Jan. 3, 1961

J. T. MAYHEW

2,967,114

COATING APPARATUS AND METHOD

Filed July 22, 1958

2 Sheets-Sheet 1

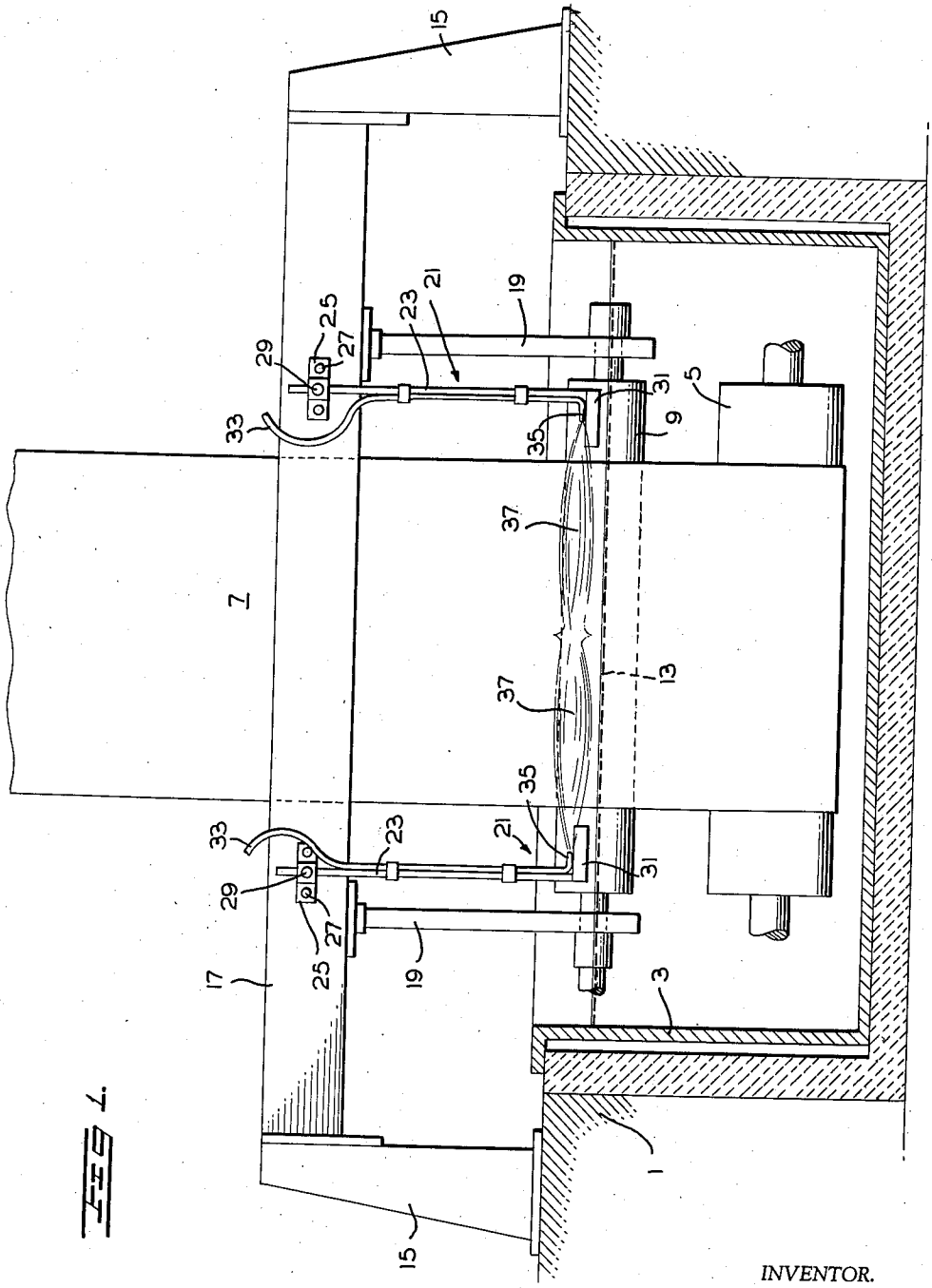


FIG. 1.

