

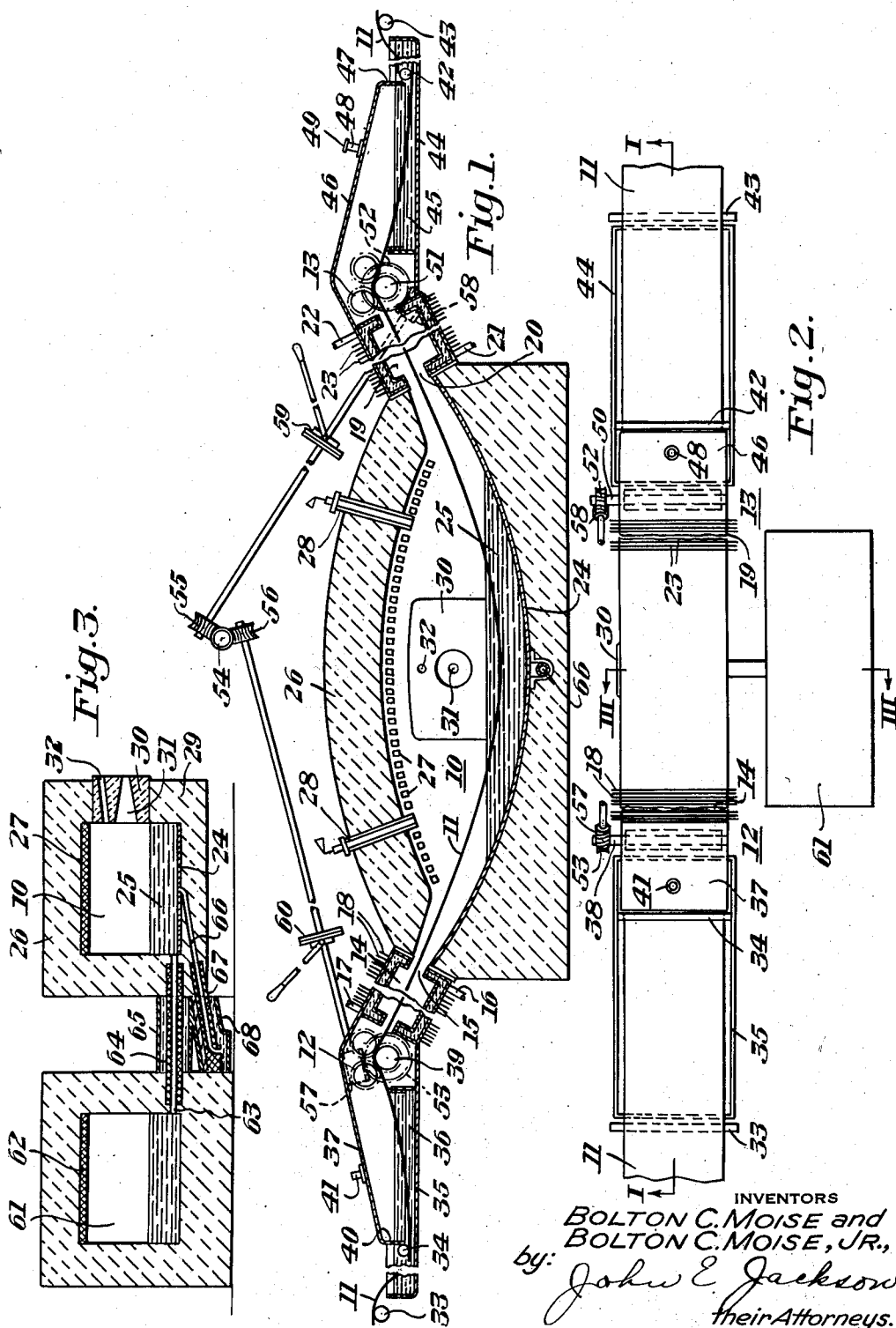
May 8, 1945.

