

May 1, 1951

J. H. CLARK ET AL.

2,551,244

MEANS AND METHOD OF BONDING METALS

Filed April 6, 1948

FIG. 1

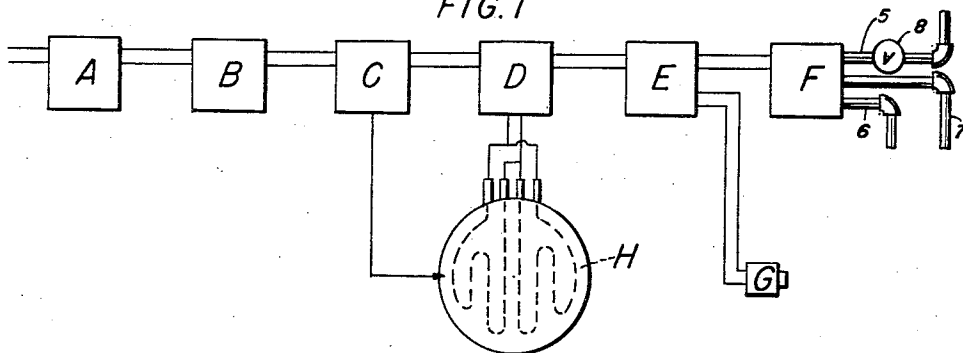


FIG. 2

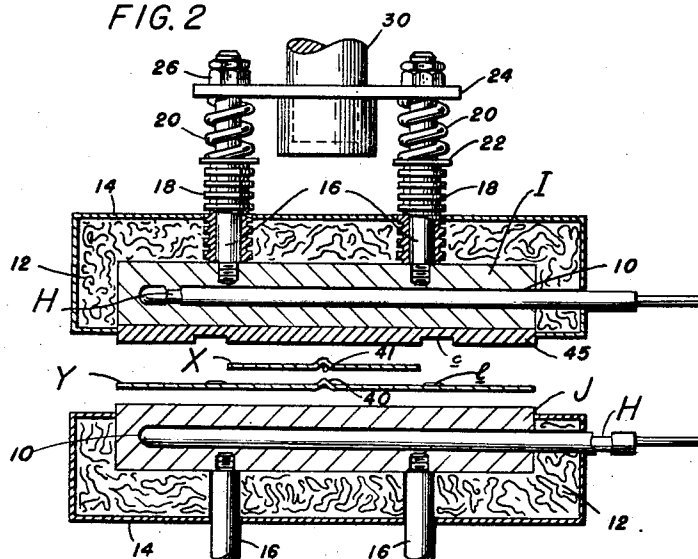


FIG. 3

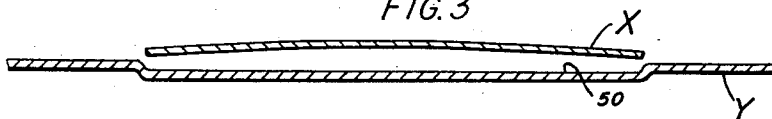
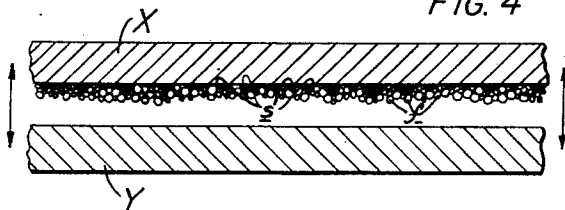


FIG. 4



INVENTORS:
JESSE H. CLARK
WALTER GRAHN
LINUS P. OVEREND
HERSCHEL R. COLE
BY

BY

DL
Burney & Burney
ATT'YS

UNITED STATES PATENT OFFICE

2,551,244

MEANS AND METHOD OF BONDING METALS

Jesse H. Clark, Walter Grahn, and Linus P. Overend, Chicago, and Herschel R. Cole, Glenview, Ill., assignors to Diebrazo Corporation, Chicago, Ill., a corporation of Illinois

Application April 6, 1948, Serial No. 19,294

1 Claim. (Cl. 219—12)

1

This invention relates to a means and method whereby to bond two like or unlike metals, and to do this expeditiously, dependably, and in a way which is adapted to commercial practice. Our invention has special advantages in connection with the bonding of a corrosion-resistant metal with a non-ferrous metal.

