This invention relates to coating sheet iron and particularly to providing sheet iron with a coating of metal such as tin or zinc.

In order to simplify the description of the invention, I will refer to it hereinafter as used in the manufacture of so-called "tin plate," that is, sheet iron which is provided with a thin coating of tin.

According to the present practice, tin plate is made by passing sheet iron either in the form of separate plates or in the form of a long strip, through a bath of molten tin contained in a so-called "tin pot," said pot having at the entering side, that is, the side at which the sheet metal is entered into the pot, a flux box containing flux through which the sheet metal passes before it enters the bath of molten tin, and also having on the discharge side a compartment containing oil through which the coated sheet passes as it emerges from the bath of molten tin.

The sheet metal entering the bath of molten tin has a chilling effect on the tin, this being partly due to the heat absorbed from the molten tin to heat the sheet metal, and partly due to the heat absorbed from the molten tin in evaporating the moisture which remains on the surface of the sheet metal after its passage through the pickling bath.

This chilling effect on the molten tin controls to a certain extent the speed at which the sheet metal can be fed into and passed through the tin bath, for if the sheet metal is moved into and through the bath at too rapid a rate, the chilling effect will be such as to interfere very materially with the coating operation.

One of the objects of my present invention is to provide an improved apparatus which is constructed so as to reduce to a minimum the chilling effect on the molten tin caused by the sheet metal entering the tin bath, thereby enabling the thinning operation to be speeded up to a point considerably in excess of that at which tin plate can be produced with the machine now in common use.

A further object of the invention is to provide a novel coating apparatus so constructed that the mass of molten tin in the tin pot is maintained at its proper temperature not only by heat applied to the pot externally in usual manner but also by heated means submerged in the material in the pot and so located as to provide substantially equal heat flow therefrom in all directions.

A still further object of the invention is to provide a novel apparatus by which the sheet metal to be tinned is fed through the tin bath by means of heated rollers. Such rollers not only assist in producing a more even tin coating, but they furnish means for heating the tin bath internally, thereby offsetting to a considerable extent the chilling effect which the sheet metal has on the bath as it is fed thereinto.

In the drawings, wherein I have illustrated some selected embodiments of the invention:

Fig. 1 is a fragmentary sectional view illustrating the coating element of a machine embodying my invention and adapted to coat separate sheets.

Fig. 2 is a similar view of the machine adapted to coat sheet metal in the form of a long strip.

Fig. 3 is a section on the line 2—2, Fig. 1.

Fig. 4 is a fragmentary sectional view illustrating the means by which the separate sheets are cooled after they emerge from the tin bath.

Fig. 5 is an enlarged section on the line 3—3, Fig. 4.

Fig. 6 is a section on the line 6—6, Fig. 3.

Fig. 7 is a fragmentary view of the carrier for receiving the sheets after they emerge from the tin bath and while they are being cooled.

Fig. 8 is a sectional view showing a complete machine embodying my invention and having the pickling bath and the coating apparatus.

Referring first to Fig. 1, I indicates a tin pot of any suitable or usual construction containing a bath 2 of molten tin. This tin pot is shown as mounted in a suitable furnace 3 which is provided with a gas or oil burner 4 by which the pot is heated externally, said furnace having an opening 24 for discharging the products of combustion. In practice, this opening 24 would lead to a suitable flue pipe.

The tin pot 1 is constructed with the partition 5 which extends downwardly to a point somewhat below the level of the molten tin. The space 6a on one side of the partition, the side which constitutes the entering side of the pot, that is, the side at which the sheet metal is fed into the pot, constitutes a flux box containing a body of flux 8 which is supported on the molten tin 2, and the space 7a on the other side of the partition, that is, the discharge side of the pot, constitutes an oil box or grease box containing a body of oil 7 which also is supported on the molten tin 2, this being the usual practice in devices for tinning sheet metal.

In Fig. 1, 8 indicates separate sheets or plates of metal which are being fed through the pot to be tinned. Each sheet enters the pot on the entering side and passes through the flux 8 be-
before it is fed into the bath of molten tin, and
2. The sheet is discharged from the bath of molten tin through the oil bath 7.

