

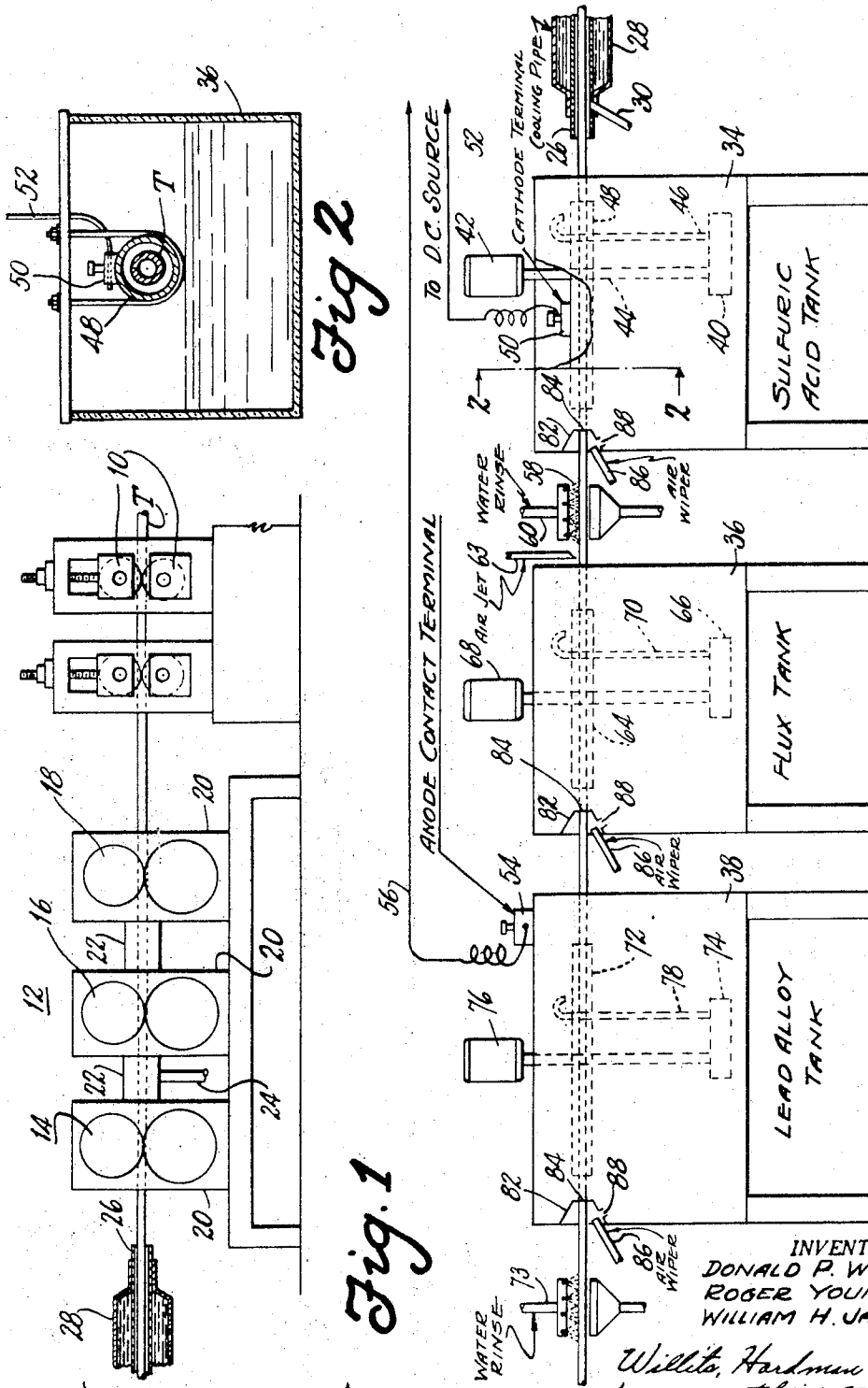
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PROCESS OF COATING STEEL TUBING

