

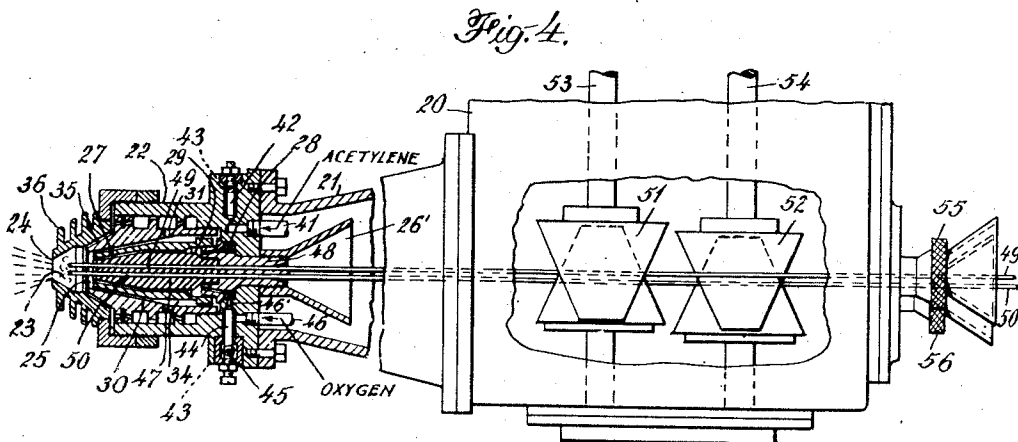
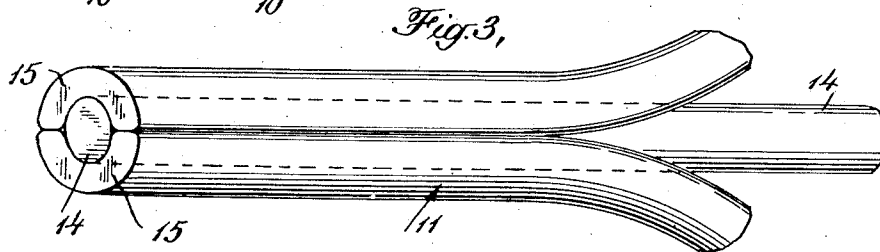
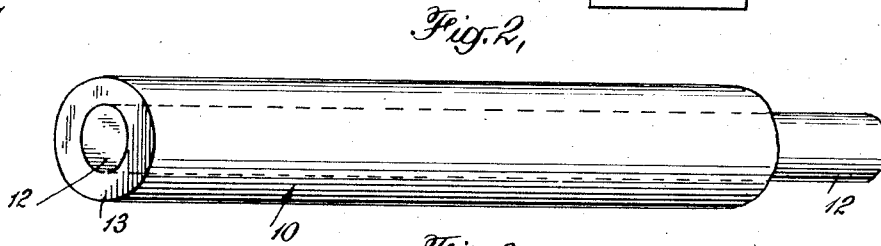
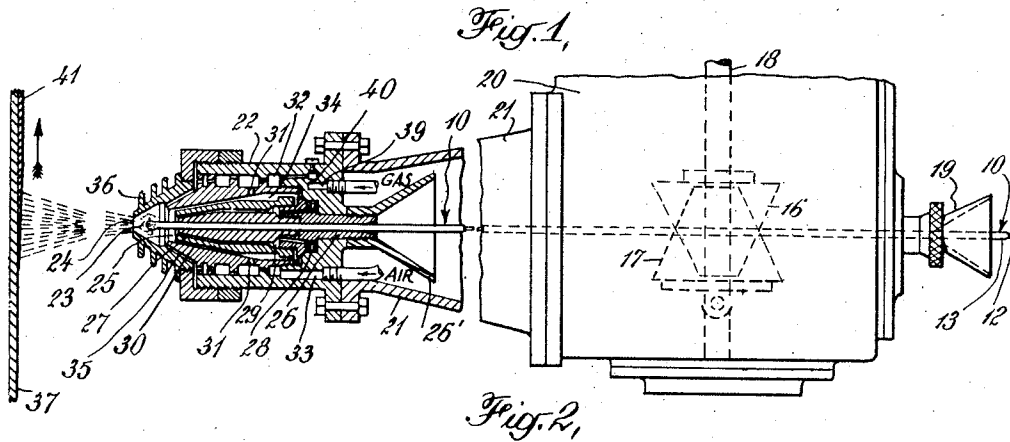
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P. A. BLEAKLEY

