

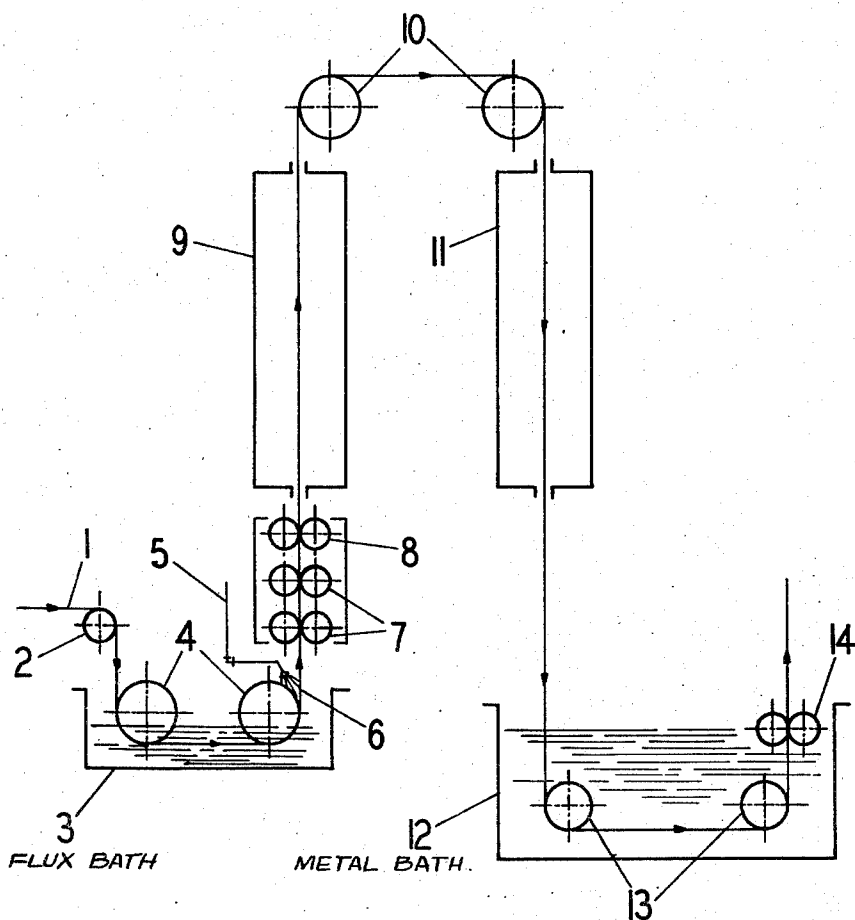
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FLUXING AND COATING METAL STRIP

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FLUXING AND COATING METAL STRIP

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This invention relates to fluxing and coating metal strip. In its broader aspects the invention relates to fluxing and coating wire as well as to fluxing and coating flat strip and we hereby define the word "strip" as used herein to comprehend metal in elongated form and flexible so as to be adapted to be guided in a circuitous path as it advances in the direction of its length, irrespective of whether the metal is of flat, round or other cross section, unless in particular instances the context requires otherwise.

The invention is concerned with fluxing and coating metal strip when flux is applied to the strip in preparation for coating. In certain of its aspects the invention may be considered as relating to the art of applying flux to metal strip in preparation for coating while in other of its aspects the invention may be considered as relating to the art of coating metal strip including in combination the preliminary step of applying flux to the strip and the subsequent step of coating the strip.

More particularly the invention is concerned with the application to metal strip to be coated of flux which reacts with the molten coating metal at the temperature of the molten coating metal so that the flux cannot be floated upon the molten coating metal. The invention is applicable broadly in the metal coating art, examples of specific branches of the metal coating art in which the invention is applicable being galvanizing, terne coating and aluminizing. For purposes of explanation and illustration we shall describe the invention as applied specifically to the art of tight coat hot dip galvanizing, i. e., coating strip with spelter which contains aluminum by passing the strip through the molten spelter.

Our Patent No. 2,647,305 covers a tight coat galvanizing method and a product produced by that method. The present invention is specially well adapted for employment in connection with the method covered by our said patent and to produce the product covered thereby, although it is emphasized that the present invention is of broad scope and not limited to such application.