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PROCESS OF COATING STEEL TUBING

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This invention relates primarily to an improved method of applying to steel tubing a thin layer of a non-ferrous and non-corrosive coating to protect the tubing against oxidation or other corrosive action, and a suitable apparatus for carrying out such method. The process which is the subject of the present invention was designed particularly for the purpose of applying a protective coating to steel tubing formed from a flat strip by a continuous process in which the strip is bent into a tube having a seam at the top which is continuously welded as the tube is continuously formed from the strip, the coating being applied to the formed and welded tube as it is moved continuously from the tubing apparatus, the tubing after it leaves such apparatus passing through devices designed to apply the coating thereto which are located adjacent such apparatus. It will be understood, however, that the process is not applicable merely to tubing formed in the manner described, but can be employed to apply a protective coating to steel tubing formed in any known way. In other words, the method of applying the protective coating is of entirely general application and the manner of making the tubing to which the coating is applied is entirely immaterial.

In certain methods of applying a non-corrosive metallic coating on steel tubing which have been previously used, the tubing has been subjected to the action of a bath containing hydrochloric acid and such methods are highly objectionable since such acid both gives off fumes which are highly corrosive and attack any metallic objects with which they come in contact and, in addition, are highly objectionable to persons who are employed in carrying out the method. It is an object of the present invention to devise an improved method and apparatus for applying a non-corrosive metallic coating to steel tubing which is highly effective and in which the use of a hydrochloric acid bath is eliminated.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figure 1 is a diagrammatic view of an apparatus which can be successfully employed for carrying out the applicants' method of coating tubing.

Figure 2 is an enlarged section on the line 2—2 of Figure 1.

In forming steel tubing from a flat strip of steel, the strip passes through a plurality of pairs of forming rolls which bend the flat strip into an approximately round tube with the edges of the strip abutting at the top of the tube, the tube moving through the forming rolls at a suitable speed which may vary considerably, depending on wall thickness and size of the tubing to be formed, for example. After the tubing leaves the forming rolls it passes through a welding device which welds the abutting edges of the tubing, and then beneath a tool which trims off the excess metal from the welded seam at the

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top of the tube. The mechanism above referred to is not shown herein as it constitutes no part of the present invention, but is fully shown and described in the co-pending application of Rea I. Hahn, S. N. 101,402, filed January 25, 1949, now Patent No. 2,822,291.

After the tube passes the cutting tool above referred to it goes through a plurality of pairs of sizing rolls indicated at 10 in Fig. 1, two pairs of such rolls being illustrated and the welded tubing is indicated at T. These rolls are effective to form the tube in exactly the shape and size desired. After the tube leaves the sizing rolls 10 it is moved through an annealing device 12 which comprises a plurality of pairs of rolls 14, 16 and 18 which are the contact rolls of an electric heating device. These pairs of rolls are in housings 20 which are connected by short tubes 22 of refractory material through which the tube T passes, as fully described in the aforesaid application of Hahn. In the annealing device the temperature of the tubing is raised to a point between 1500° and 2000° in the presence of a reducing gas which is introduced through the conduit 24. Subsequent to the annealing operation the tubing is cooled by passage through a pipe 26 provided with a water jacket 28 and a reducing gas is also introduced into the pipe 26 through a conduit 30, at the rate of 250 to 500 cubic feet per hour, depending on the amount required to produce a tube having a surface of the desired brightness.

