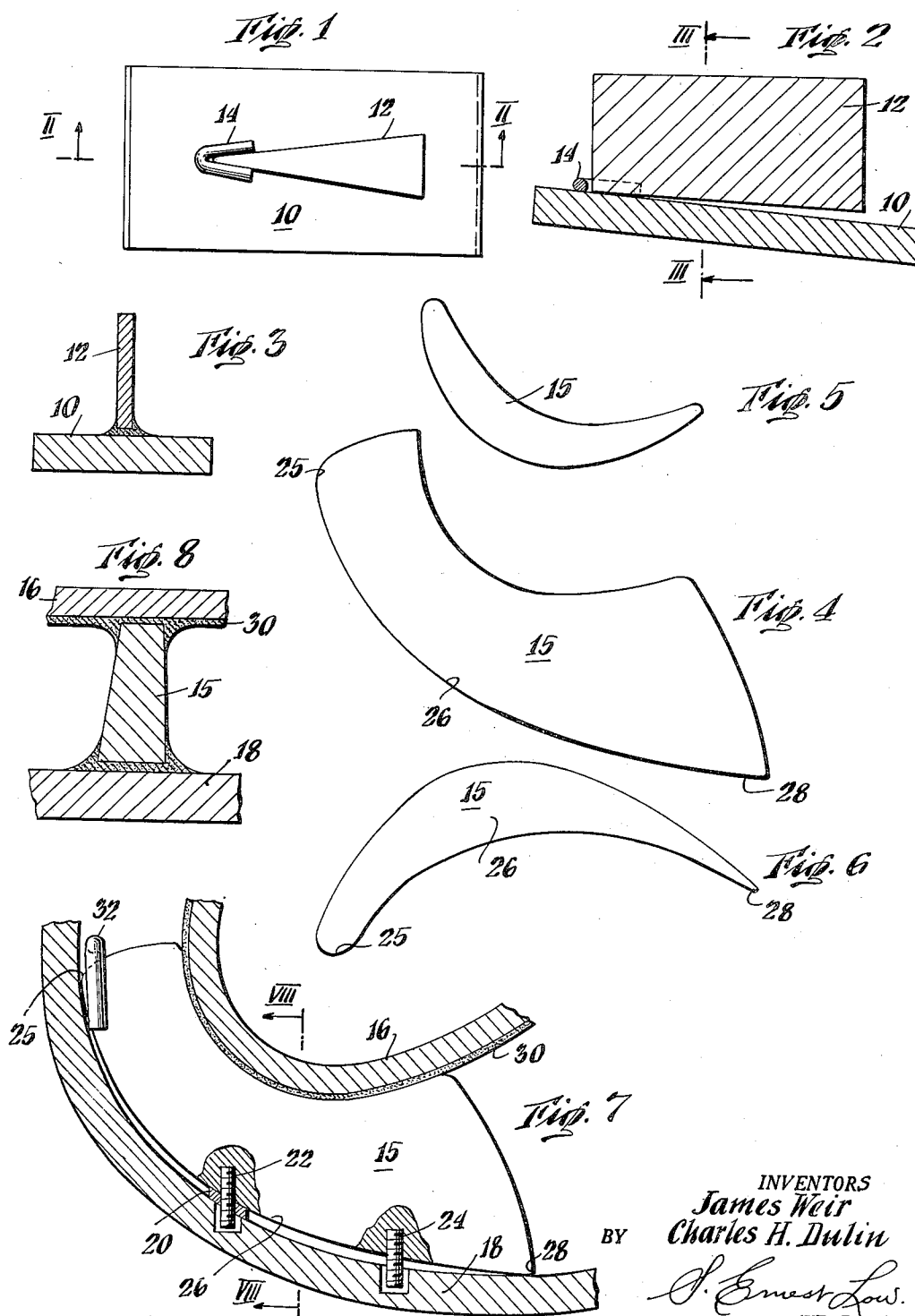


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METHOD OF FUSION JOINING

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METHOD OF FUSION JOINING

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This invention relates in general to a method of fusion joining metallic parts. It is more particularly directed to furnace brazing aluminous parts wherein at least one part is of varying width or thickness adjacent that portion which enters into and forms an integral portion of a finished fusion joint.

Fusion joining has reached a high state of development, and in the light metal field, represented by aluminum and its alloys, it is now possible to replace many of the ferrous and other metals and alloys in structures which heretofore offered considerable manufacturing difficulties. There are, however, many designs and structures, regardless of the metal or alloy from which they may be produced, that do not lend themselves to known and practiced methods and procedure of fusion joining or brazing. This is particularly noticed in structures wherein the strength of the joints does not come up to that required in a particular service. For example, in the construction of pump and turbine units of the centrifugal type, wherein intricately shaped vanes or blades of varying widths and thickness are employed, it has been considered a structural necessity to fabricate such units by casting the blades as an integral portion of their housings to insure against failure of the units under operating conditions. Automotive and industrial torque converters are examples of such units which are being manufactured by casting methods.

