

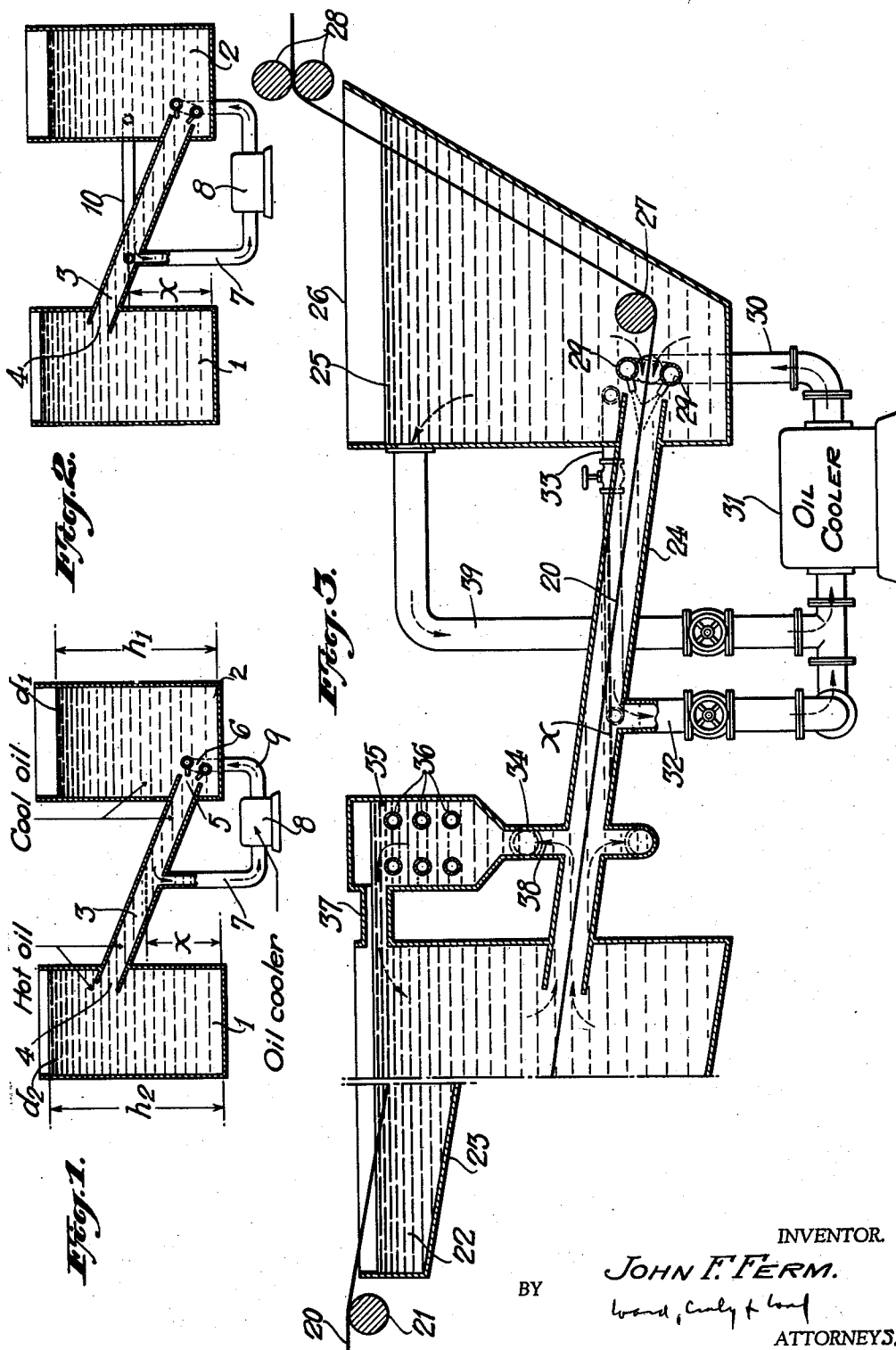
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APPARATUS FOR TREATING PLATED STRIP METAL

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APPARATUS FOR TREATING PLATED STRIP METAL

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This invention relates to apparatus for treating plated strip metal having a coating of a lower melting metal on a base metal of higher melting point, such as tin coated or plated sheet or strip steel, for imparting to the coating, a smooth, impervious surface of high lustre approximating mirror brightness. The invention is particularly applicable for imparting a mirror bright finish to coatings applied by a process of electrodeposition.

This application is a continuation in part of my application Serial No. 224,101, filed August 10, 1938, now Patent No. 2,141,382.

