March 30, 1948. C. A. MANN 2,438,568

METHOD AND APPARATUS FOR MAKING COMPOSITE STRIP MATERIAL

Original Filed Jan. 29, 1941 2 Sheets-Sheet 1

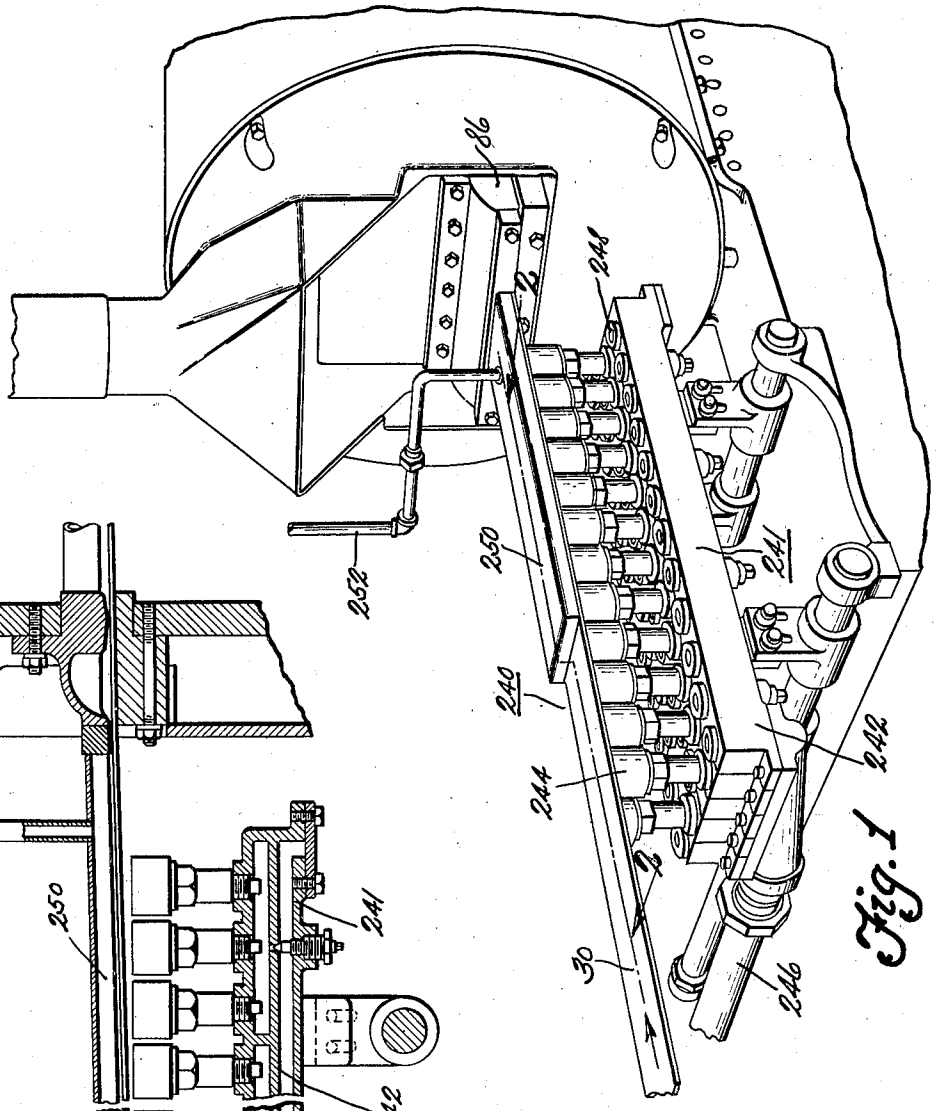

Fig. 1

Fig. 2

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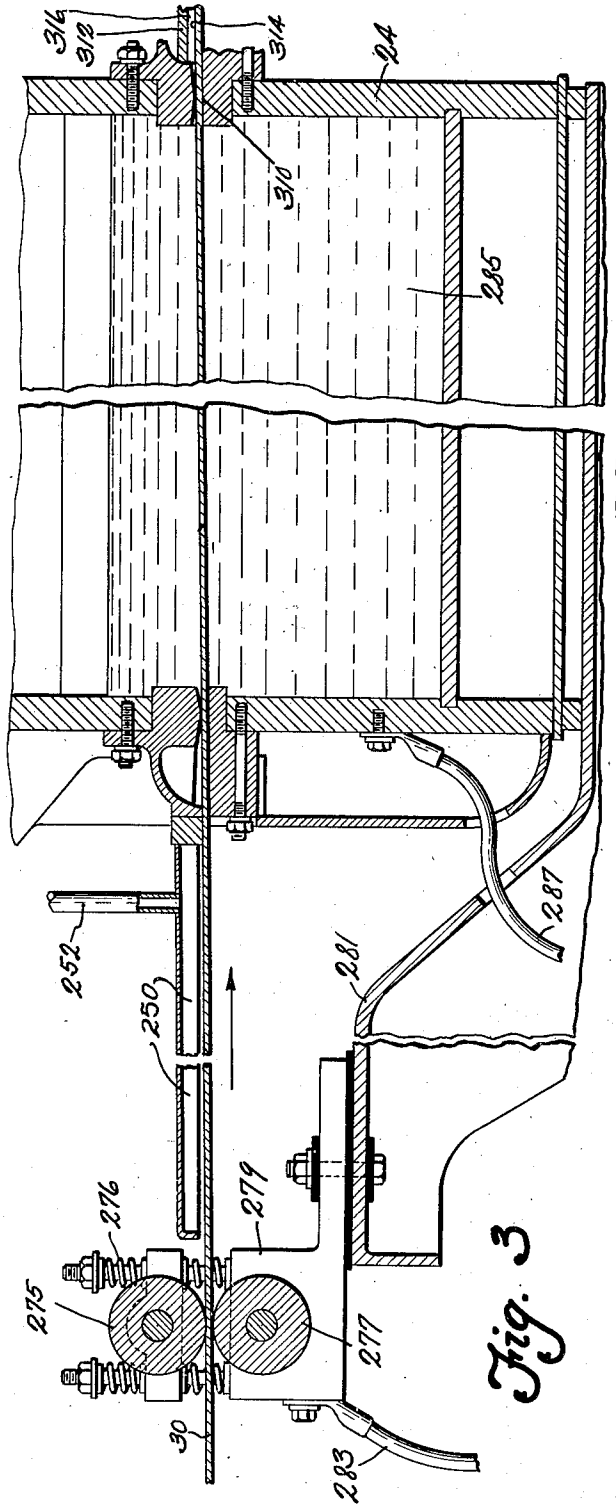

Fig. 3

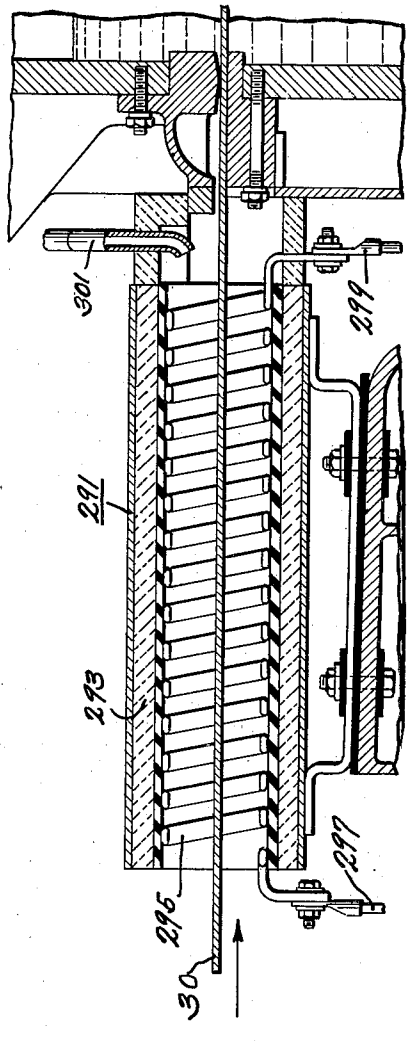

Fig. 4

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METHOD AND APPARATUS FOR MAKING COMPOSITE STRIP MATERIAL

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Original application January 29, 1941, Serial No. 376,512. Divided and this application April 3, 1944, Serial No. 529,325

5 Claims. (Cl. 117—48)

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This invention relates to a method and apparatus for conditioning the surface of a metal strip for subsequent casting operations thereon and is particularly concerned with the conditioning of the surface of a strip wherein another metal is cast on to the surface thereof to make a bimetallic strip.