INVENTOR.
JOHN T. MAYHEW
BY Shanley & O'Neil
ATTORNEYS

Jan. 3, 1961

J. T. MAYHEW

2,967,114

COATING APPARATUS AND METHOD

Filed July 22, 1958

2 Sheets-Sheet 2

Fig 2.

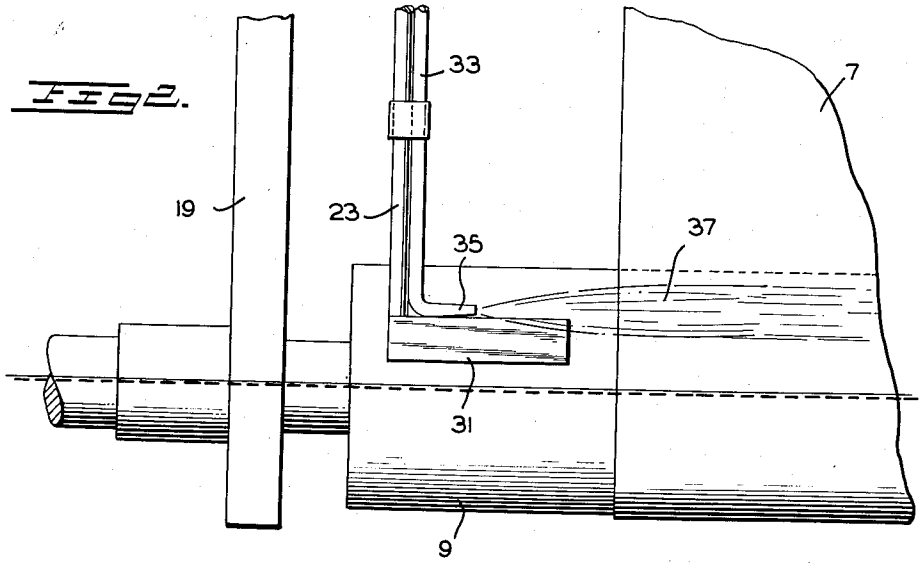
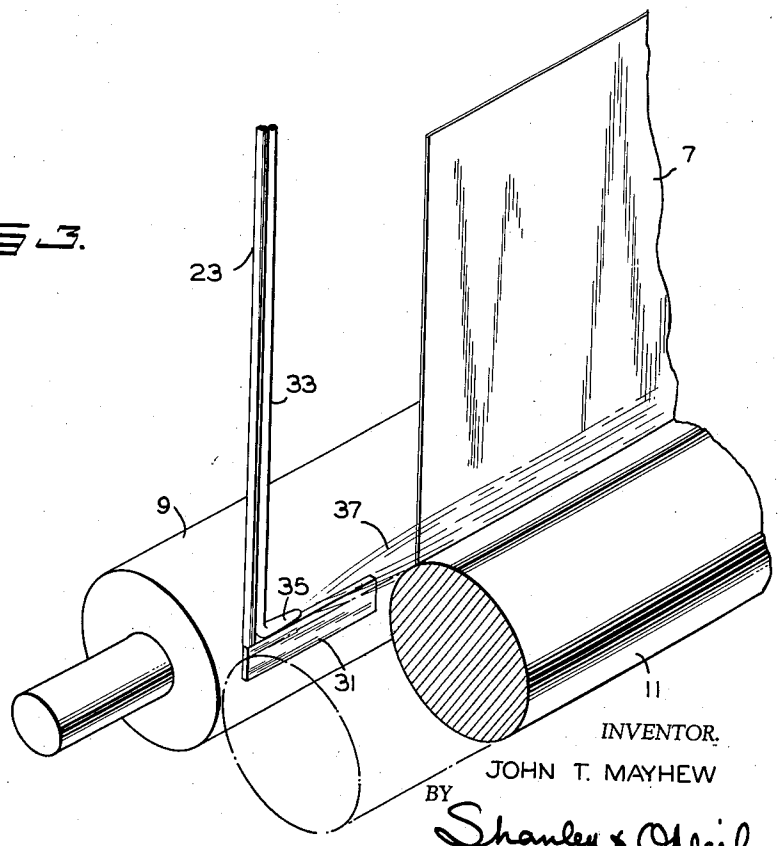


Fig 3.



