Oct. 1, 1940. B. L. QUARNSTROM 2,216,519

MAKING TUBING

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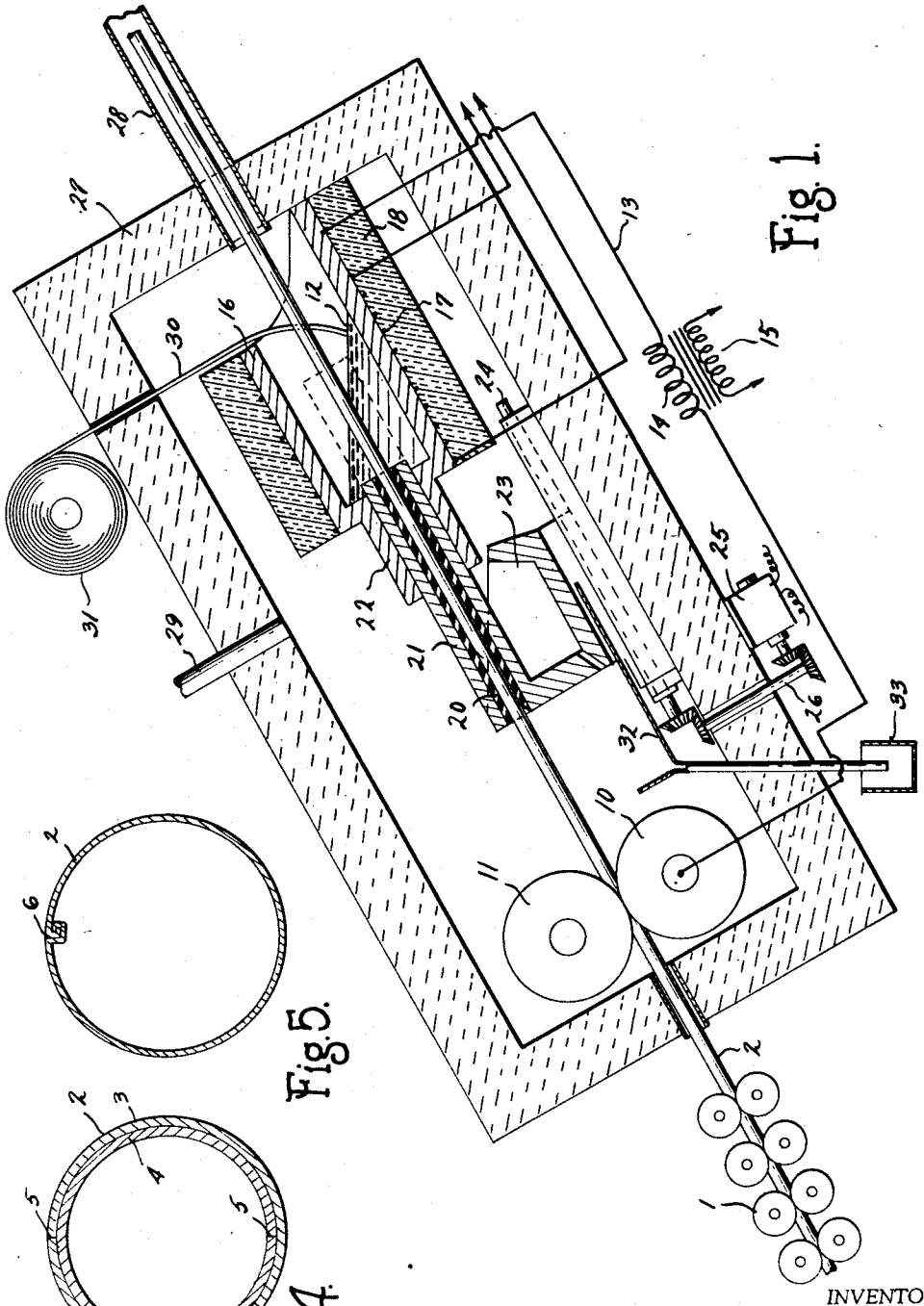



Fig. 1.




Fig. 5.




Fig. 4.

