METHOD AND APPARATUS FOR THE CONTINUOUS FORMING, GALVANIZING AND COLORING OF TUBING

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ABSTRACT OF THE DISCLOSURE

The continuous forming, galvanizing and coloring of tubing wherein the continuously formed and galvanized tubing is overcoated with a color coating as a continuous operation with the tube forming and galvanizing by advancing the tubing after the galvanize coat has been set through processing steps of coating the galvanized surface with a color coating composition formulated of a hardenable resinous vehicle containing a diluent and a tinctorial agent, rapidly heating the coated tubing to drive off the diluent and set the resinous base without bubble formation, cooling the heated tubing to harden the resin, engaging the tubing between driving rolls located upstream of the coating and heating sections to pull the tubing through said processing sections while supporting the tubing to avoid contact with the surface of the tubing from the time that the coating composition is applied until it is set and then straightening and cutting the colored tubing to lengths, and including means adjacent the path of travel of the tubing in a straight line through the said processing sections for detecting deviations of the tubing from the normal line of travel and means responsive to any such deviations for shutting down the entire line.

This invention relates to the process of tube forming, galvanizing and color coating of metal strip in a continuous operation and to apparatus for use in the practice of same.

In the previously issued patents of Krengel et al., No. 3,122,114 and No. 3,320,615, description is made of a process and apparatus for tube forming and galvanizing steel strip in a continuous operation whereby galvanized tubing is produced at low cost with a uniform zinc galvanize on the outer surfaces of the formed tubing.

It is an object of this invention to incorporate a color coating as an overcoat on the zinc galvanize coat and to provide a method and means for applying and setting the coloring coat on the zinc galvanize as a continuous operation with the tube forming and galvanizing from strip whereby a colored zinc galvanized tubing can be produced in a continuous operation.

These and other objects and advantages of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawings in which:

FIG. 1 is a schematic flow diagram of the tube forming, galvanizing and coloring process embodying the features of this invention;

FIG. 2 is a flow diagram of a portion of the arrangement shown in FIG. 1 with particular attention to the continuous coloring of the galvanized tubing in accordance with the practice of this invention;

FIG. 3 is a cross-sectional view showing the step in coating the galvanized tubing;

FIG. 4 is a sectional elevational view showing the limit switch for signaling malfunction in the operations;

FIG. 5 is a schematic view showing a portion of the process for setting and hardening the applied coating;

FIG. 6 is an elevational view of the roller support and drive for the tubing; and

FIG. 7 is a sectional view through the tubing produced in accordance with the practice of this invention.

It has been found that an undercoat of zinc galvanize on the steel tubing provides improved corrosion resistance while enhancing the interbonded relationship between the applied color coating and the formed steel tubing in a manner which resists chipping or deterioration characteristic of color coatings otherwise baked upon plain steel tubing. Material advantage is derived from the zinc galvanize undercoat while producing colored tubing having an attractive appearance, good weather resistance, good color retention and high strength at minimum cost. When a clear tinted overcoat is applied onto the galvanized steel tubing, the color coating embodies a metallic luster of a unique and attractive character. All shades of color can be obtained by formulation of the color coating with various dyes and/or pigments in a suitable carrier.

As the carrier, it is preferred to make use of a resinous base which is cured or hardened by baking at elevated temperature, such as a resins base formed of an alkyd resin comprising the reaction product of a polyhydric alcohol such as glycerol, pentaerythritol, or glycol, with a polybasic acid such as phthalic acid or anhydride or maleic acid or anhydride, with or without oil modification with linseed, soya, or the like partially drying oil. Instead, use can be made of a polyester resin or other heat hardenable resinous base ordinarily formulated into baking enamels or paints. A tough protective coating having an attractive appearance and color can also be formulated of the high polymers such as the polyamides (nylon), polyvinylidine chlorides (Saran), polyethylene or polyesters (Dacron), or natural or synthetic rubbers formulated into suitable carriers.

For coloring, use can be made of conventional tinctorial agents, such as dyes, pigments and the like, of the type conventionally formulated into paints or enamels. Since the invention does not reside in the formulation of the color coating composition, detailed description thereof will not be given except to specify the use of a clear varnish having a dye color dissolved therein when a clear color coating is desired on the galvanized tubing; otherwise the coating composition can be formulated with the usual pigments and fillers employed in paints and enamels.