INVENTOR.
JOHN T. MAYHEW
BY
Shanley & O'Neil
ATTORNEYS

United States Patent Office 2,967,114
Patented Jan. 3, 1961

2,967,114

COATING APPARATUS AND METHOD

John T. Mayhew, Toronto, Ohio, assignor to National Steel Corporation, a corporation of Delaware

Filed July 22, 1958, Ser. No. 750,218

21 Claims. (Cl. 117—46)

The present invention relates to coating apparatus, and more particularly to coating apparatus adapted to prevent deposition of excess material on the edges of continuously coated strip material. The invention has utility in connection with a variety of coating operations but is particularly advantageous in connection with the deposition of metallic coatings on metallic substrates by the continuous hot dipping of metallic strip material, as in galvanizing, in which connection the invention will be disclosed by way of example.

In the continuous coating of strip material, it is common practice to provide a container in which is disposed a liquid bath of coating material which is usually at an elevated temperature. The continuous strip material is run through the bath in a tortuous path about a plurality of rolls submerged in the bath. The strip material is thus coated on both surfaces with a layer of coating material at least partly in liquid phase and leaves the bath between a pair of closely spaced exit rolls. Thereafter, the coating material or the liquid portion thereof hardens on the substrate by cooling or drying or other physical and/or chemical mechanisms.

The exit rolls are only partly submerged in the bath and function to limit the thickness of the coating on the substrate as the level of the bath is no higher than the "bite" or "nip" of the rolls, that is, the line along which the rolls most closely approach each other. Thus, the strip material serves as a plug or closure member between the portions of exit rolls contacted by the strip so as to prevent the passage of excess coating material between the strip and either of the exit rolls.

But there is no such closure member between the exit rolls on either side of the strip; and in these two regions the exit rolls tend to pump the coating material up through the nip of the rolls to form elevated pools of liquid coating material. The liquid of these pools tends to drain back into the bath lengthwise of the rolls. In doing so, a portion of the liquid overruns the edges of the strip material above the nip of the rolls and is carried up and away from the bath on those edges. As a result, there is deposited on the edges a coating of bath material which is thicker than the coating medially of the strip. This excess deposit on the edges of the strip not only wastes coating material but also prevents winding the coated strip into a desirably compact, cylindrical coil.

The contact of the edges of the strip material with the unconfined pools of liquid above the nip of the rolls also results in the deposit on the edges of the strip of irregular formations of coating material which extend edgewise outwardly of the strip. These deposits give a rough, unfinished appearance to the edges of the strip and hence are known in the art as "feather edge." The extent of feather edging is largely dependent on the nature and viscosity of the coating bath and often necessitates further treatment of the coated strip to smooth the edges thereof.

In addition to thickened edge deposits and feather edge, as described above, a third type of coating irregularity

is commonly encountered as a result of passage of the strip material between the exit rolls upon emerging from the bath. This third type of irregularity is characterized by a number of very shallow hills and valleys extending lengthwise of the applied coating. To understand why these form, it is necessary to realize that the thickness of the coating which finally hardens on the strip is not the same as the distance between the sheet and the roll at the nip of the rolls. Instead, the thickness of the coating at any point depends to some extent on the adhesion of the liquid coating material to the strip and to the rolls. In effect, the strip and the rolls divide the liquid coating material between them. If the adhesion of the strip to the liquid coating material varies transversely of the strip or lengthwise of the rolls, as often occurs in practice, then the coating on the strip will have relatively greater or less thickness at those points. These irregularities have much the same appearance as paint which has run down a wall in streaks and are known in the art as "stringers."

Accordingly, it is an object of the present invention to provide methods and apparatus for preventing the formation of thickened edge deposits on coated strip material.

Another object of the present invention is the provision of methods and apparatus for preventing the formation of feather edge on coated strip material.

Still another object of the present invention is the provision of methods and apparatus for the removal of stringers from coated strip material.

Finally, it is an object of the present invention to provide improvements in methods and apparatus for coating strip material, which will be relatively easy and inexpensive to provide, simple to practice and maintain, and dependable in use.

