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ATORNEYS.
The invention relates to tinplate brightening apparatus of the type wherein the tin-containing coating is melted while immersed in a relatively hot bath, and is thereupon passed into a cooler bath to solidify the coating in brightened condition. In the use of such apparatus it is important that the tinplated strip be kept out of contact with solid surfaces during the above mentioned steps of treatment, and it has been customary to provide a passageway communicating between the baths below their liquid level, through which passageway a strip under treatment is passed, as in the patents to J. F. Fern No. 2,141,392, dated December 27, 1938, and No. 2,192,903, dated March 5, 1940. The use of such a passageway creates a problem of preventing or minimizing intermingling of the two baths and consequent temperature equalization as caused by flow of the liquid through the passageway, due both to convection currents set up by the difference in density between the hotter and cooler liquids, and to the tendency of a certain amount of the hotter liquid to be entrained along with the moving tinplated strip and thus pass from the hotter to the cooler bath.

The primary object of the present invention is to provide a simple and effective method of minimizing temperature equalization of the above character, with consequent conservation of heat. The invention also contemplates effective control of rate of cooling and crystallization of the tin coating, thereby promoting the production of a uniform high quality product having a bright finish.

In accordance with the present invention I interpose between the hotter and cooler baths above mentioned a chamber which is constructed to contain the use of successive treating chambers which are located one above the other.

The invention involves the use of tanks located side by side, and with the apparatus also modified as compared to Fig. 1.

Fig. 5 is a section on line 5-5 of Fig. 4 looking in the direction of the arrows.

Fig. 6 is also a view similar to Fig. 1 and showing a further modification of the invention.

In Fig. 1 the invention is shown as applied to a tinplate brightening apparatus having a compartment containing a bath of appropriate liquid, for example as described in the patent to Pkn No. 2,393,955, November 24, 1942, in which bath the continuously moving tinplate strip is immersed during the stage that its tin containing coating is melted as above described. As shown in Fig. 1 the strip 2, before passing into chamber 1, first passes over guide rolls 3 and 4, the latter of which is located in a preliminary bath containing chamber 1a. From this chamber 1b the plated strip passes through a passageway 5 and then through chamber 1c in a substantially horizontal direction as shown, being led out of chamber 1 by a narrow passageway 6. From the standpoint of the present invention in its broader aspects, the particular method of melting the tin containing coating is not essential, i.e., the bath itself may supply all the heat needed to melt the coating, as may be considered to be the case in the apparatus of Fig. 1, or as hereinbefore described appropriate additional heating means such as a high frequency electrical induction unit or heating by electrical resistance currents, may be used.

From the compartment 1 the strip 2 passes into a chamber 7 which is interposed between the hotter oil of compartment 1 and a cooler oil bath contained in a compartment 8, the strip 2 passing from chamber 7 through a passageway 9 in the side wall of compartment 8. The clearance between the walls of the passageways 6 and 9 is made as small as possible consistent with keeping the strip 2 out of contact with these walls, thus constraining as far as possible, the flow of liquid between the chamber 1 and compartments 2 and 3, and also enabling a higher liquid pressure to be maintained in chamber 7 as hereinbefore described.

Liquid under pressure is then caused to circulate through chamber 7 so as to build up a higher liquid pressure therein. In the form of the invention shown in Fig. 1 a pump 10 supplies cooler liquid from compartment 8 through a pipe 11 to a header 12, from whence the liquid passes into chamber 7 through inlet ports 13 which are disposed on opposite sides of strip 2. Streams of liquid thus flow along the opposite surfaces of the strip as indicated by the arrows in Fig. 1, in general countercurrent direction with respect to the
direction of travel of the strip 2 and of the liquid which tends to be entrained along therewith. The streams of liquid thus oppose the flow of liquid from compartment 1 through passageway 6 into chamber 7, and also the pressure produced by the pump 10 in chamber 7 is somewhat higher than the normal hydrostatic pressure at passageway 6 when the pump is not in action. Thus when the liquid is put into motion a certain amount of liquid may flow initially from chamber 7 into the compartment 1 to raise the level of the liquid therein to some extent, until operating conditions substantially reach an equilibrium such that the flashing liquid is very little flow of hot liquid into chamber 7 from compartment 1.

The conditions of operation will be such that the tin containing coating of strip 2 as it leaves compartment 1 will be in molten condition, and the temperature of the liquid in chamber 7 may be regulated to control the rate of crystallization and cooling of the coating.