While the method and means of this invention can be employed in combination with other methods and means for the continuous tube forming and galvanizing of strip, the invention has particular application and will be described with reference to the continuous tube forming and galvanizing process and means illustrated in the aforementioned issued patent.

Briefly described, the metal strip 10 is unrolled from reels 12 mounted for rotational movement on a stand 14. The strip is advanced through suitable end-joining and takeup means 16 to 44 to an edge shaver 46 wherein the lateral edges of the strip are trimmed to size the strip and to present freshly cut metal to the subsequent operation for welding after the edges are brought together by the tube forming rolls 48.

From the edge trimmer 46 the strip is advanced through a wiper 47 and into the bank of forming rolls 48 wherein the strip is formed to tubular shape.

From the forming rolls 48, the tubing is advanced through a weld section including a seam welder 50, a seam shaver 52, a water cooling spray 53, and a welder 54 to produce a welded tubing 56 which is subsequently advanced through washers 58 and 74, a rinse 78 and acid wash 80, followed by a water rinse 81 of oxide, grease, etc. from the surface of the metal tubing in preparation of the tubing for the subsequent galvanizing operation.
The welded and cleaned tubing 56 then proceeds continuously from the cleaning section to a steam blast 97 for the removal of surface moisture and then to induction heating 113 for preheating the formed tubing to a temperature suitable for entry into the bath 132 of molten zinc for galvanizing. The preheat and the housing containing the molten zinc is maintained under an inert atmosphere to minimize oxidation and to enhance the galvanizing operation.

At the outlet from the housing 132 containing the molten zinc, a die system is embodied for the removal of excess molten zinc from the surface and thereafter the galvanized tubing 56 is advanced through a water spray 164 for freezing the zinc onto the surface of the steel tubing. From there, the galvanized tubing is put through water spray section 190 for cooling down the tubing before being advanced to the marking roll 191, sizing rolls 192 and traveling shears 194 wherein the galvanized tubing is sized to the desired length for use.

The method and means embodying the features of this invention for color coating the zinc galvanized tubing as a continuous operation with the tube forming and galvanizing step is interposed in the line immediately upstream of the galvanizing trough, the knife for removal of excess coating, water spray to freeze the coating and the sizing and straightening rolls and downstream of the traveling shears by which the finished colored tubing is cut to desired lengths.

Application of a color coating as a continuous operation with the tube forming and galvanizing presented a number of problems which were not easy to overcome. Since continuous tube forming and galvanizing of strip is, of necessity, a high speed operation, considerable space would ordinarily be required for application of the coating composition in uniform thickness and for drying the coating and setting the coating on the tubing. However, such space is at a premium so that it was incumbent to achieve coating, drying and setting in minimum time so as to occupy minimum space in a straight line function with the tube forming and galvanizing operation, but without interfering with the tube forming and galvanizing process and without the formation of blisters in the applied coating while achieving adequate cure for subsequent handling and use.

A further problem existed in the proper support and displacement of the tubing from the galvanizing section through the coating and curing section without disturbing or distorting the applied coating while in a wet or uncured state.

A still further problem existed by reason of the deformations which can take place in the tubing during the coating, drying and hardening steps as well as the subsequent straightening and sizing steps whereby considerable waste of material, time and labor would occur unless detected immediately for automatic shutdown of the entire line before a severe jam is created and before a large amount of waste is generated.

These are but a few of the problems to which the invention of this application is addressed in the production of a colored coating over a galvanize undercoat on steel tubing, all carried out as a continuous operation in the fabrication thereof from strip.

With reference now to FIG. 2 of the drawings, from the galvanizing bath 150 with its accompanying means for removal of excess coating and for freezing the zinc coating to set the galvanize, the galvanized tubing 198 is advanced in a straight line through a series of sizing rolls 200 and straightening rolls 202.

The sizing rolls work the exterior surfaces of the formed and galvanized tubing to eliminate out-of-roundness which might subsequently interfere with the free passage of the tubing through the subsequent processing apparatus and thus not only interrupts the continuous tube forming and coating operations but also to generate considerable waste with consequent loss of time, materials and possibly damage to equipment.

