

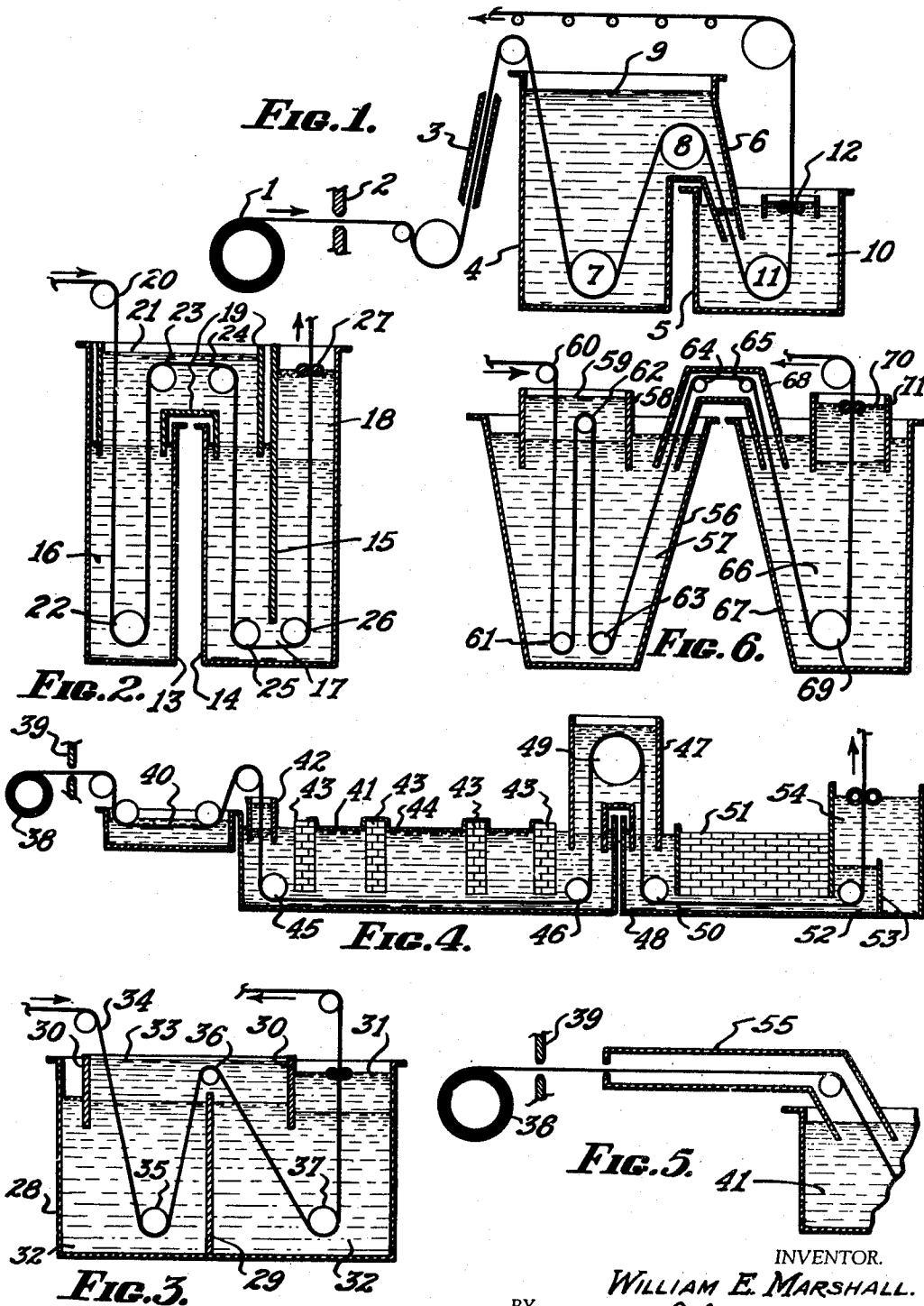
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APPARATUS FOR AND METHOD OF COATING METAL STRIP AT HIGH SPEEDS

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APPARATUS FOR AND METHOD OF COATING METAL STRIP AT HIGH SPEEDS

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In recent years the coating of metal strip, in endless lengths at high speed, with molten metal such as zinc, terne, aluminum, tin and various alloys, has come to be of ever increasing commercial importance. The handling of strip materials at high speeds involves a number of problems not inherent in the familiar sheet coating processes. The problem of cleaning is one of paramount importance, since the same sort of care which can be applied to low speed individual sheet coating processes and the same sort of inspection procedures whereby imperfect sheets may be thrown out without unduly increasing the overall loss in manufacturing, are not applicable. The best results so far, have been obtained by taking scale-free iron or steel strip, passing it first through an oxidizing furnace wherein a thin, controlled coating of oxide is formed on its surfaces with the concurrent burning off of oil and other combustible materials, then passing it through a reducing furnace wherein the controlled coating of oxide is reduced, and finally, while still protecting the strip from oxidation, passing it directly into the molten metal coating bath, usually without the use of any flux.

