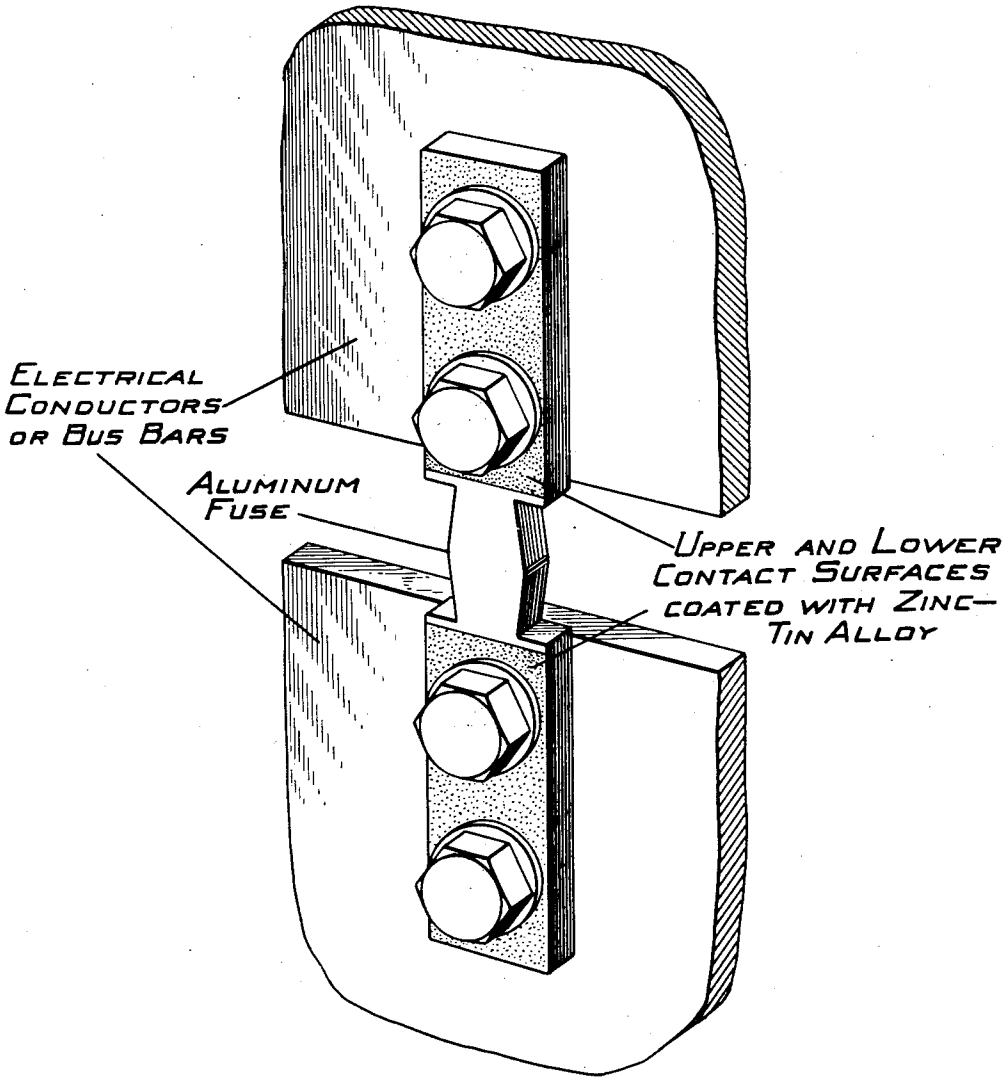
May 12, 1953 E. R. THOMAS 2,638,521

CONTACT FOR ELECTRICAL CONDUCTORS
OF ALUMINUM OR ALUMINUM ALLOYS
Filed Jan. 25, 1952



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Patented May 12, 1953 2,638,521

UNITED STATES PATENT OFFICE

2,638,521

CONTACT FOR ELECTRICAL CONDUCTORS OF ALUMINUM OR ALUMINUM ALLOYS

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Application January 25, 1952, Serial No. 268,237

3 Claims. (Cl. 200—166)

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This invention relates to improved contacts or contact surfaces for electrical conductor members formed of aluminum or aluminum alloys and which in use are designed to contact under mechanical pressure with other electrical conductor members of aluminum or other material.