Two unlike metals which will be considered as examples here are stainless steel in any of its various alloys and copper in any of its various alloys. Stainless steel is a general term used to designate a corrosion-resistant metal in which is usually comprised iron, nickel, chromium, silicon, and manganese. In certain cases aluminum, copper, columbium, or other elements may be added.

As an aid to an understanding of this invention, reference will be made to the accompanying drawing which illustrates more or less diagrammatically one form of conventional apparatus wherein the bonding of stainless steel and copper may be successfully performed according to our invention.

Figure 1 shows a proposed layout which includes in an electrical circuit a main switch A, a time control clock B, a heat control C operating through a thermo-couple, a relay D, and a program switch E for controlling operation of a valve F. There is also shown a push button switch G in connection with the program switch for initiating operation of the latter.

The relay D is in electrical connection with a heating element H which is contained within a die I as will hereinafter be explained. Likewise the heat control C through the thermo-couple is in connection with the same heating element to confine its operation to a prescribed temperature range. The valve F which may be solenoid-actuated is interposed in a fluid system which operates a press wherein the die I is secured. This system includes an inlet pipe 5 and outlet pipes 6 and 7 in connection with one of two complementary dies. A manual shut-off valve 8 is also placed in the inlet pipe, as shown.

A suggestive construction of the press itself is set forth in Fig. 2 which is a central vertical section therethrough. This press comprises upper and lower dies I and J, respectively, one largely a duplication of the other. Each die is in the general form of a block having excellent heat-conductivity and high resistance to corrosion at elevated temperatures. Such a material which is well suited for our invention is aluminum bronze or the like. Embedded in each die-block is the heating element H, which may be

2

arranged in coils disposed in a single plane to transmit heat uniformly to substantially every point of the die. The heating element may, if desired, be encased in a sheathing 10 of copper or the like, applied thereto as by a casting operation. This sheathing acts to stabilize the coils of the heating element and also to accelerate the conductivity of the heat therefrom into the surrounding die block.

The die blocks I and J, each of aluminum bronze or the like, are each shielded by a suitable insulating medium 12 such as rock wool enclosed within a housing 14 which affords thermal protection thereto from the exterior. Each die block is supported from above or below by two or more posts 16, each in fixed connection therewith, and each passing through the enclosing housing as shown in Fig. 2. Surrounding each post is a column of grooved spacers 18 to promote dissipation of heat, and, in the case of each upper post, a compression spring 20 which rests on the top of the column. A pressure plate 24 is carried by the top posts 16, resting on the tops of the springs 20 and held thereagainst by nuts 26 which are applied to the threaded end portions of the posts. By suitable adjustment of each nut the associated spring 20 may be maintained in a desired state of compression to assure accurate seating of the dies. A vertically extending thrust rod 30 is in connection with the pressure plate 24 at substantially its center point. This rod is part of a piston mechanism (not shown) contained in the fluid system so as to be operated thereby. In response to actuation of the valve F fluid under pressure is released through one of the two outlet pipes 6 or 7 to actuate the piston mechanism whereby to force the rod 30 endwise and exert a downward pressure on the entire unit which comprises the die block I.

The second complementary die block J unit is disposed immediately below the die block I, and is shown as stationary. Its posts 16 of which four may be used serve as legs to support the lower die block J in a fixed position. In all other essential respects the lower die block J is the same as the upper die block I, and all like parts in the two units are given identical reference designations.

The pieces of work to be operated upon by a press mechanism such as has been described may vary widely as to form and shape. For convenience in illustration and description we have chosen two blanks such as are commonly produced from sheets. One blank, designated as X,

3

is of one metal—copper, for example; and the other, designated as Y, may be of another metal—stainless steel, for example. The one is centered with respect to the other to occupy the desired position in which it is to be bonded thereto, and for this purpose it may be found convenient to provide an outset boss 40 in the blank Y which extends upwardly to enter within an inset boss 41 that is formed in the blank X. If these two blanks are circular, then the two bosses will be centrally located. When subjected to pressure, both bosses will be flattened out and all traces thereof eradicated.

