Jan. 18, 1949. J. S. NACHTMAN 2,459,674

CONTINUOUS TINPLATE BRIGHTENING APPARATUS

Filed Dec. 30, 1939 4 Sheets-Sheet 1

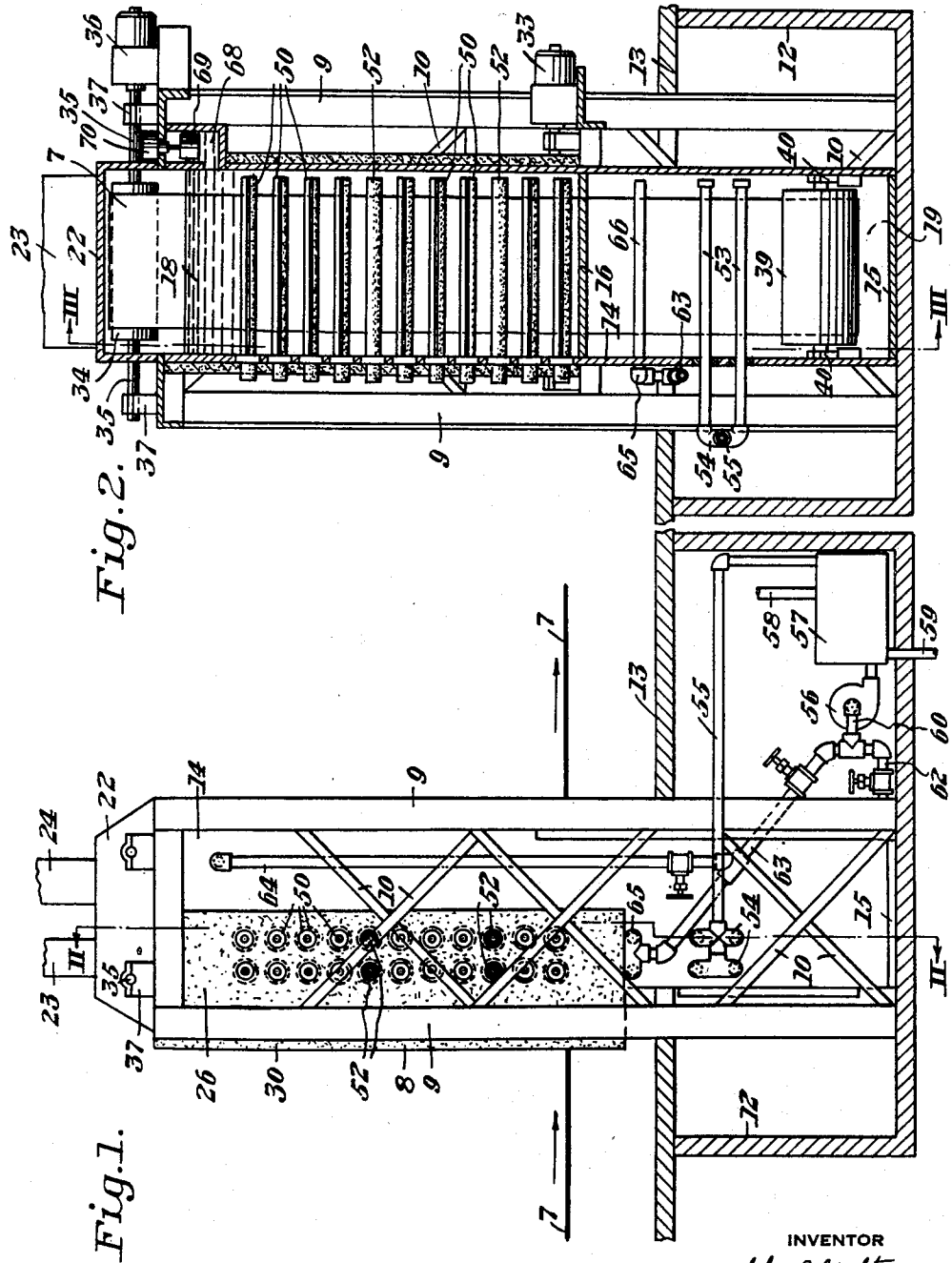


Fig. 2.

Fig. 1.

