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T. B. CHACE

2,156,331

METHOD OF COATING STEEL STRIPS

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Fig. 1.

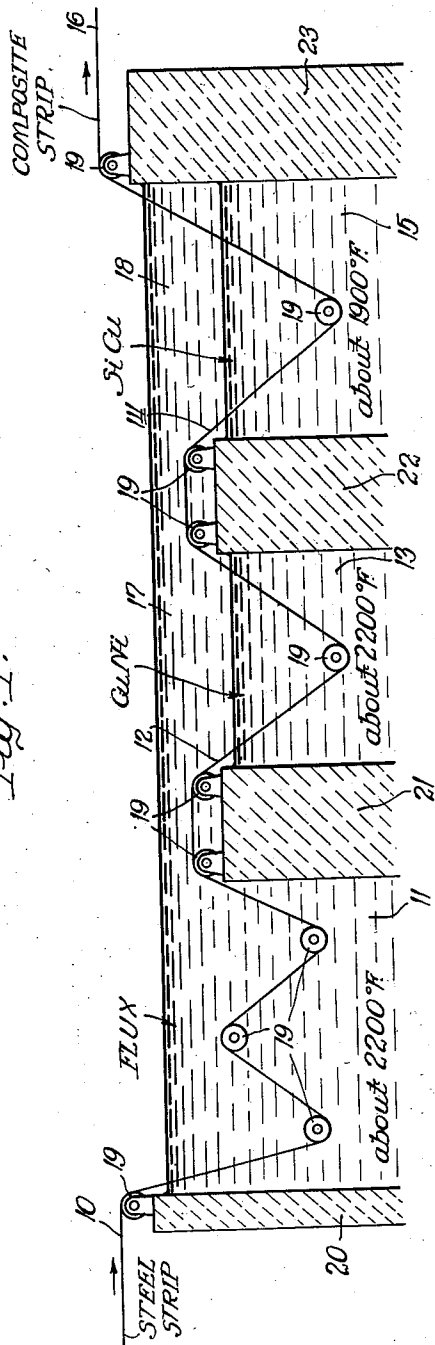


Fig. 2.

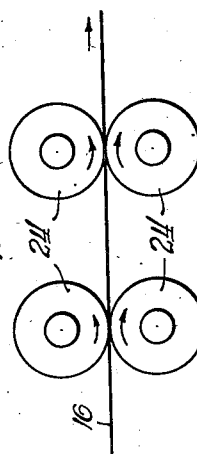
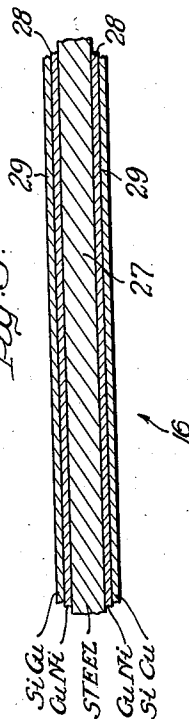


Fig. 3.



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UNITED STATES PATENT OFFICE

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METHOD OF COATING STEEL STRIPS

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4 Claims. (Cl. 91—70.2)

My invention relates, generally, to the art of cladding metals and it has particular relation to the cladding of strips or sheets of base metal as a continuous process to make a composite strip or sheet product having a corrosion resisting surface.

It is well known to employ tin, lead, and zinc, or alloys of the same, for galvanizing steel sheets and strips. The products obtained from this process are not all that is desired, particularly for the more severe corroding conditions to which metals are often subjected. One reason for failure of these products is the fact that there is no real weld between the coating metal and the base metal. The coating metal cracks or peels off in places, particularly if there is any bending or forming after coating. Furthermore, this type of coating metal is comparatively soft and can be readily bruised or scratched through to the base metal, thereby leaving exposed spots that readily corrode. There are many applications for corrosion resisting sheets or strips. These include metal culverts, roofing sheets, and the like, which require that the metal be coated on both surfaces and edges. It is desirable that the coating metal be more resistant to corrosion than those now available, while still remaining in a similar price range.

By my process, as disclosed herein, it is possible to coat steel sheets and strips with copper or high copper alloys and to secure an inseparable bond between the base and coating metals which will not crack or peel during any subsequent bending, forming, or rolling. The resulting composite strip having its surface formed by copper or copper base alloys, which are much harder than the tin, zinc and lead alloys, will be corrosion-resisting and it is not possible to scratch through the clad surface as readily as is the case when the softer tin, lead and zinc alloys are used.

In order to weld properly a coating of copper to steel sheet or strip material, a temperature of about 2200° F. for both metals is required and this should be maintained for several minutes to sufficiently diffuse the two. At this temperature, and during this length of time, considerable iron dissolves from the strip or sheet metal and it contaminates the molten metal bath and also the copper coating which, on solidification, is found to contain appreciable amounts of free iron that not only embrittles the copper but also decreases its resistance to corrosion. Pure copper does not make as good a coating metal as some of the high copper alloys, such as silicon copper. However, this alloy requires a long period

of soaking to weld to steel, thereby exaggerating the iron pickup in the bath.

