METHOD OF MANUFACTURE OF A CONDUCTOR RAIL

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ABSTRACT

There is concerned a method of manufacture of a conductor rail comprising an aluminum body and a layer of more resistant for instance ferrous material attached thereto, whereby said layer is applied in liquid form suppressing an intermetallic layer of poor conducting properties usually obtained when uniting aluminum with ferrous and like materials.

8 Claims, 1 Drawing Figure
METHOD OF MANUFACTURE OF A CONDUCTOR RAIL


The present invention relates to a method of manufacture of a conductor rail, consisting of a body of aluminum or an aluminum alloy with a layer of more wear-resistant material arranged on the body and forming a sliding surface. Such conductor rails serve for supply of energy to a device, such as a locomotive, a elevator or similar electrically driven apparatus.

Special mechanical and electrical requirements are placed on conductor rails of this kind, which cannot be without influence on the method of manufacture of the conductor rails. The mechanical requirements are of a static and mechanical-technological kind, in that a conductor rail is required which is in the first place free of sag and in the second place resistant to wear. Electrically in order to avoid an excessive number of supply points, a good conductivity of the article is indispensable. By the development of corresponding sectional extrusions one has independently of the material of the conductor rail substantial control on the sag. However, from the requirements of resistance to wear with simultaneous good conductivity for conductor rails certain problems of optimisation arise, because, especially with said composite bodies of steel and aluminum, the different physical properties of the materials oppose one another. Thus steel has the necessary resistance to wear, but a poor conductivity, whereas the behaviour is the opposite with aluminum.

In the past there has been no lack of attempts to provide methods of manufacture of component bodies of the kind mentioned, the products of which will constitute a best possible compromise with reference to the properties required. In general the known methods aim at the union of a pre-shaped steel sectional extrusion as a component resistant to wear, with an extruded static load bearing and electrically well conducting component, e.g., of aluminum. The union occurs by introduction of a sectional part consisting of a ferrous material into a corresponding recess of the extrusion of nonferrous metal with the employment of pressure and heat. For additional security of the connection, screws or rivets are also inserted in the composite body. It is also known to form the component consisting of aluminum or its alloys in several parts, so that the steel part can be tightened by means of fastening elements between the individual parts of aluminum. Finally there is in the state of the art a method that envisages the rolling in of aluminum under pressure and elevated temperature in a load-bearing section extrusion consisting of steel.

All these methods have disadvantages, in that they require a large technical expenditure, which lies in at least two press tools and devices for uniting the extrusions, great costs for labour for handling fastening means such as screws or rivets, and special rolling devices with heating arrangements.

In addition the composite bodies manufactured by the known methods are limited in employment as conductor rails because of deficiencies. Thus the components of the composite body formed as wearing parts take up a large part of the total volume of the conductor rail, with the consequence that the current must travel relatively long paths in a poorly conducting ma-

terial to reach the pick-up surface. Furthermore in this way joints of large area are formed between the load-bearing and wear-resisting components, which form a high internal resistance. A further disadvantage which has hitherto been unavoidable, is inherent in a product of manufacture which is formed with the help of pressure and heat or with employment of heat alone, thus for example by pressing of aluminum onto a steel body at elevated temperature or casting of aluminum into a steel body. In the union of metals of the kind mentioned, this is also true for the union of copper or its alloys with steel, there is formed at the engaging surfaces of the metals a layer of intermetallic compounds. These intermetallic compounds are brittle, electrically poorly conducting, and in particular the layer is not stable in its size, but continuously increases, because by means of it an electrical resistance is produced which develops heat, while its growth with rising layer thickness rapidly increases. The invention starts from this and has set itself the task to provide a method of manufacture of a conductor rail, the product of which shows optimum mechanical and electrical characteristics such as resistance to wear and electrical conductivity, and the task is solved by a method of manufacture of a conductor rail consisting of a body of aluminum or an aluminum alloy on which is a layer of a second material more resistant to wear in which method the second material is applied while it is in its liquid condition and simultaneously the heat content is carried away through the body.

