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APPARATUS FOR HOT COATING OF METAL STRIP AND THE LIKE

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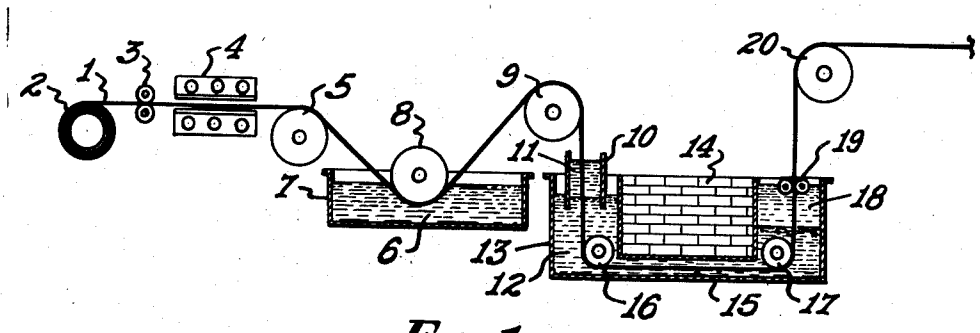

FIG. 1.

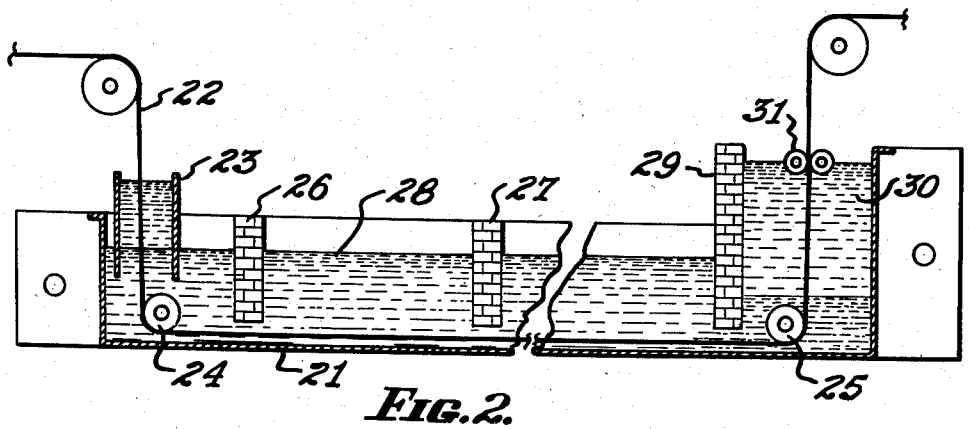

FIG. 2.

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APPARATUS FOR HOT COATING OF METAL STRIP AND THE LIKE

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4 Claims. (Cl. 91—12.5)

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My invention relates to improvements in the coating of metals, usually iron or mild steel, with a layer of molten metal. It has special application to treatments for the base metal where it is in the form of a continuous strand, strip, wire or the like. It will be evident, however, from my description that many of the principles of the invention may be applied to separate sheets if suitable means are provided to carry the sheets through the treatment apparatus. Nevertheless, the treatment of strand type materials at very high speeds has given rise to new problems in the metal coating industry, and the exemplary embodiments of my invention will be described in connection with the treatment of such materials.

My invention relates to the coating of metal bases with pure aluminum, alloys of aluminum and zinc, alloys of aluminum and silicon with or without magnesium, pure zinc, the various alloys of zinc, and, indeed, with any alloy or metal which may be superimposed as a substantially immiscible, floating layer upon the surface of molten lead or a molten lead alloy.

It has hitherto been suggested to support a molten coating bath of zinc and aluminum, by way of example, upon lead for the purpose of isolating the coating bath itself from an entrance flux. The endeavor is not always successful, for the reason that some materials, such as aluminum and silicon, are capable of dissolving in molten lead to some extent. Where these materials form undesirable compounds with constituents of the flux, some difficulty may be encountered in this direction. Solutions for such difficulties are taken up in part in my copending application entitled the Cleaning of metal strip at high speeds, Serial No. 439,846, filed April 21, 1942, together with teachings relating primarily to the proper fluxing of strand type materials at high speeds. But there are other problems connected with the use of a molten supporting bath such as a bath of lead, in combination with a coating bath and a fluxing bath. It is frequently desirable that the fluxing bath be maintained at a temperature different from the temperature of the coating bath. A flux of zinc chloride and ammonium chloride, frequently used in galvanizing metal, is, if properly handled, an efficient cleaner; but if it is maintained at too high a temperature, a great deal of the ammonium chloride will be lost through vaporization, and the flux will have to be replenished frequently. It is possible, by adding such a salt as sodium chloride to the exemplary flux mentioned, to cut

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down the vaporization of ammonium chloride at higher temperatures; but where coating, for example, with pure aluminum, the temperature of the coating bath ought to be around 1200° F. whereas such a flux will not stand that temperature. Hence, one of the objects of my invention is to provide a structure and a mode of operation which will permit fluxing at one temperature and coating at another temperature.