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CONTINUOUS TINPLATE BRIGHTENING APPARATUS

Filed Dec. 30, 1939 4 Sheets-Sheet 2

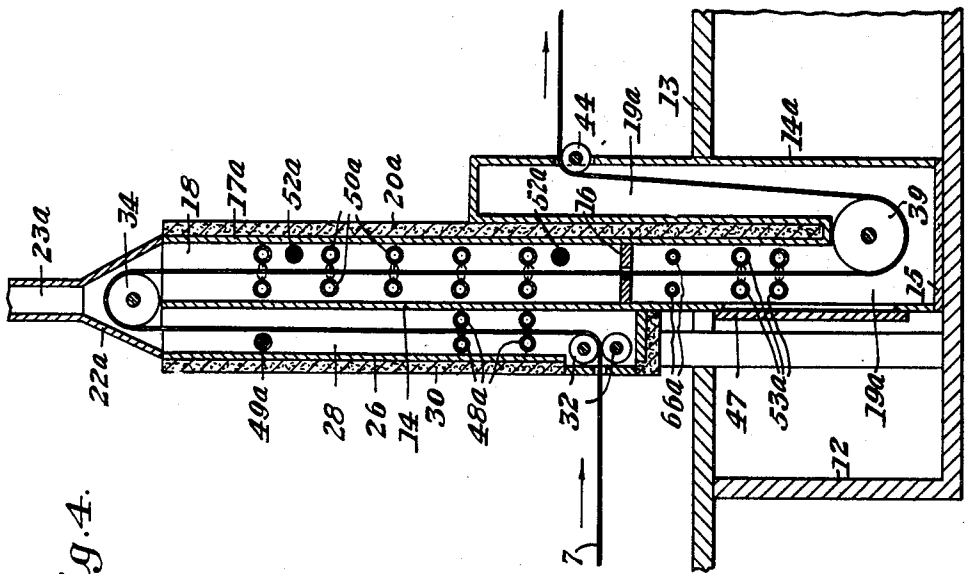


Fig. 4.

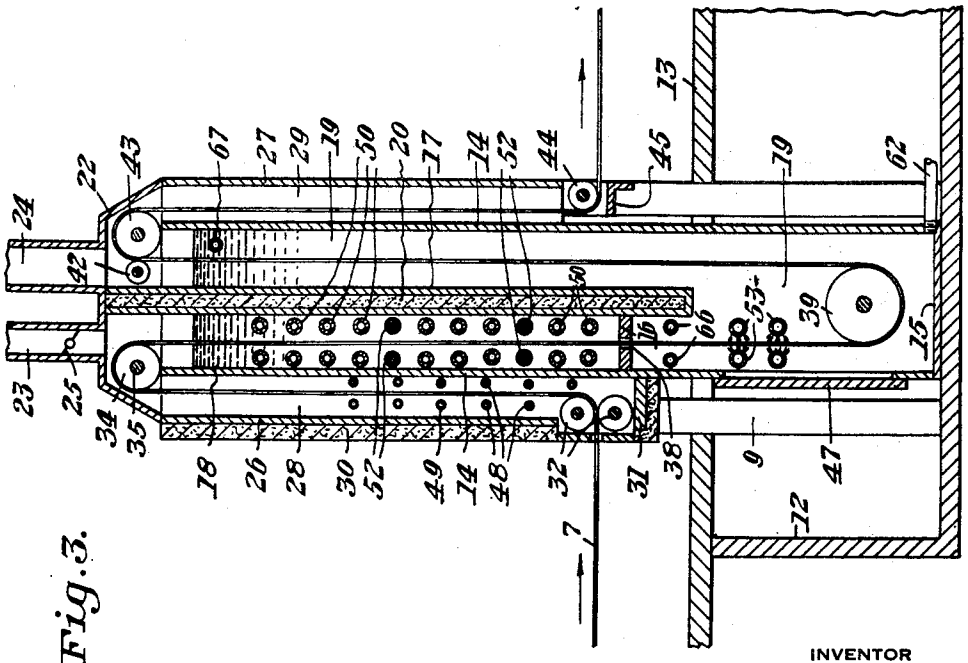


Fig. 3.