To avoid the formation of the intermetallic layer, the invention, in contrast to the teaching of the state of the art, sets out to make the most of the good thermal conductivity of the aluminum body for a deliberate forced carrying away the heat content of the layer of wear resistant material which is applied as liquid. The aluminum body is ready formed previously. It is coated with metal only in the places where necessary. By the term "deliberate forced carrying away the heat content" there is to be understood the maintenance of the body temperature before application of the coating of wear-resistant material, even with introduction of auxiliary means. The wear-resistant material can, for formation of the sliding surface, be cast, or applied by flame spraying or spray welding. It is preferred to melt the wear-resistant material in an arc and to apply it onto the aluminum body by means of a plasma jet. The method which is known under the term "plasma spraying" for coating of turbine blades and the like has, for avoidance of intermetallic intermediate layers in the manufacture of conductor rails of material of the kind mentioned, the special advantage that locally sharply defined heat can be introduced into the aluminum body with the consequence of good removal on account of the remaining great cross sections with their favourable temperature gradients.

If the removal of heat produces special problems, or if for metallurgical considerations it is not advisable, then the method according to the invention is furthermore more advantageously carried out, in that before application of the wear-resistant material on the corresponding surface of the body, an intermediate layer is applied which has good adhesion on the body and on the wear-resistant material and hinders diffusion of the wear-resistant material into the body or vice versa, whereby the intermediate layer advantageously consists of nickel, or a nickel-aluminum alloy, of tin, zinc,
silver, copper or alloys of these metals, and which, in accordance with the thermal or other requirements should have a thickness of 5 to 300μ, and according to a further development provision is made to melt the materials of the intermediate layer in an arc and to apply them by means of a plasma jet which is an ionised carrier gas stream. According to the invention materials are used for the intermediate layer which do not make brittle intermetallic compounds either with the wear-resistant material, i.e., steel, nor with the electrically well-conducting aluminum.

Below, by way of an example the method according to the invention will be explained more closely by means of a product of said method.

FIG. 1 shows a sectional extrusion of aluminum intended for formation of a conductor rail 10, which consists of a box-shaped hollow section 11 and a T-section 12 connected with the box-shaped hollow section 11. The box-shaped hollow section 11 has three sides 13, 14, 15 suitable for pick-up of current, each of which is required carry a layer of wear-resistant material 19. The flange 17 is intended for mounting of the conductor rail 10 at both sides. According to the shape or arrangement of the pick-up 18, the current flowing through the conductor rail 10 is taken up either from the side 13, the sides 13 and 14, the side 15, or combinations of them. By reason of the frictional engagement between the pick-up 18 consisting of a wear-resistant material and the conductor rail made of aluminum or its alloys, the latter would be subjected to a rapid alteration of dimension by reason of the insufficient resistance to wear for this purpose, which alteration would endanger a required substantial air gap transfer between conductor rail 10 and pick-up 18. The layer 19 of wear-resistant material connected to the sides 13, 14 and 15 provides a remedy against this alteration. The layer 19 consists suitably of a ferrous alloy such as steel. It can however also consist of an alloy of the metals nickel, chromium, or copper, with such metals, which provides for the layer the required resistance to wear.

The layer 19 is applied in liquid condition to the sides, 13, 14, 15 with simultaneous rapid removal of humidity, to avoid the formation of an intermetallic layer of for example steel and aluminum. During said forced heat removal there is transferred heat from the layer to a third medium in contact with the body in such amount until the heat content of the layer is equal to that of the body and the transfer is performed so quickly that no increase in heat content of the body is noticable. According to one kind of coating, the sides 13, 14, 15 can be cast out of the wear-resistant material, in doing which it is suitable to carry out the application layer by layer, that is to say in individually thin layers with a simultaneous good distribution of the liquid material over the sides 13, 14 and 15. To produce as great as possible a heat gradient and so that the requirement of rapid removal of heat is satisfied, which as already indicated includes a maintenance of the conductor rail temperature at the beginning of the casting process, the conductor can in addition be cooled.