Another object of my invention is to provide a structure and mode of operation in which the strand-form material may be treated at different temperatures at different times for particular effects, such for example as the effect of annealing the material at temperatures which are too high for the flux and may even be too high for the coating bath.

It is an object of my invention to provide an apparatus and a mode of procedure minimizing diffusion of ingredients of the coating bath through the supporting bath, and at the same time minimizing the tendency of the material being coated to carry over into the coating bath particles of flux or dross.

It is still another object of my invention to provide an apparatus and a mode of procedure whereby the temperature of the molten coating bath is rendered independent of the fluxing temperature and other temperatures throughout the apparatus, for the attainment of special effects. By way of example, even in coating iron or mild steel with zinc, it is frequently desired to avoid the production of a spangle, especially where the coated material is to be given a subsequent treatment to increase its receptivity to paint, enamel and the like. It is known that if the zinc bath can be heated to a temperature of 950° F. or over, and the other conditions are proper, a spangle free coated strip may be produced. Such a high exit temperature, however, is detrimental to the ordinary fluxes, for which reason the operation has heretofore been unsatisfactory.

It is a further object of my invention to provide an apparatus and a mode of procedure whereby the entrance flux can be maintained at a higher temperature than that of the metal coating bath. This makes it possible to employ fluxes having very high melting points, and to coat with metals having very low melting points.

These and other objects of my invention which will be set forth hereinafter or will be apparent to one skilled in the art on reading these specifications, I accomplish by that certain construction and arrangement of parts and in that pro-

cedure of which I shall now describe certain exemplary embodiments.

Reference is made to the drawings, which are diagrammatic in nature and which illustrate several embodiments of my invention.

Figure 1 is a diagrammatic representation of the invention in a simple form showing also means for precleaning the strip.

Figure 2 is a view of a coating apparatus of somewhat more elaborate form.

Essentially in the practice of my invention, I employ an elongated vessel in which I maintain a bath of molten lead or lead alloy. The vessel has an entrance part, in connection with which I maintain a flux, and an exit part in connection with which I maintain the bath of molten metal which is to form the coating on the strip. The vessel itself is so greatly elongated that a temperature gradient may be maintained in the lead bath. I prefer also to minimize the diffusion of heat through the lead by providing suitable baffles to interrupt convection currents, and to minimize the conduction of heat, and where possible I prefer to provide that portion of the lead bath which extends between the entrance and the exit in the form of a long and narrow neck.

Referring to the drawings, in Figure 1, I have shown a strip 1 being withdrawn from a coil 2 by means of pinch rolls 3. The strip may be passed through an oxidizing furnace 4, which will burn from the surfaces of the scale-free material any oil or other combustible substances and which will form on those surfaces preferably, a thin, controlled coating of oxide varying in color from straw to blue and into the gray.

Over a roll 5, the strip enters a pickling bath 6 contained in the tank 7, where it is held down by roll 8. The oxidizing furnace and pickling bath referred to are exemplary of suitable cleaning means for the strip; but the strip may be otherwise cleaned as desired.

After leaving the pickling bath, the strip is shown as passing over a roll 9 and downwardly through a flux box 10 containing a flux 11, into the lead bath 12 contained in a suitable vessel 13. This vessel is of elongated form and I have shown a wide, deep, refractory partition 14 extending downwardly into the lead throughout the entire midsection of the pot. This partition confines the lead between the entrance and exit portions to a narrow throat marked 15, through which throat the strip passes, being guided by rolls 16 and 17. Over the latter roll the strip passes upwardly through the metal coating bath 18 which is floating on the lead. The partition 14 serves to isolate the coating bath from the entrance portion of the lead bath. The strip may emerge through exit rolls 19 and be carried away over a roll 20.