The stainless steel blank Y may be rested directly upon the die block J of aluminum bronze or the like. However, it is preferred that the die block I of similar material shall carry on its exposed face a plate 45 which is resistant to flow of current from a copper blank such as might tend to produce a deposit of that metal on the die as a result of electrolytic action. For such a plate stainless steel will be found suitable. The exposed side of this plate 45 which engages the copper blank X may be provided with a shallow annular channel c which closely surrounds the periphery of the blank. Such a channel will then receive any excess flux that is squeezed out from between the blanks when the pressure operation is under way. In addition, if desired, a soapstone line l may be marked upon the upper face of the lower blank Y of stainless steel, closely surrounding the periphery of the copper blank X. A soapstone pencil drawn over the surface of the blank will suffice to mark thereon a line l that will prevent spread and adherence of the flux or solder that may be expressed from between the two blanks when pressure is applied.

Fig. 3 illustrates a blank Y of one metal, say stainless steel, which is preformed with a shallow outset panel 50 of the proper size and shape for reception of the blank X of another metal, say copper. This is one way of centering the two blanks, and of confining the edges of the copper blank within prescribed limits. A bond of two metals, when one is fitted within a recess of the other, will present a very finished and neat appearance.

Fig. 4 is an exaggerated showing, in vertical section, of the disposition of a solder s and flux f when sprayed over the face of one blank, say copper, that is to be bonded to the other blank, say stainless steel. Further particulars on this part of our invention will be given at a later point.

The steps of the process, and the order in which they take place, are these:

1. One of the two blanks, the one of copper let us say, is first treated to abrasion (as by blasting or etching) to clean and roughen its surface where the bond with the other blank will be made.

2. A high temperature solder s of silver or the like is then spread over the treated surface, and upon cooling off it adheres thereto in a condition ready to be flowed in response to heat for establishing a bond with the other blank. The solder may be applied by spraying, by electro-deposition, by rolling, as a foil, etc., although spraying appears to be advantageous from the standpoints of greater flexibility, closer control, less solder used, etc. For the purposes of this invention a solder of silver is the one which is entirely suitable, presumably because of its high melting point, its excellent heat conductivity, its flow characteristics, and the high temperatures which

4

it will successfully stand. If there be other solders having these generally same properties, and particularly if they will become fluid and withstand high temperatures within the range of 750°–1350° F., then they should be equally suitable. As an example, zinc will serve as a satisfactory bonding medium. The term "solder," as used herein should be understood, therefore, to include such a high temperature bonding medium as zinc even though it may not be alloyed with any other metal.

3. A flux f (such as borax or a compound containing a detergent and having borax for its base) is then applied, as by spraying, over the solder coating to provide a substantially continuous sealing film.

4. The flux may then be dried, as by heat, thereby reducing its water content to a point which will produce a cleaner bond.

5. The treated blank in this condition is then positioned upon a blank of the other metal, say stainless steel, from whose contact face corrosion and grease has been previously removed.

6. Both blanks, when so positioned one upon the other, are then placed in a press between dies which are heated to a temperature requisite for the melting of the solder used, say about 1200° F. in the case of silver solder; they are held between these dies long enough—probably fifteen seconds or more—for the temperature of both blanks to be raised to approximately the flow point of the solder and for an alloying to take place between the solder and the two blanks; and during this operation, while the blanks are held between the heated dies, a moderate degree of pressure is maintained—enough to assure a rapid transmission of the heat to every point of the contacting faces of the metals to be united, and to maintain the blanks in their proper form and shape, or possibly to change the blanks to another form and shape, if such a step is to be included in the operation.

7. After the two blanks are thus bonded together, they are removed as a unit from the press when the dies are opened up for this purpose. The bonded article is then allowed to cool; and pickling, cleaning, or other finishing operations, as desired, may follow.

The temperature maintained in the press, and the duration of maintenance of pressure, may vary considerably depending upon such factors as the alloys of the two metals, the mass of metal in each blank, etc. The flux when first spread is in liquid form. It is then dried to become solid, and provide a substantially continuous seal to prevent oxidation. When the blank surface is first abraded, it is rendered practically free of oxide, and it is desirable that this condition should be maintained from that time on. When subject to heat and pressure, the flux melts and tends to run out from between the blanks, any small amount remaining therebetween being inconsequential.