In the operation of coating sheet metal with tin as now commercially carried out, the plates to be tinned are first submerged in a pickling bath and hence are usually wet when they are fed into and through the flux 6. As the cool wet plates enter the molten tin, the latter becomes chilled somewhat, such chilling of the tin being partly due to the heat absorbed from the tin in heating the plates, and partly due to the heat absorbed from the tin in vaporizing any moisture on the plates. Although the molten tin is being continually heated by the burner 4, yet the burner is usually located below the tin pot and the chilling of the molten tin at the point where the plates enter the tin bath at the top is frequently so great that some of the tin becomes solidified or partially solidified, with the result that particles of the solidified or partially solidified tin adhere to the sheets as they enter the bath, thereby producing an imperfect coating. This chilling of the molten tin has a direct influence on the speed at which the sheet metal is fed to and passed through the bath of molten tin. The greater the speed, the greater the chilling effect, and hence the practice is to advance the sheet metal at a slow enough speed to avoid any undue chilling of the molten tin.

In order to reduce the chilling effect on the molten tin, I have provided an apparatus in which the feeding means used for feeding the plates through the tin bath is heated and is constructed to heat the plates before they enter and during their passage through the tin bath. In this way, the formation of solidified tin at the point where the plates enter the molten tin is greatly reduced, and, moreover, since the plates are heated by the feeding means while they are passing through the tin bath, any tin which is partially solidified and which adheres to the plate will become melted again before the plate leaves the bath so that the plates which are discharged from the bath will be free from any particles of solid tin.

In Fig. 1, 9 represents a pair of feed rolls which are partially submerged in the tin bath 2 of molten tin and partially in the flux 6, said feed rolls serving to feed the plates 8 downwardly through the flux and into the molten tin.

Situated within the bath of molten tin is a large feed roller 10 which serves to feed the plates through the bath, said feed roller having smaller idler rolls 11 cooperating therewith. The feed roller 10 is positively driven and the idler rolls 11 are spring pressed and thus act as presser rolls.

As each plate 8 is delivered from the feed rolls 9, it passes between stationary guide plates 12 which direct it between the large feed roller 10 and the first idler roll 11. The idler rolls 11, being spring pressed, press the plate 8 against the feed roll, and said plate 8 is thus positively carried through the bath 2 of molten tin by the feeding action of the large feed roller 10.

When plate 8 leaves the large feed roller 10, it passes between guide walls 13 and then between two pairs of driven rolls 14, 15 which serve to deliver the plate from the oil bath.

Each idler roll 11 is shown as carried in bearings 20 that are mounted between guiding ribs 26 formed on the end walls of the pot 1. Each bearing 25 is acted on by a spring 27 which yieldingly forces it toward the large feed roller 10.

Suitable means are provided for heating the large roller 10 to a high temperature so that each plate 8 is being fed through the tin bath by heated feeding means. The feed roller 10 is shown in the form of a hollow drum, and in Figs. 1 and 3, there is provided a gas burner 19 provided with burner openings 24 which extend into the drum and serves to heat the latter. The drum or large roll 10 is provided with trunnions 18, 19, which are journalied in bearing members 20. The trunnion 19 has a rigid collar 21 which extends through the wall of the furnace 3 and carries at its outer end a gear 22 by which the drum 10 is rotated. Said gear may be connected to any source of power. The trunnion 18 is shown as hollow, and the wall of the tin pot 1 has an opening therefor in alignment with the opening through the trunnion 18, thereby providing an exit for the products of combustion.

Instead of using a gas or oil burner for heating the drum 10, I may use an electrical heating unit without in any way departing from the invention.

The feed rolls 9, as well as the idler rolls 11 may be heated rolls, and hence, as each plate 8 is fed into the machine, it becomes heated by its contact with the feed rolls 9, and it continues to receive heat while passing between the drum 10 and the idler rolls 11.

The feed rolls 9 and the idler rolls 11 may be heated in any appropriate way without departing from the invention.

Merely for illustrative purposes, I have shown each roll as in the form of a tube and have also shown an electric heating unit 28 which is illustrated diagrammatically in Fig. 3, for heating each of the rolls 9 and 11.

17 indicates wipers or brushes which contact with the feed rolls 9 and serve to keep the rolls clean and free from any tin oxide or solid tin particles which may be formed at the point where the plates are fed into the machine, or any iron particles which may be carried into the bath by the plates.

The feed rolls 14 are also shown as provided with wipers or brushes 30 for the purpose of keeping the surface of said rolls free from any solid particles which might injure the tin plating.

By employing heated feed rolls 9 for feeding the plates 8 into the bath of molten tin, and by employing heated feeding means for feeding the plates through said bath, only a portion of the heat required to heat the plates to the proper temperature is taken from the molten tin, the rest of the heat required for this purpose being received from the heated rolls. Thus the chilling effect of the plates 8 on the bath of molten metal will be greatly reduced, thereby obviating to a large extent the formation of solid tin particles.