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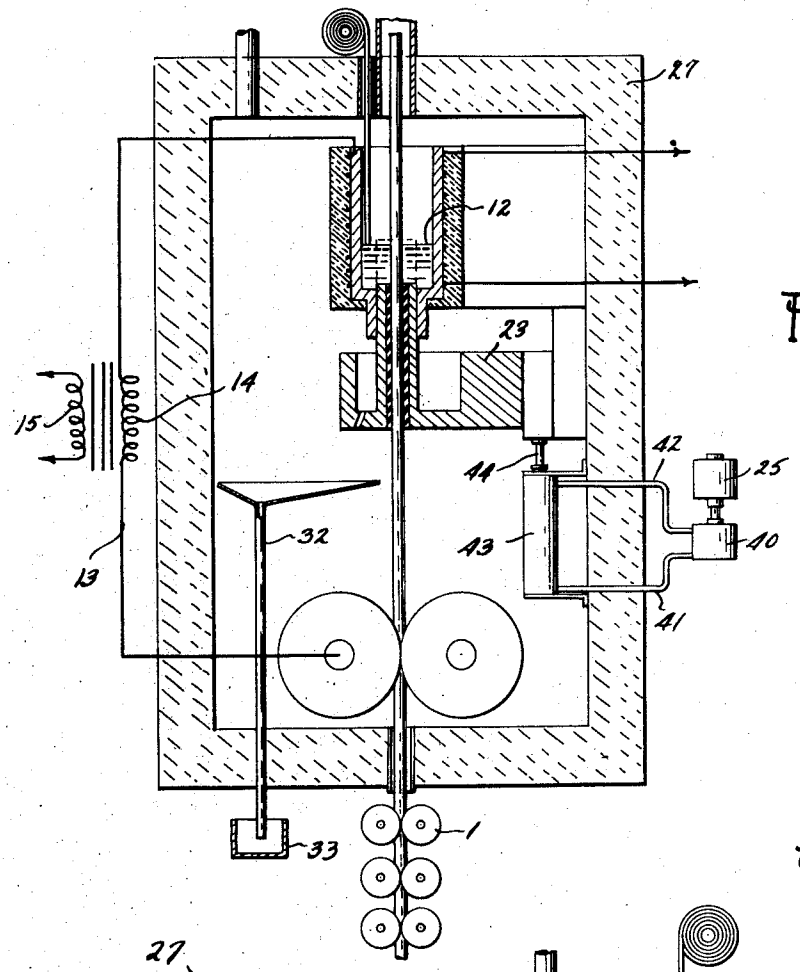



Fig. 2.

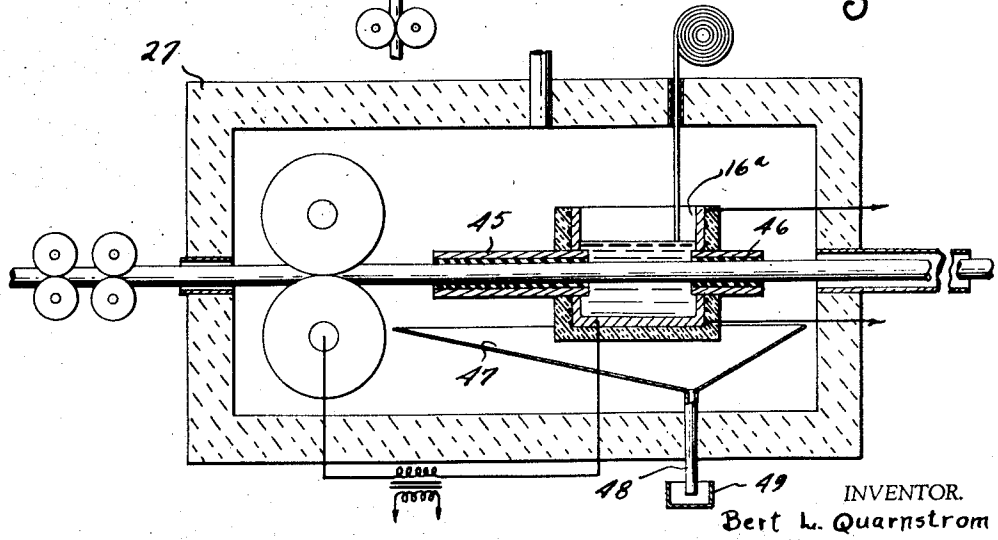



Fig. 3.