Broadly, the present invention achieves the above objects by providing heat conductive means adjacent each side edge of the sheet contiguous to the nip of the rolls and heating at least a portion of the heat conductive means to a temperature substantially higher than the temperature of the coating bath. More specifically, heat conductive members are partially immersed in the pools of coating material pumped above the nip of the rolls on either side of the sheet, and flames are directed along these members toward the edges of the sheet. Heat from the flames is conducted by the immersed members into the pools to heat the pools and reduce the viscosity of the material in the pools and thus reduce the thickness of the layers of coating material which leave the pools on the edges of the strip. At the same time, the flames heat the edges of the strip, and this heating, taken with the reduced viscosity of the pool liquid, prevents feather edge. Also, the flames preferably extend along the strip on both sides thereof to level the stringers. In short, the essence of the invention is that the viscosity of selected portions of the coating material is reduced by heating (1) the pools pumped above the nip of the rolls to reduce thickened edge coating, (2) the sheet edges to remove feather edge, and (3) the surface of the coating to remove stringers.

As indicated above, the invention has particular utility in the formation of metallic coatings on metallic substrates. In order fully to appreciate the advantages of the invention in this environment, it is necessary briefly to examine the physical chemistry of the formation of this type of coating, for example in the case of galvanizing, which is essentially the coating of iron with zinc.

As is evident from the iron-zinc equilibrium diagram, the solid solubility of iron in zinc is very low, about 0.01 to 0.03 percent depending on temperature. But in addition to the solid solution, several zinc-iron alloys having high zinc content are formed during galvanizing. The first of these is the zeta phase which has the highest zinc

and the lowest iron content. Next is the delta phase, and finally the gamma phase, these last two having progressively less zinc and more iron, although the gamma phase will still have no more than 27% iron. These three phases have progressively higher melting points, all of which are substantially above that of zinc.

Thus, when steel strip is immersed in a bath of molten zinc, or "spelter," galvanization proceeds according to a sequence of main steps. First, there forms on the steel a coating of zeta phase. It will be in solid phase, as its melting point is higher than the bath temperature (790–850° F.). In order that further alloying occur, either zinc or iron must migrate through the zeta layer, and in fact it is the iron that migrates. Thus, the zeta layer grows in thickness, and the thicker the layer the higher the iron concentration in that portion of the layer adjacent the iron substrate, until the phase next richer in iron, the delta phase, begins to form.

Upon completion of the delta layer, the layer richest in iron, the gamma phase, is begun. But during formation of the gamma layer, a state of equilibrium is reached under the usual galvanizing temperature conditions. The rate of iron migration from the substrate becomes equal to the rate of iron dissolution in the spelter and the rate of increase of coating thickness falls to zero. Thereafter, the coating maintains a fixed composition and thickness but iron continues to migrate into the spelter, where it forms zinc dross of a greater density than the spelter and collects in the bottom of the receptacle.

Thus, the galvanized strip emerging from the bath consists of the solid substrate with a plurality of layers of solid alloys thereon and a layer of molten spelter adhering to the outer alloy layer. The nature, number and thickness of the alloy layers is a function of the bath temperature and above the time needed to reach equilibrium is independent of the length of time of immersion in the bath.

As pointed out above, the invention is characterized by heating of selected portions of the coating material. From a consideration of the mechanism of galvanizing as set forth above, it will be clear that this is not at all equivalent to heating the bath proper to reduce the viscosity thereof. If the bath proper were heated for this purpose, the nature of the applied coating would be radically changed. Moreover, increased bath temperature would speed the aging of steels susceptible to this change, thereby rendering them brittle, and would tend to bring out the internal discontinuities of the steel. These discontinuities are in effect pockets which become filled with hydrogen during pickling prior to galvanizing, and increased bath temperature would raise the pressure of the pockets to the point that blistering of the coating would frequently result.

In sharp contrast, in the present invention, heat is applied only to those portions of coating material which no longer form a part of the bath proper. Thus, the galvanizing characteristics of the bath and the characteristics of the solid alloy layers of the coating are unaffected, but the viscosity of the adherent spelter layer is substantially changed. As a result, the excess coating material which would otherwise cause thickened edge deposits or feather edge is not retained by the edges of the strip, and the viscosity of the spelter intermediate the edges of the sheet is so reduced that the surface tension of the fluent spelter smooths out the stringers.