Accordingly, the object of my invention, generally stated, is to provide a process for making a composite strip having a corrosion resisting surface formed by cuprous metal that may be simply and efficiently performed and which will provide a relatively inexpensive product.

Another object of my invention is to apply a cuprous metal layer around the entire surface of a base metal strip or sheet that will be integrally bonded thereto and have a relatively smooth finished surface.

A further object of my invention is to apply cuprous cladding metal to steel strips or sheets by passing them through molten cuprous cladding metal at such speed that very little of the iron in the strips or sheets dissolves out into the molten cladding metal or is present in the cladding metal bonded to the strips or sheets.

A still further object of my invention is to prevent oxidation of a metal strip while it is being passed into and out of baths of molten cladding metal.

Another object of my invention is to preheat a base metal strip to welding temperature before passing it into a bath of molten cuprous metal.

Still another object of my invention is to successively pass a base metal strip through a plurality of molten cuprous metal baths maintained at successively lower temperatures while excluding the atmosphere from contact with the strip as it is being passed into and out of the molten metal baths.

A further object of my invention is to pass the composite strip between finishing rolls to provide a smooth finished surface and increase the density of the metal forming the coating.

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

My invention is disclosed in the embodiment hereof shown in the accompanying drawing and it comprises the process steps which 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 illustrates, diagrammatically, how the composite strip may be formed by passing it through a plurality of cuprous metal baths maintained at certain predetermined temperatures;

Figure 2 illustrates how the composite strip may be passed between finishing rolls after the cladding process has been completed; and

Figure 3 is a fragmentary sectional view of the composite strip showing, at an exaggerated scale, the different layers of clad metal on the base metal backing strip.

Referring now particularly to Figure 1 of the drawing, it will be observed that the reference character 10 designates a steel strip or base metal strip that is first passed into a bath 11 of molten flux, such as glass or borax or the like, and then it passes as shown at 12 into a bath 13 of molten cuprous metal such as a copper-nickel alloy, a portion of which is integrally bonded to the base metal strip. As shown at 14, the strip then next is passed through a second bath 15 of molten cuprous metal that is preferably formed of a silicon-copper alloy. The composite strip, as shown at 16, then may be wound on a suitable reel or worked as will be presently set forth. It will be observed that the base metal strip or the composite metal strip is not exposed to the atmosphere after it has passed into the bath 11 of molten flux. As shown at 17 and 18, the flux extends over the molten cuprous metal baths 13 and 15, so that the strip is always underneath the flux and contact with atmosphere is prevented. Suitable rollers 19 are provided, as illustrated, for guiding the strip through the various flux and metal baths. Suitable walls 20, 21, 22 and 23, formed of suitable refractory material such as fire brick, carborundum and the like, may be employed for holding the several baths and separating them. These walls may have metal reinforcing or backing as is well known in furnace and foundry practice.

As pointed out in my copending applications, Serial No. 6,497, filed February 14, 1935, and Serial No. 64,280, filed February 17, 1936, nickel greatly increases the weldability of copper to steel and at the same time it raises the melting point of copper. These two properties are of great importance in the production of the composite strip as disclosed herein. For example, a 5% nickel-copper alloy will weld to properly cleaned and fluxed steel surfaces almost instantaneously at a temperature slightly above the melting point of the nickel-copper alloy. Because of this rapid welding action the strip 10 may be rapidly pulled through the molten cuprous metal bath 13 at a high rate of speed and, consequently, the amount of iron that is dissolved into the bath 13 is minimized, as is likewise the amount of iron held in the coating metal on solidification.

It is desirable to have the base metal strip 10 heated to the welding temperature before it is passed through the bath 13. The strip 10 may be preheated before entering the slag bath or it may be preheated by contact with the bath. The bath 11 of flux is heated to approximately 2200° F., so that the base metal strip will be preheated to the desired temperature. This preheating temperature is employed if the cuprous metal bath 13 is composed of 80% copper and 20% nickel. Such an alloy melts at about 2170° F., so that the flux bath 11 is maintained at approximately this temperature to properly preheat the base metal strip.

While the copper-nickel alloy readily welds to the steel backing strip, it is very sensitive to oxidizing atmospheres and it must be prevented from coming in contact with them. Furthermore, the surface that is obtained on solidification of the copper-nickel alloy is not as smooth

as is desired. In order to prevent oxidation of the copper-nickel layer and to provide a smooth finished surface, the base metal strip is passed through the bath 15 of cuprous metal that is formed of an alloy of silicon and copper, such, for example, as 1½% silicon and 98½% copper. Since this alloy melts at about 1860° F. the copper-nickel layer has a chance to solidify and is then adapted to receive the layer of silicon-copper. The silicon content may be as high as 3% or slightly higher with the addition of small amounts of manganese, tin or zinc to make it more workable and to hold the melting temperature down below that of the copper-nickel alloy. By passing the strip from the bath 13 into the bath 15 underneath the layer of flux 17-18, oxidation of the copper-nickel layer is prevented and the surface thereof is well adapted for receiving the silicon-copper layer.