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# UNITED STATES PATENT OFFICE

2,216,519

## MAKING TUBING

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Application January 3, 1938, Serial No. 183,225

6 Claims. (Cl. 219—12)

This invention has to do with the making of tubing from strip stock, and it is concerned particularly with a method where an electrical current is passed lengthwise through the tube to seal the seam or seams, or to unite the plies and, if desired, to apply an exterior metallic coating to the tube.

In general, the invention aims to provide improvements in the method and apparatus where tube is passed with longitudinal movement through longitudinally spaced electrodes so that electrical current passes through and heats successive sections of the tube. At least one of the electrodes, and preferably the one which contacts with the tube where it is in a heated condition, is in the form of a bath of molten metal. This molten metal not only serves as an electrode but serves as well to supply the metal for sealing the tube and, where desired, to provide an exterior coating. Thus the molten metal electrode is in itself the sealing metal. In this way, the basic metal forming the tube may be bare or uncoated stock and the sealing metal or coating metal, or both, is derived from the metal which comprises one of the electrodes. Mechanical contact with the surface of the heated tube, by an electrode either in the form of a roller, shoe or otherwise, is eliminated, as there need be no surface contact with the tube as it emerges from the molten bath with the sealing metal in position in the seam or between the plies, and covering the surfaces of the tube as a coating. The process lends itself to a speedy operation, and the sealing and coating process may be carried out as the tube emerges from a tube mill.

Different metals may be used for the strip stock and for the sealing and coating metal. However, as specific examples, it may be pointed out that the strip stock for forming the tube may be of ferrous metal such as low carbon steel, and the sealing and coating metal may be any one of various metals such as copper, tin, zinc, lead, a lead and tin mixture commonly known as solder, or a mixture or alloy of any one of the above metals or other metals. The strip stock may be of copper or copper alloy, and the bath of molten metal may be tin, zinc, lead, or an alloy of these or similar metals, or a copper alloy for that matter, but preferably the molten metal which is used should have a melting point lower than that of metal forming the strip.

The method and apparatus are somewhat diagrammatically illustrated in the accompanying drawings.

Fig. 1 is a view illustrating one form of apparatus for making the tubing, the arrangement being that the tube moves in an upwardly inclined direction.

Fig. 2 is a view showing an arrangement where the tube moves vertically.

Fig. 3 is a view illustrating the arrangement of an apparatus for moving the tube horizontally.

Figs. 4 and 5 are cross sectional views taken through tubes of different types and illustrating different forms of tubes which can be made of this method.

In Fig. 1 a tube mill is generally illustrated having rollers 1, this tube mill being of the type generally known to those versed in the art. The tube mill may form a tube of the type illustrated in Fig. 4, which is formed of two strips of stock fashioned with an outer ply 3 and an inner ply 4, each with a seam structure generally illustrated at 5. On the other hand tubes of other types may be made such as the tube illustrated in Fig. 5 which is of single ply construction with a so-called lock seam 6. Both tubes are generally illustrated at 2. These two forms of tubes are shown merely as examples of different forms of tubes which can be made by the process, it being understood that there are quite a number of different types of seams and different ways of making single and double ply tubing.

The tubing may be passed directly into the sealing unit as it passes from the tube mill as illustrated in Fig. 1, although it is within the invention to cut the tubing which passes out of the tube mill into lengths, and to pass the lengths at a later time, through the sealing unit. There is an electrode 10 in the form of a roller which first engages the tube, and the tube may be held against the electrode by a roller 11. The other electrode is in the form of a bath of molten metal 12. A conductor for conducting electrical current to the two electrodes as illustrated at 13, this conductor being connected to the secondary coil 14 of a transformer having a primary coil 15. The transformer is arranged to give the proper type of current which is usually of low voltage and high amperage.