Strip steel may be coated with tin by a process of electrodeposition from a tin plating bath. The process may be made continuous by feeding the strip from a roll through the plating bath and out again. The tin coating thus applied to the strip has, however, a dull, matte appearance, requiring further treatment for imparting the mirror finish required by the trade. This may be imparted by passing the plated strip through a hot oil bath of appropriate temperature and other characteristics, such as a bath of palm oil maintained at about 475 to 500° F., whereby the tin coating softens and fuses to form the requisite bright, impervious surface, free from pin holes. However, upon so brightening the coating, the tin must be cooled and hardened rapidly in a non-oxidizing atmosphere to retain its brilliance and prevent surface crystallization or spangling. Air cooling is, therefore, unsatisfactory for this reason and for the additional reason that the molten surface of the tin is marred by air jets incident thereon. Hardening may be accomplished by passing the strip rapidly from the hot oil bath into a cool oil bath maintained at a sufficiently low temperature to harden the tin quickly, for example, about 135 to 150° F.

A problem is presented, however, in passing the strip through the hot oil bath and thence into the cool oil bath in such manner that the tin coating will not be exposed to atmospheric or oxidizing conditions or to mechanical mar-
ring, while the tin is in a molten or plastic state caused by immersion in the hot oil bath. If, for example, the known expedient were employed of passing the strip by means of a series of feed or guide rolls, first down into the hot oil bath, thence up out of this bath and over and down into the cool oil bath, the strip must of necessity pass over a number of such rolls while the tin is molten or plastic, whereby the rolls would leave imprints in the brightened surface and thus destroy the smooth, mirror finish. Likewise, unless an appropriate reducing atmosphere were maintained above the baths, the tin coating would be subject to oxidation causing a dulling of the surface during passage of the strip be-

tween the baths. The provision for and maintenance of such a reducing atmosphere adds both to the complexity of the apparatus and to the expense of its operation.

In accordance with the invention of my above mentioned parent application, defects of the character aforesaid are overcome by arranging the hot and cool oil baths in tanks situated adjacent one another and by interconnecting the two with a duct such that the strip may be fed in a straight line from a point outside the hot oil bath, through the hot bath and thence through the duct into the cool oil bath. To this end, the strip is arranged to pass over a feed roll just prior to immersion in the hot oil bath, but does not encounter any additional feed roll or other mechanical element until it has reached such a point in the cool oil bath that the coating has been well hardened, at which point the strip passes over a second feed roll and out of the bath.

As is further explained in said application, the fact that the hot and cool baths are in direct liquid contact with each other through the duct interconnecting the two, introduces an additional problem of preventing the establishment of rapid thermal exchanges between them such as would bring them quickly to a common equilibrium temperature. If, for example, the baths were merely separated by a partition having an orifice therein or by a duct extending horizontally between the tanks, pressure differences between the hot and cold baths are bound to establish themselves at various elevations within the orifice or duct due to the different density of the hot oil in comparison with the cool oil, in consequence of which convection currents will be established between the baths bringing them rapidly to a common temperature and thus rendering the brightening process inoperative.

This difficulty is overcome in accordance with the invention of said application, by arranging the interconnecting duct in inclined relation, preferably such that it slopes downwardly from the hot oil to the cool oil tank, and to such a degree that its entry into the cool oil bath is situated entirely below its entry into the hot oil bath. With this arrangement the surface level of the hot oil bath will so adjust itself in relation to the surface level of the cool oil bath by appropriate transferences of liquid between the two through the duct, that the hot and cool oil baths will be in approximate pressure equilibrium within the duct at a level intermediate between the levels at which the duct enters the hot and cool oil bath respectively. By virtue of this arrangement, the hot and cool oil baths will contact each other in a horizontal surface within the duct, the opposing pressures at all points of which are the same, so that there is little tendency for establishing convection currents in the

manner aforesaid thereby to destroy the difference in temperature of the baths. Also, owing to the downward slope of the duct from the hot to the cool oil bath, the hot and hence less dense oil will be situated within the duct above the cooler and hence denser and more viscous oil thereby further stabilizing the tendency of the two baths to remain in equilibrium at the surface of equal pressure above described. Furthermore, owing to the relatively small cross-sectional area of the duct, thermal exchanges occurring by conduction, diffusion or otherwise between the two baths will be slight.

It has been found that with the system arranged as above described the elevation within the duct at which the hot and cool oil baths will normally adjust themselves to a condition of substantial surface equilibrium as above explained, is determined primarily by the density of the hot oil in relation to that of the cool oil, the action being analogous to the equilibrium adjustment of water and mercury in opposite sides of a U tube. Since the density of the hot oil is somewhat less than that of the cool oil, the hot and cool oil baths will normally adjust themselves to a condition of equilibrium within the inclined duct somewhat above the median level between its openings into the two baths, which is to say, that the cool oil will extend up to and somewhat above the median level with the hot oil occupying the upper remaining portion of the duct.