2,231,247

METHOD OF FORMING COMPOSITE METAL STRUCTURES

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INVENTOR

Pauling A. Bleakley

BY

Hoguet, Leary & Campbell
ATTORNEYS

UNITED STATES PATENT OFFICE

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METHOD OF FORMING COMPOSITE METAL STRUCTURES

Purling Allen Bleakley, St. Louis, Mo., assignor,
by mesne assignments, to The Bleakley Corporation,
Toledo, Ohio, a corporation of Delaware

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2 Claims. (Cl. 91—70.2)

This invention relates to a method of forming composite structures, and has particular reference to method for spraying mixed molten metals or other materials, or mixtures of molten metals and non-metals, and the like, to form structures for various uses.

In copending application Serial No. 63,587 filed February 12, 1936, there are described a composite metal structure, and the present invention is directed to the method of making the said composite metal structure.

An example of a composite metal structure, which is effectively made in a superior form with the apparatus of this invention, is a copper-lead bearing liner, which has been made heretofore with indifferent and non-uniform results by means of centrifugal casting apparatus or by means of a furnace by the simultaneous quiescent fusion method. The principal reason that intimate mixtures of finely-divided copper and lead have not been readily secured in proper proportions heretofore is because the lead vaporizes at the melting point of copper and with the former apparatus and methods it cannot be enmeshed in a copper matrix with any suitable degree of distribution and only in small volume before escaping.

In accordance with the present invention, method is provided for simultaneously melting two or more materials under pressure in a substantially closed melting chamber at a temperature greatly in excess of their normal melting points, and then simultaneously conveying them in this mixed, molten condition to the surface of application in the form of a finely-divided spray, by means of and within a high pressure tubular envelope of a gas, which sufficiently maintains the mixed materials in their molten or plastic state, and which also protects the molten metal against oxidation by means of an included neutralizing agent in the gas of the envelope, or, by means of an active agent in the gas of the envelope, converts, reduces, or reacts with one or more of the metals to change its physical or chemical structure.

The preferred apparatus for practicing the method of this invention includes a mechanism for continuously and simultaneously feeding two or more metals or other materials for melting to supermolten condition under high pressure within a substantially closed melting chamber by means of an oxy-acetylene, oxy-butane or other high combustible gas flame in the presence of combustion-supporting gas, and being provided with means for supplying the aforementioned

envelope gas at high pressure over the inner surface of the melting chamber and out of a restricted orifice therein, to carry the molten metals or materials at high pressure and velocity in a finely-divided state within its core to the surface of application. The pressure at which the metals or materials are maintained during their molten condition precludes vaporization of the lower melting metals or materials, and their high velocity of travel reduces the time that they remain in the highly heated state and thus aids in retarding vaporization of such low melting metals or materials.

The plurality of metals or other materials, or metals and nonmetals, to be combined in the ultimate composite structure, are preferably provided in the form of strands, which are separately but simultaneously fed to the melting chamber at a rate determined by the degree of mixture desired of the plurality of materials in the finished structure, or in the form of a built-up rod or wire of the plurality of materials, each element of which has a cross-sectional area determined by the proportion of the materials desired in the finished structure, this rod or wire being fed into the melting chamber as a unit.

In the first mentioned arrangement, the plurality of strands are simultaneously fed by separate feed rolls to the melting chamber, preferably through separate guides, and at a rate determined by the predetermined proportions in the finished product. In the second arrangement, a single set of feed rolls supplies the unitary, multi-material rod or wire to the melting chamber, this rod or wire comprising a cored element having concentric layers of the different materials, or a stranded element comprising a plurality of complementary sectional strands cooperating to form a circular-section unitary element, and the like. The higher melting metal or material is preferably fed to the hottest portion of the melting chamber. For example, in the cored rod, the higher melting material forms an envelope for the lower melting material.