It has long been known that when electrical conductor members of aluminum or aluminum alloys are maintained in contact by mechanical pressure with other conductor members, there will be a continuous and objectionable increase in the resistance to the flow of current through the contacting surfaces, the increase apparently depending on the number of duty or heating cycles to which the contacting surfaces are subjected as the result of passage of current therethrough as well as upon the elapsed time. This difficulty persists in practice, no matter how carefully one attempts to clean the contact surface which consists of or contains the aluminum. While methods or means for overcoming this difficulty have been the subject of investigation by experts in the art of electrical contacts substantially ever since the use of aluminum for electrical conductor purposes was inaugurated, so far as I am aware, there has heretofore been no reliable and inexpensive solution for the problem.

I have discovered that, according to the present invention, the contact surfaces on such aluminum or aluminum alloy conductor members may be made to have a remarkably stable and constant electrical resistance to the flow of current through the contact surface into another member held in contact therewith, by applying to a cleaned surface of the aluminum or aluminum alloy members a coating consisting preferably of an alloy of about 10% zinc, the remainder essentially tin. The percentage of zinc however may vary from about 5% to 15%.

By way of examples, the invention is particularly adapted for providing contact surfaces of stable electrical resistance on aluminum alloy fuse elements and on the surfaces of aluminum electric cables or the like, at the areas where a splice to another cable length or conductor is to be maintained by the use of mechanical clamping means.

Further and more specific objects, features and advantages of the invention hereof will appear from the detailed description given below, which also sets forth in further detail the preferred manner of carrying out the invention.

In the drawings there is shown by way of example an aluminum or aluminum alloy fuse element on which the contact surfaces as formed

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in accordance with the invention, are mechanically held under pressure by bolting the contact or end portions respectively to other metal conductor members which conduct the current to and from the fuse element.

The use of the invention has been found to be highly advantageous both for providing a contact surface on electrical conductor members formed merely of aluminum as well as those formed of any of the aluminum alloys commonly used as electrical conductors, i. e. where the amount of aluminum in the alloy is great enough so that any contact surface thereon in use would normally become sufficiently oxidized to cause objectionable changes in the resistance to the passage of electric current through the surface. That is, whether the conductor member is of aluminum or an aluminum alloy containing a substantial percentage of aluminum, is not a particularly critical factor, whereas the composition of the zinc-tin alloy coating to be applied in accordance with the invention, is in practice preferably made within the above stated limits.

In carrying out the invention, the surface portion of the aluminum or aluminum alloy conductor member which is to form a mechanical contact with another member, is first carefully cleaned, preferably by the use of an abrasive and then such surface portion is promptly heated to a temperature, for example of from 300° to 350° C., or in any event to a temperature substantially above the melting point of the alloy coating to be applied thereto. Thereupon a coating is preferably promptly applied to the cleaned surface, consisting of the above-mentioned zinc-tin alloy. The alloy is preferably applied by simply rubbing a small bar or stick of the alloy on the surface while the latter is kept heated as aforesaid. It will be found that the surface of the coating will bear a small amount of zinc oxide which should be wiped off before the coating solidifies. The conductor member is then allowed to cool and the alloy coating thereon solidifies. The zinc oxide arises from the fact that portions of the zinc in contact with the aluminum surface are reacted upon by aluminum oxide, the reaction producing zinc oxide which rises to the surface of the coating and may thus be readily brushed off. This reaction of the zinc with the aluminum oxide is believed effectively to remove all troublesome traces of aluminum oxide which inevitably form on aluminum when exposed to the atmosphere. The outer surface of the polished alloy coating will now provide a contact surface which, when held under mechanical pressure in use

against the surface of some other electrical conductor member, will have the desired remarkably constant resistance to the flow of current through the contact surface. Sufficient of the zinc-tin alloy should be applied so that the coating preferably has a thickness of several thousandths of an inch, for example from about .002 to .010 of an inch.