The use of flux in metal coating processes is essentially a cleaning use, and it is usual to have a mass of molten flux floating on the molten coating metal at the entrance end of the coating bath, or floating on a supporting metal bath in certain instances. When dealing with individual sheets, a satisfactory cleaning or pickling material may be had by passing the sheets relatively slowly through a thin layer of the molten flux and into the bath. With the high speed handling of strip materials the use of flux in the old ways has not been found satisfactory, and a number of difficulties have arisen. The high speed strip, entering the flux bath in a cold condition, tends to freeze the flux on its surfaces. This not only prevents a proper cleaning action of the flux, but promotes carrying over or down into the molten coating bath particles of flux. If these particles reach the exit side of the bath they cause trouble, and if they continue to adhere to the surfaces of the strip, they prevent a thorough coating of the base metal with the molten coating metal. Other troubles also arise in many instances due to an interaction of the flux, or ingredients of it, with the molten coating metal, or one or more of its ingredients. Thus, where coating is being done with zinc containing small amounts of aluminum, the usual fluxes tend to react with aluminum and form a refractory com-

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pound or dross which becomes exceedingly troublesome.

The question of cleaning is even a broader question, having to do with the ultimate coating result, and the adhesion, ductility and bendability of the coating.

The fundamental objects of my invention are the solution of the problems outlined above, and problems ancillary thereto, in high speed strip coating processes involving the use of flux. These and other objects of my invention which will be pointed out hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish by that certain construction an arrangement of parts and in those methods of which I shall now describe certain exemplary embodiments. The accompanying drawings are diagrammatic and schematic in their character.

Figure 1 is a sectional view of an exemplary metal coating arrangement.

Figures 2 and 3 are views of coating pots and fluxing arrangements of modified character.

Figure 4 shows another form of coating assembly.

Figure 5 is a partial view showing an alternative mode of leading the metal into a treatment apparatus.

Figure 6 is a view showing an assembly of apparatus for treating the strip with flux and for coating with the molten metal, wherein the fluxing means is divorced from the coating means.

As to cleaning in general, it is contemplated in my present invention that fluxing be employed in conjunction with pre-treatments, which pre-treatments, however, may be considerably varied. I have found that the solution of the problems connected with the fluxing of high speed strip enables me to use several types of pre-treatment with excellent results. Where the strip is in a cleaned and scale-free condition, as is usually the case with cold rolled strip, as a pre-treatment it may be sufficient merely to burn oil and other combustible materials from the surfaces of the strip, as by means of an oxidizing furnace which will also form upon the surfaces of the strip a thin and controlled coating of oxide, varying in color from straw to blue and into the gray. In other instances, I may prefer to pass my strip through a pickling bath of continuous character, just before it enters the fluxing and coating apparatus. Other modes of pre-cleaning, including electrolytic cleaning may, of course, be employed.

While I have directed my disclosures primarily

to strip, the skilled worker in the art will understand their utility as applied to other endless or indefinite lengths of base metal such as bands, wire and the like.

The utility of my invention is not dependent upon nor confined to any particular molten metal or alloy for coating. As will be apparent hereinafter, certain metals and alloys involve special problems which must be taken into account; but the teachings of this application are of utility in connection with such special procedures. In general, it is necessary to permit an interaction of the flux and the surfaces of the metal being treated, under such conditions that the flux will be molten and the metal will be at such temperature as to preclude the freezing of the flux on its surfaces. It is possible in some instances to preheat the metal prior to its entry into the flux. This, however, is not usually the most feasible solution of the problem. The problem can be solved in several analogous ways. The flux may be so disposed that the metal can be preheated by the flux to the extent of producing interaction between the two at the desired temperatures. In this procedure, the flux has to be so disposed as to be able to preheat the metal to the desired temperature. In other instances, in spite of the freezing of the flux onto the surfaces of the metal, it is possible to pass the strip through the flux and then, thereafter treat the surfaces of it in such a way as to produce the desired interaction and to free the surfaces from clinging flux particles. Yet again it is possible, with intervening means for heating and maintaining the temperature of the metal to treat the metal with the flux a plurality of times prior to the introduction of the metal into the molten coating bath.