This invention is a division of my co-pending application, Serial No. 376,512, for Method and apparatus for applying molten metal on strip stock, filed January 29, 1941, and which application has matured into Patent No. 2,405,220, issued August 6, 1946.

An object of this invention is to thoroughly condition strip material by means of a reactive gas under suitable temperature conditions whereby the surface of the strip is partially cleaned, and fluxed.

It is another object of the invention to heat the strip electrically, for example, by resistance or induction heating.

It is a further object to utilize a bath of the molten metal to be cast upon the surface of said strip as one electrode in the electrical heating operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred forms of embodiment are shown.

In the drawings:

Fig. 1 is a view in perspective showing a gas heated type of fluxing apparatus;

Fig. 2 is a view taken on the line 2—2 of Fig. 1;

Fig. 3 shows a fragmentary sectional view of the apparatus wherein resistance heating is utilized to heat the surface of the strip while the same is conditioned by means of a suitable atmosphere; and

Fig. 4 shows a fragmentary sectional view of another embodiment of the invention wherein an inductive heating apparatus is utilized.

In my prior Patent No. 2,405,220, referred to above, an apparatus and method for casting a layer of lower melting point metal on metallic strip stock is disclosed. This apparatus may be used in connection with steel or the like having a porous metal layer bonded thereto, which layer is impregnated with babbitt and includes a predetermined thickness of babbitt overlay thereon. The overlay thickness is regulated by means of a casting gate included with the apparatus. It is manifest that the casting operation may be carried out on strip stock without the porous

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metal layer if a simple cast layer of predetermined thickness is desired.

In all cases in order to obtain a satisfactory alloy bond between the strip stock and the lower melting point metal, it is necessary that the surface of the strip stock be conditioned so that the molten metal will flow evenly thereover and bond thereto after cooling. This conditioning step is required for a number of reasons. One of these reasons is that the surface of steel, iron, nickel, copper or alloy strips usually includes some volatile material thereon. Obviously, when low melting point metal, such as lead, tin or alloys thereof, various babbitts, aluminum, bronze, brass or the like are cast thereon, this material if not removed, forms an integral layer and actual contact of the molten metal is not obtained with backing metal, whereby the bond is made weak and the babbitt layer is easily detached.

Second, it is a known fact that most metallic strips after manufacture contain a submicroscopic layer of oxide at the surface thereof. This oxide likewise is very detrimental to the bonding operation and in fact a strip will not, as a rule, bond readily to a lower melting point metal unless this oxide layer is removed. This may be accomplished to a degree of success by scratch brushing, acid pickling, sand blasting or the like, but it is best accomplished by a reaction between the oxide and a reducing gas.

In order to eliminate these past difficulties, I utilize a fluxing apparatus at the entrance to the main casting apparatus. This fluxing apparatus, as shown in my co-pending application, includes a heating means, positioned beneath the strip prior to its entry into the babbitt, which has sufficient heating capacity to bring the moving strip to a suitable elevated temperature considerably less than the melting point of the strip. In most cases a temperature of 600° to 800° F. contingent on the material is satisfactory. In this connection the strip is preferably preheated to a temperature approximating the temperature of the molten metal. This heating step under a controlled atmosphere, conditions the strip by volatilizing any volatile material on the surface of the strip and thereby cleans the surface of the strip of these materials. While at an elevated temperature, the strip passes under a hood wherein a reducing gas is present, for example, incompletely burned hydrocarbon gas including hydrogen and carbonmonoxide or hydrogen, carbon monoxide mixtures thereof and the like.

The reducing gas reacts with the oxide on the strip to reduce the same. In its reduced state

the surface of the strip is highly reactive as it is in what may be termed "nascent condition" which is highly desirable for the bonding operation. The strip after conditioning immediately enters the casting apparatus whereby the surface of the strip is covered with molten casting metal prior to exposure to atmospheric air and prior to cooling of the strip. In this condition, the lower melting point metal readily attaches itself by means of an alloy bond to the surface of the strip and when cast to the desired thickness and cooled, a strong bond is apparent between the cast metal and the surface of the strip.