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CONTINUOUS TINPLATE BRIGHTENING APPARATUS

Filed Dec. 30, 1939 4 Sheets-Sheet 3

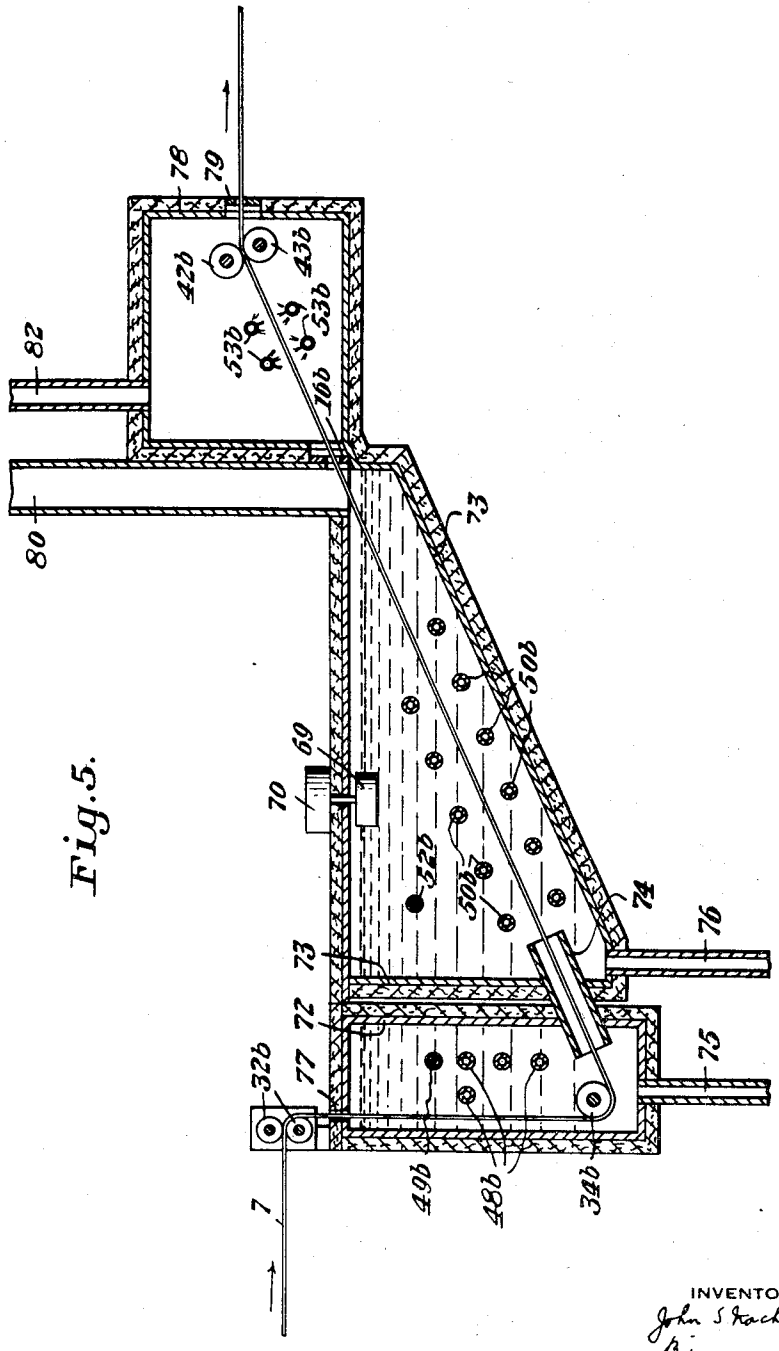


Fig. 5.

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CONTINUOUS TINPLATE BRIGHTENING APPARATUS

Filed Dec. 30, 1939 4 Sheets-Sheet 4

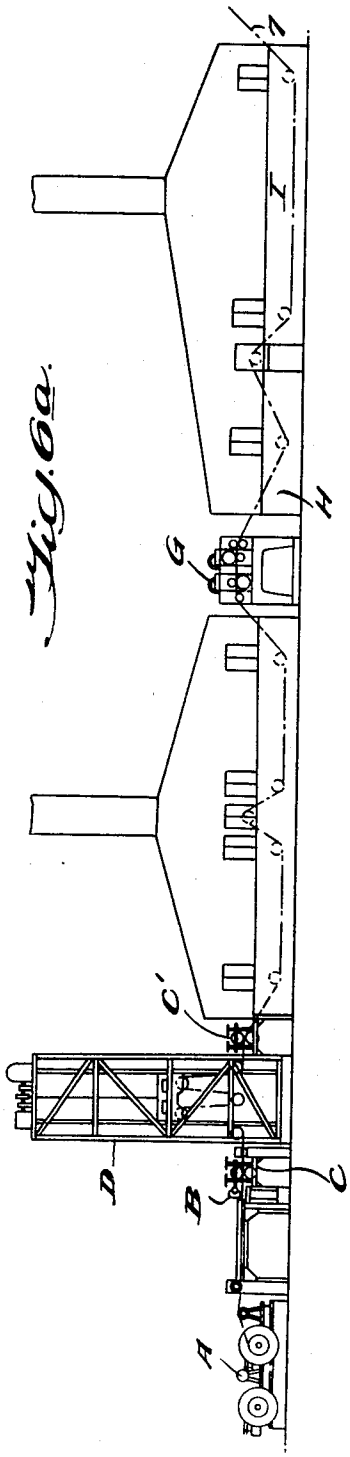


Fig. 6a.

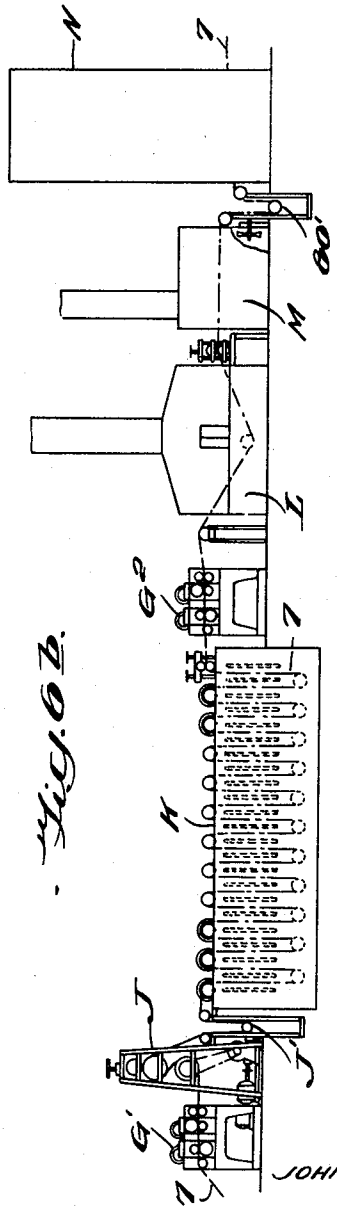


Fig. 6b.

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2,459,674

UNITED STATES PATENT OFFICE

2,459,674

CONTINUOUS TINPLATE BRIGHTENING APPARATUS

John S. Nachtman, Beaver, Pa.

Application December 30, 1939, Serial No. 311,929

14 Claims. (Cl. 266—3)

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The present invention relates to apparatus for applying a finishing treatment—although not necessarily the final treatment—to coated strip metal such as a sheet metal base carrying a film or layer of metal, e. g., electrodeposited metal, on a surface thereof. This application is a continuation-in-part of apparatus subject-matter of my copending applications, Serial No. 133,911, filed March 30, 1937, now Patent No. 2,240,265, granted April 29, 1941; Serial No. 206,257, filed May 5, 1938, now Patent No. 2,357,126, granted August 29, 1944; Serial No. 257,107, filed May 18, 1939, now abandoned; Serial No. 279,866, filed June 19, 1939; and Serial No. 675,897, filed June 11, 1946.

