March 18, 1941. T. B. CHACE 2,235,200

METHOD OF MAKING COMPOSITE METAL

Filed April 24, 1939

Fig. 1.

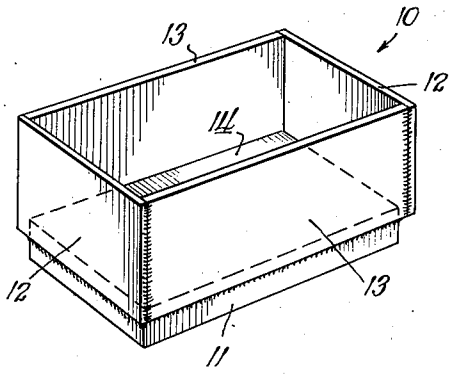


Fig. 2.

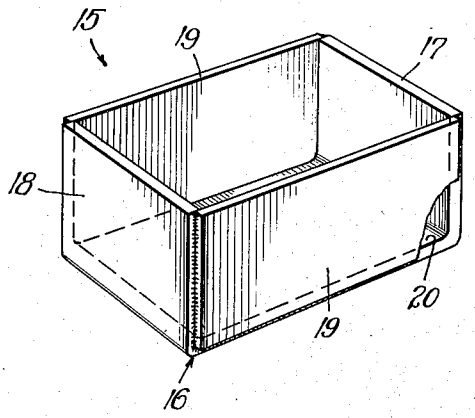
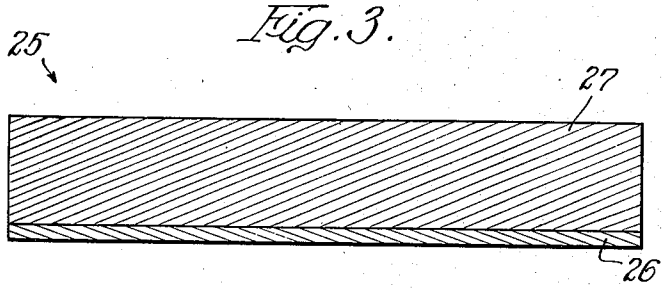


Fig. 3.



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METHOD OF MAKING COMPOSITE METAL

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8 Claims. (Cl. 22—204)

My invention relates, generally, to uniting composite metal, and it has particular relation to uniting a layer of chromium ferrite alloy with other metals.

Heretofore, a great deal of work and research have been directed to producing composite metal stock suitable for making cooking utensils, containers, and apparatus for the chemical and process industries wherein high strength, toughness, ductility, workability, resistance to staining and corrosion, and high heat conductivity are required. Since the amount of composite metal stock required for these uses is relatively large, the cost thereof is also a consideration of great importance.

To date no single metal or alloy appears to have satisfactorily met all of the above requirements, and the logical solution has been to resort to composite metal stock having a plurality of united layers of different metals each having been selected with reference to some particularly desirable property or properties thereof. I have found that composite metal stock comprising a thin layer of chromium ferrite alloy bonded to a relatively thick layer of copper more fully and adequately meets the above requirement than any composite metal stock provided heretofore. By chromium ferrite alloys I refer to alloys comprising 16 to 18% chromium and carbon under 0.10% or 0.12%, the remainder being iron. Such an alloy has also been designated as "stainless iron."

However, due to the peculiar rapidity with which oxide film forms on clean chromium containing metals and alloys, the conventional techniques and fluxes used in uniting different metals, such as copper, to chromium alloys are unsatisfactory.

Accordingly, an important object of my invention is to unite metals and alloys to chromium alloys by using a technique whereby the difficulties of oxide film formation on the chromium alloys are prevented and an integral bond of excellent character is obtained.

Other objects of my invention will, in part, be obvious and in part appear hereinafter.

Accordingly, my invention is disclosed in the embodiments thereof shown in the accompanying drawing, and it comprises the features of construction, combination of elements, arrangement of parts, and methods of production as will be exemplified hereinafter and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description, taken in connection with the accompanying drawing, in which:

Figure 1 is a perspective view of a mold assembly for producing a composite metal slab;

Figure 2 is a perspective view of a modified mold assembly; and

Figure 3 is a sectional view of a composite metal slab adapted to be rolled into composite metal stock.