The sizing rolls are of conventional construction as embodied in conventional well known equipment and thus not detailed description thereof need not be given. However, in the process of this invention, it is desirable, though not essential, to wet the outer surfaces of the galvanized tubing with an aqueous chromate or chromium solution to prevent seizure of the zinc coated tubing during processing with the sizing and straightening rolls. The chromium or chromate solution also contributes, to some degree, to the preparation of the zinc coated surface for strong anchorage between the subsequently applied color coating and the undercoat of zinc galvanize.

The galvanized tubing travels continuously from the sizing rolls 200 to the straightening rolls 202 for straightening the tubing before coating and finishing. The straightening rolls are also of conventional construction and available in commercial equipment.

From the straightening rolls, and before entrance into the coating section, the galvanized tubing is advanced continuously through a predrying chamber 204 for the removal of moisture and other volatiles from the outer surfaces of the galvanized tubing. The drying chamber comprises an elongate chamber having an inlet 206 at one end and an aligned outlet opening 208 at the other end for the continuous passage of the tubing into and out of the chamber. Drying can be effected by the introduction of hot drying gases, preferably in counter-current flow, through the chamber for circulation from the outlet end to the exhaust 210 communicating with the inlet end portion for exhaust into the atmosphere.

From the drying chamber, the warm tubing is advanced continuously and in straight line function through the coating section 212 formed of an enclosed housing 214 which substantially completely confines a length of tubing of about 10–20 feet. The housing is formed with an inlet opening 216 in one side wall and an aligned outlet opening 218 in the opposite side wall with the openings being dimensioned to be slightly greater in cross-section than the cross-section of the tubing to enable passage of the tubing linearly into and out of the housing without contact therewith when properly supported. Spray guns 220, circumferentially arranged about the tubing, are spaced a short distance radially from the tubing with their outlets addressed towards the tubing to direct the spray onto the tubing as it passes therebetweeen.

It is preferred to make use of an electrostatic spray system, such as a Ransburg system, for application of the coating. For this purpose, an electrical connection is made with the tubing whereby the spray of coating composition is attracted to the galvanized surface of the tubing for more efficient utilization of the coating composition and for more uniform coverage of the galvanized surface of the tubing. It will be understood, however, that other coating techniques may be employed for uniform coverage of the outer surface of the tubing during passage through the housing but it is preferred to make use of a flow coat or spray coat technique to achieve uniform coverage all around.

From the housing the coated tubing is advanced directly to an elongate heating chamber 222 for removal of diluent present in the coating composition and for hardening the resinous component of the coating. The heating chamber, in the illustrated modification, comprises an elongate chamber having electrical induction coils therein for raising the temperature within the unit to elevated temperature depending somewhat upon the resinous component making up the coating. For rapid removal of diluent and advancement of the coating to a hardened or cured stage, the temperature within the heating chamber is maintained at a temperature within the range of 400–600 °F., although higher temperatures may be used, depending somewhat upon the linear speed of the tubing and the length of the heating chamber.
Means for support of the tubing and for continuous displacement of the tubing cannot be employed in engagement with the tubing from the time that the tubing enters the coating section until the time that the coating has been set and hardened on the surface, otherwise undesirable markings and imperfections will be imparted on the coating applied to the galvanized surface. Means for support and displacement of the tubing are provided upstream of the heating chamber 222 in the form of a pair of metal rolling rolls 224-226 formed with a convexity in their peripheries and spaced one from another by an amount to engage the peripheral surfaces of the coated tubing between. In order to provide for the desired gripping relationship for operation as a driving means and in order to avoid marring of the freshly coated surface of the tubing, it is preferred to make use of plastic or hard rubber rolls or, as illustrated in FIG. 6, metal rolls 228 having a hard rubber or plastic layer 230 on the peripheral surfaces for establishing the desired gripping relationship with the tubing. The rolls are rotated in a direction to pull the tubing for linear advancement through the processing stages described. This operation is not only to minimize the strains on the tubing in the preceding processing sections but it also provides support for linear travel of the tubing through the processing sections in a manner to minimize buckling of the tubing or sagging such as might otherwise occur in the event that the tubing is pushed therethrough.