In Figure 1, I have illustrated means of the first type. Coils of strip are decoiled at 1. The leading end of a fresh coil may be welded or otherwise fastened to the trailing end of the last coil at 2. It will be understood that suitable looping means may be provided to permit this to be accomplished. The strip may then, if desired, be passed through an oxidizing furnace 3 to burn oil and the like from its surfaces and to produce thereon a controlled thin coating of oxide.

The flux is contained in a flux pot 4 which is separate from and lies off side from the coating pot 5. The flux pot, however, has a neck 6 which extends down into the coating pot. In the flux pot, I locate as many rolls 7 and 8 as may be desired to cause the metal strip to follow an elongated path therethrough. Heat is separately applied to the flux 9 in the flux pot to keep it at high temperature so that the flux can heat the metal strip in the elongated path aforesaid. Modifications of the flux may be made to enable it to stand a higher degree of heat, where that is desirable or necessary. By way of example, the ordinary flux used for galvanizing, and consisting of zinc chloride and ammonium chloride in admixture, may be caused to withstand a higher temperature by the addition of a substantial quantity of such a substance as sodium chloride.

The strip may enter the flux pot 4 from the oxidizing furnace 3 at a somewhat elevated temperature; but I do not prefer to rely on this. Even though the strip may enter the flux 9 cold and even though the flux may, therefore, tend to freeze upon its surfaces initially, during the travel of the strip through the flux in the elongated path which I have shown, it will be brought up to the temperature of the flux, and a temperature high enough to insure that the flux on its surfaces will

be molten. I have found that where the metal in the presence of the flux body attains a high enough temperature, a satisfactory interaction between the metal surfaces and the flux will be had, but the flux will not tend to adhere to the surfaces of the metal in such manner as to be carried down into the molten coating metal. The molten coating metal is indicated at 10 in the pot 5; and the metal strip, passes down through the neck 6 and into the molten coating metal. Its direction is reversed around a roll 11 and it may be brought out of the molten coating metal through exit rolls 12, which may be fluxed if desired. The neck 6 serves to confine the entrance flux to the entrance side of the bath.

In Figure 2, I have shown a modified apparatus. An initial treatment tank 13 is located adjacent a coating pot 14. The coating pot has a central partition 15; both the treatment pot 13 and the coating pot 14 contain inert baths say of lead, as indicated at 16 and 17. The molten coating metal floats on the lead at the right hand side of the partition 15, in the coating pot 14, as at 18. I have provided in this structure a flux box 19 which is common to the two vessels 13 and 14. The flux in this instance, is very much less in quantity than that required in the apparatus of Figure 1. It will be noted that the strip 20 passes first downwardly through the flux 21 in the flux box and enters the lead bath 16. Heat will, of course, be applied to both vessels 13 and 14, though they need not necessarily be heated to the same temperatures. If the strip 20 enters the flux cold, the flux may, of course, freeze on its surfaces; but as it passes down through the lead bath 16, reverses its direction over a roll 22 and comes up again, the strip will be heated to the proper temperature for fusing the flux particles on its surfaces. Excess flux will thus be dislodged and will float to the surface of the lead bath in compartment 13. As the metal comes out of the lead bath, it again enters the flux, where its direction is changed by rolls 23 and 24, over the latter of which it goes down into the lead bath 17. During its second entry into and travel through the flux, the strip will be at such a temperature as to permit proper cleaning without the accumulation of fluxing particles in adherence to the strip surfaces. The second application of flux is an advantage in that it is a safeguard, making for more perfect cleaning.

The strip, as indicated, passes down through the lead bath 17, under rolls 25 and 26, and upwardly to the right of the partition 15. Leaving the lead bath, it passes through the molten coating metal 18 floating upon its surface; and it may be withdrawn through exit rolls 27.

A somewhat simpler arrangement is shown in Figure 3. Here I employ a single pot or vessel 28 provided with suitable heating means, not shown. A partition 29 is located therein. A single flux box 30 is used in this pot, and a right hand wall thereof may serve as a partition to confine the bath 31 of molten coating metal floating upon the surface of a lead bath 32 in the vessel. The flux 33 floats on the surface of the lead bath. The strip 34 first passes downwardly through the flux, travels through the lead bath 32, returning over a roll 35, re-enters the flux bath in heated condition, reverses its direction over roll 36, re-enters the lead bath, passes beneath roll 37, and leaves the lead bath through the molten coating bath 31.