The common hot-dip method involving, for example, the application of tin to strip steel, produces a coating generally poor in quality both as to uniformity and appearance. Electrodeposition alone, particularly in continuous high-speed processes, tends to produce a coating which, while having a better appearance and an improved uniformity, has localized areas wherein the strength of union or adherence of coating to base metal is too low. This problem is increased where the union is between the deposited metal and steel of relatively low carbon content.

Accordingly, it is the primary object of the present invention to devise and provide apparatus for treatment resulting in the production of a surface coating which is uniform in thickness, smooth and bright in appearance, and firmly and uniformly united to the base metal.

Another object of the present invention is to provide for suitably tensioning or controlling the strip material while it is being treated, plated, brightened, etc., by providing in the apparatus or line for suitably proportioning the tension, speed and rate of treatment of the material, particularly while continuously moving the material through the line.

Such a control of tension in the line avoids objections encountered heretofore in the apparatus used. I discovered that in plating of extremely thin strips or fine wires at relatively high speeds, there was a progressively building up of tension in the strip, and that this building up was particularly great in the case of a long plating line which was required of course in connection with high speed operation. High as well as unsuitable tension of the strip being treated, as well as "surging" in the line, not only tend to distort the strip but also to spoil the plating operation and the coating provided thereby. I discovered that there are a number of factors involved in

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electroplating from the standpoint of conveying or moving the strip continuously past or through the necessary treatment zones that entered into the characteristics of the product, as well as the effectiveness of the individual and collective treatments.

I determined also that it is important that the elimination of tension surges and the maintaining of proper tension in the line produced a more or uniform deposit of metal on the strip and a better and brighter appearance resulting from the brightening operation.

This desired control of tension may be provided in various ways as set forth more in detail in my above-mentioned prior applications, particularly in the application for my patent, No. 2,240,265, granted April 29, 1941, and in my application, Serial No. 257,107, now abandoned, filed February 18, 1939. For instance, it is preferred that provisions be made at various points in the line to move the strip continuously through the line and through the various operations thereof at a suitable speed and under the desired tension. Such provisions may be by the driving of the guide rolls by motors that will operate the rolls in contact with the strip while preventing the undesirable building up of tension in the strip, or operating pinch rolls by motors in such manner as to provide a "drag" tension, or by the provision of dancer rolls at suitable points in the line, or these various elements may be combined according to the needs and requirements of the operation and the speed of the line.

The major objects of the present invention will be apparent from the preceding discussion. Further important objects reside in the provision of novel and useful apparatus in several forms for effectively treating a strip of coated material in the manner set forth, and other objects will appear as the description proceeds. The drawings accompanying this specification consist of the following illustrations:

Figure 1 is a side elevational view, with portions of the supporting structure in section, of a preferred form of apparatus constituting a part of this invention;

Figure 2 represents a vertical section taken substantially on the plane of line 2—2, Figure 1, looking in the direction of the arrows;

Figure 3 represents a further vertical section taken on a plane normal to that of Figure 2, substantially on the plane of line 3—3 of Figure 2, looking in the direction of the arrows;

Figure 4 is a view similar to Figure 3, but showing a somewhat modified form of apparatus;

Figure 5 represents, in section on the order of Figures 3 and 4, a still further modified form of apparatus; and

Figures 6a and 6b are side elevations of an electroplating line showing tensioning means for the strip.

With continued reference to the drawings, wherein like characters are employed to designate like parts, and with particular reference for the moment to Figures 1 to 3, the numeral 7 designates, let us say, a very long, i. e., "continuous" strip of sheet steel that has passed continuously through a series of treating apparatus (see Figs. 6a and 6b) and has just come through a plating bath where it received, by electrodeposition, a surface coating of metal, e. g., of tin, all as described in my application, Serial No. 133,911, now Patent No. 2,240,265. It is shown entering into, passing through and emerging from the brightening apparatus, indicated generally and in its entirety by the numeral 8.

The apparatus 8 has a shaping and supporting framework including vertical corner stanchions 9 intertied by cross members 10, the stanchions projecting downwardly into a pit 12 below a floor 13. This framework carries four vertical walls 14, properly joined and sealed at their edges to form a rectangular tank closed at the bottom by a plate 15. The tank is substantially filled with liquid as indicated, and by means of a horizontal baffle plate 16 and a vertical partition 17 the tank is divided into a pair of chambers 18 and 19, hereafter referred to respectively as the fusing and chilling chambers. The partition 17 is a hollow double-walled structure filled with a heat-insulating material 20.

The chambers 18 and 19 open upwardly into a hood 22 and have individual stack vents 23 and 24, separated by the upper part of the partition 17. The vent 23 preferably is provided with a damper 25. Two of the hood walls, as shown (Fig. 3) are inclined to overhang two of the walls 14 and form therewith and with a pair of added vertical walls 26 and 27, a pair of chambers 28 and 29 hereafter referred to respectively as the pre-heating and exit chambers. The walls 26 and 27 are approximately U-shaped in cross section, and the former is covered with heat-insulating material 30.