Another advantage of the present invention which becomes apparent from the above discussion of galvanizing an analogous coating operations is a reduction in the tendency of the coating to peel. In general, the tendency of a coating to peel varies directly with the thickness of the coating. But in the case of galvanized and analogous coatings, it is not the alloy layer which causes the coating to tend to peel but only the solidified spelter layer. Thus, a thick alloy layer has no more tendency to peel than a thin alloy layer, but a thick spelter layer tends much more to peel than a thin spelter layer even though it may overlie a thick alloy layer. Thus, two coatings, each of which has a thick alloy layer, may not differ much as to proportionate total thickness, but if the difference of total thickness is accounted for by the spelter layers alone, then the tendencies of the coatings to peel will be different out of all proportion to the total thicknesses of the coatings. In other words, a coated strip which otherwise has satisfactory resistance to peeling may nevertheless peel quite readily in the region of thickened edge deposits or stringers. The present invention, by reducing excessively thick deposits of spelter without affecting the underlying alloy layers, yields coated strip having uniformly satisfactory resistance to peeling.

Other objects and advantages of the present invention will become apparent from a consideration of the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a front elevational view of apparatus according to the present invention, shown in the environment of a continuous galvanizing pot;

Figure 2 is an enlarged fragment of Figure 1; and

Figure 3 is a fragmentary perspective view of the structure in the region of Figure 2.

Referring now to the drawings in greater detail, there is shown in Figure 1 a supporting base 1 in which is supported a continuous galvanizing pot in the form of a receptacle 3 adapted to contain a quantity of liquid spelter comprising an example of a coating bath of the present invention. Immersed in the spelter is a plurality of guide rolls 5 about which continuous strip material 7 in the form of steel strip passes in a tortuous path through the bath until the layers of alloy coating are completed, as explained above.

Upon emerging from the bath, the strip material passes between a pair of closely spaced parallel exit rolls 9 and 11 which at their closest points define a bite or nip which is represented by a horizontal dotted line 13 which also represents the bath level. The bath level, in turn, coincides with the plane common to the axes of rolls 9 and 11. Thus, rolls 9 and 11 are partially immersed in the bath about up to the nip of the rolls. The rolls are adapted to rotate in opposite directions so that their peripheries at the nip are moving in the same direction and at the same speed as the strip material as the strip material emerges from the bath. Standards 15 are mounted on base 1 on either side of receptacle 3 and support between them at their upper ends a frame 17 on which downwardly extending brackets 19 are supported which in turn support rolls 9 and 11 in the desired relationship to the bath.

The structure described thus far is conventional and comprises only one of the many environments in which the present invention may be practiced. The novel structure according to the present invention is indicated generally at 21 and comprises, on each side of the strip material, a supporting rod 23 vertically adjustably mounted in a bracket 25 which is detachably secured to frame 17 by means of bolts 27. A set screw 29 locks rod 23 in any selected position of vertical adjustment relative to bracket 25.

Secured to the lower end of each rod 23 is a thin flat elongated shoe 31 in the form of a strip of heat-conductive material of a length several times its height. Shoe 31 may for example be of 16-gauge stainless steel or other metal. It is disposed in a vertical plane which is perpendicular to the common plane of the axes of the exit rolls and parallel to strip material 7 as the latter rises vertically from between rolls 9 and 11. The lowermost portion of shoe 31 slidingly contacts both of rolls 9 and 11. Shoe 31 extends from rod 23 in the direction of the strip material but terminates a substantial distance short of the strip material. Thus, shoe 31 is disposed adjacent but spaced from strip material 7 and contiguous to the nip of the rolls.

A gas conduit 33 extends along and is supported by

rod 23 and terminates downwardly in a horizontal end portion comprising a burner tip 35 which is directed toward the strip material along the top of shoe 31. Conduit 33 is continuously supplied with a combustible mixture of coke oven gas and compressed air which is ejected from tip 35 in a stream which may be ignited to provide a flame 37.

The novel structure 21 is arranged in a pair of units in opposition to each other, one on either side of the strip material. Shoes 31 extend toward each other and are coplanar. Burner tips 35 are directed toward each other and are coaxial. Flames 39 are also directed toward each other and are generally coaxial and meet at about the mid line of strip material 7.