As shown herein, the apparatus for applying the non-corrosive coating to the tubing is positioned adjacent the tube forming apparatus so that as the formed tube leaves the above described cooling device it is moved on through the mechanism for applying such coating. As illustrated, this apparatus includes three tanks 34, 36 and 38 through which the tubing passes successively as it leaves the water jacketed cooling pipe 26. The tank at the right, 34, through which the tube passes first contains dilute sulphuric acid which cleans off any oxides or other impurities on the tube surface by electrolytic action as later more fully described. The second tank, 36, through which the tubing passes contains a suitable flux which facilitates the application of the coating metal, when the surface of the tubing is subjected to the action of the flux before the coating metal is brought into contact with the tube surface. The tank 38, at the left, contains the protective metal coating in molten form; and, in the particular embodiment of the invention specifically described herein, this coating metal is an alloy of lead and tin, but it will be understood that the invention is not limited to this particular compound and other non-corrosive metals or alloys could be used. It will also be understood that the apparatus employed for applying the non-corrosive coating does not have to be positioned adjacent the tube forming mill so that the tubing passes through such apparatus as it leaves the mill. It can be positioned elsewhere and the tubing can be moved through the apparatus by any suitable means instead of as disclosed.

The tubing passes through all of the tanks at some distance above the level of the contents of the tanks and in the end walls of the tanks any suitable anti-friction devices (not shown), may be provided if desired, so that the tubing will pass freely through such walls.

The tank 34, which must be of acid-resistant material, is partly filled with a somewhat dilute form of sulphuric acid, which is maintained at a temperature preferably between 200 and 250° F. The sulphuric acid strength is somewhat variable, but excellent results have been obtained with an acid concentration of approximately 25% by volume, when the speed of the tubing, as it moves through the mill and the acid bath is from 60 to 110 feet per minute. The acid at the degree of concentration referred to is sufficiently dilute to produce no objection-

able fumes and does not evaporate to any material extent. Also, since the acid is relatively dilute, considerably less acid is used than in processes previously known where concentrated hydrochloric acid was used and the process is correspondingly cheaper to carry out.

In order to bring the acid into contact with the tubing as the latter is moved through the tank above the acid level, the tank has submerged therein a pump, diagrammatically indicated at 40. The specific construction of the pump is in no sense material to the present invention but, of course, the pump must be of such a construction as to be acid-resistant. Such pumps are well known. The pump may be operated in any suitable way as by a motor 42, supported by suitable means and connected by a drive shaft 44 with the pump. The pump has a delivery conduit 46 connected at its upper end with a metal pipe 48 which is suitably supported within the tank above the acid level therein and is of larger diameter than the tubing T. The tubing T passes through the pipe 48 and the pipe is kept substantially filled with the acid by the pump 40 so that the acid contacts the entire surface of the tubing as it passes through the pipe 48.

The action of the acid in cleaning the tubing is aided by an electrolytic process which is the reverse of the process ordinarily used in electroplating. To this end a cathode terminal, to which a lead 52 extending to a suitable D. C. source of current is connected, is secured to and in electrical contact with the pipe 48, which is a lead pipe, preferably about 2 inches in diameter and about 25 inches long. A second or anode terminal 54, similar to the cathode terminal 50, is secured to and in electrical contact with the tank 38, which is a lead tank, and a lead 56 extends from the terminal 54 to the source of current previously referred to. The tank 38 contains the non-corrosive coating and the anode terminal is in electrical contact with the tubing through such metal. Therefore, the tubing is itself, the anode in effect, and the lead pipe 48 in tank 34, the cathode, so that the path of the current is the reverse of that used in electroplating and instead of depositing metal on the tube, the effect of the current is to take a small quantity of metal off of the tube, for deposit on the cathode. The removal of this small quantity of metal by electrolytic action aids the action of the acid in cleaning the tubing, which is necessary in order to effect a good bond between the steel and the non-corrosive coating. The current and voltage employed may both vary considerably as, for example, from 240 to 1000 amperes and 10 to 40 volts.

After the tubing leaves the acid tank 34 it passes under water jets 58 supplied by a nozzle 60 which rinses off any acid remaining on the tubing, and the rinse water is carried off through a suitable drain 62. Subsequent to the rinsing of the tubing with water, it passes into the flux tank 36 and between the nozzle 60 and the tank 36 the tubing passes under an air jet 63 which blows off any surplus water from the tubing surface before it is subjected to the action of the flux. It has been found that the tubing surface is better prepared for application of the coating metal, or alloy when subjected to the action of the flux bath in addition to the electrolytic cleaning treatment previously described than when the flux bath is not used, a more uniform coating and better bonding being obtained.

