

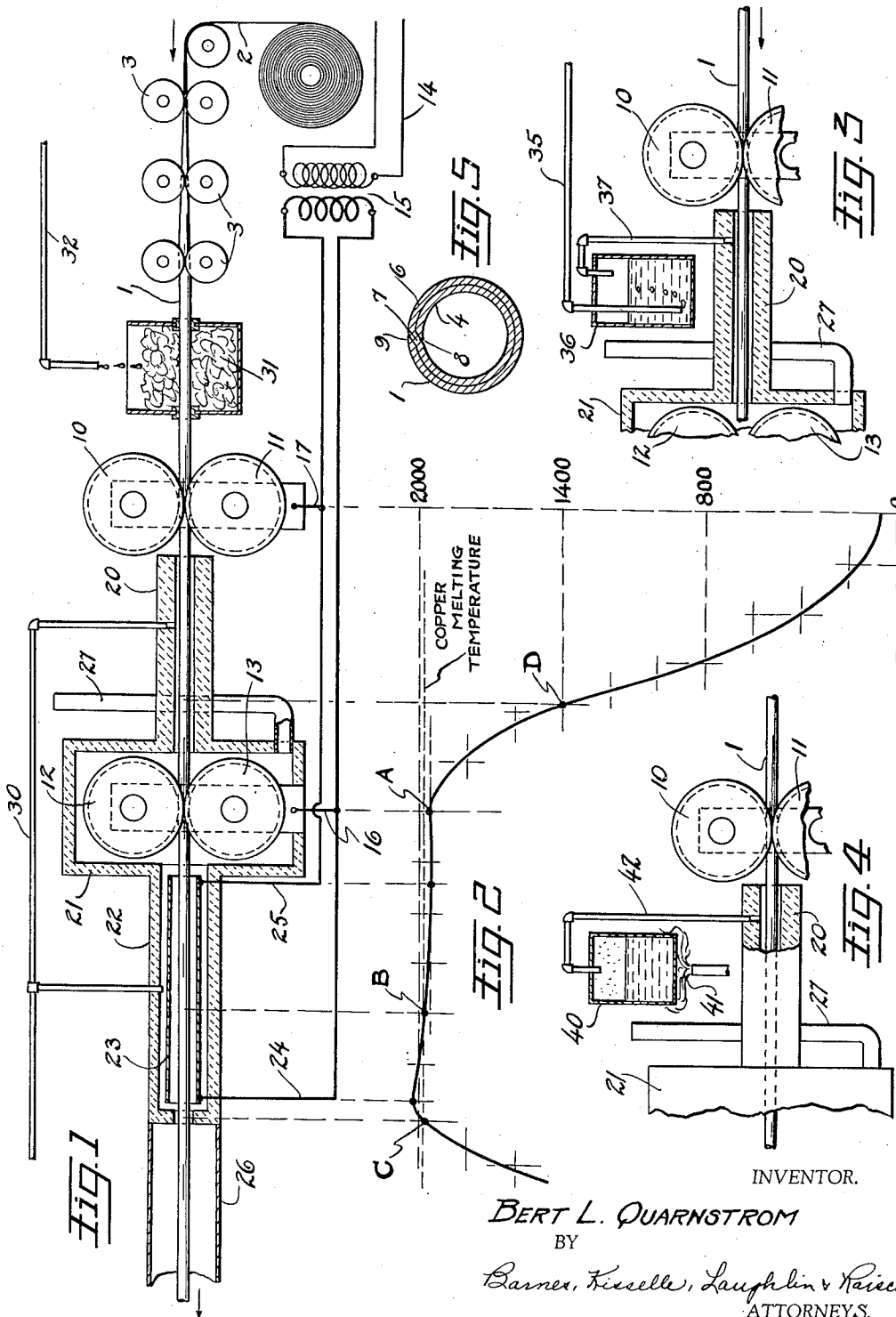
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TUBE MAKING AND COPPER COATING PROCESS

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TUBE MAKING AND COPPER COATING
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Bundy Tubing Company, Detroit, Mich., a cor-
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6 Claims. (Cl. 219-12)

This invention relates to a method of copper coating ferrous metal. The process is particularly adaptable to the making of tube fabricated from copper-coated ferrous strip stock having portions united together and the tube sealed by the use of a metal having a melting point lower than that of the strip stock. The invention is concerned with such a tube wherein the outside or inside surfaces of the tube, or both, are copper coated.