We have discovered a fusion brazing or joining method and technique, which has met with success in the commercial production of centrifugal type pumps and turbines, and in which the developed strength of the fusion joints between housings and vanes, in aluminum alloys, is equal to, and in many instances higher than integrally cast units of similar design, by selecting and employing wrought or forged and cast aluminum base alloy elements that respond to thermal treatments to increase the over-all strength of a fusion joined assembly incorporating the same. The invention is not confined to aluminous materials, however, since the method to be herein-after described in detail, is applicable to other metals and alloys that respond to fusion joining.

It is a general object of the invention to provide a method of fusion joining metal parts which permits development of maximum strength at joints between parts of varying width or thickness immediately adjacent a surface forming an integral portion of such joints.

Another object of the invention is to provide a method of fusion joining metallic parts in which

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the zone of jointure between the parts is generally sloping or curvilinear, as viewed in a vertical plane through such joints.

Other objects and advantages will present themselves to those skilled in this art on consideration of the following description and appended claims, when read in conjunction with the drawing, in which:

Fig. 1 represents a plan view of elements or parts of a joint in assembled relationship prior to fusion joining;

Fig. 2 represents a sectional elevation taken along the line II—II of Fig. 1;

Fig. 3 represents a sectional elevation taken along the line III—III of Fig. 2 following a fusion joining operation;

Fig. 4 represents an elevational view of a turbine or pump vane;

Fig. 5 represents a view of the upper face of the vane in Fig. 4;

Fig. 6 represents a bottom plan view of the vane in Fig. 4;

Fig. 7 represents a fragmentary assembly view of the vane in Fig. 4 in relation to housing members prior to fusion joining; and

Fig. 8 represents a sectional elevation taken along the line VIII—VIII of Fig. 7 following a fusion joining operation.

Referring to the drawing, and particularly Figs. 1 through 3, an assembly is illustrated comprising a metal plate or base member 10 above which is mounted a wedge-shaped metal member 12. The member 12, in accordance with the practice of the invention, is supported in bearing contact at its thin or pointed end on the base member 10, and is otherwise progressively spaced therefrom towards its thickened end. This particular spacing of members 10 and 12 is readily accomplished through the use of a suitable jig or fixture. In accordance with a feature of the invention the members 10 and 12 are positioned in such a manner that the clearance increases progressively from an elevated point towards a point of lower elevation in the zone of jointure, as viewed from the thin towards the thick end of member 12.

In fusion joining the members 10 and 12, a fusible joining metal or alloy 14, in the form of a hairpin or bent wire, is positioned adjacent the thin end of member 12, as by encompassing the end and portions of the surfaces defining the thin end of the member. The joining metal or alloy 14 is selected in reference to the metals or alloys being joined and a suitable flux is used, if required, adjacent the surfaces of members 10 and 12 in the immediate area of the finished joint.

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Heat is thereafter applied in sufficient amount to melt the joining material or alloy 14 which, through gravitational flow and capillary attraction, distributes itself along the edges of the joint and fills the intervening space between the juxtaposed surfaces of members 10 and 12. Proper selection of materials and temperature control will insure high strength jointure of the elements, furnace brazing technique, wherein the entire assembly is heated to a uniform temperature sufficient to melt the fusible material 14, having been found satisfactory for this purpose.

In the preferred practice of the invention the volume of metal represented by the hairpin 14 is selected in sufficient amount to provide a continuous fillet around the lower edges of member 12, as well as fill the space under the bottom surface of member 12, shown to advantage in Fig. 3. It will also be understood that diffusion of the molten wire 14 into the metals or alloys constituting the members 10 and 12 will take place in the formation of the fusion joint therebetween.

Figs. 4 through 8 illustrate a specific example of a commercial application of the invention in the manufacture of furnace brazed aluminum alloy turbine units for torque converters. Herein turbine or pump vanes or blades 15 previously made to exact shape (Figs. 4 through 6) in aluminum alloy, as by casting the same, are assembled within top and bottom housing members 16 and 18, respectively. As shown in Fig. 7, the vane 15 is spaced from its complementary housing member 18 by means of an aluminum washer 20 surrounding an aluminum alloy dowel or positioning stud or pin 22. The stud or pin 22 is preferably threaded into the bottom surface of the vane 15 and projects into a clearance hole or aperture in the housing 18. Also, it is preferred to use a second positioning stud or pin 24 mounted in the same manner, and for the same purpose as member 22. It is not essential that the studs or pins 22 and 24 be threaded elements, or that they be in threaded engagement with the underside of the vane 15. They may be loose pins or may be secured in either the vane 15 or housing member 18, their chief purpose being to insure proper relative positioning between their adjacent associated elements.

The vane is positioned within the housing 18 in contact therewith adjacent its two extreme ends, and is otherwise spaced therefrom over its curvilinear zone of jointure therewith. The spacing of the blade or vane 15, in respect to its housing member 18, progressively increases from its highest point of contact, defined by a narrow width of the vane, as at 25, towards an increased width of the vane 15, as at 26, at some lower level in the curvilinear plane or zone of juncture between the parts.