It is not necessary in all instances that the metal re-enter a bath of flux prior to its intro-

duction into the molten coating bath. The pre-association of the flux with the strip, and passage of the strip in a sufficiently elongated path of travel through a lead bath or similar bath at the required temperature, may be sufficient for proper cleaning and for the removal from the surfaces of the metal of any clinging particles of flux. Hence, in Figure 3, the partition 29 could be eliminated and the roll 36 could be located beneath the surface of the lead bath 32.

In many instances, it is advantageous to be able to maintain the flux and the associated lead baths or the like, at a temperature different from the temperature of the molten coating bath, as more particularly set forth in my copending application entitled The hot coating of metal strip and the like, Serial No. 438,999, filed April 15, 1942. But the principles of this invention are applicable to such systems also. In Figure 4 I have shown the strip being decolled at 38 and welded at 39. Thence, it passes through a pickling bath at 40 and into a lead bath 41, through an entrance flux box 42. This lead bath is of horizontally elongated character and it may have in it a plurality of partitions 43 to minimize the transfer of heat. The lead bath may be provided with a cover 44. The strip, passing down into the bath, proceeds under rolls 45 and 46 and beneath the partitions 43. A flux box 47, common to the lead bath 41 and the coating pot 48, may be provided as indicated. The strip may pass upwardly from roll 46, over a roll 49 in the flux and downwardly into the coating pot and under a roll 50. The coating pot may likewise be divided by a wide partition 51 permitting the maintenance of a temperature gradient. The pot contains lead as at 52, confined by a partition 53; and above the lead will be located the molten coating metal 54.

In the first lead bath the temperatures may vary, say, from 650 to 800° F. at the entrance end, up to 1300° F. at the central portion, then downwardly again to 650 to 850° at the exit end. Similarly the temperatures may vary in the pot 48 from 650 to 850° F. at the entrance end to whatever temperatures may be required in the bath 54. If the bath 54 is a bath of zinc, a temperature range of 810 to 860° F. is usually desired. If the bath is of aluminum, the temperature will need to be maintained at around 1250° F.

The advantages of this structure will be apparent. Aside from the more efficient treatment of the strip with the flux, due to the elongated path of travel and of the temperature gradient, it will be seen that the elongated lead bath 41 may be used to anneal the material. The use of a temperature gradient, likewise, permits the use of different fluxes at different points in the apparatus; and the flux used at 42 need not be the same as that used at 47.

Again it may be desired to bring the metal up to temperature and/or anneal it prior to bringing it into contact with the flux at all. Thus, instead of leading the metal into the bath 41, through the flux box 42, I may lead it into the bath through a hood 55 (Figure 5) in which a non-oxidizing atmosphere is maintained.

I have already mentioned the fact that available fluxes frequently interact with ingredients of the molten coating bath in an undesirable way. Thus, the usual fluxes for galvanizing, give trouble where the molten coating metal is zinc containing minor amounts of aluminum, and where

the flux comes into contact with the molten coating metal. The flux tends to rob the bath of aluminum, with the consequent production of a dross which is very troublesome. Aluminum is not very soluble in lead; but the isolation of the zinc-aluminum alloy from the flux, by means of a lead bath, is not completely satisfactory. There is still a slight solubility, sufficient to produce enough aluminum compounds at the flux box to give occasional trouble at high speed. The provision of elongated lead baths such as those shown in Figure 4, minimize the diffusion of the aluminum through the lead. However, it is possible, following the principles in my invention, to provide for a thorough fluxing of the surfaces of the strip, while at the same time, isolating the fluxing apparatus entirely from the coating apparatus, in the sense of preventing any diffusion of aluminum to any point where it could come into contact with the flux. A mode of accomplishing this is illustrated in Figure 6. Here a primary pot 56 contains a bath of lead 57 and is provided with a flux box 58, containing flux 59. The strip 60 passes downwardly through the flux, returns over a roll 61, re-enters the flux, passes downwardly over a roll 62, re-enters the lead bath 57 and returns over a roll 63. In leaving the lead bath 57, the strip does so elsewhere than through the flux box 58. I have shown it passing out of the lead bath 57, changing its direction over rolls 64 and 65, and entering a lead bath 66 in the coating pot 67. Throughout the course of its travel, from the lead bath 57 to the lead bath 66, the strip passes through a hood or housing 68, which has portions extending into the two lead baths. This housing is kept filled with an inert or nonoxidizing atmosphere. The strip during its passage from one lead bath to the other, will be in a thoroughly cleaned condition although its surfaces will be free, or substantially free, from any adherent particles of flux. The strip in the pot 67 changes its direction over a roll 69 and leaves the pot through a molten coating bath 70, confined by a box 71. Where the coating bath 70 is a bath, for example, of zinc and aluminum, a little aluminum will diffuse through the lead 66. The loss of aluminum by such diffusion can readily be taken care of after a suitable period of service by additions to the bath 70. After the lead 66 has reached its saturation point in aluminum, there will be no further loss of aluminum from the bath 66. Since the strip reaches the bath 66 in a cleaned and scale-free condition, there will be no tendency for a chemical interaction of the flux and the bath 66 to deplete aluminum therein nor to form refractory aluminum compounds.