The drawings show three embodiments of the conditioning apparatus each utilizing a different heating means. In all cases, however, the cleaning action on the surface of the strip is the same; that is, the surface of the strip is deoxidized and cleaned of any volatile material through the action of a suitable atmosphere reacting with the undesirable material on the surface of the strip while the strip is maintained at an elevated temperature.

Referring particularly to Fig. 1, one very satisfactory type of apparatus is shown at **240**. This fluxing equipment includes a gas burner **241** which comprises a cored out block **242** which carries therein a plurality of blast burners **244**. The block **242** is connected to an air-gas supply through a pipe **246**. Additional outlets in the block, such as **248**, are also provided so that when varying width strips are used additional burners may be inserted. These openings **248** may be plugged when not in use. The strip **30** passes over the burner **241** and is heated to a suitable elevated temperature but below its melting point. Prior to its entry into the apparatus through the throat **66**, a hood **250** is provided which is hollowed out as noted in Fig. 2 and is connected by means of the pipe **252** to a source of a reducing atmosphere. Thus as the strip **30** in the heated condition passes beneath hood **250** it is subjected to the action of a reducing atmosphere, such as; hydrogen, carbon monoxide, mixtures thereof, incompletely burned natural gas, or any other suitable reducing atmosphere. Thus, the action of the atmosphere on the oxides at the surface of the strip causes the reduction thereof which is hastened by the heated condition of the strip. In this manner the strip **30** is preheated and likewise is cleaned and deoxidized and is in a fluxed condition as it enters the molten babbitt that is contained in tank apparatus **24**.

Another type of fluxing equipment is shown in Fig. 3 wherein resistance heating of the strip is utilized.

In this instance the strip **30**, as shown in Fig. 3, passes between a pair of pinch rolls **275** and **277** which are spring pressed by means of springs **276** and are carried by block **279** which is supported by and insulated from a support **281**. The block **279** is connected to one side of a suitable electrical current source by means of a conduit **283**. The hood **250** is similar to the hood shown in Fig. 2 and is supplied with reducing gas through tube **252**. The strip **30** passes into the babbitt designated at **285** which is carried within chamber **24**. The babbitt and chamber are connected to the other side of the current source by means of the conduit **287**. Thus a complete circuit is set up through conduit **283**, block **279**, pinch rolls **275** and **277**, strip **30**, babbitt **285** and conduit **287** whereby the portion of the strip between the pinch rolls **275** and **277** and the babbitt **285** is heated by means of the resistance thereof to a suitable temperature. This temperature can be varied by either changing the current input, or by increasing the distance between the pinch rolls and the babbitt **285**. In this manner, the strip is heated to a temperature approximating the temperature obtained when using the apparatus as shown in Fig. 2 and reducing gas is held thereover by hood **250**. Thus, the apparatus fluxes the surface of the strip and cleans the same of any oxidation while the temperature attained removes volatile impurities. After passing into the babbitt **285**, the strip passes out of the babbitt tank through an opening **310** into a casting gate **312** (shown in part) the strip **30** now has a babbitt layer **314** therein held in place by side rails **316** until the babbitt is solidified by a quenching device not shown.

Fig. 4 shows another modification of the electrically heated equipment wherein the strip **30** passes through an elongated tunnel **291** which includes an insulating outer portion **293** and a coil **295** therein which is connected by means of conduits **297** and **299** to a suitable current source. As the strip **30** passes through the coil, it is heated inductively to a suitable temperature. Reducing gas is supplied chamber **291** from tube **301** and fluxes the strip in the same manner as previously described in connection with Figs. 1, 2 and 3. Resistance and inductive heating are well-known in the art and, therefore, specific currents, etc., will not be designated other than the single example hereinafter noted since these factors are best arrived at by trial and in accordance with the width, thickness, speed and length of the strip used.

An example of the control factors utilized in fluxing a strip of the character described will be given with respect to the resistance heating of one type of strip. In this instance a strip 5 inches wide is moved at a rate of 20–25 feet per minute through the pinch rolls **275** and **277**. These rolls are 30 inches from the babbitt **285** in chamber **24**. The strip utilized is .056 inch thick. In order to heat the strip to 750° F. a current of 8900 amperes at 8.8 volts is utilized. Obviously, these currents and voltages change with varying widths and thickness of the strip as well as speed of the feed of the strip, all of these variables being interrelated. However, the example given is one satisfactory set of conditions to flux properly a strip when using a reducing atmosphere of incompletely burned natural gas in the hood **250**. In this instance the hood **250** is 20 inches long. The babbitt utilized is a lead base babbitt maintained at a temperature of 750° F.