One of the objects of the present invention is to make possible considerably increased strip speed in a continuous metal-coating process utilizing a flux which reacts with the molten coating metal at the temperature of the molten coating metal. The flux is applied to the strip in advance of entry of the strip into the molten coating metal in the coating pot. The fluxed strip enters the molten coating metal in a vertically downward direction, being thereafter guided by guide rolls in the pot submerged in the molten coating metal to emerge from the bath of molten coating metal at another point. When the fluxed strip enters the molten coating metal the flux reacts with the molten coating metal, and it is important to the production of coated metal of high quality and optimum surface characteristics that the reaction between the flux and the molten coating metal be complete before the strip engages the first guide roll in the coating pot. In other words, the speed of advance of the strip is limited to such a speed as will permit substantial completion of

the reaction between the flux and the molten coating metal before the zone of engagement of the strip with the first guide roll in the coating pot is reached.

Many fluxes employed for application to strip to be metal-coated are stable in air only up to limited temperatures. We prefer to employ a flux which is stable up to a temperature relatively closely approaching the temperature of the molten coating metal and to preheat the fluxed strip, before introducing it into the bath of molten coating metal, to a temperature approaching the maximum temperature at which the flux is stable in air and consequently to a temperature relatively closely approaching the temperature of the molten coating metal. The lower the temperature differential between the fluxed strip as it enters the bath of molten coating metal and the metal of the bath the faster will be the reaction between the flux and the coating metal and consequently the faster can be the speed of advance of the strip for a given position in the coating pot of the first guide roll.

It is also important that the flux be applied smoothly and uniformly to the strip and that the thickness of the coating of flux on the strip be controlled. An unnecessarily thick coating of flux should be avoided. The flux is preferably applied to the strip in liquid form, and we find it desirable and convenient to apply the flux in a water solution. This may be done in various ways, our preference being to pass the strip through a bath of flux in water solution. When the strip is passed through such a bath it should be withdrawn from the bath substantially vertically upwardly to insure a uniform coating of flux on the strip. The strip passes about guide rolls, one guide roll being positioned to change the vertically upward movement of the strip to movement in another direction as the strip moves generally toward the coating pot. The flux should be dry before the fluxed strip engages that roll as if the flux is not dry it will be adversely affected by contact with the guide roll with a consequent adverse effect upon the ultimate product.

Consequently the fluxed strip should be substantially completely dried between the time when it emerges from the bath of flux and the time when it engages the first guide roll. We preferably control the thickness of the flux on the strip by engaging the strip at a zone above the bath of flux solution. Such engagement reduces the thickness of flux solution on the strip and insures an even coating. The strip is then heated to evaporate the water in the flux solution so that the water is substantially entirely evaporated when the fluxed strip engages the first guide roll.

We prefer to heat the fluxed strip in two stages, the first heating stage being to evaporate the water in the flux solution and being between the bath of the flux solution and the first guide roll thereafter and the second stage following the first stage and further heating the dried fluxed strip before it enters the bath of molten coating metal.

By way of example, we may employ a flux comprising ammonium chloride and zinc chloride in liquid solution in such relative proportions that the mixture has the property when evaporated to a dry coating on the strip of being substantially stable up to a temperature of the order of 500° F. We have used with success a flux comprising 45% ammonium chloride and 55% zinc chloride, although the proportions may be varied. After passing the strip through a bath of the flux in water solution and as the strip moves upwardly from the bath we engage the strip, preferably between rolls and/or brushes, to remove excess flux and insure a smooth uniform coating of flux on the strip. As the strip continues its upward movement and before it engages the first guide roll after emerging from the flux bath we apply heat to the strip

to evaporate the water in the flux, leaving a uniform dry coating of controlled thickness of flux upon the strip. This may bring the temperature of the fluxed strip to in the neighborhood of 250° F. As the dried fluxed strip continues its advance toward the metal-coating pot it is further heated to bring it to a temperature approaching the maximum temperature at which the flux is stable. In this stage the temperature of the fluxed strip may be raised to 450°-500° F. Such raising of the temperature of the fluxed strip before it enters the metal coating bath accelerates the reaction between the flux and the molten coating metal so that such reaction is complete before the strip is engaged by the guide means in the bath. This is true even at strip speeds as high as 300 feet per minute or more. The reaction between the flux and the molten coating metal is complete in the first few inches of passage of the strip through the molten coating metal.