The bottom of chamber 28 is formed by a platform 31 upon which is mounted a pair of entrance rolls 32 which pinch and feed the strip 7 into said chamber. One of these rolls is driven by a motor 33 (Figure 2). The strip passes upwardly, centrally of the chamber 28, to a driven guide roll 34, the latter being disposed within hood 22 and having a shaft 35 driven by a motor 36 and mounted in bearings 37. This guide roll is so located that the strip then passes downwardly centrally of the chamber 18 through a slot 38 in the baffle 16 and thence to a second guide roll 39. The latter is journaled in bearings 40 so disposed that the strip can be drawn off toward the center of the upper section of the chamber 19. Atop the chamber 19 and above the liquid level there is disposed a pair of rolls, 42, 43 (Fig. 3) which serves as a squeegee and guide assembly for the traveling strip. The strip preferably is then drawn downwardly toward floor level to leave the apparatus by way of a delivery roll 44 and thence either to be reeled or to be passed on for further treatment. A platform 45 carries the roll 44, and a shielding wall 27 preferably is provided to protect the strip in its passage to said roll.

One of the walls 14 has a removable cover 47 for facilitating assembly, adjustment and repair of some of the parts.

As previously stated, the preheating and fusing may be done in any manner suitable for obtaining the requisite temperatures. The illustrated embodiment of preheating means comprises two banks of electrical heating elements 48 arranged in the chamber 28 on opposite sides of the strip 7 and controlled by a thermostat 49 which is adjusted to afford a chamber temperature that will cause some alloying between the coating metal and the steel without actually fusing the coating metal. If the coating material happens to be such as will oxidize readily, reducing gas may be injected into the preheating chamber or may be caused to pass from the hood above the fusion chamber 18 into the chamber 28 by closing the damper 25. In some cases, sufficient preheating temperatures are obtainable by conduction through and radiation from the wall between the fusing and preheating chambers.

The liquid in the fusion chamber 18 may likewise be heated by banks of electrical units, 50, under the control of one or more thermostats 52 that are adjusted to afford a temperature that will cause the coating to fuse and flow sufficiently to spread uniformly and smoothly over the surface of the base metal; at the temperature of the fusion chamber the coating further alloys itself simultaneously with the base metal of the strip. The liquid heat-transmitting medium may consist of oil or oily medium with a sufficiently high flash point and no appreciable tendency to attack the metal coating.

The baffle plate 16 tends to prevent liquid circulation and heat exchange between the chilling and fusion chambers. It minimizes the formation of eddy currents by the moving strip.

Almost immediately after passing the baffle the strip 7 has its coating chilled and hardened by the impingement thereon of jets of cooling liquid which come from opposed sets of immersed pipes 53 designed to spray the cold liquid toward the two surfaces of the strip. These pipes connect to manifolds or headers 54 externally of the chamber and the manifolds in turn connect by way of a pipe 55 to the discharge side of a liquid cooling and circulating unit that comprises a pump 56 and a heat exchanger 57 (Fig. 1). The exchanger has the usual connections 58, 59 for circulation therethrough of a separate heat removing liquid.

The intake side of the pump 56 is designed to withdraw the heat-transmitting oil or other liquid from the chilling chamber 19, and, to effectively accomplish this, the withdrawal is effected at three points by means of a pipe 60 having branches 62, 63, the branch 63 in turn having a branch 64. Each branch is equipped with a valve, as shown, for manually regulating the flow through each and thus controlling the chamber temperatures at and adjacent the points where the branches enter the chamber.

The branch 62 enters the bottom of the chilling chamber and is regulated to draw off just enough liquid to insure constant mixture or internal circulation of the liquid. Branch 63 is connected to a manifold 65 from which a pair of pipes 66 project into the chamber immediately adjacent the baffle 16. Best temperature conditions are obtained by removing most of the total withdrawn liquid through these pipes 66. The third branch, 64, Figure 1, terminates in a pipe section 67 that is disposed in the extreme upper part of the

chilling chamber (Figure 3). In some instances, where the heat-transmitting or chilling liquid is viscous it will be desirable to use this pipe section, or added heating elements adjacent thereto, to heat the surface portion of the liquid and render it readily removable by the squeegee assembly 42, 43.

As shown in Figure 2, a chamber 68 containing a float 69 may be provided in communication with the upper part of the liquid body, with the float connected to an electrical switch device 70 for the purpose of maintaining the desired constant liquid level, in obvious manner, with the switch device in circuit with means governing the liquid supply. Obviously, the control for the heating units, 50, may be connected in this circuit so that the heat will be disconnected if liquid level falls too far.

The mode of operation of the above described apparatus and the results obtained thereby in the several successive steps should now be well understood, and a detailed summary therefore is believed unnecessary. The preheating step has several functions as above set forth, but its primary purpose is to bring the entire strip to a temperature approaching but short of the fusion temperature of the coating, thus permitting the fusion chamber to be of a desirably short length. The vertical stretch of the strip is preferable for passage through the fusion chamber as it aids in producing a rapid and uniform spreading of the fused metal, and supports the strip without tendency to distort or to deflect. Hence the slot 38 in the baffle may be of a desirable minimum width. During the interval between contacting driven guide roll 34 and contacting roll 39 the coated strip does not contact any solid object: in that interval the already preheated coating is brought to fusion temperature and then is solidified, solidification being complete before the coated strip reaches roll 39. Preferably, the procedure is so effected that actual melting of the coating occurs by the time the strip approaches the bottom of chamber 18, thereby making the interval of actual molten condition of the coating an extremely brief one. This is desirable because if the coating is maintained at or above melting temperature too long there is a tendency for the depth of coating to become less uniform than otherwise.