The flux preferably employed is a solution of approximately 30% zinc chloride in water. The tank 36 contains this solution, the level of which is considerably below the tubing as the latter passes through the tank. The tubing passes through a pipe 64 similar to the pipe 48 and the flux solution is forced into the pipe by a pump 66 similar to the pump 40 and operated in the same way by a motor 68, the pump having a delivery conduit 70 similar to the conduit 46. The flux solution is heated to between 200° and 250° F., which considerably increases its effectiveness. The tank 36 must, of

course, be made of a material or lined with a material which resists the corrosive action of the flux solution and the pump 66 must be of such construction as to be unaffected by such solution.

Subsequent to treatment with the flux solution, the tubing passes through the tank 38 which must be of a material which is electrically conductive in order to carry current from terminal 54 to the coating metal and through such metal to the tubing if the terminal is mounted on the tank, as shown. If the tank is not of such material, the terminal 54 might be secured to the pipe 72 which is similar to pipe 48 and suitably supported in the same way. The tank 38 is heated by any suitable means (not shown) to a degree sufficient to maintain the coating metal in a molten state, and this temperature would, of course, depend on the specific metal or alloy which is being used. For example, although various metals or alloys might be used, an alloy known in the trade as "Terne" is employed in the specific embodiment of the invention disclosed herein, this being an alloy comprising 93 percent lead and 7 percent tin. When this alloy is used, the tank 38 is kept at a temperature of approximately 700° F. Due to the better cleaning of the tube and the use of the flux, this is a somewhat lower temperature than that required in the process in which hydrochloric acid was used as a cleaning bath and is a matter of some importance for two reasons. First, the amount of drossing of the coating alloy is reduced since the formation of oxides and other impurities on the surface of the molten metal is less at the lower temperature and, second, the cost of maintaining the coating alloy at the lower temperature is somewhat reduced.

The molten metallic alloy or metal for coating the tube which is contained in the tank 38 is pumped into the pipe 72 by a pump 74, driven by motor 76 and connected with a delivery conduit 78 in the same way as the acid and flux tanks 34 and 36 are pumped into the pipes 48 and 64, respectively.

The construction of the pump 74 is not material, so far as the present invention is concerned, and any pump of suitable construction for pumping molten lead can be used, such pumps being well known.

After leaving the tank 38, the tubing passes under jets of cooling water for the purpose of immediately cooling and solidifying the thin coating of lead alloy which has been applied to the tubing during its passage through the pipe 72. The means for supplying the cooling water is of any suitable construction and may be a nozzle 73 similar to the nozzle 60 that is employed to cool the tubing after it leaves the acid bath. Subsequent to the step of cooling and solidifying the lead alloy coating, the tubing is wound in any suitable way on reels, if desired, or it may be cut into shorter straight lengths, depending on the ultimate use of the tubing. In other words, the tubing may be cut off into pieces of specific length concurrently with its formation, if desired, or rolled up on reels like wire or cable and stored on such reels for future use.

As already stated an air jet 63 is employed to blow air over the tubing after being rinsed by water from nozzle 60 to eliminate any water remaining on the surface of the tubing before it enters the flux tank, and as the tubing leaves each of the tanks 34, 36 and 38 it is subjected to the action of an air jet or wiper to remove excess acid, flux and the coating alloy. As shown, there is secured to each of the tanks 34, 36 and 38 on the left vertical wall thereof, in any suitable way, a funnel-shaped element 82 positioned so that the small end is toward the right and of such a size as to leave a small annular space 84 between such small end of element 82 and the tubing. An air jet 86 extends through the left end wall of each of the tanks 34, 36 and 38 into the element 82, terminating below the tubing and adjacent the space 84 so that the compressed air supplied by the jet 86 is blown through the space 84 in a direction substantially opposite to the

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direction of movement of the tubing. This will blow most of the surplus acid or other material off the tubing and back into the tank, but each funnel-shaped element 82 may have an opening 88 at the bottom thereof to permit surplus acid or other material falling off the tubing within the element 82 to drain back into the associated tank.