Reference is herein made to tube in giving the detailed disclosure of the invention. In the making of the tube, strip stock is preferably copper coated before being fashioned into tube and may be coated on either one or both sides. The tube may be made from one strip or from more than one strip and arranged to have overlapping parts to be copper welded together. The invention is directed toward the heating of the tube to render the copper molten so that upon cooling the overlapping parts are welded together. This is sometimes termed "copper welding" and sometimes termed "copper brazing". The invention is concerned also with the preservation of the copper coating on the strip, to the end that the finished tube is copper coated.

In accordance with the invention two ways of heating the tube are employed. First the tube is preheated by electrical resistance, wherein electric current is passed through the tube, the tube acting as a resistance element whereby it is heated. This preheating of the tube is carried up to a point which is below the melting point of copper. Immediately after the preheating of the tube by electrical resistance the same is further heated in a furnace. This method may be utilized where long lengths of tube are moved lengthwise, so that successive sections are preheated by electrical resistance and then heated to copper melting temperature or above in a furnace, and this makes it possible to move the tube rapidly, and at the speed of a tube making machine, resulting in a large increase in the rate of production.

The invention may be employed for affixing copper coating to long lengths of ferrous metal, whether in ribbon form or wire form, or the like. For instance, the copper coating may be originally electroplated on to the strip or wire or the stock from which the tube is made, and when the same is heated or rendered molten it alloys with the underlying ferrous metal, with the result that the coating is securely affixed thereto. Accordingly, the wire or ribbon of copper coated ferrous metal may be treated in ac-

cordance with the present invention by first preheating it by electrical resistance and then adding more heat in a furnace to melt the copper. The copper coating is retained on the stock and is intact when cooled in the same manner as it is on the tube, but of course, in such a method there is no copper welding of ferrous portions together.

In the accompanying drawing:

Fig. 1 is a diagrammatic illustration of the method showing certain apparatus which may be used in carrying out the same.

Fig. 2 shows the temperature curve.

Fig. 3 is a partial view illustrating another form or variation of the method.

Fig. 4 is a partial view of an apparatus which may be used in another modification of the method.

Fig. 5 is a cross-sectional view of a tube which may be made in accordance with the invention.

It will be appreciated that various tube structures can be made such as tube having single ply walls or double ply walls, there preferably being overlapping parts to be copper welded together. One form of tube is shown at 1 made from copper-coated steel stock 2 which is run through a suitable tube forming machine having tube forming rollers 3. Such machines are well known to those versed in the art and need not be further considered in detail herein.

One form of tube which is generally known in the trade as "Bundy" tube is shown in Fig. 5, and this tube is fashioned from a single strip of stock having double walls with an inner ply 4 and an outer ply 6, and an offset 7 in the stock against which the edges of the stock 8 and 9 substantially abut. This process may be used to make such a tube to copper weld the plies together, thus sealing the tube and retaining the copper coating on the exposed surfaces inside or outside of the tube, or both, intact, so that the finished tube is copper coated.

The tube forming machine is preferably lined up with the heating apparatus as illustrated in Fig. 1, so that the tube moves directly from the tube forming machine into the heating apparatus. The heating apparatus comprises electrodes 10 and 11, which may be rollers, through which the tube passes, and other electrodes which may be rollers 12 and 13. These electrodes may be of any desirable type such as dies or brushes. A primary of an electric power line is shown at 14 and a secondary of a transformer at 15, and the secondary circuit connects to the electrodes as at 16 and 17 so that when the tube bridges the

sets of electrodes the current passes therethrough and heats the same. The tube is preferably confined, while being heated, in a muffle 20 which connects into a housing 21 for covering the electrodes 12 and 13. This housing connects into a furnace 22, which is heated in any suitable manner, as for example, by electric heating elements which may be connected to a suitable source of electrical energy, as for example, the secondary circuit, as by means of wires 24 and 25. The heating element or elements may be a muffle 23 as shown. A cooler 26 extends from the furnace. The tube when moved lengthwise passes successively through the electrodes, the muffle, the housing 21, the furnace and the cooler. The closure may have a flue 27.

