METHOD OF JOINING DISSIMILAR METALS BY PLATING

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Field of Search........................................204/16, 40

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ABSTRACT

Dissimilar metal parts such as aluminum and stainless steel are machined to prepare a connecting joint between the parts. Preliminary adherent coatings are individually applied to the dissimilar metal parts in the machined areas. The parts are then positioned together and subject to anodic and cathodic treatments. Metal is then electrodeposited to fill in machined portions of the joint, to provide a mechanical structure capable of transmitting stress from one part to the other.

4 Claims, 9 Drawing Figures
METHOD OF JOINING DISSIMILAR METALS BY PLATING

In some instances dissimilar metals cannot be joined together by conventional methods such as welding, soldering, and adhesive bonding. This applies when the metals have completely different properties such as steel and aluminum. Furthermore, operational conditions in other instances prevent the use of soldering or adhesive bonding.

Other methods of joining which would be competitive with plating techniques include diffusion and explosive bonding. Although the latter diffusion and explosive bonding techniques may be readily applied to joining flat surfaces, they are difficult and sometimes impossible to use in joining curved or irregular surfaces.

It is an object of this invention, therefore, to provide an improved method of joining parts of dissimilar metals which avoids one or more of the disadvantages of the prior art methods and which provides a joint of improved strength.

It is a further important object of this invention to provide an improved method of joining two dissimilar metal sections by electrodepoating metal between the section to enable the transmission of stress from one section to the other section through the electrodeposited metal.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is a view in cross section of an aluminum tube constituting one part to be joined;

Fig. 2A is a view in cross section of a steel tube which is to be joined to the tube illustrated in Fig. 1;

Figs. 2 and 2A show joint preparation by machining of the parts illustrated in Figs. 1, 1A;

Fig. 3 is a view similar to that shown in Fig. 2 but illustrating a first coating applied to the aluminum section;

Fig. 4 is a view similar to Fig. 3 but illustrating a second coating applied over the first coating of the aluminum section;

Fig. 5 shows the machined end portion of the aluminum section of Fig. 4 positioned into engagement with the machined end portion of the steel section of Fig. 2A;

Fig. 6 illustrates the positioned together parts of Fig. 5 with metal electrodeposited on the machined surfaces of the dissimilar metal sections;

Fig. 7 is a view similar to Fig. 6 with the excessive build-up of the electrodeposited metal at the joint juncture machined away.

Referring to Fig. 1 of the drawing there is shown a section of metal 10 such as aluminum, which part or section is capable of being joined to a second part 11, Fig. 1A, of dissimilar metal such as stainless steel in accordance with the method of the present invention. Both parts 10, 11 while illustrated as being in the form of a tube, may be of other irregular shape having dissimilar contours. The aluminum tube 10 is shown as including a joint end portion 13 which is adapted to be joined to end portion 14 of the steel part 11.

With reference to Fig. 2, the portion 13 of the aluminum tube 10 is machined as at 15 to enable it to be received within the inner bore 17 of the steel tube. For this purpose the diameter of the machined portion 15 is of slightly less diameter than that of bore 17. An inclined surface 16 is contiguous with the cylindrical surface 15 of part 10. The steel part 11 is like machined with a bevel cut as at 18 such that when the parts 10, 11 are positioned together, as will be later described, the bevel surface 18 together with the inclined surface 16 of portion 13 of aluminum part 10 define a recess or cavity 20 for the reception of electrodeposited metal.

Prior to so positioning the parts together the aluminum part 10, Fig. 3, has applied thereto an adherent coating zinc indicated by reference numeral 21. The latter coating may be applied by a double immersion process in a zincate solution. A typical solution is as follows:

<table>
<thead>
<tr>
<th>Sodium hydroxide</th>
<th>2.7 oz/gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc oxide</td>
<td>6.7 oz/gal</td>
</tr>
<tr>
<td>Rochelle salts</td>
<td>0.41 oz/gal</td>
</tr>
<tr>
<td>Ferric chloride</td>
<td>0.3 oz/gal</td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>0.13 oz/gal</td>
</tr>
</tbody>
</table>