As stated, some variation in the concentration of the acid bath and also in the proportions of the flux solution, is permissible. For example, although probably the best results are obtained with an acid bath and flux solution such as specifically referred to previously, satisfactory results can be obtained with an acid concentration from 12% to 25%, and a flux varying from 30% to 75% zinc chloride. Also, it is apparent that the temperatures of the acid bath and flux solution are not exceedingly critical and can vary from 50 to 250 degrees Fahrenheit.

Because of the reduction in dosing, the temperature of the coating metal in the tank 38 should be kept at a degree as little over the melting point as possible and should not be permitted to rise more than 125 degrees F. above the melting point of the particular coating material being used.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. The continuous method of coating steel tubing with a layer of non-ferrous, anti-corrosive and protective metallic coating which comprises successively applying to the tubing as it is moved longitudinally a relatively dilute sulfuric acid bath containing approximately 12% and 25% sulfuric acid by volume through which direct electric current is passed in such a manner that the tubing constitutes an anode, directing jets of water over the tubing after application of the acid bath to reduce the temperature of the tubing and to remove any excess of acid remaining on the surface thereof, then applying to the moving tubing a flux consisting essentially of approximately 30% to 75% by weight zinc chloride and the balance water to facilitate adherence of the coating layer to the tubing surface, subsequently applying a lead alloy coating to the moving tubing while maintaining the lead alloy at a temperature above its melting point, directing cooling water over the surface of the tubing after application of the coating layer thereto in order to cool the tubing and solidify the coating material on the tubing surface.

2. The continuous method of coating steel tubing with a layer of non-ferrous, anti-corrosive and protective metallic coating which comprises successively applying to the tubing as it is moved longitudinally a relatively dilute sulfuric acid bath containing approximately 12% to 25% sulfuric acid by volume through which direct

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current is passed in such a manner that the tubing constitutes an anode, directing jets of water over the tubing after application of the acid bath to reduce the temperature of the tubing and to remove any excess of acid remaining on the surface thereof, then applying to the moving tubing a flux consisting essentially of approximately 30% to 75% by weight zinc chloride and the balance water to facilitate adherence of the coating layer to the tubing, subsequently applying a lead-tin alloy coating to the moving tubing while maintaining the lead-tin alloy at a temperature above its melting point, directing cooling water over the surface of the tubing after application of the coating layer thereto in order to cool the tubing and solidify the coating material on the tubing surface.

3. The continuous method of coating steel tubing with a layer of non-ferrous, anti-corrosive and protective metallic coating which comprises successively applying to the tubing as it is moved longitudinally a relatively dilute sulfuric acid bath containing approximately 12% to 25% sulfuric acid by volume through which direct electric current is passed in such a manner that the tubing constitutes an anode, directing jets of water over the tubing after application of the acid bath to reduce the temperature of the tubing and to remove any excess of acid remaining on the surface thereof, then applying to the moving tubing a flux consisting essentially of approximately 30% to 75% by weight zinc chloride and the balance water to facilitate adherence of the coating layer to the tubing surface, subsequently applying a lead-tin alloy coating consisting essentially of about 93% lead and 7% tin by weight while maintaining the lead-tin alloy at a temperature above its melting point, directing cooling water over the surface of the tubing after application of the coating layer thereto in order to cool the tubing and solidify the coating material on the tubing surface.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,876,132

March 3, 1959

Donald P. Worden et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 32, for "and 25% sulfuric acid" read -- to 25% sulfuric acid --.

Signed and sealed this 30th day of June 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents