface of the connector and to coat the connector with metallic zinc, heating the aluminum connector thus zincated to a temperature between 350° and 900° F., spraying molten copper entrained in a blast of gas under pressure onto the heated aluminum connector whereby the gas vaporizes the zinc coating to remove it from the surface of the connector, said copper being sprayed at a sufficient velocity whereby the copper particles penetrate the surface of the hot aluminum and form an intermediate mixed layer of copper and aluminum particles between .002 inch and .010 inch in thickness on which an outer layer of copper may be deposited.

2. The process of fusing a copper layer on a groove of an aluminum electrical connector comprising chemically removing from the surface to be coated all aluminum oxide and substituting for the removed oxide a coating of metallic zinc, heating the aluminum connector thus zincated to a temperature between 350° and 900° F., and spraying molten copper particles entrained in a blast of air under pressure onto the groove of the heated aluminum connector, said copper particles being sprayed at a velocity on the order of 225 feet per second whereby they penetrate the surface of the aluminum connector and form an intermediate layer of mixed copper and aluminum particles of from .002 inch to .010 inch and an outer layer of copper of at least .020 inch in thickness on the intermediate layer.

References Cited in the file of this patent

UNITED STATES PATENTS

2,081,047	Basch	May 18, 1937
2,514,474	Cook	July 11, 1950
2,662,831	Culverhouse	Dec. 15, 1953
2,833,668	Dailey et al.	May 6, 1958
2,858,520	Chance	Oct. 28, 1958
2,955,886	Fritzlen et al.	Oct. 11, 1960
2,974,400	Sowa	Mar. 14, 1961
3,031,330	Hornick	Apr. 24, 1962

FOREIGN PATENTS

520,729	Canada	Jan. 17, 1956