May 17, 1960 J. K. BAXTER 2,937,262

METHOD OF ATTACHING STUD TO TITANIUM BODIES

Filed Dec. 23, 1957

Fig. 1

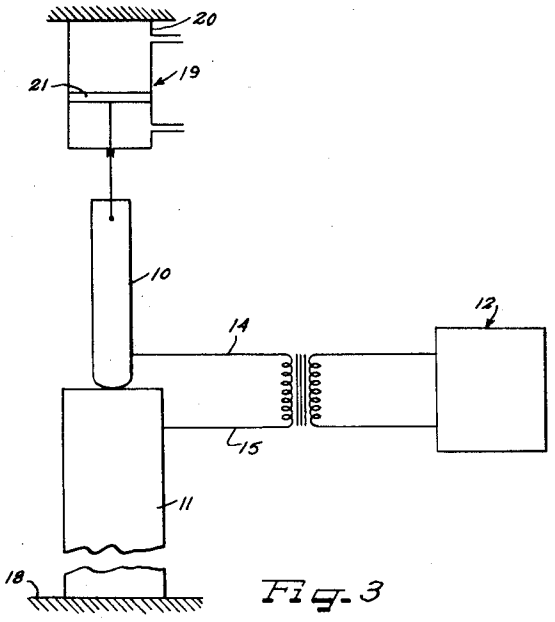


Fig. 2

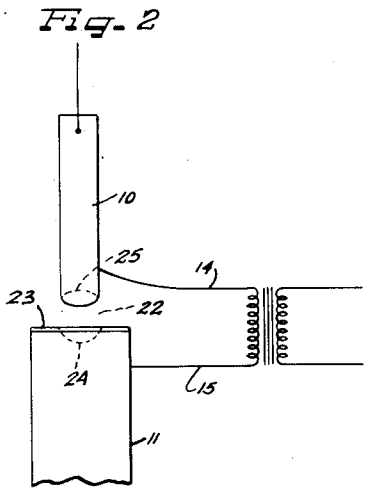


Fig. 3

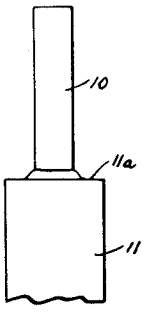


Fig. 4

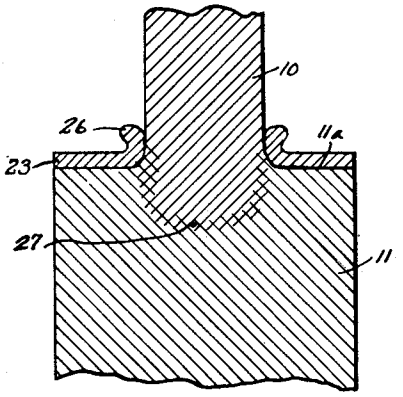
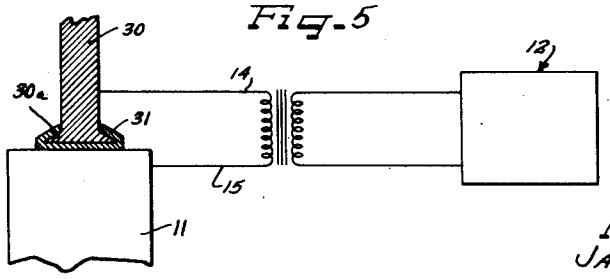


Fig. 5



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METHOD OF ATTACHING STUD TO TITANIUM BODIES

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14 Claims. (Cl. 219—100)

This invention relates to a method and means for securing members to titanium bodies and to the product formed by such method and means.

It is an important object of the present invention to provide a simple and economical mehtod and means for securing members to titanium bodies.

A further object of the invention is to provide a novel and economical handle construction for titanium forging blanks.

Another object of the invention resides in the provision of a novel joint construction between a stud and a titanium body.

Still another object of the invention is to provide a member having an improved bond with a titanium body.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a somewhat diagrammatic illustration of a first step in securing a member to a titanium body in accordance with one embodiment of the present invention;

Figure 2 is a diagrammatic illustration similar to Figure 1 and illustrating a second step in the method of the present invention;

Figure 3 is a view similar to Figure 1, but illustrating a third step in the method of the present invention;

Figure 4 is a somewhat enlarged diagrammatic view similar to Figure 3 and illustrating the bond between a member and a titanium body formed by the method of Figures 1, 2 and 3; and

Figure 5 illustrates a method of securing a steel stud to a titanium body in accordance with a second embodiment of the method of the present invention.

As shown on the drawings:

Figures 1, 2 and 3 illustrate an embodiment of the present invention wherein a copper rod **10** is secured to a titanium body **11** to provide a handling extension for the body. Heretofore in forging titanium compressor blades it has been customary to provide an additional portion of titanium on the forging blank for gripping and handling of the blank. This gripping portion must be discarded during the process of forming the compressor blade as waste material. By providing the blank with a handling extension formed from a copper rod, a savings is effected since the copper is considerably cheaper than titanium. Thus, Figures 1, 2 and 3 may represent the process of securing a copper handling extension **10** to a titanium forging blank **11**.