A feature of primary importance is the rapidity with which the requisite heat is transmitted from the press to the work. This is assured by using dies of some such material as aluminum bronze which is resistant to oxidation and stable at elevated temperatures up to 1350° F. or more, and whose coefficient of heat transmission lies somewhere between that of aluminum on the one hand and of copper on the other hand. A blank of stainless steel, when subjected to pressure from a heated die of aluminum bronze, will be quickly heated to the point necessary for melting of the

solder whereby to become bonded to the other blank. Between the other aluminum bronze die and the copper blank it may be desirable to interpose a plate of current-flow-resistant metal such as stainless steel or "Inconel" which will retard the deposition of copper on the die in response to electrolytic action. This plate may be formed with a shallow annular channel which is disposed closely adjacent the periphery of the copper blank to receive any excess flux that may be expressed from between the two blanks. The use of dies of a material having a coefficient of heat transmission comparable with that of aluminum bronze is, therefore, an important factor in the achievement of a satisfactory bond between stainless steel and copper according to this invention.

In the preceding description we have indicated that the dies are heated electrically. While this may be the preferred way in many installations, we contemplate other means for heating the dies such as with the use of gas or other appropriate fuel. Also it has been indicated that the application of flux to the coating of solder is one of the steps of this invention. This is true in most cases, but not all. For example if a controlled atmosphere be maintained around the work so that oxygen is excluded therefrom, the use of a flux may be dispensed with. Also if the piece to be bonded to a copper piece be copper clad to start with, so that the ensuing contact will be copper to copper, a flux need not be used, at least with some of the solder alloys. In fact, there is some advantage in copper plating a piece of stainless steel if this is one of the metals to be bonded. Such a plating, in the process of its application, removes the oxides from the surface of the stainless steel and protects the copper-clad surface from oxidation thereafter. As a result, flux may be dispensed with, permitting a high temperature solder, melting at approximately 1350° F., to be used, or a relatively low temperature solder melting at approximately 1140° to 1175° F., provided that the operation be carried out in a controlled atmosphere from which oxygen is substantially excluded.

Our invention is applicable to the bonding of pieces of like or unlike metals which may vary widely in form and shape. For this purpose suitable recesses or cavities would be formed in the contacting faces of the heated dies or the block of heat-resistant stainless steel which contacts one of the pieces, so that a uniform pressure is directed thereagainst at every point when the two dies are brought to closed position. For certain small work this process may also be performed by a hand tool which is brought up to the work. In such a case it may not be necessary to employ fluid pressure for operation of the dies, since the pressure applied by the hand may be sufficient for work of this kind.

There are many uses to which our invention

may be advantageously put. One of them is the commercial production of cooking utensils where a composite structure will have special utility. With such an article, a copper bottom is specially desirable. According to our invention it may be bonded to the body of the utensil, made perhaps of stainless steel, either before the latter is shaped into its final form, or concurrently during the drawing operation. This example is cited as one of many possible places wherein our invention may be used with special advantage.

The term "bonding" as used herein has reference to the union established between the two metal pieces which are joined in a substantially inseparable relation, in accordance with our process. It might be termed a soldered connection in a lower temperature range, or a brazed connection in a higher temperature range. Whatever be the term that is most applicable will depend largely upon the melting point of the bonding medium that is used. The term "bonding," however, is sufficiently broad to describe the characteristics of the union thus established, and should be construed accordingly.

We claim:

An apparatus for the bending of two sheet metal blanks, one of corrosion-resistant metal and the other of non-ferrous metal, comprising a press mounting two coating die blocks each of aluminum bronze having opposed pressure-applying and heat-transmitting surfaces, means contained within the die blocks for heating each die block to a high temperature, a current-flow-resistant contact plate carried by one die block for engaging with the non-ferrous metallic blank to retard electrolytic action, and means for advancing one heated die block toward the other to subject to heat and pressure the two blanks to be bonded when placed therebetween with the non-ferrous blank facing the current-flow-resistant plate and with at least one of the two said blanks carrying a coating of solder and flux located between the blanks.

JESSE H. CLARK.
WALTER GRAHN.
LINUS P. OVEREND.
HERSCHEL R. COLE.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
916,140	Fulton	Mar. 23, 1909
1,451,880	Lightfoot	Apr. 17, 1923
1,816,115	Helle	July 28, 1931
1,885,992	Coyle et al.	Nov. 1, 1932
2,155,029	Westin	Apr. 18, 1939
2,195,314	Lincoln	Mar. 26, 1940
2,366,164	Weick et al.	Jan. 2, 1945