The temperature increases in the tube are indicated by the curve in Fig. 2. Here it will be noted that the temperature of the tube is increased by the electrical resistance to a point below copper melting temperature, which is 1983° F. The tube may reach this temperature substantially at the point A, which is on center with the axes of the electrodes 12 and 13. As the tube continues to move through the furnace, it is further heated and it may reach copper melting temperature substantially at the point B, and as it continues to move the temperature goes above copper melting temperature and then drops, reaching copper melting temperature at the point C.

The tube is preheated to a point below copper melting temperature by the direct application of the electrical current passing lengthwise through the tube, and the furnace 22 increases the temperature of the tube to melt the copper and effect the welding.

As the copper is thus rendered molten and then solidified, the plies or the overlapping parts of the tube are copper welded together. However, in order to preserve the coating and/or have the coating remain intact on the finished tube, the method contemplates the use of a non-oxidizing environment for the heated tube and also contemplates a deposition of carbon upon the tube preferably before the copper becomes molten. A suitable non-oxidizing or reducing gas may be fed into the muffle and the furnace by a pipe 30, as shown in Fig. 1. For the purpose of depositing a film of carbon upon exposed copper surfaces the tube may be passed through a mass of absorbent material 31, kept moistened by a suitable substance dripping thereinto from a supply line 32. This substance is one which decomposes in presence of the heat and deposits carbon upon the tube. Mineral oil may be used for this purpose, and vegetable oil or animal fat may be employed, preferably together with carbonaceous matter, the oil or fat acting as a vehicle therefor. As a result a film of the liquid is placed over the exterior surfaces of the tube prior to the tube entering the heating zone. In the presence of the heat the mineral oil decomposes into some of its various constituents and deposits a film of carbon upon the tube. For explanatory purposes, the decomposing may take place anywhere from the point D on the curve (Fig. 2) to the point B. In the case of vegetable oil or animal fats, they decompose and the carbonaceous material deposits a film of carbon upon the tube and some carbon may be derived from the decomposing of the fat or oil vehicle.

When the copper becomes molten it has a tendency to shift, flow or migrate on exposed surfaces. This is particularly true of the exterior

surfaces of the tube. Surfaces other than those located in a seam or between plies are herein termed exposed surfaces, whether they be on the inside or outside of the tube. The copper may collect in pools or spots, with the result that the ultimate copper coating may imperfect and may be spotty or present globules or other forms of copper concentrated at points, leaving other portions more or less bare. The presence of the carbon, however, prevents this. One possible explanation is that the presence of the carbon breaks down or minimizes the surface tension of the molten copper, so that the coating is maintained in a substantially smooth, uniform manner and is intact in the finished cooled tubing. This subject matter is gone into in more detail in my co-pending application, Serial No. 731,722, filed June 21, 1934.

Another form of the invention, so far as applying carbon to the tube is concerned, is that of introducing a gas into the muffle, which deposits a carbon film upon the tube. This is illustrated in Fig. 3, where a suitable gas, as illuminating gas, may be supplied through pipe 35 and bubbled through liquid, such as methanol, alcohol or a commercial grade of lacquer thinner retained in a container 36. The gas absorbs or evaporates some of the liquid and then is introduced into the muffle by the pipe 37. The absorbed or evaporated liquid provides sufficient carbon deposits when the gas decomposes.

A still further form is illustrated in Fig. 4, where a suitable oil in the container 40 is vaporized by heat, as for example, by a flame 41, and conducted into the furnace by a pipe 42. These gases or vapors, both the treated illuminating gas and the vaporized oil, may provide sufficient non-oxidizing or reducing conditions in the muffle and the housing, to the end that the separate reducing or non-oxidizing gas through pipe 30 need not be introduced into the muffle. Of course, the liquid material applied as shown in Fig. 1, provides a non-oxidizing or reducing environment, and a separate supply of non-oxidizing or reducing gas in this case may be dispensed with so far as introducing the same into the muffle is concerned.