Since the heated feed roll or feed drum 10 is submerged in the material in the pot 1 and is internally heated, there will be a substantially even heat flow from said feed drum to all directions. In other words, there will be a heat flow from the lower portion of said drum to the plates passing around the drum and heat flow from the upper surface of the drum directly into the molten tin immediately above the drum. In the same way, since the feed rolls 9 are submerged in the liquid mass in the pot 1 and are internally
heated, there will be a substantially equal heat flow from each of said rolls in all directions.

This heat flow from the submerged drum 10 into the portion of the molten tin through which the plates enter the tin bath serves to replace the heat lost by said molten tin due to the feeding of the cold sheet metal into the bath. The drum 10 and the rolls 9 are, therefore, important factors in maintaining the molten tin at its proper temperature, which is in the neighborhood of approximately 575°F., at the points where the strip or sheet enters and leaves the drum. These factors all cooperate to speed up the tinning operation so that with my invention it is possible to feed the plates 8 through the tin bath at a speed which is considerably in excess of that at which such plates are fed through the tin bath, without producing any deleterious chilling effect on the molten tin.

I will preferably employ a feed roller 10 of sufficient diameter so that its peripheral area is two or three times more than the superficial area of any plate so that when said plates are being fed through the bath of molten tin, each plate will have its entire surface in engagement with the feed roller or drum 10 for a definite time period. In this way, all portions of any sheet are simultaneously subjected to the heating effect of the drum 10 during such time period.

In Fig. 2, there is shown an apparatus similar to the one illustrated in Fig. 1, but adapted to operate on a long strip of sheet metal 6 instead of separate plates 9. The strip 8 is fed into the bath by the feed rollers 9 and is fed through the bath in the same manner as above described. Fig. 2 illustrates also the feed drum 10 as being heated by an electric heating unit indicated conventionally at 31.

As stated above, it is customary to submerge the sheet metal to be coated in a pickling bath just prior to delivering the sheet metal into the coating bath, and in order to obtain the desired benefit from the pickling bath, it is necessary that the sheet metal should remain in the bath for a period of 90 seconds or more.

As further stated above, it is possible with my apparatus to advance a strip of sheet metal 6 through the coating bath at a speed considerably in excess of that possible with machines now in use but producing any deleterious chilling effect on the molten tin, and in order to provide for submerging the sheet metal to the pickling bath for the requisite period of time, notwithstanding the relatively rapid advancing movement of said sheet through the bath of molten tin, I propose to use a pickling bath such as shown in Fig. 8. In said figure, 55 indicates a tank containing a pickling bath 56, which is usually an acid bath. Located within the bath 56 are driven rollers 57, 59 and 93, around which the strip 6a of sheet metal passes, said strip being taken from a coil 6b. The sheet metal passes from the coil 60 over a roller 61, and thence into the pickling bath and around the driven rolls 57, 58 and 59. The strip then passes between squeeze rolls 62 which feed the strip forward, and over a direction roll 63, to the feed rolls 9. By means of this construction, the time required for any portion of the strip 6a to pass through the pickling bath 56 will be sufficient to produce the necessary pickling effect on the sheet metal, notwithstanding the relatively rapid forward movement thereof. This pickling bath 56 may have any desired depth, and any desired number of direction rolls 57, 58, 59, may be employed in order to maintain the strip in the pickling bath for the required length of time.

In the operation of applying a tin coating to plates 8, it is necessary to allow the plates to cool somewhat after emerging from the oil bath and before they are polished. This cooling period is required in order to permit the tin coating to harden sufficiently so that it will not be injured or marred by the polishing operation.

In Figs. 4, 5 and 7, I have illustrated a device for receiving the coated plates 8 from the coating machine and retaining said plates with the coated faces out of contact with any object and for a sufficient length of time to permit the tin coating to harden by cooling. Such device is in the form of an endless carrier constructed to engage and retain the plates by the edges only.

This carrier comprises two endless bands or members 33, each having apertures 34 to receive the teeth 37 of sprocket wheels 36, 38, 39 and 40, around which the endless bands 33 pass. Each band 33 is provided with outwardly projecting inclined arms 35. The sprocket wheels 36, which are mounted on a shaft 42, are situated adjacent the delivery side of the tin pot and in such a position that as the separate plates 8 are discharged from the squeeze rolls 15, the leading end of each plate will be carried in a position between the outwardly extending arms 35 of the two endless bands 33, so that the side edges only of the plate will be engaged by these arms, as shown in Fig. 5. It will be noted that each plate 8 is delivered from the squeeze rolls 15 at a slight angle so that as the leading end of the plate moves upwardly into the dotted line position, Fig. 4, said leading end will tend to gravitate toward the left and will thus fall naturally into the space between the arms 35. The frictional engagement between the arms 35 and the edges of each coated plate 8 will be sufficient to carry said plate along with the carrier, and as the carrier is fed around the sprocket wheels 36, 38, 39, the coated plate will be carried thereby. It will be noted that each plate is curved in the direction of its length as it is passing through the various sprocket wheels, and such curvature prevents the plate from being buckled longitudinally by any pressure between the edges of the plate and the arms 35. By the time each plate reaches the vertical lefthand run of the endless carrier, it has become cooled sufficiently so that the tin plating will not be marred by contact with any object. Each plate is discharged from the carrier by means of a finger 41 which is situated to engage each plate as it reaches the lower end of the vertical run. As each plate is discharged from the carrier, it is received by a platform 44, a traveling belt or any other receiving element.