In accordance with the method of the present invention, a welding machine generally indicated at **12** may have its terminals represented by lines **14** and **15** electrically connected with the member **10** and body **11** respectively to establish an electric current through the portions of the member and body which are to be joined. By way of example, the welding machine **12** may comprise a conventional stud welding machine having a 240–300 ampere motor generator arc welding set. The body **11** may be supported by suitable insulated mechanical means diagrammatically indicated at **18**, while the member **10** may be mounted for axial movement by suitable mechanical means indicated at **19**. The mechanical means **19** has been diagrammatically illustrated as comprising a cylinder **20** and a piston **21** connected with the member **10**.

As a first step in the method, the member **10** is brought into contact with the body **11** to provide a continuous electric circuit between the terminals **14** and **15**. When the electric current has been established through the bodies, the member **10** is moved into spaced relation to the body **11** to establish an electric arc. The portions of the member **10** and body **11** to be joined are heated to a molten condition by this arc indicated at **22** in Figure 2. An oxide layer is indicated at **23** on an end face **11*a*** of the titanium body. The molten areas produced by the arc are indicated by reference numerals **24** and **25**. It is found that in spite of the considerably lower melting point of copper, the copper can be plunged into the molten area **24** on the titanium body.

As the rod **10** of copper is rapidly plunged into the molten area **24** of the titanium body, the oxidized surface material **23** is forced out from between the member **10** and body **11** to a position indicated at **26**. It is found that the copper rod may be pressed into the titanium under these conditions to a point at which the joint between the copper and titanium indicated at **27** is protected from atmosphere and is free of oxides to form a sound alloy. A plunging pressure of about 8 to 10 pounds is used for copper rods varying from ¼ inch to 7/16 inch in diameter. By way of example, oxide layer **23** may have a depth of about 1/32 inch and the depth of penetration of the rod **10** into body **11** may be about 1/16 inch.

A shield of inert gas can be added to the welding area to improve surface appearance and reduce surface oxides; however this is not necessary to achieve full joint strength.

It is found that many metals such as aluminum, iron, brass, and titanium cannot be used as the material for the member **10** since such materials will not penetrate into the titanium as will copper, and oxidation contaminated surfaces prevent good joints.

Figure 5 illustrates a second embodiment of the method wherein a stud of stainless steel **30** is provided with a cap **31** of copper which may be swaged onto the enlarged head **30*a*** of the stud **30** or may be brazed thereon. The method of this embodiment may otherwise be entirely similar to that of Figures 1, 2 and 3, wherein an electric arc is established between the head end of the stud **30** and the titanium body to place an area of the titanium body in a molten condition, after which the stud **30** is plunged into the molten area of the titanium body. As previously, this plunging action forces the oxidized surface material out from between the stud and the titanium body, and the stud is plunged into the titanium to a point at which it is protected from atmosphere to form a sound alloy. A shield of inert gas can be added to the welding area to improve surface appearance and reduce surface oxides, but this is not necessary to achieve full joint strength. In both embodiments, other heating means may be utilized such as an electrical resistance welding machine.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. The method of securing a member to a titanium body which comprises heating an area of said body to a molten condition, and relatively pressing the member into said molten area of said body.

2. The method of securing an appendage to a titanium body which comprises heating an end portion of a member and an area of said body to a molten condition by passing an electric current through said end portion and through said area of said body, and relatively pressing the member into said area of said body.

3. The method of securing an appendage to a titanium body which comprises establishing an electric arc between an end portion of a copper member and an area of said body, and relatively pressing said member into said area of said body.

4. The method of attaching an end of a stud to a titanium body which comprises capping said end of said stud with copper, heating an area of said body to a molten condition, and pressing said copper capped end of said stud relatively into the molten area of said body to form a copper titanium bond.

5. The method of attaching a handle to a titanium forging blank in the formation of a titanium compressor blade which comprises heating an area of said blank to a molten condition and relatively pressing a member into said molten area.

6. The method of attaching a member to a titanium body which comprises heating said body to form a molten area on said body, and rapidly relatively plunging said member into said body to force oxidized surface material out from between the member and the titanium body, the member plunging into the titanium to a point at which the joint between the member and the titanium body is protected from atmosphere and a sound alloy is formed.

7. The method of attaching a member to a titanium body which comprises providing a shield of inert gas about said member and said body, heating an area of said body to a molten condition, and relatively pressing the member into said area of said body.

8. As an article of manufacture a compressor blade blank of titanium having a handle joined with said blank by means of a copper-titanium bond beneath the surface of said blank.

9. As an article of manufacture, a titanium body, and a copper rod secured to said body by means of a substantially oxide-free bond beneath the surface of said body.

10. As an article of manufacture, a titanium body having a stud secured thereto by means of a copper-titanium bond beneath the surface of said body.

11. As an article of manufacture, a titanium body, and a stud having an enlarged head secured to said body beneath the surface of said body by means of a copper-titanium bond.

12. As an article of manufacture, a titanium body, and a member having an end portion of copper forming a substantially oxide-free bond with said body beneath the surface of said body.

13. The method of attaching a low melting high heat conductivity metal member to a higher melting metal body of relative low heat conductivity which comprises heating an area of said body to a molten condition, relatively pressing said member into the molten area of said body beyond any oxide layer on the molten area, and thereafter solidifying the molten area around the member.

14. The method of attaching a high heat conductive metal member to a metal body of low heat conductivity which comprises heating an area of said body to form a molten pool, subsequently pressing said member into the molten pool of said body below any oxide layer on the pool, and thereafter solidifying the molten pool to integrally unite the member and body along a zone in the body spaced from any oxide layer.

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