It will be evident that any procedures considered good practice in coating with molten metal may be employed in connection with my invention such as phosphorizing the base metal in accordance with the teachings of my copending application, Serial No. 340,912, filed June 17, 1940.

Modifications may be made in my invention without departing from the spirit thereof.

Having described my invention in certain exemplary embodiments what I claim as new and desire to secure by Letters Patent, is:

1. A process of fluxing strip metal at high speeds for coating with molten metal, said process comprising passing the strip at high speed through a bath of molten flux floating on a bath of lead, passing the strip into the lead bath in a substantially vertical direction and for a suffi-

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cient path of said substantially vertical travel to bring the temperature of the strip to a temperature higher than the melting temperature of the flux and to permit flux masses carried into the lead bath by the strip to float away from the surfaces of the strip when fused, then returning the strip to a flux bath, and transferring it from said flux bath into a bath of molten coating metal without reexposing it to air.

2. The process claimed in claim 1 wherein the direction of motion of the strip is substantially reversed within the lead bath and wherein the strip is returned to the original bath of molten flux.

3. The process claimed in claim 1 wherein said strip is transferred from the said bath of flux to the said bath of molten coating metal through an intervening bath of lead, whereby to isolate the flux from the molten coating metal.

4. Apparatus for fluxing metal strip at high speeds and for coating it with molten metal comprising a pot within which a bath of lead is maintained, a flux box for confining a bath of molten flux which floats on said lead, means for confining a metal coating bath which also floats on said lead, and means for conducting a metal strip through said flux into said lead bath, in a substantially vertical path of travel and for a sufficient distance to cause the lead to heat the metal strip to a temperature above the melting point of said flux and to cause flux masses carried into said lead on said strip to float away after fusion, means for conducting said strip again into said flux, means for returning said strip to said lead bath and means for conducting said strip from said lead bath into and through said metal coating bath.

5. Apparatus for fluxing metal strip at high speeds and for coating it with molten metal, comprising vessels for the maintenance of molten flux and molten coating metal floating on molten lead, and means for conducting metal strip through the molten flux into the molten lead in a substantially vertical path of travel and for a sufficient distance in said path of travel to cause the lead to heat the strip to a temperature higher than the melting point of said flux and to cause flux carried into said lead by said strip to float away from its surfaces upon fusion, means for passing said strip from said lead again into molten flux, and means for transferring said strip from said molten flux to said molten coating metal without reexposing it to air.

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6. Apparatus for fluxing metal strip at high speeds and for coating it with molten metal, comprising vessels for the maintenance of molten flux and molten coating metal floating on molten lead, and means for conducting metal strip through the molten flux into the molten lead in a substantially vertical path of travel and for a sufficient distance in said path of travel to cause the lead to heat the strip to a temperature higher than the melting point of said flux and to cause flux carried into said lead by said strip to float away from its surfaces upon fusion, means for passing said strip from said lead into molten flux, and means for transferring said strip from the molten flux to the molten coating metal without reexposing it to air, said means comprising means for passing said strip from said flux through molten lead prior to introducing it into said molten coating metal, whereby to isolate said molten coating metal from said flux.

7. Apparatus as claimed in claim 6 in which the molten lead is contained in two vessels, including means for maintain molten flux in contact with the lead in both vessels whereby the said metal strip may be conducted from one vessel to the other through said flux.

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