The provision of the elongated throat 15, as demarked by the partition 14, enables me, by way of example, to heat the exit portion of the bath to a very high temperature as compared with the entrance portion. By applying heat only to the exit portion, a very substantial temperature gradient may be attained because of the diminished transfer of heat from the exit portion to the entrance portion of the bath. Thus, while the temperature at the entrance portion may be maintained low enough to preserve the qualities of a flux having volatile constituents, the temperature of the molten coating bath may be raised far above such a temperature for any of the purposes which have been given above. Thus, it is entirely possible to maintain a bath of molten aluminum

on a lead bath at a temperature of say, 1250°, while the fluxing temperature at the entrance of the bath is say, 600 to 800°. Moreover, aluminum is very slightly soluble in lead, and the long constricted throat 15 minimizes the diffusion of the aluminum toward the entrance end of the bath thereby greatly cutting down the difficulties which may arise due to the interaction of aluminum and the flux.

The same elongated throat 15 enables me to operate the entrance portion of the bath, which carries the flux, at a higher temperature than the exit portion which carries the coating metal. Thus I am enabled to carry out special effects such as the use of very high melting fluxes or very low melting coating metals. When operating in this manner, it may not be necessary to apply heat to the coating end of the bath because of the heat carried into it by the strip. In some instances it may even be necessary to apply cooling means to the exit end of the coating bath to avoid heating above the desired coating temperature.

In Figure 2, I have shown a vessel which is still more elongated and may be elongated to any extent desired. This vessel is indicated at 21. The strip 22 enters it through a flux box 23, and under rolls 24 and 25, it passes along the bottom of the vessel substantially throughout its entire length. Where the vessel is very long, a plurality of supporting rolls may be arranged along the bottom to prevent the strip from dragging. The vessel is provided throughout its length with a series of refractory partitions 26, 27, terminating short of the bottom of the vessel, and serving to divide the lead bath 28 into a series of compartments between which there will be a minimum of flow by convection and a minimum of heat transfer by conduction.

At the exit end of the vessel, there is a partition 29 serving to confine the coating bath 30, through which the strip passes as it emerges from the vessel. Again, I may employ exit rolls 31.

The vessel 21 may be made as long as desired and there may be as many as desired of the partitions 26, 27.

The point, however, of the structure of Figure 2 and its variants is, that the temperature of the lead bath in its various parts or of the several lead baths where more than one are employed, may be maintained at substantially any desired temperature differentials. Further, the path of travel of strip through the lead bath is very greatly elongated so that where I desire to do so, the bath may be caused to anneal the strip or strand at substantially any desired annealing temperature for substantially any length of time consonant with the speed of travel of the strip and the space limits in the coating plant. By way of example, using the structure of Figure 2, I may maintain a temperature of say, 600 to 850° F., at the entrance end of the bath, but I may cause this temperature intermediate the ends of the lead bath to rise to say, 1250° F. or higher, falling again toward the exit end of the bath say, to 600 to 850° F. where I am coating with low melting point metals. Where, however, the coating metal is one, like aluminum, which requires a high temperature, such a temperature may be maintained at the exit end of the bath, and the temperature there may, if desired, be greater than the temperature elsewhere.

Modifications may be made in my invention without departing from the spirit of it. Having now fully described my invention in certain ex-

emplary embodiments, what I claim as new and desire to secure by Letters Patent, is:

1. In apparatus of the character described an elongated vessel, a partition extending down into said vessel but terminating short of the bottom thereof and dividing said vessel into widely spaced entrance and exit portions, said partition comprising a metallic shell and a filling of refractory insulating material the dimensions of said shell in the direction of the length of said vessel, being greater than the corresponding dimensions either of the entrance or exit portions, said partition providing beneath it a long narrow throat connecting said entrance and exit portions whereby a wide temperature differential may be maintained between said portions.

2. In apparatus of the character described, a vessel for molten metal of elongated form, refractory partitions extending down into said vessel but terminating short of the bottom thereof, said partitions being widely spaced and serving to divide said vessel into an entrance portion and an exit portion, and a plurality of intermediate portions of at least the width of the entrance and exit portions, whereby a series of temperature differentials may be maintained in said vessel.

3. In apparatus for coating with molten metal, an elongated vessel of regular cross-section having sides, ends and a bottom and being open at the top, and refractory partition means extending down into said vessel intermediate the ends thereof, having close contact with the sides of said vessel and approaching the bottom thereof so as to leave at said bottom a narrow constricted throat, said partition means serving to divide said

vessel into widely spaced entrance and exit portions, so that when a bath of molten supporting metal is placed in said vessel so as to rise on both sides of said partition means, heat transfer between the metal in said entrance and exit portions is greatly minimized as well as diffusion of said supporting metal by convection, wherefore said supporting metal in said entrance and exit portions may be maintained at widely differing temperatures in spite of the passage of metallic stock to be coated through said entrance portion, beneath said partition means, and through said exit portion.

4. The structure claimed in claim 3 wherein said partition means is a single refractory partition occupying the greater part of the length of said elongated vessel.

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