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2,375,434

APPARATUS FOR COPPER COATING FERROUS METAL STRIP

Original Filed Nov. 28, 1940



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UNITED STATES PATENT OFFICE

2,375,434

APPARATUS FOR COPPER COATING
FERROUS METAL STRIPBolton C. Moise, Rock Point, Md., and Bolton C.
Moise, Jr., Cambridge, Mass.Original application November 28, 1940, Serial No.
367,550. Divided and this application January
8, 1943, Serial No. 471,754

4 Claims. (Cl. 91-12.7)

This invention relates to copper coated sheet-like ferrous material and one object is to provide a simple, relatively inexpensive method of forming, on a continuously moving strip of sheet-like ferrous material, a non-porous coating or envelope of copper which is joined to the ferrous base by an alloy bond.

Various methods have heretofore been proposed for obtaining such a product. Bimetallic ingots having a ferrous metal core and a copper jacket have been worked down to sheet-like form by successive rolling operations. Sheet-like ferrous material has also been coated with copper by electrodeposition.

The methods using bimetallic ingots are expensive and various difficulties have been encountered, not only because of bad or spotty bonding of the copper jacket metal to the core or base metal, but because of difficulties in roll reducing such ingots to sheet-like form.

Methods in which the copper coating is obtained by electrodeposition are not only difficult to carry out, but are expensive, and in the main unsatisfactory. The copper coating is more or less porous and bonding between the coating and the base metal is difficult to obtain.

There is a large and growing demand for sheet-like ferrous material having a non-porous copper coating or sheath which adheres to the base during any manipulations to which the product may be put.

An object of our invention is to provide an apparatus by means of which a non-porous copper sheath or coat may be formed on sheet-like ferrous material to produce a product which is relatively cheap and which may be drawn, stamped or pressed without disrupting the bond between the copper coat or sheath, and the base metal.

Ferrous sheet-like material having a copper coating which is joined to the ferrous base by an alloy bond is superior to galvanized sheet-like material for many uses and a still further object of this invention is to provide an apparatus by means of which sheet-like ferrous material in strip form having a smooth copper coat which is permanently joined to the ferrous body by an alloy bond may be readily produced at a relatively low cost.

These, as well as other objects, which will be apparent to those skilled in this particular art, we attain by the means described in the specification and more or less diagrammatically illustrated in the drawing accompanying and forming part of this application.

In our apparatus of producing on a continuously moving strip of sheet-like ferrous material a copper coating which is connected to such strip by an alloy bond, we take advantage of a fact, well known in the art, that when clean iron or steel at the proper temperature is wet with molten copper while in a reducing atmosphere, a copper coating will almost immediately be formed on this iron or steel and such coating will be connected to the iron or steel base by a ferrous copper alloy bond.

The roll stands are manipulated so that that portion of the strip located therebetween and within the furnace chamber is forced downwardly to form a bend. The furnace chamber is charged with reducing gas and its temperature raised to about 2100° F. Sufficient molten copper to form a bath which submerges the lower part of the strip bend is then charged into the furnace chamber. When the strip reaches temperature, one or the other of the roll stands is manipulated to readjust the contour of the bend and position the same so that it clears the floor of the furnace chamber and avoids contact with the walls of the furnace chamber inlet and outlet openings.

The roll stands which are coupled together so as to operate in synchronism are then driven and the strip continuously propelled through the furnace chamber at the desired speed.

The strip as it passes through the heated reducing atmosphere and the molten copper bath acquires a continuous non-porous coating of copper which is connected to the ferrous base by an alloy bond. The coated strip, upon leaving the furnace chamber, travels through a temperature reducing chamber in which a reducing atmosphere is also maintained. In this cooling chamber, the temperature of the coated strip is gradually reduced from about 2000° F. to about 800° F. at which temperature it reaches the exit rolls.

The exit rolls not only function in conjunction with the entrance rolls to propel the strip and maintain the bend within the furnace chamber but serve to compact and planish the copper coating.

In the drawing accompanying and forming part of this application:

Figure 1 is a more or less schematic view in longitudinal section of an organized apparatus such as may be used in carrying out our novel method and is taken on line I—I of Fig. 2;

Figure 2 is a top plan view of the apparatus illustrated in Fig. 1, and in this view, the appa-

ratus is reduced in size to about one-third of that of Fig. 1 and part of the means for driving the roll stands in synchronism is omitted; and

Figure 3 is a transverse section of the organized apparatus and is taken on line III—III of Fig. 2, but is drawn to a larger scale, being about two thirds the size of Fig. 1.