As fully described in my copending applications referred to hereinbefore, the silicon-copper alloy is difficult to weld directly to steel but it bonds readily to a copper-nickel alloy. Thus the time required to bond the layer of silicon-copper to the layer of copper-nickel alloy is reduced to a minimum. Since nickel increases the melting temperature of a copper alloy while silicon decreases it, the proper temperature differential may be provided for the baths 13 and 15 to effect the desired coating of the base metal strip with a composite layer of cuprous metal. The metal baths and their slag coverings may be kept hot by electric heat such as an arc furnace.

As shown in Figure 2 of the drawing, the composite strip 16 may be passed between one or more pairs of finishing rolls 24 in order to further smooth out the surfaces and to improve the density of the cladding metal.

In Figure 3 of the drawing the resulting composite strip 16 is shown at an enlarged scale. It will be noted that it comprises the steel backing portion 27 having integrally bonded thereto layers 28 of the copper-nickel alloy and then integrally bonded to these layers are the outer layers 29 of the silicon-copper alloy. This composite strip or sheet material has excellent corrosion resisting qualities and at the same time the surface is sufficiently hard so that it cannot be readily scratched through and damaged to expose the inner portion 27 of steel backing material.

While I speak herein of the air excluding blanket 17 as "flux" it is to be noted that this material might more properly be designated as a slag. It may consist of a mixture of borax and boric acid with or without the addition of molten glass. It may consist of melted limestone and silica, as in the case of smelting of iron, or any other glass-like slag suitable for the purpose. The purpose of such slag is, first, to exclude the oxygen of the air and, second, to take up or dissolve metallic oxides or salts or like metallic impurities.

Any suitable means for keeping the metal baths hot, such as electric arc heating or resistance heating, may be employed. A gas furnace may also be utilized. The rollers shown may be refractory bodies. Some of these rollers may be free bodies or they may have fixed axes.

While the strip is preferably passed entirely under the slag blanket, this is not always necessary, since the slag is made sticky and viscous enough to protect the surface of the hot strip if it be run above the surface of the bath or blanket.

Since certain changes may be made in the

foregoing process without departing from the scope of the present invention, it is intended that all matter shown in the accompanying drawing or disclosed hereinbefore shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. Method of making a composite metal strip, which comprises: preheating a base metal strip to approximately the same temperature as the first bath through which it is passed, passing the metal strip through a copper-nickel bath maintained slightly above its melting temperature to cause a layer of cuprous metal to be integrally bonded thereto, passing the strip through a silicon-copper bath maintained slightly above its melting temperature to cause a second layer of cuprous metal to be integrally bonded to the first layer without substantially melting the same, and excluding the atmosphere from the strip while it is being passed into and out of the molten metal baths.

2. Method of making a composite metal strip, which comprises: preheating a base metal strip to approximately the same temperature as the first bath through which it is passed, passing the metal strip through a copper-nickel bath maintained slightly above its melting temperature to cause a layer of cuprous metal to be integrally bonded thereto, passing the strip through a silicon-copper bath maintained slightly above its melting temperature to cause a second layer of cuprous metal to be integrally bonded to the first layer without substantially melting the same, excluding the atmosphere from the strip while it is being passed into and out of the molten metal

baths, and passing the resulting composite metal strip between finishing rolls.

3. Method of making a composite metal strip, which comprises: passing a base metal strip through a molten flux bath maintained at approximately 2200° F., passing the metal strip from the flux bath into a molten metal bath composed of about 80% copper and 20% nickel maintained at a temperature of about 2200° F. to integrally bond a layer of the copper-nickel alloy thereto, and passing the metal strip back into the flux bath and then into a molten metal bath composed of about 1½% silicon and 98½% copper maintained at a temperature of about 1900° F. to cause a layer of the silicon-copper alloy to be integrally bonded to the layer of copper-nickel alloy.

4. Method of making a composite metal strip, which comprises: passing a base metal strip through a molten flux bath maintained at approximately 2200° F., passing the metal strip from the flux bath into a molten metal bath composed of about 80% copper and 20% nickel maintained at a temperature of about 2200° F. to integrally bond a layer of the copper-nickel alloy thereto, passing the metal strip back into the flux bath and then into a molten metal bath composed of about 1½% silicon and 98½% copper maintained at a temperature of about 1900° F. to cause a layer of the silicon-copper alloy to be integrally bonded to the layer of copper-nickel alloy, and passing the resulting composite metal strip between finishing rolls.

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