Consequently our invention enables the operation at unprecedentedly high speeds of strip coating lines in which a flux is used which reacts with molten coating metal at the temperature of the molten coating metal. Also, the quality of the product is enhanced by reason of the application of the flux to the strip as a uniform coating of controlled thickness. The controlling of the thickness of the coating is a feature of importance. The apparatus is claimed in our copending application Serial No. 412,265, filed of even date herewith.

As contributing to the uniformity of the coating of flux on the strip we also prefer to flow flux in liquid solution into the crotch between the last guide roll in the bath of flux solution and the strip as the strip emerges from the bath of flux solution. That guide roll preferably has its lower portion immersed in the flux solution and its upper portion above the surface of the flux solution. The roll axis may be slightly above the surface of the flux solution. The flowing of flux in liquid solution into the crotch between the roll and the strip compensates for a tendency which exists for more liquid flux solution to cling to the surface of the strip disposed away from the guide roll than to the surface of the strip disposed next the guide roll.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred method of practicing the same proceeds.

The accompanying drawing is a diagram illustrating a present preferred method of practicing the invention and showing a present preferred form of apparatus which may be employed.

In the drawing the strip 1, which may, for example, be steel strip to be galvanized, is shown as passing in the direction of the arrows first about a guide roll 2 and then about guide rolls 4, 10 and 13 as shown. The method being performed will be considered by way of example to be a tight coat galvanizing method employing spelter containing aluminum. The method may be that of our Patent No. 2,647,305. The power for advancing the strip may be applied by a reel (not shown) which coils up the coated strip and which may, if desired, be supplemented by other driving rolls in the line.

The guide rolls 4 are mounted with their lower portions immersed in a bath of flux in water solution in a receptacle 3. The guide rolls 4 are shown as having their axes slightly above the surface of the flux solution. The flux solution will for purposes of example be deemed to be a water solution of 45% ammonium chloride and 55% zinc chloride. The strip 1 moves vertically upwardly from the flux bath as shown. There is a tendency in the flux bath for more flux to adhere to the surface of the strip disposed away from the guide rolls 4 than to the surface of the strip disposed against the guide rolls, and to compensate for that tendency flux solution is introduced through a pipe 5 and flowed into the crotch 6 between the right-hand guide roll 4 and the strip as show in the drawing. This insures the ap-

plication of a relatively uniform coating of flux to the respective faces of the strip. The bath of flux is replenished to compensate for the flux removed on the strip. The flux solution may have a specific gravity of 10-20° Baumé and a temperature of 150-200° F. The flux solution may, if desired, be continuously recirculated and filtered.

As the strip moves upwardly from the crotch 6 it carries on both faces a relatively heavy layer of flux solution. The strip passes between rubber surfaced metering rolls 7 and levelling brushes 8 which may, for example, be nylon bristle brushes. The rolls and brushes are for the purpose of removing part of the flux solution and insuring that the unremoved flux solution is in a smooth uniform coating on the strip. The rolls and brushes may all be used at the same time or only selected ones thereof may be used, depending on conditions. Those of the metering rolls 7 which are in use at any given time preferably turn in the direction in which the strip tends by friction to rotate them and at the same surface speed as the strip. They are preferably rotated by frictional engagement with the strip, although they may be independently driven. The metering rolls 7 are preferably grooved. The portions of the metering rolls 7 which engage the strip squeeze off the flux solution and the grooves "meter" the amount of flux solution which can pass through, later to be smoothed out or levelled by the levelling brushes 8. The levelling brushes 8 may be rotated or not, and if they are rotated they may be rotated in either direction at selected speeds. Normally the levelling brushes 8 will be rotated slowly in the direction opposite the direction in which the strip tends by friction to rotate them. Preferably the rubber covered rolls 7 are provided with spiral grooves, the grooves being of different size and pitch in the lower rolls 7 than in the upper rolls 7 for selective or conjoint use depending on circumstances. By selection of desired rolls 7 and/or brushes 8 and rotation of the brushes at desired speed the thickness of the coating on the strip may be closely controlled.

As the strip carrying a controlled coating of liquid flux solution passes upwardly from the brushes 8 it enters a heating chamber 9 in which the strip is heated to evaporate the water in the flux solution. The heat may be supplied by any appropriate means, such as electric heating elements, heated air, products of combustion, etc. The strip is free from engagement by any portion of the apparatus after it leaves the brushes 8 until it reaches the left-hand guide roll 10. As a consequence the flux is dried on the strip uniformly and smoothly. The uniformity and smoothness of the coating of flux on the strip might be impaired if the strip were engaged by any portion of the apparatus during the drying operation and before that operation had been substantially completed.