As shown in Fig. 1 the liquid stream passes out of chamber 7 through ports 14 located respectively above and below strip 2 near the passageway 6, and communicating with a header 15 from which the oil is returned to compartment 8 through a pipe 16. A heat interchange is indicated diagrammatically at 17 for cooling the circulating liquid if desired. Palm oil may be mentioned as a liquid suitable to be used in carrying out the invention, the temperature of the oil in compartment 1 being about 460° F., or slightly higher, and the relatively cooler oil circulating through chamber 7 and compartment 8 being at a temperature say of 150° F. The tin coating should be relatively cool before coming into contact with the guide roll 18 in compartment 8, from whence the strip may pass up and out between the rolls 18 as shown in Fig. 1.

Due both to the streams of oil passing through chamber 7 and the increase in pressure which is made possible by the constricted passageways connecting this chamber with the compartments 1 and 8, the carry over of hot oil from compartment 1 along with the strip is minimized, the rate of cooling the strip is kept under control, and the various areas of the tin coated surfaces are subjected to substantially uniform treating conditions.

Fig. 2 shows a somewhat modified form of apparatus wherein an electrical high frequency induction heating unit 20 is used to melt the tin containing coating. As shown the strip passes from a compartment 16 containing a liquid bath similar to compartment 1 except that the liquid may be at somewhat lower temperature. From compartment 16 strip 2 passes through a constricted throat 21 which is surrounded by the induction heating unit 20 above described, it being understood that the latter may be constructed as known in the art or in appropriate manner, its specific design not being a part of the present invention.

From the throat 21 the strip 2 preferably passes in this instance through a heat trap chamber 22. It being understood that the tin coating is in melted condition as the strip leaves throat 21. The temperature in chamber 22 may range say from 300°-400° F. thus causing the coating to solidify in chamber 22, and further causing a substantial amount of residual heat in strip 2 to be absorbed by the oil in chamber 22, from whence the hot liquid is pumped back through ports 23 in chamber 22 and a header 24, through pump 25 and a pipe line 26 leading back into compartment 1a. The temperature of the liquid in compartment 1a may range say from 150° to 300° F., thus imparting a certain amount of preheat to strip 2 which passes through compartment 1a, and circulating liquid passes through throat 21 along with the strip.

From the chamber 22 the partially cooled strip may pass through a constricted passageway 6a similar to that shown by Fig. 1 and into a cooler liquid containing chamber 16 similar in construction and function to the chamber above described in connection with Fig. 1, and into a cooler liquid containing chamber 16 in connection with Fig. 1 and having outlet ports 14a, a header 15a and a pipe 16 similar respectively to the parts 14, 15, 16, etc., of Fig. 1. In fact the parts which are cut away at the right of Fig. 2 may all be understood as similar to the parts appearing at the right of Fig. 1.

Fig. 3 shows a form of the invention adapted for use in connection with tinplate brightening apparatus wherein an initial liquid bath is located in a compartment 21, from whence the strip 2 passes downwardly through a throat 21a surrounded by an electrical induction heating unit 20a to a subjacent heat trap chamber 22a. The last mentioned parts may be understood as comparable respectively to the parts 21, 21a, 22, 22a, and 22 above described in connection with Fig. 2, and the heat trap chamber 22a will also have outlet ports 23a, a header 24a, pump 25a and pipe 26a leading back to the compartment 21, and respectively comparable to the parts 23, 24, 25, 26, above described in connection with Fig. 2.

In the apparatus of Fig. 3, residual heat from strip 2 as the tin containing coating solidifies in chamber 22a, will be absorbed by the liquid contained in such chamber, and the heated liquid circulated back into compartment 21 to serve for preheating the strip 2 as it passes through the latter. In the apparatus of Fig. 3 the oil will also circulate downwardly through throat 21a in opposition to the rising convective currents of liquid which otherwise would tend to be formed in such throat.

From the chamber 22a above described the strip passes through a constricted passageway 6b into a chamber 7b which may be understood as similar in construction and function to the chambers 7 and 7a already described and having a pump 10b, a pipe 11b, a header 12b, inlet ports 14b, outlet ports 15b, a header 16b, pipe 16b and heat exchanger 17b respectively similar to the parts 10 to 17 already described in connection with Fig. 1. In this instance however the relatively cool oil in chamber 7b, being at all points beneath the level of the hotter liquid in chamber 22a, will not tend to admix with the latter. Both the circulating oil streams passing through chamber 7b and the pressure produced therein by pump 105 will minimize the downward entrainment of hot oil through passageway 6b. From the chamber 7b the strip passes downwardly through a narrow passageway 9b to a final compartment 8b containing cooler liquid, such compartment being in this instance U-shaped and having guide rolls 10b which lead the strip to pass throat 21b. The temperature in compartment 8b is somewhat lower than the temperature in compartment 1a, thus the latter may be compared to the parts 18 and 19 of Fig. 1. In this vertical form of apparatus there is very little tendency of the strip to vibrate or sag in passing through the throat 21a and the passageways 6a and 6b, and thus the latter may be made exceedingly narrow, as is advantageous in promoting the efficiency of the apparatus.