The heating and cooling arrangements of Figures 1 to 3 are important, but may be modified somewhat within the scope of this invention. For example, the liquid medium may be omitted partially or entirely. Figure 4 illustrates a modification where it may be completely eliminated. In describing this form no specific reference will be made to those parts which are duplicates of some of those in Figure 3.

The major change in Figure 4 consists in removal of the upper section of the chilling chamber and its squeegee assembly and in withdrawal of the strip directly from the top of the shortened chamber. In doing this, the hood is narrowed to afford a suitable hood 22a having an intake pipe 23a, and a shortened wall structure 14a is substituted for three of the walls 14 of Figures 1 to 3. The partition 17a and its insulating material 20a are brought downwardly into proximity to the lower guide roll 39, for efficiency in chilling by gas in the chamber 19a. The delivery roll 44 is mounted on the wall structure to receive the strip direct from the roll 39 since the squeegee action is unnecessary where gas is used for the chilling purpose.

The sets of heating elements 48a, disposed in the preheating chamber and controlled by the thermostat 49a, preferably consist of gas jets which burn with reducing flames directed against the strip surfaces. This is true also of the heating elements 50a of the fusion chamber 18 under control of thermostats 52a. If a reducing atmosphere is desirable, and not sufficiently provided by the gas jets, reducing gases may be injected into the heating chambers through the hood pipe 23a. The injected gases may be sufficiently hot for preheating, and hence need to be augmented only by fusing elements in the chamber 18. It is of course to be understood that the temperatures and their relationship to each other and the fusion point of the strip coating must be maintained as previously set forth in the objects and in the description of Figures 1 to 3.

Although liquid may be used for cooling in conjunction with gaseous heating, the chilling apparatus of Figure 4 is designed to operate through a gaseous cooling medium, such as cold air, cold neutral gas or cold reducing atmosphere—preferably a cold reducing atmosphere. To this end the pipes 53a receive the cold gas under pressure and discharge it in jet form against the strip. Circulation is maintained by withdrawing the warmer gas through the pipe sections 66a, any suitable pumping and heat-exchanging apparatus being connected to pipes 53a and 66a externally of the chamber in obvious manner.

By filling the chilling chamber with liquid to a level just below the baffle 16, and substituting a pair of squeegee rolls for the delivery roll 44, a liquid cooling medium such as cold oil, or cold water, may be circulated through the pipes 53a and 66a in lieu of the cold reducing atmosphere.

In Figure 5 there is illustrated a further modification, having the same three major parts as the preceding forms but having said parts rearranged, and designed to operate with a liquid medium in both heating chambers and a gaseous medium in the chilling chamber. This entire apparatus may be above floor level, or its heating chambers may be disposed in a pit. In view of its close relationship to the previous forms, and its three-step process, a very brief description will suffice.

The heating chambers of Figure 5 comprise a vertical preheating tank 72, and a fusion tank 73 substantially in the shape of a triangular prism having one side inclined to the horizontal in a direction upwardly and away from the tank 72. An inclined tube 74 which is rectangular in cross section joins the two chambers, both of which are filled with liquid to the indicated level, maintained by the float-switch device 69, 70 in conjunction with any suitable supply means. The tanks have normally closed drain pipes 75, 76.

The upper end of the preheating tank has a slot 77 for the entrance of the strip 7 from the feeding rolls 32b. From these rolls the strip passes downwardly to the guide roll 34b and then is drawn off at an angle through the tube 74, the fusion tank and the baffle 16b by a pair of squeegee rolls 42b, 43b. The latter are located adjacent the strip outlet side of a chilling tank 78, which at said outlet side has a baffle 79 through which the treated strip is discharged.

The liquid is preheated in the tank 72 by elements 48b that may comprise hot pipes but which preferably consist of electrical units controlled by a thermostat 49b. Likewise the units 50b in the fusion tank may take various forms but preferably comprise electrical elements under con-

trol of a thermostat 52b. A vent pipe 80 serves to remove hot vapors and gases adjacent the baffle 16b, thus minimizing the heat transfer between the fusion and chilling chambers.

The strip is quickly chilled in the tank 78 by jets of cold air, cold neutral gas or cold reducing gas, preferably fed against it from pipes 53b. A withdrawal pipe 82 at a higher point in the tank serves to return the warmer gas to the cooling system from which the pipes 53b receive their supply.

If desired, the direction of strip travel in Figure 5 may be reversed; and the chilling chamber may be removed and the preheating chamber converted into a cooling chamber; this would combine the preheating and fusion units, in effect, into one tank, but such an arrangement is satisfactory in cases where the strip is permitted or caused to travel at slow speed.