The copper coating is not touched or contacted by an electrode while it is in a molten condition, and likewise where alternating current is used the molten copper is unaffected thereby. Accordingly, in carrying out the method whatever undesirable effects may be produced by electrodes contacting with molten copper, or alternating current forming interruptions in the molten copper, may be totally disregarded.

The combination of the invention secures new and beneficial results. By the preliminary heating of the product, by passing of electric current directly therethrough below the melting point of copper, and the subsequent passage through the heating zone, where the melting and welding is effected, defective welding is practically eliminated in the product. Scrap is also largely eliminated, the speed of production is increased as the passage through the heating zone is at the speed of operation of the tube forming machine, and the period of subjection to the heating zone or furnace and the size of the latter is largely decreased. In addition, and because of these factors, the cost of production is reduced without any sacrifice in the quality of the tubing.

In the making of tubing or other articles such as copper-coated wire or copper-coated strip,

the same may be annealed by passing the same through the cooler and the cooler may have the desired length for this purpose. While I have herein made reference to the process as regards coating and welding with copper, it is to be appreciated that the invention covers the coating and/or welding with cuprous metals such as various copper alloys, and where copper is mentioned in the claims the same is to be interpreted as covering such alloys. The term "overlapping" has been applied to parts which are to be welded together. This is to be construed to cover parts to abut or contact with each other, so as to be copper welded together. Where tubing is mentioned in the claims, it is to be understood that this term is meant to cover wire, strips or other shapes, such as molding or the like, except in those claims where characteristics of the treatment of the tubing are specifically incorporated.

I claim:

1. The method of affixing a copper coating to a long length of ferrous metal, which comprises passing a length of copper-coated metal lengthwise through electrodes whereby to pass an electrical current through successive sections of the length of metal, heating the metal by electrical resistance to a point somewhat below copper melting temperature and then passing the length of metal through a heating zone for additionally heating the metal to a point above copper melting temperature, whereby the molten copper alloys with the ferrous metal, and then cooling the metal with the copper coating intact.

2. The method of affixing copper coating to a length of ferrous metal, which comprises passing the length of copper-coated metal lengthwise through spaced electrodes while in a non-oxidizing atmosphere, passing electric current through successive sections of the length of metal to heat the same to a point somewhat below copper melting temperature, then passing the metal directly into a heating zone for additionally heating the metal to a point above copper melting temperature while in a non-oxidizing atmosphere, and then cooling the length of metal with the copper coating intact.

3. The method of making tube from copper-coated strip ferrous stock, which comprises fashioning the stock into tube form with overlapping parts, passing the tube lengthwise through spaced electrodes to heat successive sections to a temperature somewhat below copper melting temperature by electrical resistance, then passing the tube into a heating zone to additionally heat the same to a temperature above copper melting temperature.

4. The method of making tube from copper-coated strip ferrous stock, which comprises fashioning the stock into tube form with overlapping parts, passing the tube lengthwise through spaced electrodes to heat successive sections to a temperature somewhat below copper melting temperature by electrical resistance, then passing the tube into a heating zone to additionally heat the same to a temperature above copper melting temperature, and then cooling the tube to complete the copper weld of overlapping portions.

5. The method of making tubing from copper-coated strip ferrous stock, which comprises fashioning the stock into tubular form with overlapping parts, moving the tube lengthwise through spaced electrodes to heat successive portions of the tubing to a temperature somewhat below copper melting temperature while the tube is in a non-oxidizing atmosphere, passing the tube into a heating zone to additionally heat the same to a temperature above copper melting temperature while in a non-oxidizing atmosphere.

6. The method of making tubing from copper-coated strip ferrous stock, which comprises fashioning the stock into tubular form with overlapping parts, moving the tube lengthwise through spaced electrodes to heat successive portions of the tubing to a temperature somewhat below copper melting temperature while the tube is in a non-oxidizing atmosphere, passing the tube into a heating zone to additionally heat the same to a temperature above copper melting temperature while in a non-oxidizing atmosphere, and then cooling the tube while in a non-oxidizing atmosphere to complete the copper weld of overlapping parts and with the copper coating intact.

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