It will be understood that the power for driving the endless bands 33 can be applied thereto through any one of the shafts 42, 43, 44 or 45. 29 indicates guiding bars or blades that are located between the various presser rolls. Such guiding elements serve to guide the leading edge of each plate from one presser roll to the bite between the next presser roll and the feed roll 16.

It will thus be seen that I have provided an apparatus for coating sheet metal in which the sheet metal to be coated is fed through the molten coating material by heated feeding means, which serve to heat the sheet metal, with the result that the amount of heat which the sheet
metal absorbs from the molten coating material is considerably reduced.

It will also be noted that in my improved apparatus, the heat for maintaining the coating material at the proper temperature is obtained partially from the burner 4 which applies heat externally to the pot and partially from heating means (herein shown as feed rollers) located within the pot.

With my apparatus, therefore, the molten metal is maintained at the correct temperature by heat applied both externally and internally thereto.

I claim:

1. An apparatus for plating sheet metal with tin comprising a pot containing molten tin, means to heat the pot externally, a relatively large feed roll entirely submerged in the mass of molten tin, means to rotate the feed roll to feed the sheet to be tinned through the molten tin, and means to heat said roll, and thereby supply heat directly to the portion of the mass of molten tin at the points where the sheet metal enters and leaves said mass.

2. An apparatus for plating sheet metal with tin comprising a pot containing molten tin, means to heat the pot externally, a relatively large hollow feed roll entirely submerged in the mass of molten tin, means to rotate the feed roll to feed the sheet metal to be tinned through said molten tin, and means to heat the feed roll interiorly, whereby the heated feed roll serves to supply heat directly to the portions of the mass of molten tin at the points where the sheet metal enters and leaves said mass.

3. An apparatus for plating sheet metal with tin comprising a pot containing molten tin, means for heating the pot externally, and heated feeding means entirely submerged in the mass of molten tin for feeding the sheet metal through said mass and so located in said pot as to have substantially equal heat flow in all directions whereby the heat loss due to the feed of the cold strip is replaced by the heat from the heating means.

4. An apparatus for plating sheet metal with tin comprising a pot containing molten tin, flux, and oil, a relatively large rotary roll submerged in the mass of molten material in the pot and around which the sheet metal passes and with which said sheet metal has contact throughout a substantial portion of its peripheral surface, means to rotate said roll, means to heat said roll and thereby supply heat directly to the portion of the mass of molten material at the points where the sheet metal enters and leaves said mass, and a pair of feed rolls to deliver the plated sheet metal from said mass of molten material.

5. An apparatus for plating sheet metal with tin comprising a pot containing molten tin and provided with a flux box at its entering side above the mass of molten tin and an oil box at its discharge side also above said mass of molten tin, means to heat the pot externally, a relatively large hollow feed roll submerged in the mass of molten tin and situated below the flux in the flux box and the oil in the oil box, means to rotate the feed roll, thereby to feed the sheet metal to be tinned downwardly through the flux box and around the feed roll and then upwardly through the oil box, and means to heat the feed roll internally whereby the heated feed roll supplies additional heat to the molten tin at the points where the sheet metal enters and leaves the latter.

6. An apparatus for plating sheet metal with tin comprising a pot containing molten tin and provided with a flux box at its entering side above the mass of molten tin and an oil box at its discharge side also above said mass of molten tin, means to heat the pot externally, a relatively large hollow feed roll situated within the pot and entirely submerged in the mass of molten tin, the side walls of said pot having bearings in which the feed roll rotates and said roll having trunnions rotatable in the bearings, one of said trunnions being hollow and extending through the wall of the pot, a driving gear on said trunnion outside of said pot by which the roll is rotated to feed sheet metal downwardly through the flux box, around the feed roll and upwardly through the oil box, and a burner pipe extending through said hollow trunnion into the hollow feed roll and by which the latter is internally heated.

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