The strip reaching the left-hand guide roll 10 therefore has on both faces a substantially dry uniform coating of flux at a temperature of the order of 250° F. The strip passes over the guide rolls 10 and thence downwardly toward the galvanizing pot 12 which contains molten spelter containing aluminum. In its downward passage the strip passes through a further heating chamber 11 wherein its temperature is raised to a temperature approaching the maximum temperature of stability of the dry flux coating on the strip. That temperature in the case of flux containing 45% of ammonium chloride and 55% of zinc chloride is 450-500° F. The heat in the heating chamber 11 may be applied by any of the methods mentioned in connection with applying heat in the heating chamber 9.

Thus as the strip enters the bath of spelter in the galvanizing pot 12 its temperature relatively closely approaches the temperature of the molten spelter with the result that the dry flux coating on the strip reacts with relatively great rapidity with the spelter. The re-

action is so rapid that it is substantially complete by the time the strip reaches the left-hand guide roll 13 in the galvanizing pot. Thus we provide for the formation of coated strip of controlled high quality and at the same time make possible material increase in the speed of advance of the strip in the coating line. The coated strip emerges from the galvanizing pot 12 between the rolls 14 which may be the conventional exit rolls of the galvanizing rig.

While we have illustrated and described a present preferred method of practicing the invention and have illustrated a present preferred form of apparatus which may be employed it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously practiced, and with the use of other apparatus, within the scope of the following claims.

We claim:

1. A method of applying flux to metal strip in preparation for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length in a path having a generally vertical reach in which the strip moves upwardly, applying flux to the strip adjacent the bottom of said reach, drying the flux on the strip before it reaches the top of said reach and advancing the strip from the top of said reach to the point of immersion in the molten coating metal.

2. A method of applying flux to metal strip in preparation for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length in a path having a generally vertical reach in which the strip moves upwardly, applying flux in liquid solution to the strip adjacent the bottom of said reach, heating the strip with the flux thereon to evaporate the solvent before the strip reaches the top of said reach so that at the top of said reach the flux is in the form of a dry coating on the strip and advancing the strip from the top of said reach to the point of immersion in the molten coating metal.

3. A method of applying flux to metal strip in preparation for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length through a bath of flux in liquid solution, withdrawing the strip from the bath generally vertically upwardly, heating the strip with the flux thereon to evaporate the solvent before the strip reaches the top of its upward movement so that at the top of the upward movement of the strip the flux is in the form of a dry coating on the strip and advancing the strip with the dry coating of flux thereon to the point of immersion in the molten coating metal.

4. A method of applying flux to metal strip in preparation for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length about a guide roll the lower portion of which is immersed in a bath of flux in liquid solution, withdrawing the strip from the bath generally vertically upwardly, flowing flux in liquid solution into the crotch between the roll and the strip as the strip moves upwardly, heating the strip with the flux thereon to evaporate the solvent before the strip reaches the top of its upward movement so that at the top of the upward movement of the strip the flux is in the form of a dry coating on the strip and advancing the strip with the dry coating of flux thereon to the point of immersion in the molten coating metal.

5. A method of applying flux to metal strip in prepara-

tion for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length in a path having a generally vertical reach in which the strip moves upwardly, applying flux in liquid solution to the strip adjacent the bottom of said reach, engaging the strip with the liquid solution of flux thereon to limit the amount of liquid solution of flux on the strip as the strip moves upwardly past the zone of engagement and through such engagement also controlling the thickness and uniformity of the coating of liquid solution of flux on the strip, heating the strip as it advances farther upwardly to evaporate the solvent before the strip reaches the top of said reach so that at the top of said reach the flux is in the form of a dry coating on the strip and advancing the strip from the top of said reach to the point of immersion in the molten coating metal.