Flame spraying or spray welding are similarly suitable methods for application of the wear-resistant layer 19 in liquid form, which permit an even better distribution of the liquid with simplified additional provisions such as molding means in case of casting. Especially good results concerning the adhesion of the applied layer 19 on the corresponding surfaces of the conductor rail 10 and with reference to as small as possible an electrical transfer resistance between each layer 19 and the conductor rail 10 are obtained, if the material of the layer 19 is applied by means of a plasma spray pistol. In this connection the material of the layer 19 is melted in an arc, the material being generally supplied in powder from to the arc burning in the spray pistol and is conveyed under high pressure in the direction out of the spray pistol onto the conductor rail 10, by means of an ionised carrier gas supplied to the spray pistol, which can be an inert gas or also disassociated water ionised into its constituents. With this there arises a locally sharply defined zone of high heat application, while the remaining volume of the body aids for rapid removal of the heat application with practical exclusion of formation of an intermetallic layer. In the same way a reliable breaking up of the aluminum oxide layer at the instantaneous application point is achieved, whereby by the simultaneous coating a possible reformation of the oxide layer is suppressed.

If the production of a strong temperature gradient gives rise to doubts of a constructional or metallurgical nature, there can be applied first to the corresponding sides 13, 14, 15, before the application of the liquid material of the layer 19, an intermediate layer 20 which has good adhesion to the body, i.e., to the conductor rail 10 and to the layers of wear-resistant material, and which hinders diffusion of the wear-resistant material into the body or vice versa, which can consist of nickel, of a nickel-aluminum alloy, of tin, zinc, silver, copper, or alloys of these metals. These metals form, with the aluminum body and the material of the wear-resistant layer 19, intermetallic compounds, which in contrast to one of aluminum and iron or one of their alloys, are not however brittle and electrically poorly conducting. The thickness of the intermediate layer 20, which can amount to between 5μ and 300μ, conforms substantially to the requirements of the wear-resistant layer 19, such as life with pre-determined coefficients of friction and frequency of rubbing operations, permissible tolerances of layer thickness, etc., which substantially call for the thickness of the layer 19.

With increasing thickness of the layers the thermal stresses upon the composite structure resulting from environmental influences will increase and thus the intermetallic connection mechanism must be able to pick-up and reduce these stresses.

The lowering of thermal stresses or tensions on the ground of external influences and also those brought about by coating is further supported, in that the intermediate layer 20 has pores.

The materials of the intermediate layer are, in a possible embodiment of the method, melted in an arc and applied by a plasma jet onto the corresponding sides 13, 14, 15, cooperating with the pick-up 18. Since these materials form no intermetallic compounds, which could disturb conduction of current, suitable considerations of manufacture, such as a rational assembly, simplification of the expenditure on apparatus etc., call for this mode of application. In addition it has appeared surprisingly that, by the application of the wear-resistant layer by means of a plasma jet, the thickness of the layer to achieve the same life as those produced according to the remaining methods, can be reduced by reason of its increased resistance to frictional wear despite the same material composition, as used
for the remaining methods. Under certain conditions the wear-resistant layers produced according to the invention should subsequently be ground. The danger of a local formation of cells favouring corrosion is counteracted, in that on the narrow sides of the layers which are exposed to the surrounding atmosphere sealings can be applied.

Suitably the layers of wear-resistant material is applied in a thickness of 0.3 to 2 mm.

What we claim is:

1. Method of manufacture of a conductor rail consisting of a body of aluminum or an aluminum alloy on which is a layer of a more resistant to wear material selected from an alloy of a metal of the group consisting of iron, nickel, chromium, and copper in which the method the material is applied while it is in its liquid state, and simultaneously the heat content of the material is carried away through the body.

2. Method according to claim 1, wherein the material is cast.

3. Method according to claim 1, wherein the material is applied by flame spraying.

4. Method according to claim 1, wherein the material is applied melted in an arc by means of a plasma jet.

5. Method according to claim 1 wherein before the application of the material on the surfaces of the body intended for the pick-up of electrical current, an intermediate layer is applied which has good adhesion to the body and to the material and hinders diffusion of the material into the body and vice versa.

6. Method according to claim 5, wherein the intermediate layer is of a metal selected from the group consisting of nickel, nickel-aluminum alloy, tin, zinc, silver, copper and alloys thereof.

7. Method according to claim 5, wherein the intermediate layer is applied in a thickness of 5µ to 300µ.

8. Method according to claim 5 wherein the material of the intermediate layer is applied in a melted state by means of a plasma jet.

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