The same conditions are existing when using any other of the fluxing apparatus disclosed. That is to say, the strip should be raised to a temperature of 750° F. according to the temperature of the babbitt prior to its entry into the molten babbitt and should be adequately exposed to reducing gas in order that the surface of the strip is properly cleaned. In each instance, as noted heretofore, best results can be obtained by making several trial runs in order to definitely determine that the results obtained are entirely satisfactory since it is apparent that metals other than the babbitt noted in the example, may require slightly higher or lower temperatures to induce the best wetting action. However, all of these variables can be easily determined by one skilled in the art.

After the strip has passed into the chamber **24** in its cleaned and heated condition the babbitt readily wets the surface of the strip whether or

not a porous metal strip is utilized and the babbitt will cling tenaciously to the surface thereof. In each case after complete wetting is obtained the strip passes out of the babbitt and through a casting gate, not shown, wherein a predetermined thickness of the babbitt layer is chilled into a solid condition on the surface of the strip. Due to the clean condition of the strip surface this chilled cast babbitt or other cast metal will be completely and satisfactorily bonded to the surface of the strip by a metallurgical bond.

It is to be noted that in the first two examples given herein that the back of the strip is oxidized by the action of the flame and/or air so that the babbitt does not adhere thereto. With particular respect to Fig. 4 the babbitt will wet both surfaces of the strip if both surfaces are fluxed. However, if it is desirable only to flux one surface only of the strip, it is possible to oxidize the under surface of the strip just prior to its entry into the babbitt by directing a stream of an oxidizing gas thereon. This will prevent adherence of the babbitt. The very fact that the babbitt does not adhere to the back surface of the strip as conditioned in the apparatus shown in Figs. 1 and 3, is adequate proof of the importance of the herein described operation since it is very obvious that babbitt or other metal will not adhere to an oxidized surface and, therefore, even if cast thereon would have an unsatisfactory bond of no strength which would readily crack off or peel during subsequent operations.

The invention described herein has proved highly successful commercially and produces a clean and conditioned surface that may readily be operated upon in the casting tank and subsequent casting apparatus.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An apparatus for continuously fluxing one surface only of metallic strip material that is to be subsequently babbitted on one surface only, comprising in combination, heating means for progressively heating a portion of the strip at both sides thereof, and fluxing means consisting of a confining hood adapted to be filled with reducing atmosphere and disposed adjacent one surface only of the strip so that said atmosphere affects the heated portion of the strip for deoxidizing said one surface only thereof, and means for babbitting the surface of the strip immediately after the strip has been fluxed and before it has been exposed to atmospheric air.

2. The apparatus as claimed in claim 1 wherein the heating means consists of a gas burner.

3. The apparatus as defined in claim 1 wherein the heating means consists of two terminals spaced from one another and contacting the strip and adapted to pass an electric current through the strip whereby the strip is heated due to its resistance.

4. In a method for continuously casting a lower melting point metal on one surface only of metallic strip stock, the steps comprising, progressively heating a portion of the stock in the atmosphere as it is moving toward a casting tank containing the metal to be cast thereon in the molten state, progressively supplying a reducing atmosphere to one surface only of the heated strip for cleaning that surface of the strip and for fluxing the same, and then continuously immersing the strip in the molten metal in its heated and cleaned condition prior to exposure to atmospheric air, and finally casting a predetermined thickness of the lower melting point metal on said one surface only of the strip.

5. In a continuous method for conditioning the surface of a metallic strip for subsequent casting operations of a lower melting point metal on one surface only thereof, the steps comprising; heating the surfaces of said strip in the atmosphere by causing a current to pass from a point remote from said molten metal through said strip and into said molten metal, heating the strip by its own resistance to a suitable temperature, simultaneously reducing oxides at one surface only of the strip by means of a reducing atmosphere adjacent said one surface of the heated strip and prior to its introduction into said molten metal whereby the said one surface of the strip is cleaned and placed in a nascent condition for facilitating the casting operation thereon and finally immediately casting molten metal onto the clean surface of said strip.

CECIL A. MANN.

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