In the apparatus which is more or less schematically illustrated in the drawing 10 represents the furnace chamber through which the strip 11 of ferrous material is propelled by means of stands of rolls 12 and 13.

Roll stand 12, which is located at the entrance side of the furnace chamber is separated from said chamber by a temperature reducing chamber 14. The exit passage 15 of chamber 14 communicates with the entrance passage of furnace chamber 10 as shown in Fig. 1.

Temperature reducing chamber 14 is water jacketed and provided with a water inlet 16 and a water outlet 17 so that cooling water may be circulated therethrough. The water jacket is also preferably provided with heat radiating fins 18. A temperature reducing chamber 19, having its inlet 20 connected with the outlet of furnace chamber 10 is interposed between such outlet and exit roll stand 13.

Temperature reducing chamber 19 is also provided with a water jacket having a cooling water inlet 21 and an outlet 22. Heat radiating fins 23 are also preferably provided for chamber 19.

The floor of furnace chamber 10 is preferably overlaid with a cover 24 formed from one of the ferrous alloys which will withstand the temperatures encountered in the furnace chamber and which will not contaminate the molten bath of copper 25 in contact therewith and contained within the furnace chamber.

Roof 26 of the furnace chamber carries electric heating elements 27. The terminals 28—28 of these heating elements extend through the roof and are adapted to be connected to a suitable source of current supply.

Side wall 29 of the furnace chamber is provided with an opening which is adapted to be sealed by a door member 30. This door member is provided with a peep-hole 31 and an opening 32 for accommodating a thermocouple.

Strip 11 in entering the organized apparatus, passes over a guide roller 33 and under a guide roller 34. Guide roller 34 is located within a tray or receptacle 35 adapted to contain suitable sealing liquid 36 which with a cover or hood member 37, forms a gas sealing device which entirely surrounds roll stand 12 except for the shaft 38 of roll 39. This shaft extends through one side of cover or hood member 37, and the joint between said shaft and the cover or hood side is formed to prevent leakage of reducing gas through the joint. The sides of hood or cover 37 as well as end 40 thereof extend into tray or receptacle 35 to a position well below the surface of sealing liquid 36. Hood 37 is provided with an inlet 41 for connection to a suitable source of supply of reducing gas, such as hydrogen.

The coated strip upon leaving roll stand 13, passes under a guide roller 42 and thence over a guide roller 43 on its way to a collar or shearing device as the case may be.

Guide roller 42 is located within a tray or receptacle 44 adapted to contain suitable sealing liquid 45.

A hood or cover member 46 which joins the outer end of the water jacket of temperature reducing chamber 19 and covers roll stand 13, is

provided with sides and an end portion 47 which extend into tray or receptacle 44 to a position well below the surface of sealing liquid 45. This hood or cover 46 is provided with a reducing gas outlet 48 and such outlet is surrounded by a constantly burning gas flame 49 so that reducing gas as it escapes through said outlet will be ignited and burned.

Shaft 50 which is the drive shaft of the lower roll 51 of roll stand 13 extends through one side of hood 46 and the joint between said shaft and hood side is formed to prevent the escape of reducing gas therethrough.

Shaft 50 is provided with a worm wheel 52 and shaft 38 of lower roll 39 of roll stand 12 is also provided with a worm wheel which in this case is numbered 53.

Roll stands 12 and 13 are driven from a master worm 54 through worm wheels 55 and 56 which mesh with worm 54, and worms 57 and 58 which mesh with worm wheels 52 and 53.

The shafting between worm wheels 55 and worm 58 is provided with a disconnectible clutch device 59, while the shafting between worm wheel 56 and worm 57 is provided with a disconnectible clutch device 60.