The molten metal is preferably retained in a metallic receptacle 16 which may be heated electrically to keep the metal in a molten condition, as for example, by electrical resistance elements 17. The receptacle may be retained in a heat insulating substance 18.

The tube enters the molten metal by passing through an inlet device of tubular form and of such internal diameter as to rather snugly fit the tube. This inlet device is preferably lined

with a non-conducting material 20 for relatively snugly fitting the tube and is supported by an exterior protection 21 which slidably fits in a projection 22 on the receptacle 16. The part 21 may be carried by a bracket 23 mounted for sliding movement in the direction of the extent of the tube. This may be done by a screw threaded shaft 24 driven through the means of a motor 25 connected to the shaft through the several connections shown at 26. The electrodes may be located within a housing 27 connected to which is a cooler 28 and through which the tube passes as it emerges from the bath. A suitable non-oxidizing or reducing gas may be maintained within the housing 27 where the metals employed are such as to require such an atmosphere to avoid oxidization, and this gas may be introduced through the inlet 29. The mass of molten metal may be maintained at a proper level by feeding metal into the same, as for example, by running a wire 30 of the metal into the bath from a supply coil 31. If any of the molten metal should escape between the parts 21 and 22, it may flow into the drain 32 and be collected in a suitable vessel 33.

When the device is out of operation the motor 25 may be operated to shift the sleeve 20—21 to a position where its upper end is above the level of the molten metal in the vessel 16. This position of the sleeve 20—21 is shown by dotted lines in Fig. 1.

In use, the sleeve 20—21 may be positioned substantially as illustrated in Fig. 1 and as the finished tube leaves the tube mill it is heated by electrical resistance due to the current passing lengthwise through the tube between the electrodes 10 and 12. The molten metal thus serves as one electrode. At the same time this molten metal flows into the seam so that upon being cooled the seam is sealed. With the form of tube shown in Fig. 4 the molten metal may not only flow into the outer seam 5 but the process may be so timed that the metal may flow in between the plies 3 and 4 so as to seal the plies together substantially throughout the contiguous surfaces and to seal the inner seam. As the tube emerges from the molten bath it passes into the cooler 28 so that the metals are sufficiently cooled prior to being introduced into the atmosphere to prevent the formation of deleterious oxides. Of course, the temperatures used may vary, depending upon what metals are employed. For example, where copper is the molten metal the temperature will have to be high enough to melt the same, but if a lower melting point metal is used, lower temperatures may be employed.

In this manner, the tube is heated prior to being introduced into the molten metal so that it is conditioned by the preheating to properly receive the metal for soldering, tinning or brazing purposes as the case may be. The tube passes through the molten metal without substantial friction and without mechanical contact with the hot tube; that is to say, mechanical from the standpoint of an electrode in the form of a roller or shoe contacting with the hot tube or molten coating. Thus where a coating is applied to the tube it is not rendered rough or imperfect or defective by mechanical contact therewith. Nothing touches the tube on its exterior surface after it becomes heated until it has passed out of the cooler and the the coating metal is solidified. The electrode 10 and the opposing roller 11 engage the tube at a point where it is relatively cold so that there is no difficulty with mechanical contact at this point. By disposing the apparatus so that the tube extends angularly upwardly, the vessel 16 may be disposed at an angle and this permits of the sleeve 20—21 to act as a valve as above described.

The variation shown in Fig. 2 embodies generally the same parts and the reference characters applied above are applied to corresponding parts in this form, and thus duplication of description is avoided. A further variation shown in this view is that of moving the sleeve structure 21 hydraulically. The motor 25 is connected to a hydraulic pump 40 which is in turn connected by tube lines 41 and 42 to opposite ends of a cylinder 43 having a piston therein (not shown). A piston rod 44 connects to the bracket 23. Of course, it is to be understood that this hydraulic shifting arrangement may be used in the inclined form shown in Fig. 1, and the screw threaded rod arrangement may be used with the vertical form shown in Fig. 2.

A horizontal arrangement is shown in Fig. 3, and here again the same reference characters are applied to similar parts. In this form the vessel 16a has a closed bottom and the tube enters and leaves the same through an inlet 45 and an outlet 46, and any metal which escapes falls into the drain 47 and is conducted out of the chamber 27 by a tube 48 where the metal may be collected in a vessel 49.