In some instances, however, it is desirable that the cool oil extend to a greater height within the duct than would result with the arrangement above described. For example, in the brightening of electroplated tinned strip, it is desirable that the tin coating be hardened or frozen as quickly as possible as it passes out of the hot oil bath into the duct, which action is expedited by increasing the cool oil level in the duct. In accordance with the present invention, the cool oil level may be established and maintained at any desired elevation in the duct by connecting a horizontally disposed equalizing pipe between the cool oil tank and the inclined duct at the level in question. With this arrangement, cool oil will flow from the cool oil tank through the horizontally disposed equalizing pipe and into the inclined duct until the cool oil level therein has been brought up to the level of the equalizing pipe.

The arrangements above described have proved quite effective in practice for the brightening of tinned strip and the like, where the speed of the strip through the duct is not too great. If, however, the rate of feed of the strip is high, it tends to carry a portion of the hot oil along with it through the duct into the cool oil bath. This tendency is effectively offset in accordance with a further feature of the invention of my aforesaid parent application, by directing one or more jets of cool oil under pressure into the duct at its entrance into the cool oil bath and by correspondingly withdrawing cool oil from the duct through a suction pipe located at some point further along the same toward its entrance into the hot oil bath, the oil thus withdrawn being passed through an oil cooler, returned thence under pressure to the jets in the cool oil tank.

With the system as thus arranged, some care must be taken with respect to the point at which the suction pipe is connected to the inclined duct, since if the connection is located either wholly or partially above the upper cool

oil level in the duct, hot oil will be withdrawn from the duct, passed through the oil cooler and returned to the cool oil bath. This is undesirable because the hot oil thus withdrawn is replaced by cool oil returning through the duct to the hot oil bath, and also because it results in an unnecessary increase in the cost of fuel and power required to maintain the hot oil bath at its appropriate temperature and to cool the oil passing through the cooler to the proper temperature.

The system of my parent application offers little flexibility with respect to location of the junction between the suction pipe and the inclined duct, inasmuch as it requires locating the junction below the upper cool oil level as determined by the relative densities of the hot and cool oil. With the present invention on the other hand, the suction pipe may be connected at any desired level to the inclined duct, by merely connecting the equalizing pipe above referred to, to the same or a higher point along the inclined duct. In this way it is assured that only cool oil will be withdrawn by the suction pipe irrespective of its point of connection to the inclined duct.

Referring now to the accompanying drawing:

Fig. 1 shows schematically in longitudinal section, the brightening baths and interconnecting duct as arranged in accordance with my parent application aforesaid;

Fig. 2 is a similar view employing the equalizing pipe in accordance with this invention; while

Fig. 3 is a view similar to Fig. 2, but showing more of the details of the baths as actually employed in commercial operation and the manner of feeding coated strip therethrough for brightening.

Referring to Fig. 1, the hot oil bath is shown at 1, the cool oil bath at 2, and the inclined duct at 3 having openings 4 and 5 into the hot and cool oil baths respectively. The coated strip to be brightened is fed into the hot oil bath 1, thence through the inclined duct 3, and through and out of the cool oil bath 2, in a manner explained more in detail hereinafter. For offsetting the tendency to carry hot oil along with it into the cool oil bath when fed rapidly, cool oil is directed under pressure by nozzles 6 into the opening 5 of the duct 3 into the cool oil bath, the cool oil thus injected being in turn withdrawn at a point further along duct 3 by the suction pipe 7 extending to an oil cooler 8 and thence through a pressure line 9 to nozzles 6.

Representing the densities of the hot and cool oil by d_2 and d_1 , respectively, and the surface elevations of the hot and cool baths by h_2 and h_1 , the pressure heads of the two baths are in equilibrium at but one elevation X, where:

$$X = \frac{d_2 h_2 - d_1 h_1}{d_2 - d_1}$$

The surface elevations will so adjust themselves by interchange of liquid between the baths that the equilibrium surface X will normally lie somewhat above the medium level between openings 4, 5 as determined by the relative densities of the hot and cool oil in accordance with the above equation. The level X is thus more or less inflexibly determined with the apparatus arranged as in Fig. 1, and necessitates connecting the suction pipe 7 at a point well down in duct 3 to assure that its opening into the duct will be below the upper cool oil level X, and hence will not suck hot oil into the oil cooler 8.

With the system as modified in accordance with the present invention as shown in Fig. 2, there is added a horizontally disposed equalizing pipe 10, connected between the cool oil bath 2 and the inclined duct 3, at a level at which it is desired to establish and maintain the upper cool oil level in the duct. With the arrangement of Fig. 2, cool oil will flow from the cool oil bath 2 and through the equalizing pipe 10 until the equilibrium level X between the hot and cool oil baths is brought up to the level of the equalizing pipe. In this way, the upper cool oil level in duct 3 may be brought quite close to the opening 4 of the duct into the hot oil bath thereby to expedite the hardening or freezing of the fused coating as the plated strip passes from the hot oil bath through the duct. Moreover, the suction pipe 7 extending to the oil cooler 8, may, with this arrangement, be connected to duct 3 at any level desired by merely connecting the equalizing pipe to the duct at substantially the same or a higher level as shown, thereby to assure that the upper cool oil level will be above the suction pipe junction and only cool oil withdrawn.