It is also to be observed that the extreme lower end 28 of the vane 15 is in contact with the housing 18. This latter contacting relationship is primarily for purposes of assisting in the support of the vane and does not introduce any departure from the invention.

The upper or top housing member 16 is preferably prefabricated from a composite aluminum alloy brazing sheet, which has on its surface in contact with the vane 15 an integral aluminum-silicon brazing alloy coating 30.

With the various parts described above, assembled as illustrated in Fig. 7, an aluminum alloy brazing wire 32, bent to substantially hairpin shape, is placed in engagement with the vane 15 at its upper end 25. The complete turbine

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unit, only a fragmentary section of which is illustrated at Fig. 7, includes a plurality of vanes 15, all of which are mounted in the same manner within the housing 18, which is preferably in the form of a forged or cast aluminum alloy, disk-shaped member. Similarly, the member 16 is substantially U-shaped and is preferably drawn from a duplex brazing alloy sheet product.

In practice, the surfaces entering into the joints are suitably fluxed, the members assembled as illustrated in Fig. 7, and the entire assembly subjected to a furnace temperature sufficient to melt the hairpin brazing wires 32 and cause the same to gravitationally flow and react to capillary attraction to provide filleted jointure around the base of each vane 15, as well as fill up the intervening space between the underside of each vane and the housing member 18 (Fig. 8). The upper joint between each vane 15 and channel member 16 is formed in the manner described in United States patents to Gustav O. Hoglund 2,258,681 and 2,312,039, issued October 14, 1941, and February 23, 1943, respectively. As in the description of the fusion joint illustrated in Figs. 1 through 3, selection of the aluminum alloys, flux, brazing wire and brazing temperature are essential to produce maximum strength characteristics in the final fusion joined assembly. Known thermal treatments may be used to develop high strength properties in the finished articles. Also the volume of brazing metal in each of the wires 32 should be such that the desired size of fillet for definite strength requirements is produced, the clearance under the vanes being selected and controlled to provide any desired size of fillet, and location of the same.

What is claimed is:

1. A method of making a joint between metallic members, wherein the zone of jointure is defined by a member of varying section width juxtaposed above the member to which it is to be joined, the steps comprising, assembling the first-mentioned member above and in contact with the second-mentioned member at a point defined by a narrow width of the first-mentioned member, adjusting said members to position a wider width of the first-mentioned member at a lower elevation than the point of contact between said members, progressively separating the members from the point of contact towards the wider section, providing a fusible joining material adjacent the point of contact, and raising the temperature of the fusible joining material to melt the same, whereby the melt under gravitational and capillary attraction distributes itself over the zone of jointure to completely fill the intervening space between the members and provide filleted jointure therebetween.

2. A method of fusion joining metallic parts in which the zone of jointure therebetween lies in a sloping plane, and in which at least one part to be joined varies in width adjacent the zone of jointure, the steps comprising, positioning the parts in juxtaposed relationship, providing contact between the parts at a point in the part of varying width defined by increasing width in said part beyond said point of contact, said point of contact being higher in elevation than the immediately adjacent points in the sloping zone of jointure, progressively separating the parts along the sloping zone of jointure from the point of contact towards a wider section of the part of varying width, providing a fusible joining material adjacent the point of contact, and raising

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the temperature of the fusible joining material to melt the same, whereby the melt through gravitational flow and capillary attraction distributes itself over the sloping zone of jointure to completely fill the intervening space between the parts and provide filleted jointure therebetween.

3. A method of joining metallic parts in which the zone of jointure therebetween is curvilinear in form, and in which at least one of said parts varies in width adjacent the zone of jointure, the steps comprising, positioning the parts in juxtaposed relationship, providing contact between the parts at a point in the part of varying width defined by increasing width in said part beyond said point, said point of contact being higher in elevation than the immediately adjacent points in the curvilinear jointure zone, progressively separating the parts along the curvilinear zone of jointure from the above defined point of contact towards a wider section of the part of varying width, providing a fusible joining material adjacent the point of contact in amount sufficient to fill the intervening space between the parts and provide filleted jointure therebetween, and raising the temperature of the assembled parts to melt the fusible joining material, whereby the melt through gravita-

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tional flow and capillary attraction distributes itself over the curvilinear zone of jointure to completely fill the space between the parts and provide a filleted joint.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,019,329	Warren -----	Oct. 20, 1935
2,062,706	Soderberg -----	Dec. 8, 1936
2,146,333	Deming -----	Feb. 7, 1939
2,157,918	Rankin -----	May 9, 1939
2,158,383	Saunders -----	May 16, 1939
2,166,998	Morgan -----	July 25, 1939
2,347,071	Bailey -----	Apr. 18, 1944
2,389,175	Woods -----	Nov. 20, 1945
2,390,789	Haskell -----	Dec. 11, 1945

OTHER REFERENCES

Page 7 of Bulletin No. 12-A titled "Sil-Fos and Easy-Flo." Copyrighted in 1943 by Handy and Harman, 82 Fulton St., New York, N. Y.