In accordance with this invention, it is preferred that the tube immediately pass into the sealing and coating apparatus as it leaves the tube mill. The tube mill passes the tube at a relatively high speed, and due to the fact that the tube is heated by electrical resistance it may be brought up to a proper temperature for receiving the molten metal while it is moving at this high speed. In this regard the distance between the first electrode and the molten metal electrode may be lengthened or shortened, and also the heating current may be varied as to voltage or amperage to obtain the desired preheating action on the tube. The reducing atmosphere functions to reduce oxides on the tube where this is necessary, and to prevent formation of oxides, and in this sense functions as a so-called flux. With some metals an arrangement may be used for applying a flux to a tube rather than maintaining the tube in a non-oxidizing or reducing atmosphere. In either case, the tube may be said to be in a non-oxidizing or reducing environment.

I claim:

1. In the method of making tubing fashioned from strip metal stock, the steps of moving the tubing longitudinally through a bath of molten metal which flows into the seam of the tube, passing an electrical current through the molten metal, across the contact between the molten metal and the tube, and through successive sections of the tube as the sections approach the molten metal bath to heat the tube preparatory to the reception of the molten metal in the bath, and then cooling the tube to seal the seam.

2. In the method of making tubing fashioned from strip metal stock, the steps of maintaining a body of sealing and coating metal in a molten condition, connecting the body of molten metal in an electrical circuit, passing the tube lengthwise through the bath of molten metal, establishing an electrical contact with the moving tube at a point spaced lengthwise of the tube and in advance of the bath of molten metal whereby a circuit is completed by successive sections of the moving tube with the molten metal serving as

an electrode, and passing an electrical current through the bath and successive sections of the tube for heating the successive sections prior to passage through the molten metal for sealing the seam and coating the tube, and then cooling the tube to solidify the molten metal.

3. In the method of making tubing fashioned from strip metal stock, the steps of maintaining a body of sealing and coating metal in a molten condition, connecting the body of molten metal in an electrical circuit, passing the tube lengthwise through the bath of molten metal with a straight line movement and with the tube contacting only with the molten metal while in the bath, establishing an electrical contact mechanically with the moving tube at a point spaced lengthwise of the tube and in advance of the bath of molten metal whereby the circuit is completed by successive sections of the moving tube, passing an electrical current through the bath and successive sections of the tube for heating the successive sections prior to passage through the molten metal for sealing the seam and coating the tube, cooling the tube and maintaining a non-oxidizing environment around the tube during the heating thereof, during its passage through the bath and during the cooling until the molten metal is solidified.

4. An apparatus for sealing the seam of a tube fashioned from strip stock and for coating the exterior surfaces of the tube comprising, a bath of molten sealing and coating metal, means for passing the tube through the bath, an electrode contacting with the tube at a point in advance of the bath of molten metal, and means providing a circuit for an electrical current for heating successive sections of the tube prior to passage through the bath comprising electrical conductors in electrical connection with the bath of molten metal and the electrode.

5. An apparatus for sealing the seam of a tube fashioned from strip stock and for coating the exterior surfaces of the tube comprising, a bath of molten sealing and coating metal, means for passing the tube therethrough including an entrance for the tube located below the level of the molten metal, an electrode contacting with the tube at a point in advance of the bath of molten metal, means providing a circuit for an electrical current for heating successive sections of the tube prior to passage through the bath comprising electrical conductors in electrical connection with the bath of molten metal and the electrode, a chamber surrounding the bath of molten metal, a cooler into which the tube moves as it emerges from the bath of molten metal, and means for maintaining a non-oxidizing environment in the chamber and cooler.

6. An apparatus for coating the exterior surface of a tube comprising, a bath of molten coating metal, means for passing a tube with lengthwise movement through the same, an electrode positioned to contact with the tube in advance of the bath of molten metal, means providing a circuit for an electrical current for heating successive sections of the tubing by electrical resistance prior to passage through the bath of molten metal comprising conductors having an electrical connection with the electrode and with the molten metal bath.

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