The copper which in a molten state is charged into furnace chamber 10 to form the molten copper bath 25 is melted in a melting chamber 61. This chamber is preferably provided with electric heating elements 62 and is connected to furnace chamber 10 by means of a suitable duct or passage 63. This passage is surrounded by an electric heating element 64 and the element 64 in turn is surrounded by a water jacket 65 through which cooling liquid may be circulated when it is desired to rapidly cool passage 63.

Furnace chamber 10 is provided with a drain channel 66 and an appreciable portion of this channel as shown in Fig. 3 is surrounded by an electric heating element 67. This heating element is also water jacketed as shown at 68 so that cooling liquid when desired may be circulated therethrough for the purpose of rapidly cooling outlet channel 66.

In carrying out our coating procedure, on a coil of sheet-like ferrous material in strip form, it is necessary to make sure that the material is thoroughly descaled and has the proper surface finish.

Before entering the forward portion of the strip into position in the organized apparatus, it is preferable to remove hoods 37 and 46. This gives access to the roll stands and permits the strip to be passed under guide roller 34 through the pass of stand 12, through reducing temperature chamber 14 and through furnace chamber 10. Prior to this, the door 30 of chamber 10 is removed to give access to the interior of the chamber for the purpose of guiding the strip through reducing temperature chamber 19, through the pass of roll stand 13 and under guide roller 42. It will be understood that during the placing of the strip in position in the apparatus, roll stands 12 and 13 are periodically operated and manipulated by means of disconnecting clutches 59 and 60.

When the forward end of the strip passes roller 43, clutch 59 will be disconnected. This stops roll stand 13 and roll stand 12 is utilized to advance the strip until the proper bend is obtained therein between the roll stands and within furnace chamber 10. When this is obtained, both stands are stopped and hoods 37 and 46 are replaced, door 30 is closed, and reducing atmosphere inlet 41 is connected to the source of supply of reducing gas.

Prior to this time, a sufficient amount of copper will have been melted in melting chamber 61 and during such melting, duct 63 leading from the melting chamber to furnace chamber 10 remains cold so that molten copper entering said duct freezes and thus seals the passage between chamber 61 and furnace chamber 10.

When hoods 37 and 46 and door 30 have been replaced and all joints sealed, gas flame 49 is ignited, reducing gas is admitted through inlet 41, and, traversing the seal adjacent roll stand 12, reducing temperature chamber 14, furnace chamber 10, reducing temperature chamber 19 and the seal adjacent roll stand 13 forces the air ahead of it through outlet 48, until the apparatus is filled with reducing gas at a pressure slightly above atmospheric pressure.

Complete filling of the apparatus with reducing gas will be indicated by the burning of such gas as it issues from outlet 48.

When the apparatus is completely filled with reducing gas, the copper which is frozen within channel or duct 63 is melted by turning on current to heating elements 64 surrounding such duct or passage. Molten copper from melting chamber 61 then flows into furnace chamber 10. Sufficient molten copper is charged into chamber 10 to submerge the lower part at least of the strip bend. When the bath of molten copper has reached the proper depth, the current to heating element 64 is turned off and cooling water is circulated through water jacket 65 surrounding said heating element. This freezes the copper within duct 63 and thus stops the flow from melting chamber 61 to furnace chamber 10.

While furnace chamber 10 is being charged with molten copper, the current to heating element 67 is cut off and water is flowed through water jacket 68 surrounding such heating element. This freezes the copper within duct 66 leading from the bottom of furnace chamber 10 and thus seals said duct.

Duct 66 is merely used to drain furnace chamber 10 when repairs to the furnace are to be made or when the bath is to be run out of the furnace chamber for lay overs. The molten copper when it is drained through duct 66 is preferably led to a casting bed.

Peep-hole 31 is used for observing the contour of the strip bend and conditions within the furnace chamber 10. The thermocouple entered through opening 32 is used to ascertain the furnace temperature from time to time for regulating purposes during the operation of our coating procedure.

During operation of our method, cooling chamber 14 not only prevents the temperature of furnace chamber 10 from reaching roll stand 12, and thus keeps the rolls at a safe working temperature, but keeps the ferrous strip at a temperature such that it will remain stiff and fairly rigid until it enters the molten copper bath or somewhat before it enters the bath. This we believe is of assistance in maintaining the forced bend in the strip within the furnace chamber.