In the apparatus of Figs. 4 and 5 a tin coated
strip 33 is fed from a hot oil bath 34 through a passageway 35 comparable to the passageway 6 previously described, then through a chamber 36 comparable to the chamber 7 previously described, then through a passageway 31 comparable to the passageway 9 previously described, and then into a cooler oil compartment 38 comparable to the bath 8 previously described. In this form of the invention however the oil is pumped through the chamber 36 under pressure in streams which pass substantially parallel to the strip 33 and transverse to its direction of travel. As shown in Fig. 5 the incoming oil streams may pass from a header 40 through inlet ports 41 disposed respectively above and below the level of strip 33, and the oil stream may pass out of chamber 36 through exit ports 43 also disposed respectively above and below the level of strip 33 and communicating with an offtake header 42. The headers 39 and 42 may be regarded as comparable in function respectively to the headers 12 and 15 of Fig. 1 and having similar circulating components as not shown in Fig. 4 and 5. In this instance the oil pressure obtaining in chamber 36 will also be slightly above the normal hydrostatic pressure at the passages 35 and 37 when the oil circulating system is out of operation. Then when the system goes into operation it will reach a condition of substantial pressure equilibrium at the passages 35 and 37, under which condition there will be very little interchange of oil between the compartments 34 and 36. Fig. 6 illustrates a further modification wherein the tin-coated strip 43 is led through a relatively hot oil compartment 44 comparable to the bath 34 of Fig. 4, then through passageway 45 comparable to the passageway 36 of Fig. 4, and then through a chamber 46 comparable to the chamber 36 of Fig. 4, then through passageway 47 comparable to the passageway 37 of Fig. 4, and then through a cooler oil containing compartment 48 comparable to the compartment 38 of Fig. 4. In the case of Fig. 6 circulating oil for chamber 46 is drawn from a separate reservoir 49 and supplied under pressure to a header 51 located at an intermediate point along the length of chamber 46. From the header 51 the oil under pressure passes through upper and lower ports 52 into contact with the upper and lower surfaces of strip 43, from whence the oil streams divide as indicated by the arrows in Fig. 5 and pass respectively toward the opposite ends of chamber 46, from whence they are exhausted through offtake ports 53 and 54 at the opposite ends of chamber 46. These offtake ports communicate respectively with headers 55 and 56 from whence oil circulates back into reservoir 49 through the pipes 57 and 58 respectively.

In the operation of the apparatus of Fig. 6 the pump 50 will likewise produce a pressure in chamber 46 which is somewhat above the hydrostatic pressure at passageways 45 and 47 when the circulating system is not in operation, and substantial equilibrium will be attained when the circulating system is in operation with very little interchange of oil between the compartments 44 and 46. The oil streams in chamber 46 likewise counteract kinetically the tendency of hot oil to flow along with strip 43 through the passageway 45.

Alternatively, in respect to the form of the invention above described in connection with Fig. 3, the direction of flow of the liquid through the pipe 26a may be reversed so as to cause the oil to circulate through throat 21a in the opposite direction to the direction of travel of the strip. In this case the liquid passing up from chamber 22a and through the throat 21a, will absorb heat from the strip and then pass upwardly into compartment 27, giving heat up to the downwardly moving strip 2 so as to preheat the latter.

While the invention has been disclosed as carried out by the above described specific forms of apparatus, it should be understood that many changes may be made therein without departing from the invention in its broad aspects, within the scope of the appended claims.

I claim:

1. Tinplate brightening apparatus of the class described having an upper relatively hot liquid containing compartment having associated there-with a throat 45 affording downward travel of a plated strip or the like through said compartment and throat, a heating unit enclosing said throat and constructed to melt the coating of the strip as it passes through said throat portion, a heat trap chamber disposed beneath said throat and in the path of travel of said strip, means being provided to circulate liquid between said chamber and said compartment, said apparatus including a relatively cooler liquid containing compartment disposed beneath said chamber.

2. Tinplate brightening apparatus of the class described having an upper relatively hot liquid containing compartment having associated there-with a throat portion affording downward travel of a plated strip or the like through said compartment and throat, a heating unit enclosing said throat and constructed to melt the coating of the strip as it passes through said throat portion, a heat trap chamber disposed beneath said throat and in the path of travel of said strip, means being provided to circulate liquid between said chamber and said compartment, said apparatus including a relatively cooler liquid containing compartment disposed beneath said chamber and also including a second chamber interposed between said first mentioned chamber and said relatively cooler liquid containing compartment, means being provided to pass relatively cool liquid through said last mentioned chamber.

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