It is important to note that each flame 39 is split centrally by the strip material so that a portion of the flame extends on each side of the strip material. Thus, all portions of the surface of the strip material are contacted by the flames as the strip material emerges from between the exit rolls. The contact of shoes 31 with both exit rolls centers the flames and assures that the flames will be divided midway by the strip material.

In operation, with the combustible gas streams ignited and the strip material rising from the bath between the exit rolls, the flames directly contact both sides of the upper portions of the shoes, that is, the portions of the shoes farthest from the common plane of the axes of the exit rolls, and heat these portions to a high temperature substantially above that of the bath, usually to red heat. The lower portions of the shoes are immersed in the pools which are pumped up above the nip of the exit rolls on either side of the strip material. The heat applied to the upper portions of the shoes is rapidly conducted to the immersed lower portions of the shoes and heats these pools of bath liquid, greatly lowering the viscosity thereof so that the material in the pools does not tend to build thick edge coatings on the strip material.

It is an important feature of the invention that the inner shoe ends be spaced substantial distances from the edges of the strip material. It has been found that when the shoes contact the edges of the strip material, the coating material from the pools forms balls or beads along the strip edges, and that the spacing of the inner shoe ends from the strip edges avoids this tendency and assures smooth coatings along the strip edges. Preferably, the inner ends of the shoes are spaced not less than about two inches from the adjacent edges of the strip material.

From the upper portions of shoes 31, the flames bridge the gap between the shoes and the strip material and contact the edges of the strip material. The coating material along these edges is quickly heated and reduced in viscosity; and this flame action, coupled with the reduction of viscosity of the material of the pools by heat transfer through the shoes, prevents the occurrence of feather edge.

Finally, the contact of the flames along the intermediate portions of the width of the strip reduces the viscosity of the outer spelter layer on both sides of the strip material and enables the surface tension of the spelter to smooth out such stringers as would otherwise form and harden.

From a consideration of the foregoing disclosure, it will be obvious that all of the initially recited objects of the present invention have been achieved.

Although the present invention has been described and illustrated in connection with a preferred embodiment, it is to be understood that modifications and variations may be resorted to without departing from the spirit of the invention, as those skilled in this art will readily understand. Such modifications and variations are considered to be within the scope and purview of the present invention as defined by the appended claims.

What is claimed is:

1. Apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, a pair of heat conductive members disposed one on each side of the strip material adjacent but spaced from the side edges of the strip material and contiguous to the nip of the rolls, and means for contacting a portion of each heat conductive member with flame.

2. Apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, a pair of heat conductive members disposed one on each side of the strip material adjacent but spaced from the side edges of the strip material and contiguous to the nip of the rolls, and means for directing flame toward the strip material along and in contact with a portion of each heat conductive member.

3. Apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, a pair of heat conductive members disposed one on each side of the strip material adjacent but spaced from the side edges of the strip material and in contact with the rolls contiguous to the nip of the rolls, and means for directing flames toward each other along and in contact with a portion of each heat conductive member and along and in contact with a portion of both sides of the strip material, whereby contact of the heat conductive members with the rolls accurately positions the flames relative to the strip material.

4. Apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the axes of the rolls lying in a common plane, a pair of flat, elongated, heat conductive metal shoes extending lengthwise of the rolls and disposed in a common plane perpendicular to the first named common plane, the shoes being disposed one on each side of the strip material adjacent but spaced from the side edges of the strip material and contiguous to the nip of the rolls, and means for contacting with flame at least those portions of the shoes which are the farthest from the first named plane.

5. Apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the axes of the rolls lying in a common plane, a pair of flat, elongated, heat conductive metal shoes extending lengthwise of the rolls and disposed in a common plane perpendicular to the first named common plane, the shoes being disposed one on each side of the strip material adjacent but spaced from the side edges of the strip material and in contact with the rolls contiguous to the nip of the rolls, and means for directing flames toward each other along and in contact with at least those portions of the shoes which are the farthest from the first named plane and along and in contact with a portion of both sides of the strip material, whereby contact of the shoes with the rolls accurately positions the flames relative to the strip material.

6. In a method for applying a coating to strip material in which strip material is passed through a liquid coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member in the pool adjacent each side of

the strip material contiguous to the nip of the rolls, and heating at least a portion of the heat conductive member to a temperature substantially higher than the temperature of the coating bath.

7. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent each side of the strip material contiguous to the nip of the rolls with part of the member immersed in the pool and part exposed above the pool, and contacting the exposed part of the heat conductive member with flame.

8. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent each side of the strip material contiguous to the nip of the rolls with a part of the member immersed in the pool and part exposed above the pool, and directing flame toward the strip material along and in contact with the exposed part of the heat conductive member.

9. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent each side of the strip material contiguous to the rolls with part of the member immersed in the pool and part exposed above the pool, and directing flame toward the strip material along and in contact with the exposed part of the heat conductive member and along and in contact with a portion of both sides of the strip material.

10. In a method for applying a coating to strip material in which strip material is passed through a liquid coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member in the pool adjacent but spaced laterally outwardly from each side of the strip material contiguous to the nip of the rolls, and heating at least a portion of the heat conductive member to a temperature substantially higher than the temperature of the coating bath.

11. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent but spaced laterally outwardly from each side of the strip material contiguous to the nip of the rolls with part of the member immersed in the pool and part exposed above the pool, and contacting the exposed part of the heat conductive member with flame.

12. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent but spaced laterally outwardly from each side of the strip material contiguous to the nip of the rolls with part of the member immersed in the pool and part exposed above the pool, and directing flame toward the strip material along and in contact with the exposed part of the heat conductive member.

13. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath and in which liquid metal coating material collects in a pool above the nip of the rolls at each side edge of the strip material, the improvement comprising the steps of positioning a heat conductive member adjacent but spaced laterally outwardly from each side of the strip material contiguous to the rolls with part of the member immersed in the pool and part exposed above the pool, and directing flame toward the strip material along and in contact with the exposed part of the heat conductive member and along and in contact with a portion of both sides of the strip material.

14. In apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, and a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the improvement comprising means for directing flames in the plane of the strip material from a point laterally outwardly of a side edge of the strip material edgewise against and beyond the adjacent side edge of the strip material.

15. In apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, and a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the improvement comprising means for directing flames from opposite directions toward each other in the plane of the strip material from points in the plane of the strip material spaced from the strip material on opposite sides thereof.

16. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath, the improvement comprising directing flames in the plane of the strip material from a point laterally outwardly of a side edge of the strip material edgewise against and beyond the adjacent side edge of the strip material.

17. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath, the improvement comprising directing flames from opposite directions toward each other in the plane of the strip material from points in the plane of the strip material spaced from the strip material on opposite sides thereof.

18. In apparatus for applying a coating to strip material, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, and a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the improvement comprising means for scouring the entire surface of the strip material with hot products of combustion as the strip material emerges from between the rolls, said means comprising means for directing flames from opposite directions toward each other along the plane of the strip material from points spaced edgewise outwardly of opposite edges of the strip material.

19. In apparatus for applying a coating to strip mate-

rial, comprising a receptacle adapted to contain a liquid coating bath through which the strip material passes, and a pair of closely spaced rolls between which the strip material passes upon emerging from the bath, the improvement comprising means for scouring the entire surface of the strip material with hot products of combustion as the strip material emerges from between the rolls, said means comprising means for directing flames from opposite directions toward each other in the plane of the strip material from points in the plane of the strip material spaced from the strip material on opposite sides thereof

20. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath, the improvement comprising scouring the entire surface of the strip material with hot products of combustion as the strip material emerges from between the rolls by directing flames from opposite directions toward each other along the plane of the strip material

from points spaced edgewise outwardly of opposite edges of the strip material.

21. In a method for applying a metal coating to metal strip material in which metal strip material is passed through a liquid metal coating bath in a receptacle and between a pair of closely spaced rolls upon emerging from the bath, the improvement comprising scouring the entire surface of the strip material with hot products of combustion as the strip material emerges from between the rolls by directing flames from opposite directions toward each other in the plane of the strip material from points in the plane of the strip material spaced from the strip material on opposite sides thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 18,871	Schueler	June 20, 1933
Re. 19,209	Schueler	June 12, 1934
1,673,624	Howe	June 12, 1928
1,732,504	Davis	Oct. 22, 1929
2,034,348	Lytle	Mar. 17, 1936
2,708,171	Inglefield	May 10, 1955