Chromium ferrite alloys are difficult to bond to other metals because of the weld-interfering chromium oxide film which forms almost instantaneously on exposure to atmosphere at room temperature. This oxide is not readily dissolved by the usual fluxes which are suitable for subsequent bonding operations such as heating to high temperatures. To overcome this problem and to secure an inseparable bond which will withstand rolling strains, I first dissolve the chromium oxide with a 35 to 50% cold hydrochloric acid solution. This can be accomplished by pouring a sufficient amount of the acid pickle into the mold to cover the bonding surface to a depth of one-eighth inch. A period of about twenty minutes is required to thoroughly dissolve the chromium oxide, after which the excess acid is poured off. While the surface is still wet and covered with a thin film of the acid, it is quickly covered with a sealing flux such as borax or boric acid. Such a flux covering prevents exposure of the bonding surface to the atmosphere with the resultant re-forming of the weld-interfering oxide. I prefer to apply the borax or boric acid flux as a powder which may be quickly spread over the bonding surface before the acid film dries. The acid solution is purposely used cold so that it does not evaporate and dry as quickly as would a less concentrated hot solution. Usually powdered flux to the depth of one-half to one inch is applied. When copper is to be united to chromium ferrite alloy, the mold with the flux covering may then be subjected to furnace temperatures of about 2150° F., at which the flux covering melts and provides a viscous liquid-tight seal during preheating and conveying of the mold to the pouring platform where copper is cast to fill the mold and replace the flux. In pouring the flux rises to the surface and is skimmed off before the copper solidifies. In brief, the essential steps of bonding chromium ferrite alloys to copper alloys are; dissolving the chromium oxide with acid; keeping the surface sealed with acid film until covered with the powdered flux; and, keeping the

surface sealed with flux during transfer to the furnace, during preheating and transfer to the casting platform, and until the flux is replaced with molten copper.

Referring now to Figure 1 of the drawing, a mold assembly is shown generally at 10 comprising a slab 11 of chromium ferrite alloy having end and side thin metal welding strips 12 and 13, respectively, welded around the sides thereof. The end and side strips 12 and 13 form a liquid-tight mold space around the top surface 14 of the slab 11. To produce a composite metal slab, the surface 14 may be first cleaned by acid and the surface 14 covered with a powdered flux such as borax or boric acid as outlined above. The mold assembly 10 with the surface 14 thus cleaned and covered may be then preheated to melt the flux and heat the slab 11 above the melting point of copper. Having been thus preheated, molten copper is poured into the mold space of the mold assembly 10 and allowed to integrally bond to the surface 14.

If the slab of chromium ferrite alloy is sufficiently thin, a mold assembly may be provided as indicated generally at 15 in Figure 2 of the drawing. The mold assembly 15 comprises a slab of chromium ferrite alloy 16 having its ends 17 and 18 upturned as shown. Thin metal side strips 19 are welded on opposite sides of the slab 16 and the upturned ends 17 and 18, as shown, to provide a liquid-tight mold space around the top surface 20 of the slab 16. The mold assembly 15 may be prepared and the mold space filled with molten copper as outlined above in connection with the mold assembly 10 of Figure 1.

Referring now to Figure 3 of the drawing, a composite metal slab is designated generally at 25 which may have been formed as outlined above in connection with either Figure 1 or Figure 2 of the drawing. The composite metal slab 25 comprises a relatively thin layer 26 of chromium ferrite alloy and a relatively thick layer 27 of copper integrally bonded to the layer 26. Where the composite metal slab 25 is to be used as stock for cooking utensils and the like, the layer 27 is preferably pure copper with perhaps a deoxidizing agent such as manganese or phosphorus added to an extent of less than one-half of one percent. Other deoxidizing agents well known in the art may be used. The composite slab 25 may be rolled according to conventional rolling mill practice into thin composite metal stock of desired thickness. Thus, a composite metal slab 25 of four or five inches in thickness may be rolled into composite metal stock of No. 25 gauge.

It will be understood that although composite metal stock has been shown and described having a single layer of chromium ferrite alloy, composite metal stock could easily be likewise provided having thin layers of the chromium ferrite alloy on opposite sides of the relatively thick intermediate copper layer.

