United States Patent Office 3,001,889 Patented Sept. 26, 1961

3,001,889

METHOD AND APPARATUS FOR APPLYING METAL COATINGS TO THE INNER SURFACES OF METAL TUBES

Myron L. Robinson, Monterey Park, Calif., assignor to Phelps Dodge Copper Products Corporation, New York, N.Y., a corporation of Delaware

Filed Feb. 23, 1960, Ser. No. 10,420
14 Claims. (Cl. 117—51)

This invention relates to the application of metallic coatings to the inner surface of metallic tubular products, and relates more particularly to an improved method and apparatus for this purpose.

For illustrative purposes, the invention will be described in connection with the application of a coating of tin or tin-lead alloy to the interior of copper or copper-base alloy tubes furnished in long coiled lengths. However, the invention is also useful for interiorly coating any metal tube with a coating of metal whose melting point is substantially lower than that of the tube metal and which when molten is capable of wetting a suitably fluxed surface of the tube metal to which it is applied. Metals having low melting points commonly used in this application are: Tin, lead, tin-lead alloys, zinc, and aluminum, the last two named metals being intended for coating steel tubular products.

Copper and copper-base alloy tubes are used extensively for plumbing and for carrying gases and oils used as fuels. In some areas, the water is highly corrosive to copper and its alloys, forming metallic salts which often result in a coloring of the water and forming what is commonly described as "green water." This corrosive action eventually leads to failure of the tube by perforation of the tube wall, and it is quite often more noticeable in installations such as domestic buildings where the water flow is intermittent. Certain gases and oils used for fuel contain hydrogen sulphides and organic sulphur compounds which will form copper sulphide when in contact with copper. The copper sulphide is not formed as a tenacious or continuous film on the corroded copper. It breaks off as fine particles from the corroded base metal and is carried along by the fluid.

The "green water" problem in water lines and formation of non-adherent copper sulphide in gas and oil lines made of copper have been deterrents to the successful use of bare copper tubes for conveying the fluids, where these corrosive conditions are known to exist. In gas or oil lines, some of the hazards due to the presence of nonadherent particles of copper sulphide are:

(1) Contamination of the fluid with the loose copper sulphide particles which lodge or accumulate at some point in the line and thereby restrict the flow of the fluid.

(2) Collecting of particles at, and resultant jamming of, delicate control mechanisms on fuel lines, such as thermostatically operated valves on appliances and pilot controls on gas handling systems, causing either interrupted flow or diverging of the flow of the potentially explosive fluids into areas where a destructive explosion may be set off.

(3) Ultimate failure by corrosion of unprotected copper tube.

It is well known to those versed in the art that copper and copper-base alloy products coated with a tin or a tin-lead alloy are substantially impervious to the type of corrosive attack described above.

The coating of short straight lengths of tubes with tin or tin-lead alloys by hot-dipping or by electroplating methods is well known in the art. Coating of the inner surface of tubular products by this method, however, has been limited to straight tubes of comparatively large diameter in lengths generally not in excess of 30 feet, and the present methods used for the deposition of metallic coatings on the inner surfaces of tubes are generally so costly as to preclude their use for coating tubes whose length exceeds 30 feet.

It is an object of this invention to provide an improved apparatus and method for applying, with a measure of control over thickness, a continuous and adherent coating of metal economically on the inner surface of tubular products in coils or other shape, without coating the outer surface or substantially changing the condition of the base metal. As an example, by this invention the inner surface of coiled tubes with bore diameters as small as 1/16 inch and 1/8 inch and lengths exceeding 50 feet and 200 feet, respectively, have been successfully coated. The maximum bore size and length limit have not been established, but bore sizes in excess of 1½ inches and lengths over 1,000 feet seem practical with the apparatus of suitable capacity.

During the coating of copper and copper-base alloys by continuous hot dipping in a tin bath, an undesirable feature is that copper is dissolved in the molten tin bath, and the increasing concentration of dissolved copper in the molten bath causes an undesirable increase in the temperature required to keep the bath molten and results in the formation of a drossy waste sludge high in tin content on top of the bath. This drossy sludge requires costly reprocessing to reclaim its tin content.

It is also an object of the invention to provide a method and apparatus for bringing a controlled amount of molten tin in contact with the interior surface of a copper or copper-base alloy tube under conditions which practically eliminate the expensive drossy waste by-product normally associated with continuous hot-dip tin coating operations.

In the method according to the present invention, a coiled length of the tube is inserted in a heating chamber where it is pre-heated to a temperature at least as high as the melting point of the metal to be coated on the interior surface of the tube. A mass of the coating metal is maintained in molten condition, preferably by subjecting it to the heat in the heating chamber; and from this mass is withdrawn a slug of molten metal in excess of the quantity required to coat the interior surface of the tube. A wiper is inserted in the tube, and the slug of molten metal preceded by the wiper and in contact therewith is blown through the tube in the chamber while the tube is at substantially the temperature to which it was preheated. In this way, a film of the coating metal is deposited over the interior surface of the tube. Preferably, the wiper is saturated with a flux before it is inserted in the tube, and the wiper and excess molten metal are blown from the tube into the molten mass of coating metal, the slug of molten metal for each coating operation being withdrawn from near the bottom of the mass of molten metal. For more reliable results, the interior surface of the tube is cleaned and fluxed before blowing the wiper and molten metal through the tube, and a second wiper is blown through the tube after blowing the first wiper and slug therethrough, so as to smooth out the deposited film of coating metal. The tube may then be further treated by passing a washing fluid and then a drying medium through it.

An apparatus made according to the invention comprises an oven forming a heating chamber for receiving a coiled length of the tube to be coated interiorly, means for heating the chamber to a temperature at least as high as the melting point of the coating metal, and a container for storing a supply of molten coating metal. This container may be located in the oven so that the aforesaid