Referring now to Fig. 4 the aluminum part is then subjected to a further treatment in which a coating of nickel 23 is deposited on the previously applied zinc coating 21. The nickel coating may be applied by means of a nickel sulfamate bath comprised as follows:

| Nickel sulfamate | 43.6 oz/gal |
| Nickel content | 10.2 oz/gal |
| Nickelchloride | 0.8 oz/gal |
| Boric acid | 5 oz/gal |
| Wetting agent | 0.2 fl oz/gal |

Nickel can also be deposited from other solutions such as the Watt's type nickel solution containing nickel sulfate and nickel chloride. The layer of nickel 23 is deposited on the zinc layer 21 until sufficient thickness is obtained to permit subsequent treatments. A thickness of from 0.0005 to 0.0015 inch has been found to be sufficient. It will be understood that in the illustration of the drawing the thickness of the treatment layers is greatly exaggerated for clarity.

With reference now to Fig. 5, the nickel plated aluminum part 10 of Fig. 4 and the degreased steel part 11 of 2A are positioned together so that the machined end 15 of the former enters the internal bore 25 of the latter. In the arrangement shown, the layer 23 on the machined end 15 makes good surface contact with inner peripheral surface of bore 25.

Thereafter the metal parts so positioned are activated simultaneously by anodic treatment at approximately 80 amp per sq. ft. for approximately 2 minutes followed by cathodic treatment at approximately 20 amps per square foot for approximately 6 minutes in an acid-nickel chloride solution. The composition of the solution is 32 oz per gal of nickel chloride and 4.8 oz per gal of hydrochloric acid. This latter activation process serves to make the nickel coating 23 and the surface of the steel part 11 receptive to a good tight bond by removing oxides from the layer 23 and the part 11. With the parts 10, 11 so activated, the same are then placed without rinsing in the nickel sulfamate bath described above. Nickel 27 is then deposited in the cavity 20 until the desired thickness is obtained. As seen in Fig. 7 the excess build-up of electrodeposition 27, including the treatment layers of zinc 19 and nickel 21 on part 10 may be suitably machined off the mechanical structure so produced. In addition since the present method is adapted for short lengths of aluminum tubing, the interior diameter of part 10 is bored out to provide a non-stepped or uniform diameter through the parts so joined. It has been found that the joint strength of the parts so formed has been in excess of 40,000 lbs per square inch.

While the above description of joining has applied to the dissimilar metals of aluminum and stainless steel, it is apparent that copper could be substituted for the aluminum. Thus other combinations of metals can be joined by the above steps of the process providing that the metals can be treated individually in such a manner to make them compatible for simultaneous treatment and electrodeposition of metal.

It should also be noted from the above description that the dissimilar metals are joined without subjecting the metals to high temperatures. Also the entire electrodeposition joining process may be accomplished at room temperature or slightly thereafter.

While there has been described what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

What is claimed is:

1. The method of joining two dissimilar sections of aluminum and steel which comprises machining a portion of each of the sections to enable same to be positioned together, applying a coating of zinc to said aluminum section in the...
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presence of a zincate solution, depositing a coating of nickel on said zinc coating of said aluminum section in the presence of a nickel bath, positioning said machined portions of said aluminum and said steel sections together, subjecting said aluminum and said steel sections to anodic and cathodic treatment in the presence of an acid-nickel chloride solution, and depositing nickel on said machined portions in a nickel bath.

2. In the method of joining two dissimilar metals as set forth in claim 1 wherein said machined portions of said aluminum and said steel sections when positioned together define an undercut portion therebetween, and the nickel electrodeposited on said machined portions is received in said undercut portion.

3. In the method of joining two dissimilar metals as set forth in claim 2 wherein said aluminum and said steel sections are cylindrical, wherein one end portion of one of said sections is received within an end portion of the other section.

4. In the method of joining two dissimilar metals as set forth in claim 3 wherein one end portion of one of said cylindrical section includes a bevelled surface and wherein said nickel is electrodeposited on said surface.

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