While the process and apparatus above described were devised with particular reference to a treatment of strip steel carrying a coating of tin, they may, without the exercise of inventive genius, be employed for a like treatment of other metallic coatings and for combinations in which the base metal is other than steel. Thus, the process and apparatus are operable for like treatment of metallic strip material carrying a coating of copper, or zinc, or nickel, or lead, or bismuth, or other metal which has a melting point lower than the melting point of the base metal, or copper and zinc, or copper and tin, or nickel and copper, or lead and tin, or lead and bismuth, or any other combination of two coating metals the outermost of which shall have a melting point below the melting point of the base metal. Likewise, they are operable for treating metal-coated strips whose base metal is copper, aluminum, nickel, stainless steel, Monel metal or any other metal strip having a higher melting temperature than that of the exposed coating metal.

With reference to the specific combination hereinbefore referred to, of strip steel of relatively low carbon content and of about 30 guage, carrying on its surfaces electrodeposited coatings of tin, it is noted that the coated strip desirably is preheated to a temperature of about 400° F. in the preheating chamber; that it desirably is further heated to a temperature of about 460° F. in the fusing chamber and is held at the latter temperature for some seconds; and that it is cooled to about 150° F. or below before being contacted by any solid object.

The process described above in connection with the apparatus shown in Figs. 1 to 5, is claimed in my prior patent, No. 2,357,126.

While the invention has been specifically described hereinbefore with particular reference to the treatment of electrically deposited metallic coatings, it is to be appreciated that the process and apparatus of the invention are applicable, without inventive change, to the treatment of coatings which have been applied by the known hot dip method. It will appear, for example, that the coated strip may be fused and heat-conditioned by heating it to a temperature below the melting point of the coating (such as tin) and by continuing to subject the coated strip to such temperature treatment until the coating has been brightened and suitably alloyed to the base metal. However, as set forth herein, I prefer to preliminarily heat the coated strip and then subject the strip to a higher temperature treatment for a short period of time to obtain the desired results.

It will also appear that the term "strip" as employed herein applies to any suitable base metal preferably having some flexibility to permit it to be interleaved over or between suitable rolls.

As illustrated and described in my copending applications, Serial No. 133,911 (now patent, No. 2,240,265), and Serial No. 257,107, now abandoned, the electroplating line through which the strip passes, includes means for subjecting the strip to tensioning actions during passage through the line, as shown in Figs. 6a and 6b, as an example, substantially as illustrated in the aforesaid patent, No. 2,240,265. As here shown, the strip 7 is fed from a pay-out device A, through a welding device B, where successive lengths of strips are joined together in continuous fashion. A pressure device or squeegee C is provided for aligning and tensioning of the strip, from which the strip passes to a slack producer D, thence to squeegee rolls C'. The strip is then directed into a cleaning tank F, and through a scrubbing mechanism G, rinse tank H and pickle tank I, to another scrubbing mechanism G'. From the scrubbing mechanism G', the strip is directed through a bridle stand J, around a weighted dancer roll J', to an electroplating tank K. From the electroplating tank K, the strip 7 is again scrubbed at G2, and passes into a rinse tank L, and a hot air drier M.

After leaving the drier M, the plated stock is subjected to the tensioning action of a weighted dancer roll 80', and then passes into the brightening apparatus generally indicated at N, as described above and illustrated in Figs. 1 to 5. Not only do the dancer rolls control the tension in the strip 7, but also the tension is controlled by the bridle stand J and dancer roll J1, as described more in detail in my prior application, Serial No. 133,911 (Patent No. 2,240,265).

Moreover, set forth in my prior application, Serial No. 257,107, filed February 18, 1939, now abandoned, the squeegee rolls C and C', and other power-drive guide rolls for controlling the movement of the strip through the line, have a material effect in feeding the strip at a suitable speed under a desired tension, and prevent an undesirable building up of tension of the strip during movement through the various operations in the line. Thus, as an example, the various contacts, pinch, and/or tension rolls may be driven by electric motors which will operate these at the desired speeds to tension the strip properly through the treating operations and to eliminate line surges that arise particularly in a long line without affecting the treating operations. The pinch roll motor, as well as the bridle stand motor, may serve to provide a "drag" tension which further aids in maintaining the desired tension in the line, all as set forth more in detail in my prior application referred to and in my patent mentioned above.

Obviously, many other alterations and rearrangements of parts in the several illustrated forms may be made without departing from the spirit and scope of the invention, which may be determined from the appended claims.

I claim:

1. In apparatus for treating electroplated coatings on continuous metal strip, means for preheating the strip to a temperature below the fusing temperature of the coating thereon, separate means for briefly heating the coating to a fusing temperature, separate means for quickly solidifying the coating, means for continuously moving

the strip under tension and means for controlling the tension in the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip.

2. In apparatus for treating electroplated coatings on continuous metal strip, means for preheating the strip to a temperature below the fusing temperature of the coating thereon, separate means for briefly heating the coating to a fusing temperature, separate means for quickly solidifying the coating under non-oxidizing conditions and located substantially vertically below the last-mentioned heating means, means for continuously moving the strip under tension, and a roll acting on the strip during movement through the apparatus in a direction for controlling the tension in the strip therethrough whereby a uniform smooth bright tin surface is provided on the strip.

3. In apparatus for treating electroplated coatings on continuous metal strip, means for preheating the strip to a temperature below the fusing temperature of the coating thereon, separate means for briefly heating the coating under non-oxidizing conditions to a fusing temperature, separate means for quickly solidifying the coating under non-oxidizing conditions, means for continuously moving the strip under tension and means for controlling the tension in the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip.

