

UNITED STATES PATENT OFFICE

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MANUFACTURING PROCESS

No Drawing.

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This invention relates to a manufacturing process or to a process of coating the interior surface of a conduit with a material having different properties and more specifically to provide a method of coating the interior surface of a metal conduit which has been cut and prepared for use in refrigerating apparatus.

The principal object of this invention is to provide a method of coating the interior surface of a conduit with a material having different properties and more specifically to provide a method of coating the interior surface of a metal conduit with a metal having different properties.

A second object is to provide a method whereby the interior surface of copper tubing of relatively small diameter may be coated with a metal such as tin and more specifically to apply this coating to the tubing in assembled form.

A further object of this invention is to provide a method whereby a metal tube may be coated evenly and smoothly and more specifically to provide a method whereby this coating may be applied evenly and smoothly to the tubing in assembled form ready for use in refrigerating apparatus.

Further objects of this invention will be apparent from the following description of one method in which this process may be practiced.

In its broad aspect, this invention contemplates the coating of the inner surface of a conduit with a material having different properties by treating the said surface with the material in finely divided form, and heating the surface so treated, to a temperature sufficient to cause the material to melt and adhere to the said surface.

In a more limited aspect this invention contemplates the coating of the interior surface of a conduit or tube with a second metal by treating the said surface with a flux, carrying suspended therein in finely divided form, the metal to be applied, removing the excess flux and heating the conduit or tube to a temperature sufficient to melt the finely divided metal and cause the

same to adhere to the inner surface of the conduit.

In a still more limited aspect this invention contemplates the coating of the interior surface of a copper tube with a metal such as tin by treating the said surface with a flux, carrying suspended therein the tin in powdered form, removing the excess flux and subjecting the tube to a high temperature while slowly rotating the tube so as to cause the suspended tin to melt and adhere to the inner surface of the copper tubing.

A convenient manner of illustrating this process may be by setting forth the operations necessary to coat the interior surface of a copper coil. This coil may be $\frac{3}{8}$ inch copper tubing made up into a coil $6\frac{1}{2}$ inches in diameter and comprising approximately 20 turns. Hereinafter such a structure will be referred to as "the coil" although it is to be understood that such is taken merely for illustrative purposes only and in no limiting sense whatever for obviously the process is applicable to tubing of other size and shape.

In describing such a process the steps or operations will first be set forth generally and thereafter the individual operations will be separately and fully described.

The coil is first cleaned and this cleaning operation may comprise an alkali wash, a thorough rinsing in water, an acid wash and a second rinsing in water. The coil is then ready to be tinned, which may be accomplished by circulating through the coil, either by pumping or suction action, a physical solution of pure tin suspended in finely divided form in a flux, for example, a solution of ammonium chloride and zinc chloride in water. After removing the excess of this solution preferably by suction action, the coil may be heated to approximately 600° F. to 630° F. for 20 minutes to melt the finely divided tin, during which time the coil may be slowly rotated. Thereafter the coil may be quenched in water and it is only necessary to then remove the zinc oxide or other foreign matter deposited inside of the tube from the flux. This may be accomplished

by circulating warm water therethrough. Blowing out and drying the tube completes the inside tinning thereof.

Referring now more specifically to the details of the individual steps, the cleaning operation as heretofore stated may comprise an alkali wash and an acid wash. For an alkali wash the coil may be treated with a boiling solution of sodium triphosphate and caustic soda (4 oz. of Na_3PO_4 plus 2 oz. NAOH per gal. of water). This solution may be pumped through the coil for five minutes at the rate of about 5 gal. per minute. The coil may then be rinsed with hot water for 2 minutes. The acid wash may be effectively accomplished by circulating a hot (150° F.) acid solution through the coil for 5 minutes at the rate of 2 to 3 gal. per minute. This solution may comprise 20% sulphuric acid plus 2 oz. of sodium dichromate per gallon of H_2O . Finally the coil may be rinsed a second time by circulating cold water therethrough for 2 minutes.