Referring now to Fig. 3 disclosing a commercial form of apparatus for brightening tin-coated steel strip and the like in accordance with the invention, the strip 20, having previously been coated by passage through an electroplating bath and otherwise been appropriately cleaned and prepared for the brightening bath, is fed over a roll 21, and thence in a straight line, through a hot oil bath 22 contained in tank 23, and through duct 24 interconnecting the hot oil bath with a cool oil bath 25 contained in tank 26, whereupon the strip passes under a second feed roll 27 immersed in the cool oil bath and having its periphery in alignment with the exit from the duct as shown. Thereafter the strip passes out of the cool oil bath and between a pair of squeeze rolls 28, made of soft rubber or the like, for removing the greater portion of the oil adhering to the strip. The duct 24 extends downwardly from the hot oil to the cool oil tank as explained and to such a degree that its entrance into the cool oil bath is situated wholly below its entrance to the hot oil bath.

In order to prevent the hot oil from being carried along by the strip into the cool oil tank, cool oil is directed into the entrance of duct 24 into the cool oil tank by nozzles 29, fed by a pressure line 30 from the oil cooler 31, into which oil is drawn off from duct 24 by the suction pipe 32. For maintaining the upper cool oil level X above the junction between pipe 32 and duct 24, one or more horizontally disposed equalizing pipes 33 are provided which connect duct 24 with the cool oil tank 25 at the level X. Preferably a pair of such equalizing pipes are provided and connected to opposite sides of the duct 24 as seen in plan view. The cool oil circulates through the duct and oil cooler as shown by arrows.

As an additional aid in maintaining a sharp dividing surface X in the duct between the hot oil and cool oil and also to maintain the hot oil bath at the proper temperature, the hot oil may be drawn off from the duct adjacent the hot oil tank, by an intake line 34, passed thence through a heater 35, heated by steam pipes 36 or equivalent, and returned thence to the hot oil bath through pipe 37, the path of circulation being shown by the arrows 38. Although a pump may be employed to maintain the circulation, the drawing shows a gravity circulation obtained by

extending pipe 37 between the heater and the hot oil tank at the surface level of the oil as shown. In order to maintain the cool oil bath at its proper temperature, an intake line 39 may be provided which draws off from near the top of tank 25 the warmer layer of cool oil collecting at the surface of the bath and passes it into the cooler 31, whence it is returned to the bath through nozzles 29.

I claim:

1. Apparatus for treating plated strip metal comprising: a first tank for containing a hot bath to a preselected level, a second tank for containing a cool bath to a preselected level, a first duct joining said tanks below said levels and having an opening into the second tank situated below its opening into the first tank, and a second duct extending from a point on said first duct intermediate said openings to a point on said second tank below the bath level thereof and above the opening of said first duct therinto, and means external to said first tank and duct for conveying said strip metal therethrough and into said second tank.

2. Apparatus for treating plated strip metal comprising: a first tank for containing a hot bath to a preselected level, a second tank for containing a cool bath to a preselected level, a first duct joining said tanks below said levels and having an opening into the second tank situated below its opening into the first tank, a second duct extending from a point on said first duct intermediate said openings to a point on said second tank below the bath level thereof and above the opening of said first duct therinto, means for injecting cool liquid of said baths into said first duct and for withdrawing liquid therefrom, the point of injection being closer to the second tank than the point of withdrawal, and the latter being no closer to the first tank than the point of connection of said second duct to said first duct, and means external to said first tank and duct for conveying said strip metal therethrough and into said second tank.

3. Apparatus for treating plated strip metal comprising: a first tank for containing a hot bath to a preselected level, a second tank for containing a cool bath to a preselected level, an inclined duct joining said tanks below said levels and having an opening into the second below its entry into the first, a horizontally disposed duct extending from said second tank to a point on said inclined duct intermediate said openings, and means external to said first tank and inclined duct for conveying said strip metal therethrough and into said second tank.

4. Apparatus for treating plated strip metal comprising: a first tank for containing a hot bath to a preselected level, a second tank for containing a cool bath to a preselected level, an inclined duct joining said tanks below said levels and having an opening into the second below its entry into the first, a horizontally disposed duct extending from said second tank to a point on said inclined duct intermediate said openings, means for injecting cool liquid of said baths into said inclined duct at its opening into said second tank and for withdrawing liquid from said duct at an elevation not exceeding that of said horizontal duct, and means external to said first tank and inclined duct for conveying said strip metal therethrough and into said second tank.

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