6. A method of applying flux to metal strip in preparation for immersing the metal strip in molten coating metal having a lower melting point than the metal of the strip and which molten coating metal reacts with the flux at the temperature of the molten coating metal comprising advancing the strip in the direction of its length in a path having a generally vertical reach in which the strip moves upwardly, applying flux in liquid solution to the strip adjacent the bottom of said reach, as the strip moves upwardly with the flux in liquid solution thereon passing the strip between rolls engaging the strip at its opposite faces to limit the amount of liquid solution of flux on the strip and control the thickness and uniformity of the coating of liquid solution of flux on the strip, heating the strip as it advances farther upwardly to evaporate the solvent before the strip reaches the top of said reach so that at the top of said reach the flux is in the form of a dry coating on the strip and advancing the strip from the top of said reach to the point of immersion in the molten coating metal.

7. A method of coating metal strip with coating metal having a lower melting point than the metal of the strip comprising advancing the strip in the direction of its length in a path having a generally vertical reach in which the strip moves upwardly, applying to the strip adjacent the bottom of said reach flux which reacts with the molten coating metal at the temperature of the molten coating metal, drying the flux on the strip before it reaches the top of said reach, advancing the fluxed strip in the direction of its length into and through a bath of molten coating metal in which the strip is engaged by guide means defining its path through the bath and further heating the fluxed strip before immersing it in the bath to a temperature such as to accelerate the reaction between the flux and the molten coating metal so that the reaction is complete before the strip is engaged by the guide means in the bath.

8. A method of coating metal strip with coating metal having a lower melting point than the metal of the strip comprising advancing the strip in the direction of its length through a liquid solution of flux which reacts with the molten coating metal at the temperature of the molten coating metal, thence generally vertically upwardly and thence into and through a bath of molten coating metal, heating the strip with the flux thereon to evaporate the solvent while the strip is moving generally vertically upwardly so that at the end of such movement the flux is in the form of a dry coating on the strip and further heating the strip before its entry into the bath of molten coating metal to raise the temperature of the flux to a temperature relatively approaching the temperature of the bath of molten coating metal so that the reaction between the flux and the molten coating metal is complete in the first few inches of passage of the strip through the molten coating metal.

9. A method of coating metal strip with coating metal

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having a lower melting point than the metal of the strip comprising advancing the strip in the direction of its length through a liquid solution of flux which reacts with the molten coating metal at the temperature of the molten coating metal, thence generally vertically upwardly and thence into and through a bath of molten coating metal in which the strip is engaged by guide means defining its path through the bath, engaging the strip with the liquid solution of flux thereon to limit the amount of liquid solution of flux on the strip as the strip moves upwardly past the zone of engagement and through such engagement also controlling the thickness and uniformity of the coating of liquid solution of flux on the strip, heating the strip having thereon the controlled coating of liquid solution of flux to evaporate the solvent while the strip is moving generally vertically upwardly so that at the end of such movement the flux is in the form of a dry coating on the strip and further heating the strip before its entry into the bath of molten coating metal to raise the temperature of the flux to a temperature relatively approaching the temperature of the bath of molten coating metal so that the reaction between the flux and the molten coating metal is complete before the strip is engaged by the guide means in the bath.

10. A method of coating metal strip with coating metal having a lower melting point than the metal of the strip comprising advancing the strip in the direction of its length through a bath of flux comprising ammonium chloride and zinc chloride in liquid solution in such relative proportions that the mixture has the property when evaporated to a dry coating on the strip of being substantially stable up to a temperature of the order of 500° F., which flux reacts with the molten coating metal at the temperature of the molten coating metal, advancing

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the strip thence generally vertically upwardly and thence into and through a bath of molten coating metal in which the strip is engaged by guide means defining its path through the bath, engaging the strip with the liquid solution of flux thereon to limit the amount of liquid solution of flux on the strip as the strip moves upwardly past the zone of engagement and through such engagement also controlling the thickness and uniformity of the coating of liquid solution of flux on the strip, heating the strip having thereon the controlled coating of liquid solution of flux to a temperature of the order of 250° F. to evaporate the solvent while the strip is moving generally vertically upwardly so that at the end of such movement the flux is in the form of a dry coating on the strip which is substantially stable up to a temperature of the order of 500° F. and further heating the strip to a temperature approaching 500° F. before its entry into the bath of molten coating metal whose temperature is above 500° F. to significantly reduce the temperature differential between the flux and the molten coating metal when the fluxed strip is immersed in the molten coating metal and consequently accelerate the reaction between the flux and the molten coating metal so that such reaction is complete before the strip is engaged by the guide means in the bath.

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