My investigations have shown that the exposed surface of the coating formed in this way is free of aluminum and thus the surface embodies no metal or alloy such that any oxide formed thereof will be detrimental or objectionably resistant to the passage of current, as are surfaces of aluminum or aluminum alloys which tend strongly to become progressively coated with aluminum oxide, and thus highly resistant to the passage of current. On the other hand I have found that when such a coating is applied as above described, the surface of the aluminum or aluminum alloy member itself becomes alloyed with the under surface of the zinc and tin coating so that the interface between the aluminum and the coating becomes an alloy of zinc and tin, alloyed with the interface of aluminum, but such ternary alloy is apparently confined to a thickness of the order of a few molecules in depth, although ample to insure firm adherence of the coating as a whole to the aluminum. Apparently as above indicated, at the interface the small amounts of aluminum oxide remaining on the cleaned aluminum surface react with the zinc to form zinc oxide, thus eliminating from the aluminum surface all such traces of aluminum oxide which are so detrimental to a surface desired to maintain a stable resistance.

I have conducted severe cyclic heating tests over substantial periods of time on an aluminum alloy fuse element such as shown in the drawing, for example, in a form used to accompany service switches, and with its contact surface portions treated as above described and mechanically held under contact pressure by bolting at the ends to a tin copper connection member, a bare copper member, as well as to a silver-plated copper member. Throughout such tests the contact resistances at both ends of the fuse element remained stable and constant, substantially as uniformly as could be measured. On the other hand, like aluminum alloy fuse elements without such coatings but using various methods of securing contact as heretofore known, showed a continuous, erratic and highly objectionable increase in contact resistance depending on the number of duty cycles and elapsed time.

I am aware that alloys comprising various percentages of tin and zinc have heretofore been proposed for soldering aluminum, i. e. for integrally uniting separate pieces of aluminum or aluminum alloy by solder interposed therebetween, and in such manner that some of the aluminum becomes alloyed with the solder substantially throughout before the members are

united and usually with the introduction of other metals in the solder which would be detrimental to an exposed contact surface. However, so far as I am aware, no one has heretofore discovered or appreciated that an electrical contact surface on aluminum adapted for pressure contact with other metal members and having a stable resistance to the flow of current through the contact surface could be made by the application of a coating of zinc-tin alloy as described above. As a consequence the use of aluminum conductor parts for a wide variety of purposes has been considered inadvisable in cases where such parts have to be separable and yet held in contact under pressure in lieu of being integrally soldered together.

What is claimed and desired to be secured by Letters Patent is:

1. In electrical apparatus the combination comprising a pair of separable metallic electrical conductor members held under mechanical pressure in contact for conducting current through the contacting surfaces from one member to the other, at least one of said members embodying a substantial percentage of aluminum and the contacting surface portion thereon comprising a coating of stable electrical resistance formed of an alloy consisting of about 5% to about 15% of zinc and the remainder principally tin.

2. As a new article of manufacture, an electrical conductor member formed of aluminum or an aluminum alloy and having a contact surface portion of stable electrical resistance for conducting current from such member to another separate member when in contact therewith under mechanical pressure, said surface portion comprising a coating consisting of an alloy of approximately 10 parts of zinc and approximately 90 parts of tin, such coating being alloyed with traces of the aluminum at its interface with said conductor member, but the outer surface of the coating being free of aluminum and free of oxides.

3. As a new article of manufacture, a metallic electric fuse element embodying a substantial percentage of aluminum and having an alloy coated surface portion forming a contact through which current is conducted to the fuse when in use, said alloy coating consisting of from about 5% to about 15% of zinc and the remainder tin, the outer surface of said coating being free of aluminum but the interface between the coating and said element containing traces of aluminum alloyed with the tin and zinc.

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