United States Patent

Mattia et al.

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[54] METHOD OF JOINING DISSIMILAR METALS BY PLATING

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[52] **U.S. Cl.** **204/16,** 204/40

[51] **Int. Cl.** **C23b 7/00,** C23b 5/46

[58] **Field of Search** 204/16, 40

[56] **References Cited**

UNITED STATES PATENTS

3,455,014	7/1969	Beyer	204/40
1,871,275	8/1932	Ollard et al.	204/16
2,745,797	5/1956	Long	204/16
3,242,565	3/1966	North et al.	29/487

Primary Examiner—John H. Mack

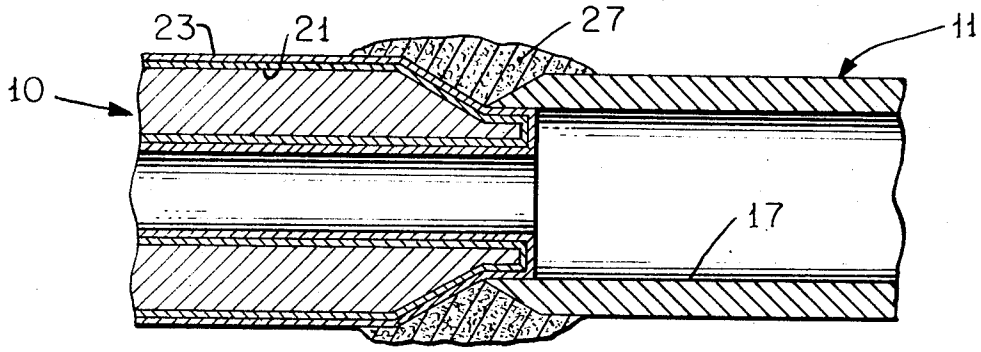
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[57] **ABSTRACT**

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



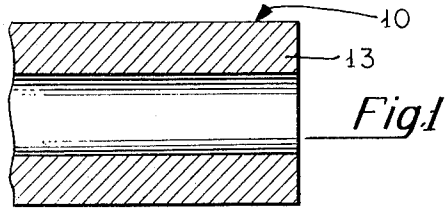


Fig.1

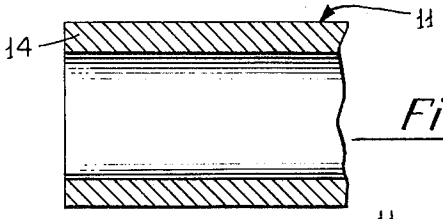


Fig.1A

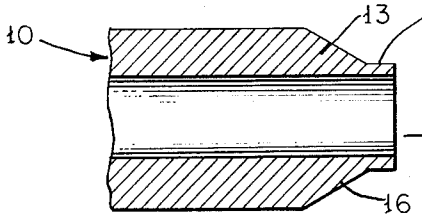


Fig.2

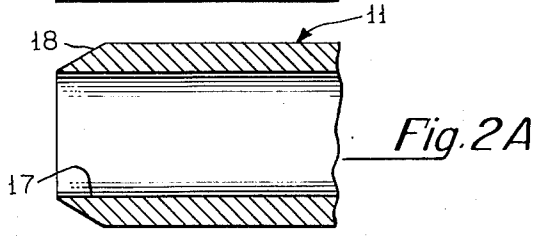


Fig.2A

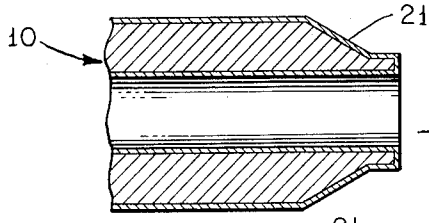


Fig.3

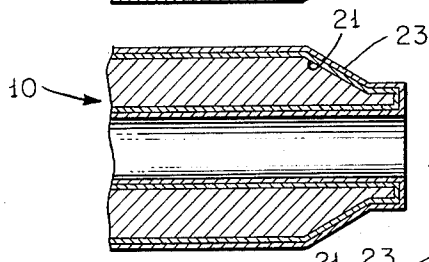


Fig.4

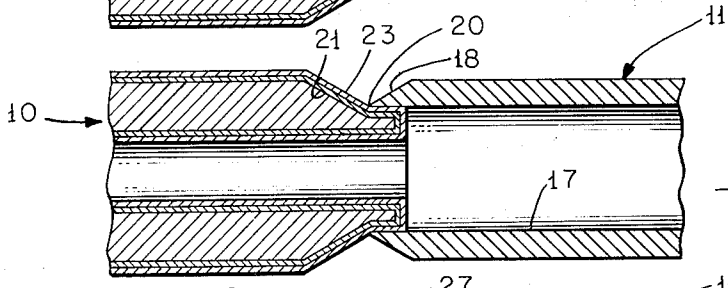


Fig.5

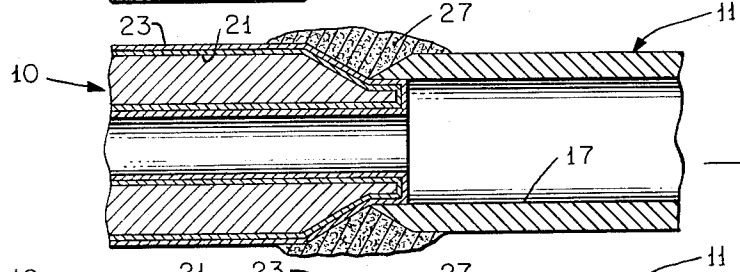


Fig.6

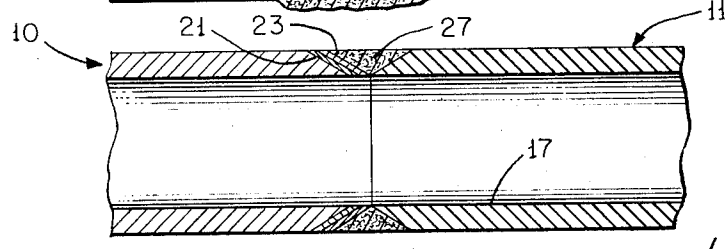


Fig.7

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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 electrodepositing 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. 1A 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:

Sodium hydroxide	16	oz/gal
Zinc oxide	2.7	oz/gal
Rochelle salts	6.7	oz/gal
Ferric chloride	0.40	oz/gal
Sodium nitrate	0.13	oz/gal

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
Nickel chloride	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 electrodeposit **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 thereabove.

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

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 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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