It is certain that the applied coating is hardened before being engaged by the supporting and driving rolls, it is preferred to interpose a means for cooling the tubing and applied coating beyond the heating chamber 222 but before the driving and supporting rolls 224-226 although, when the resinous base of the coating is heat hardenable or hardened sufficiently by the heat, the described intermediate cooling will not be necessary. As the cooling means, it is preferred to make use of an elongate enclosed chamber 231 having an inlet and outlet in opposite ends for the continuous passage of the tubing linearly therethrough. Water sprays are provided within the chamber for spraying the tubing to achieve rapid cool-down.

In combination with such water cooling or even in the absence thereof, in the preferred practice, it is desirable to make use of an air blower 232 located immediately adjacent the outlet end of the heating chamber and between the heating chamber and the rolling and heating chamber when the latter is employed. The blower is arranged so that the streams of air are caused to flow in opposite directions with the main stream directed axially into the open inlet end of the cooling chamber to hold back the water so as to prevent entrance into the heating chamber while a minor stream of air is directed into the opening in the outlet end portion of the heating chamber to provide circulation through the heating chamber for accelerating vaporization of the diluent from the applied coating and for carrying off the released vapors from the chamber. For this purpose, the chamber 222 is also provided with an exhaust 234, preferably at the inner end portion which may be connected to a solvent recovery system in the event that valuable organic solvents are employed as the diluent thereby to enable recovery of the solvent component.

As a further modification for protection of the tube from accelerated galvanizing and coating process described, it is desirable to locate a limit switch 236 in the line, preferably upstream of the coating chamber and immediately adjacent its outlet opening to signal unusual deviations or bends in the path of travel of the tubing which would be indicative of a jam or excessive bending of the tubing. For this purpose, as shown in FIG. 4, a ring member 238 is resiliently supported in linear spaced relation with the housing and in linear alignment with the opening through which the tubing passes with the ring having an inner diameter which is greater than the outside diameter of the tubing to permit easy passage therethrough without engagament of the ring during normal operation. When any bending or buckling of the tubing occurs, indicative of a jam or of the like, the deviation will be sufficient to bring into engagement the ring member with some portion of the surrounding ring 238 to effect displacement thereof from normal displaced position. The tubing is engaged by the arms of one or more limit switches 240 which are made in response to displacement of the ring for signaling a jam which operates immediately to close down the line. In addition of a surrounding ring system of the type described, other limit switches arranged about the tubing in corresponding location or in other locations within the processing steps may be employed to signal such deviations or bends as are indicative of a malfunction in the operation. In the absence of such means for protection, a jam could occur which would not only harm equipment and raise considerable difficulties but it would result in a large amount of waste time and material, especially when operating at the high through-put speeds described.

Following the drying and displacement by the supporting rolls, the process continues with conventional means for straightening with straightening rolls 242 and cutting the finished tubing to lengths as by the use of the flying shears 244, as described in the aforementioned issued patents.

It is believed that this is the first time that tubing has been produced which, as illustrated in FIG. 7, is formed of a steel or other metal base 246, a hot dip galvanized layer 248, which functions as an undercoat for an outer color coating or enamel 250. The resulting tubing has an attractive metallic glaze which can be formulated to various shades or colors when the color coating is formed of a clear varnish base and dyestuff or with an opaque color when formulated of an enamel or paint. The applied coating will be characterized as a permanently coating which is chip-free and weather resistant as formed on the galvanized tubing. Similarly a protective coating of a polyamide resin (nylon), polyvinylidene chloride resin (Saran), polyethylene, polyester (Mylar or Dacron), natural or synthetic rubber, can be applied, with or without pigment, to provide a tough, resilient, protective coating on the tubing for such uses as fencing, outdoor structural members, playground equipment and the like, where toughness, weather resistance, chip resistance and attractiveness are important.

The ability to galvanize the galvanized tubing also permits formation of galvanized tubing with various colors for identification of tubing in complex assemblies, electrical wiring, and the like.

It will be understood that various changes may be made in the details of construction, arrangement and operation, without departing from the spirit of the invention, especially as defined in the following claims.