Although my invention has been particularly described and illustrated in connection with uniting copper to chromium ferrite alloy, it will be understood that this has been by way of illustration and that the principles involved are applicable in the uniting of other metals to any chromium alloy where chromium oxide film formation prevents bonding.

Since certain further changes can be made in the foregoing construction, and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter shown in the accompanying drawing or described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. The method of producing composite metal stock for cooking utensils and the like which comprises, welding thin metal mold strips around a slab of chromium ferrite alloy to form a liquid-tight mold space around the top surface thereof, cleaning said surface with acid, covering the wet surface with powdered borax or boric acid flux, preheating the flux-covered slab, and casting molten copper in said mold space to produce a fusion bond between the copper and the face of the slab.

2. The method of producing composite metal stock for cooking utensils and the like which comprises, bending up the ends of a slab of chromium ferrite alloy, welding thin metal strips on opposite sides of said slab to form with the bent-up ends a liquid-tight mold space around the top surface of the slab, cleaning the surface with acid, covering the wet surface with powdered borax or boric acid flux, preheating the flux-covered slab, and casting molten copper in said mold space to produce a fusion bond between the copper and the top surface of the slab.

3. The method of producing composite metal stock which comprises, dissolving with acid the chromium oxide film from the surface of a chromium ferrite slab, covering the surface while still wet with acid with powdered flux thereby preventing exposure of the cleaned surface to the atmosphere and re-forming of the chromium oxide film, preheating the chromium ferrite slab, and casting base metal on said chromium ferrite slab to replace the flux and integrally bond to said slab.

4. The method of producing a chromium-ferrite and copper composite sheet which comprises, forming a liquid-tight mold enclosing the surface of a chromium ferrite alloy slab, dissolving with acid the chromium oxide film on the welding surface, preventing the reformation of the chromium oxide by covering the acid-cleaned surface with a sealing flux while still wet with acid, preheating the chromium ferrite alloy slab and mold to melt said flux, and casting copper on said surface to replace the molten flux and integrally bond to said chromium ferrite alloy slab.

5. The method of bonding chromium containing alloys having sufficient chromium to prevent welding due to the formation of chromium oxide with other metals to form composite metal stock which comprises dissolving with acid the chromium oxide film from the surface of a chromium alloy slab, covering the clean surface while still wet with acid with powdered flux thereby preventing exposure of the clean surface to the atmosphere and reformation of the chromium oxide film, preheating the chromium alloy slab with flux covering, and casting a layer of metal on said chromium alloy slab to replace the flux and integrally bond with said slab.

6. The method of producing composite metal stock which comprises, forming a liquid tight mold space by welding metallic strip to a chromium ferrite slab which forms at least an inner wall surface of the mold space, covering said surface of the mold space with an acid capable of dissolving the chromium oxide film from said surface of the chromium ferrite slab, removing the excess acid from the mold space, covering said surface of the mold space with flux while said surface of the chromium ferrite slab is still covered by an acid film and before the chromium

oxide film has had an opportunity to reform, preheating the assembly thus formed, and casting base metal in said mold space to replace the flux and integrally bond to said surface of said chromium ferrite slab.

7. Method of bonding copper to the surface of a body of alloy containing chromium in sufficient amount to produce a weld interfering film of chromium oxide which comprises applying to the surface of the alloy an acid solution capable of dissolving the oxide film, removing the excess acid, and while the surface of the alloy is still wet with a film of the acid solution, applying powdered flux to said wet surface, preheating the body of alloy to cause fusion of the flux, and pouring molten copper into contact with the fluxed surface.

8. Method of fusion-bonding a relatively lower melting point metal to the surface of a relatively higher melting point metal wherein the latter metal contains chromium in sufficient amount to produce a weld-interfering film of chromium oxide, which comprises applying to the surface of the chromium bearing metal an acid solution in which the film of chromium oxide is dissolved, removing the excess acid and leaving a film of the acid upon the surface of the latter metal, applying a powdered flux to the wet surface of the latter metal, preheating the latter metal and melting the flux, and then applying said lower melting point metal in molten form to said fluxed surface and maintaining the same in molten form long enough to secure a fusion bond.

THOMAS B. CHACE.