4. In an apparatus for treating electroplated coatings on a continuous metal strip, means for preheating the strip to a temperature below the fusing temperature of the coating thereon, separate means for briefly heating the coating under non-oxidizing conditions to a fusing temperature, separate means for quickly solidifying the coating under non-oxidizing conditions and located substantially vertically below said last-mentioned heating means, means for continuously moving the strip under tension through said preheating, heating and solidifying means and including guide means for the strip arranged in position out of contact with the fused portion of the strip, and a roll acting on the strip during movement through the apparatus in a direction for controlling the tension in the strip therethrough whereby a uniform smooth bright tin surface is provided on the strip.

5. In apparatus for treating electroplated coatings on continuous metal strip, means for heating the coating to a fusing temperature, means for solidifying the coating, means for continuously moving the strip under tension and means for controlling the tension in the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip.

6. In apparatus for treating electroplated coatings on a continuous metal strip, means forming respectively heating and quenching zones and including means for heating the coating in the heating zone to a fusing temperature and means for solidifying the coating in the quenching zone, said quenching zone being located below the heating zone for downward movement of the strip in a substantially vertical path from the heating zone to the quenching zone, means for continuously moving the strip under tension through said zones including means for guiding said strip through said path and arranged in position out of contact with the fused portion of the strip, and roll means for controlling the tension in the strip through the apparatus whereby a uniform smooth bright tin surface is provided on the strip.

7. In apparatus for treating electroplated coatings on a continuous metal strip, means forming respectively heating and quenching zones and including means for heating the coating in the heating zone under non-oxidizing conditions to a fusing temperature and means for solidifying the coating under non-oxidizing conditions in the quenching zone, said quenching zone being located below the heating zone for downward movement of the strip in a substantially vertical path from the heating zone to the quenching zone, means for continuously moving the strip under tension through said zones including means for guiding said strip through said path and arranged in position out of contact with the fused portion of the strip, and power-operated rolls acting on the strip during movement through the apparatus for controlling the tension in the strip therethrough whereby a uniform smooth bright tin surface is provided on the strip.

8. In apparatus for treating an electroplated coating on continuous metal strip, means for heating the coating to a fusing temperature, means for thereafter solidifying the coating, means for continuously moving the strip under tension through the apparatus, and power-operated rolls acting on the strip during movement through the apparatus for controlling the tension of the strip therethrough, whereby a uniform smooth bright surface is provided on the strip.

9. In apparatus for treating an electroplated tin coating on continuous metal strip, means for heating the coating to a fusing temperature, means for thereafter solidifying the coating, means for continuously moving the strip under tension through the apparatus, and a roll acting on the strip during movement through the apparatus in a direction for controlling the tension of the strip therethrough, whereby a uniform smooth bright tin surface is provided on the strip.

10. In apparatus for treating an electroplated tin coating on continuous metal strip, means for heating the coating to a fusing temperature in one zone, means for thereafter solidifying the coating in another zone, means for continuously moving the strip under tension, said strip moving means including driven rolls and guide rolls for accumulating a loop in the strip to provide for continuous movement of the strip through the heating and solidifying means during joining of discontinuous lengths of stock to said strip, and a roll acting on the strip in a direction for controlling the tension of the strip during movement of the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip.

11. In apparatus for treating an electroplated tin coating on continuous metal strip, means for heating the coating to a fusing temperature in one zone, means for thereafter solidifying the coating in another zone, means for continuously moving the strip under tension, said strip moving means including rolls for accumulating a loop in the strip to provide for continuous movement of the strip through the heating and solidifying means during joining of discontinuous lengths of stock to said strip, and power-operated rolls acting on the strip during movement through the apparatus for controlling the tension in the strip therethrough, whereby a uniform bright tin surface is provided on the strip.

12. In apparatus for treating electroplated coatings on continuous metal strip, a heating chamber containing a non-oxidizing fluid bath, a cooling chamber containing a non-oxidizing

fluid bath, said cooling chamber being located below and communicating with said heating chamber, means associated with said heating chamber for heating the strip to fuse the coating, means associated with said cooling chamber for quickly solidifying the coating, means for continuously moving the strip under tension and means for controlling the tension in the strip through said heating and cooling chambers, whereby a uniform smooth bright tin surface is provided on the strip.

13. In apparatus for treating electroplated coatings on continuous metal strip, means for preheating the strip to a temperature below the fusing temperature of the coating thereon, separate means for heating the strip for fusing the coating, separate means for cooling the strip for solidifying the coating, means for continuously moving the strip under tension and means for controlling the tension in the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip; and means for controlling the temperature of the strip during preheating, heating and cooling so that the coating is fused for only a short period of time and is quickly solidified.

14. In apparatus for treating electro-tin plated coatings on continuous metal strip, means for preheating the strip to a temperature of about 400° F., separate means for heating the strip to a temperature of about 460° F. for fusing the coating, separate means for cooling the strip to a temperature of about 150° F. for solidifying the coating, means for continuously moving the strip under tension and means for controlling the tension in the strip through the apparatus, whereby a uniform smooth bright tin surface is provided on the strip, and means for controlling the temperature of the strip during preheating, heating and cooling so that the coating is fused for only a short period of time and is quickly solidified.

JOHN S. NACHTMAN.

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The following references are of record in the file of this patent:

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Number	Name	Date
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