During operation of our method, we maintain the temperature of the reducing atmosphere within the furnace chamber at a point just high enough to keep the copper bath in a molten condition and at the desired temperature. This we accomplish by regulating the temperature of heating elements 27.

The temperature of the reducing atmosphere and the speed with which the ferrous metal strip is fed through the reducing atmosphere and

molten copper bath within the furnace chamber are so correlated that the ferrous strip as it leaves the bath is of substantially the same temperature as the bath. Under some conditions it may be desirable to have the temperature of the strip as it leaves the bath somewhat lower than that of the bath, since it is found that a copper coat properly bonded to the ferrous metal strip and which is satisfactory for some uses, can be obtained when the strip is at such lower temperature.

It is our belief that the most satisfactory copper coat and the most satisfactory bond is obtained when the ferrous metal strip leaves the molten copper bath at the same temperature as the copper bath.

Under ordinary conditions, the speed of the strip, the temperature of the copper bath and the temperature of the reducing atmosphere are so correlated as to obtain the best results.

It has been found that the ferrous metal strip as it leaves the molten bath should preferably not be at a higher temperature than that of the bath.

This application is a division of Serial No. 367,550, filed November 28, 1940.

We claim:

1. In apparatus for copper coating sheet-like ferrous material in strip form, a furnace chamber adapted to contain a bath of molten copper, two roll stands for propelling a ferrous metal strip through said chamber, one of said roll stands being located at the inlet side of said chamber and the other at the outlet side of said chamber, means for positively driving said roll stands in synchronism from a common source of power and means for disconnecting either of such stands from said source of power for adjusting the bend in the ferrous strip within said furnace chamber.

2. In an organized apparatus for copper coating sheet-like ferrous material in strip form, a furnace chamber, means for flowing molten copper into said chamber to form a molten bath therein, roll stands on opposite sides of said chamber for propelling a ferrous metal strip through said chamber, means for positively driving said roll stands in synchronism, a cooling chamber between said furnace chamber and the roll stand on the entrance side of said chamber and through which said strip passes, and a temperature reducing chamber located between the outlet of said furnace and the roll stand on the outlet side thereof and through which said strip passes; the construction and arrangement being such that said cooling chamber prevents furnace temperature from reaching the roll stand on the inlet side of said furnace chamber.

3. In apparatus for copper coating sheet-like ferrous metal strip, the combination which comprises a furnace chamber adapted to receive and to hold a bath of molten copper, two roll stands for propelling a ferrous metal strip through the said chamber, one of the said roll stands being located at the inlet side of the said chamber and the other at the outlet side of the said chamber, means for positively driving the said roll stands in synchronism from a common source of power, means for disconnecting either of such stands from the said source of power for adjusting the bend of the ferrous strip within the said furnace chamber, a melting chamber for melting the copper, means interconnecting the melting chamber and holding chamber for supplying copper from the melting chamber to the holding cham-

ber, and means for controlling the temperature of the copper supplying means for controlling flow of copper from the melting chamber into the holding chamber.

4. In an organized apparatus for copper coating sheet-like ferrous material in strip form, the combination which comprises a furnace having a melting chamber and a holding chamber for metal melted in the melting chamber, means for flowing molten copper from the melting chamber into the holding chamber to form a molten bath of copper in the holding chamber, roll stands on opposite sides of the holding chamber for propelling a ferrous metal strip through the said chamber, means for positively driving the said roll stands in synchronism, a cooling chamber between the holding chamber and the roll stand on

the entrance side of the said chamber and through which the strip passes, a temperature reducing chamber located between the outlet of the said furnace and the roll stand on the outlet side thereof and through which the strip passes, the construction and arrangement being such that the said cooling chamber prevents furnace temperature from reaching the roll stand on the inlet side of the furnace holding chamber, the said means for flowing molten copper from the melting chamber into the holding chamber including a restricted duct through which the copper flows, and means for controlling the temperature of such duct in order to control the flow of molten copper therethrough.

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