We claim:

1. In the production of colored tubing having a zinc galvanize undercoat on a metal base which includes the steps of continuously forming metal strip into tubing, continuously advancing the formed tubing through a molten bath of zinc to form a hot dip galvanize coating on the outer surfaces of the formed tubing and applying aqueous medium onto the tubing rapidly to set the zinc galvanize coat, the process for applying a color coating onto the zinc galvanized tubing as a continuous straight line operation with tube forming and galvanizing comprising applying a color coating composition onto the outer surfaces of the zinc galvanized tubing in which the color composition is formulated of a diluent, a tintorial agent and a resinous base vehicle, rapidly heating the coated tubing to drive off diluent and harden the resin, pulling the tubing through the coating and heating steps by means engaging the tubing beyond the heating zone to support the tubing during passage through said steps and to effect positive displacement of the tubing for advancement in a straight line through said steps without engaging the tubing from the time that it is coated until.
the coating is set on the tubing, and then straightening and cutting the tubing to lengths.

2. The process as claimed in claim 1 in which the color coating is applied by electrostatic coating technique.

3. The process as claimed in claim 1 which includes the steps of the drying the zinc galvanized tubing before application of the color coating.

4. The process as claimed in claim 1 which includes the step of water cooling the color coated tubing immediately beyond the heating step and before the pulling step to set the coating on the surface of the tubing before engagement by the pulling means.

5. The process as claimed in claim 4 which includes the step of blowing air in opposite directions between the water cooling means and the heating means with one increment of air directed upstream towards the water cooling means to prevent entrance of water into the heating means and another increment directed downstream towards the heating means to assist in the vaporization of diluent from the coating and to carry off the vapors, and means for exhausting the vapors from the heating section.

6. In an apparatus for continuously forming tubing, hot dip galvanizing the outer surfaces of the formed tubing and color coating the zinc galvanized tubing which includes means for the continuous forming of tubing from strip, means for hot dip galvanizing the outer surfaces of the formed tubing and means for setting the zinc galvanize on the surfaces of the tubing, in which the operations of tube forming, galvanizing and setting are carried out in a rapid continuous operation with the tube traveling in a straight line through such processing steps, apparatus for the application of a color coating onto the zinc galvanize undercoat in a continuous straight line operation with tube forming and galvanizing comprising means for application of a color coating composition onto the zinc galvanized surface of the tubing, in which the color coating composition is formulated of a diluent, a tintorial agent and a hardenable resinous base, a heating chamber immediately following the coating means having an inlet at one end and an outlet at the other in linear alignment with the tubing during travel through the coating means for passage of the coated tubing in straight line from the coating step through the heating chamber, heating means for maintaining the heating chamber at a temperature sufficient to flash off diluent and harden the coating on the zinc galvanized surface, a pair of driving rolls rotatable about an axis perpendicular to the line of travel of the tubing with the peripheral surfaces of the rolls in gripping relation with the tubing, said rolls being located beyond the heating chamber to support the tubing during passage through said processing steps and to pull the tubing through the coating means and the heating chamber, and straightening and cutting means beyond the driving rolls to straighten the colored tubing and cut the tubing into lengths.

7. Apparatus as claimed in claim 6 in which the coating means comprises an enclosure having an inlet at one end and an outlet at the other in linear alignment with the line of travel of the tubing during formation and galvanizing and means within the enclosure for the application of color coating composition onto the tubing during passage through the enclosure.

8. An apparatus as claimed in claim 6 in which the peripheral surface portions of the rolls in engagement with the tubing are formed of a plastic or rubber-like material.

9. Apparatus as claimed in claim 6 which includes a drying chamber in advance of the coating means to dry the zinc galvanize coat before application of the color coating.

10. Apparatus as claimed in claim 6 which includes a cooling chamber intermediate the heating chamber and pulling rollers in which the chamber has an inlet at one end and an outlet at the other in linear alignment with the line of travel of the tubing for passage of the tubing through the cooling chamber and means for water cooling the tubing during passage through the cooling chamber.

11. Apparatus as claimed in claim 10 which includes a blower interposed between the cooling chamber and the heating chamber for directing a stream of air upstream into the inlet to the water cooling chamber to prevent water from entering the heating chamber and for directing another stream of air downstream into the outlet of the heating chamber to provide circulation through the heating chamber for vaporization of the diluent and for carrying off diluent vapors from the chamber, and exhaust means in communication with the heating chamber for the removal of vapor and air from the chamber.

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