In order that a good bond may be procured between the surface upon which the composite metal is to be laid, it is usually necessary that the surface be first prepared, either by a "thermit" type flux, or by heating it to bonding temperature during the spraying operation, which may be done with the spray or the flame issuing from the nozzle, depending upon the position of the surface with respect to the nozzle, or by separate heating means, or by both of these methods.

It will be seen that with the new method of this invention, many materials, otherwise unmiscible in liquid state, may be combined mechanically, and numerous novel and useful composite structures, having unique physical properties resulting from the aggregate of the physical properties of the individual materials, may be provided, and, by a predetermined composition of gaseous conveying envelope, one or more of the materials may be altered in their ultimate physical or chemical structures.

For a more complete understanding of the invention, reference may be had to the accompanying drawing, in which:

Figure 1 illustrates, in partial section, the preferred apparatus for simultaneously spraying a plurality of molten materials according to the method of this invention;

Figs. 2 and 3 illustrate in perspective two forms of a cored rod formed of two or more metals for use in the apparatus;

Fig. 4 illustrates, in partial section, a modified form of the apparatus.

Assuming that a copper-lead bearing is to be made according to the present invention, a cored rod 10 such as is shown in Fig. 2 is prepared, the low melting metal, namely, lead, or an alloy predominantly lead, forming the core 12, while the higher melting metal, namely, copper, or an alloy predominantly copper, forms the tube or sleeve 13 enclosing the lead core 12. The cross-sectional area of the lead core 12 and the copper sleeve or tube 13 are predetermined in accordance with the proportion of copper and lead desired in the finished product. For example, if the finished product is desired to be a mixture of equal parts of lead and copper, the cross-sectional areas of the lead core 12 and the tube or sleeve 13 are predetermined accordingly. With this proportional arrangement of the two metals, the rod 10 can be fed by suitable means to the melting chamber and the predetermined proportion of the lead and copper is deposited on the target or other surface upon which the composite metal is to be laid.

In the rod 11 illustrated in Fig. 3 the lead core 14 is surrounded by two substantially semi-circular strands 15 of copper which are fed simultaneously with the lead core 14 so as to form a tube or sleeve around it in the manner illustrated. In this arrangement a third metal or material may be added simply by making one of the semi-circular strands 15 of such third metal or material. Likewise, the strands 15 may be made of segments less than a semi-circle if a fourth metal is to be included, and so on. Similarly, the rod may be composed of triangular segments jointly forming a rod.

As is illustrated in Fig. 1, the rod 10 or 11 may be conveniently fed to the melting chamber by a drive mechanism comprising two conical rolls 16 and 17, one of which, 16, is an idler, and the other, 17, is mounted on a shaft 18 which is driven from a suitable source of power preferably at constant speed. Details of a suitable driving mechanism for the shaft 17 are illustrated and described in copending application Serial No. 756,076, filed December 5, 1934, by Purling A. Bleakley. The cored rod, such as 10, is inserted through a guide thimble 19 which guides it between the feed rolls 16. Thimble 19 is adjustable laterally so as to change the position of the rod 10 with respect to the feed rolls 16 and 17, whereby the rate of the feed thereof may be varied at will to conform to requirements.

Suitably secured to the housing 20 in which the feed rolls 16 and 17 are located is a conical extension 21 carrying at its outer end the spray head 22 containing the melting chamber 23, which is a substantially closed chamber having a restricted orifice 24 substantially less in diameter than the maximum dimension of the melting chamber 23 and smaller in diameter than the chamber 25.

In operating the apparatus according to the method of the invention, the cored rod 10 is fed into guide funnel 26, through tube 26 and into the chamber 25 simultaneously with the oxy-acetylene or other high combustible fluid mixture, the combustion of which at upwards of 6000° F. progressively melts off the advancing end of the rod 10 within the melting chamber 23. The copper or higher melting metal, being located outside of the lead or lower melting metal, receives the full fusing heat of the flame first and the lead next, although in actual practice there is a simultaneous melting of the two metals.

As illustrated in Fig. 4, which, although embodying a modification of the apparatus for practicing the invention, nevertheless is provided with the same gas supply and mixing means as the arrangement of Fig. 1, with the section taken at right angles to that of Fig. 1, the acetylene, butane or other high temperature fluid is supplied by pipe 41, regulated by an adjustable needle valve 42, conducted by passage 43 to the opposite side of the head 22, into the center passage of needle valve 44 through cross passage 45 to passage 46' leading to turbulence chamber 28. The oxygen is supplied by pipe 46, is regulated by needle valve 44 and flows into passage 46', where it joins the acetylene in its course to be thoroughly mixed in turbulence chamber 28, which is a plurality of diagonal passages as illustrated in greater detail in aforementioned application Serial No. 756,076.

Owing to the difference in specific gravity of the acetylene and oxygen which tends to make them separate, insufficient oxygen is passed by valve 44 to support combustion of all of the acetylene passed by valve 42, the remainder of the oxygen necessary to complete combustion being supplied in the chamber in the manner to be described. The thorough oxy-acetylene mixture is maintained in baffle chamber 29 and it issues in thoroughly mixed condition into the chamber 25 through a plurality of passages or annular space 27.

Because the melting chamber 23 is substantially a closed chamber, the pressure within it builds up considerably and the temperature therein is maintained substantially equal to the temperature of the oxy-acetylene flame, namely, upwards of 6000° F., at which lead and copper are in supermolten condition inasmuch as the lead melts at approximately 625° F., and the copper at approximately 1930° F. The lead is prevented from vaporizing, probably because of the pressure within the combustion chamber 25.

The combustion-supporting air is supplied to the chamber 25 through passages 30 at proper pressure and in proper volume, determined by the metering ports 31, which are drilled passages of predetermined diameter and which pass air to chamber 34, to which it is supplied by passage 33 from a suitable source.

Air from chamber 32 also flows through passages 35 in a thin film under pressure over the interior surface of the melting chamber 23,

thereby cooling the nozzle 36 so that it is not hot to the touch even though the temperature in the center of the melting chamber is in excess of 6000° F. This air issues at considerable velocity from the orifice 24 in the form of a tubular envelope so as to not only comminute or atomize and convey the molten metals in a finely-divided, mixed state out of the combustion chamber 23, but also to maintain the molten metals at a pressure which precludes the metals, particularly the lead, from vaporizing during their travel from the combustion chamber 23 to the target or surface to which the composite metal is to be applied, such as a steel or other metal plate 37.

Depending upon the character of the metals being deposited, the distance of the plate 37 from the nozzle 36 varies from three to eighteen inches. The velocity of the molten metals is high and the temperature thereof is preserved by the high pressure tubular gaseous envelope so that it remains plastic up to the time that it is deposited upon the plate 37 or up to the time that it is deposited upon a previous layer of the metal, both this previous layer of metal and the surface of the plate being heated to a temperature such that the particles of the metal are welded to each other and to the plate 37. The velocity with which the particles strike the plate 37 assists materially in obtaining this close bond or weld.

The surface of the plate may be heated to bonding temperature by the molten metal spray, or by the flame issuing from the nozzle 24, depending upon its position with respect to the nozzle by separate heating means, or by a spray-ignitable flux on the surface, such as aluminum powder or a "thermit" mixture, and the like. Sal ammoniac and other fluxes for non-ferrous metals have been employed with success to secure a good bond between the surface and the sprayed metals. These fluxes are applied in dry or paste form to the surface of plate 37. The thermit mixtures appear to aid in roughening the surface 37 upon combustion. Also, in order to secure more rapid solidification of the composite mixture, the plate 37 may be made of copper or other good thermal conducting material to rapidly dissipate the heat of the deposit metal or material.

It has been found that in order to maintain the two metals, such as copper and lead, in their original state of purity, and to secure a strong, well-bonded structure, a volume of a third gas such as hydrogen or a reducing gas is preferably introduced at 39, metered through metering port 40, and mixed with the air in chamber 32 so as to neutralize the oxygen in the gaseous air envelope, probably by combining with the oxygen. In fact, it has been found that the best copper-lead structure can be obtained on plate 37 by incorporating in the air envelope a supply of hydrogen in the manner described. Similarly, other gases such as acetylene can be added to the air envelope or the entire envelope may be formed of a neutral gas such as nitrogen, or may constitute or include a gas which reacts with the metals being deposited, reduces it, or otherwise changes the mechanical or physical form of the deposited metal. The selection of the third gas in the air envelope or the constitution of the envelope is determined by the nature of the metals being deposited and the requirements as to their treatment during the time that they are in the molten state.

The same process is carried out with a cored rod of the type shown in Fig. 3 whether or not

this rod comprises two, three or more metals. Although the proportion of the deposited metals is determined in the preferred process of this invention by properly proportioning the cross-sectional areas of the rod 12 and its sleeve or jacket 13, it will be understood that the separate strands of different metals may be fed to the melting chamber 23 at different rates by separate feeding means and in that way the proportions of the metals in the finished product predetermined.

For example, as illustrated in Fig. 4, the parts 47 and 48 are provided with two or more passages through which wires 49 and 50, differing in composition, are supplied to the chamber 25 for simultaneous melting in the melting chamber 23 in the presence of combustion-supporting air from 30, and for atomization, mixing and conduction to the place of deposit by the aforementioned gaseous envelope issuing from passage 36 and flowing out of nozzle aperture 24. The wires 49 and 50 are separately fed by independent sets of conical feed rolls 51 and 52, respectively, the shafts 53 and 54 which are preferably driven from a constant speed source. The respective guide thimbles 55 and 56 for the wires 49 and 50 are adjustable in the manner described for positioning the wires with respect to their feed rolls to obtain a speed commensurate with the volumetric proportions of the materials desired in the finished product.

Thus, wires of standard size but of different materials may be fed at different rates to the melting chamber. Also, three or more passages may be supplied in parts 47 and 48 for three or more wires, and the speed of shafts 53 and 54 may be varied instead of employing the conical feed rolls 51, 52 with adjustable thimbles 55, 56. Wires of different compositions may be twisted together into a cable, or otherwise bound together, preferably with the higher melting materials outside, and the cable fed to the melting chamber.

The composite structure 41 of copper and lead on a base 37 may be shaped into a bearing, with the base 37 shaped into a sleeve and the copper-lead structure 41 into the liner. Other structures have different uses, depending upon their compositions and physical or chemical properties. The texture and thickness of the deposit 41 is determined by the distance of the surface 37 from the nozzle opening 24, the materials being deposited, the composition of the gas envelope and the rate of relative movement between the nozzle and the plate 37. The plate 37 may be moved relatively to the apparatus as indicated by the arrow in Fig. 1, or the apparatus may be mounted on a pivot, in guides, or on rails for movement relatively to the work. The thickness of the structure 41 may be increased by continued application of the spray or by numerous passages thereof back and forth.

Although several preferred apparatus for practicing the method of this invention have been illustrated and described herein, it is to be understood that the invention is not limited thereby, but is susceptible of changes in form and detail within its scope. Furthermore, although only certain materials, principally metals, have been mentioned as miscible according to the method of this invention, it is to be understood that the method may be employed for mixing metals and non-metals which melt, become plastic, or comminute or atomize in unmolten form, and the like, such as cements, graphite or carbon com-

pounds, glass, porcelain, sulphur, etc., any one or more of which may be mixed with nickel, copper, steel, etc., it being only necessary to properly proportion them and arrange them so that they can be fed to the melting space in the manner described.

I claim:

1. The method of forming a composite structure of at least two different metals, one of which normally vaporizes at the melting point of the other metal, which comprises supplying the metals to a melting chamber for joint melting therein, melting said metals in said chamber while maintaining therein a superatmospheric pressure sufficient to prevent vaporization of such metals and conveying said metals from said chamber and maintaining them under a pres-

sure precluding vaporization thereof during their travel from the melting chamber to the place of deposit.

2. The method of forming a composite structure of at least two different metals, one of which normally vaporizes at the melting point of the other metal, which comprises supplying the metals to a melting zone for joint melting therein, melting said metals in said zone while maintaining therein a superatmospheric pressure preventing vaporization of said metals and conveying the fused metals simultaneously out of the melting zone to the place of deposit with a gaseous carrier stream under a pressure precluding vaporization thereof.

PURLING ALLEN BLEAKLEY.