Although but one alkali cleaner and one acid cleaner have been set forth, it is obvious that others may be used. For example, a suitable alkali cleaner may comprise a boiling solution of 50 lbs. per 100 gal. of water of the following mixture: about 55% trisodium phosphate, 10% caustic soda, and 35% sodium carbonate. An alternative acid wash may comprise a solution of 1 gallon sulphuric, .3 gallons nitric and 1 c. c. hydrochloric acids in .6 gallons of water, operated at about room temperature. It is also sometimes advisable to treat the coil with a cyanide solution comprising 37½ lbs. of sodium cyanide per 100 gallons of water. However, if the phosphate cleaner and the acid solution of sulphuric acid and dichromate are used as set forth above, it is generally unnecessary to use the cyanide wash.

The coil is now ready to be tinned and although any one of several solutions carrying suspended therein the finely divided tin may be used, the following is preferred:

Ammonia chloride	6 grams
Zinc chloride	75 grams
Water	100 CC.
Pure tin powder	200 grams (M. P. 449° F.) (150 mesh)

Other tinning solutions may be used such as a mixture of lard oil, ammonia chloride and powdered tin with or without the addition of zinc chloride. Another solution may comprise a mixture of zinc chloride, ammonium chloride, ethyl and butyl alcohols, powdered tin and water.

In applying the solution to the interior surface of the tube, the coil may first be mounted on a shaft passing longitudinally therethrough and adapted to be placed in a frame for rotating movement during the heating and quenching operations. The coil may then be held upright with its dead end on top and the tin solution may be circulated through the coil either by pumping or

suction action from the bottom at the rate of one to two gallons per minute for about three or four minutes. By "dead end" is meant that end at which, due to the rotating action of the coil, the metal does not flow out during the tinning operation. Then the position of the coil may be reversed, that is, with the dead end placed on the bottom and the excess of the solution may be sucked out of the coil. The dead end of the coil should then be coated with some paste of tin powder and flux. After the coil has been so treated with the tin solution, it should be kept on its side and preferably mounted in a frame until ready for the heat treatment in order to prevent washing or too much draining of the tin solution.

The coil together with the frame on which it has been mounted for rotary motion may then be placed in a furnace in a horizontal position and the coil slowly rotated at about 2 R. P. M. while it is being heated to approximately 600 to 630° F. for approximately 20 minutes sufficient to cause the tin to melt and to adhere to the surface of the coil. At the end of the heating period the coil may be removed from the furnace, continuing the revolving and quenched in water. This gives a bright smooth coating of tin.

It may now be necessary to remove zinc oxide deposited inside of the coil from the flux and this may be accomplished by circulating therethrough warm water. Blowing out and drying the tubing completes the inside tinning operation.

While I have described the process as applied to the tinning of the interior surface of a copper tubing or coil it will be obvious that substantially the same process may be practiced in applying other materials to other tubes, and that modifications may be adopted, all falling within the scope of the appended claims.

What is claimed is as follows:

1. The process of tinning the inner surface of a copper tube which comprises slushing the said surface with a flux containing finely divided tin suspended therein, removing the excess of flux, heating the so treated tube to a temperature sufficient to melt the finely divided tin, slowly rotating the tubing during the heating operation and removing the excess flux from the tubing substantially in the manner described.

2. The process of tinning the interior surface of a copper tube comprising washing and cleaning the said surface, applying thereto by slushing, a flux solution containing suspended therein finely divided powdered tin, heating the tube to substantially 600° F., slowly rotating the tube during the heating operation, quenching the heated tube and removing the excess of flux and foreign material substantially as and in the manner set forth.

3. The process of tinning the inside surface of a copper tubing made up into the form of a coil which comprises slushing the said surface with a flux containing suspended therein the tin in finely divided powdered form, and heating the said coil to approximately 600-630° F. while slowly rotating the coil. 70
4. The process of tinning the inside surface of a copper tube which comprises slushing the inside of the tube with a flux containing suspended therein tin in finely divided powdered form, heating the tube to a temperature sufficient to melt the powdered tin, slowly rotating the tube during the heating operation, and removing the excess foreign material substantially in the manner described. 75
5. That improvement in the art of tinning the inside surface of a copper tube having applied thereto a flux carrying suspended therein, tin in finely divided powdered form, which comprises heating the tube to substantially 600-630° F. for a period of time sufficient to melt the powdered tin and slowly rotating the said tube during the heating operation substantially as and in the manner described. 80
6. The method of coating the inside surface of a metal tube with a metal having different properties which comprises cleaning the said surface, slushing the said surface with a flux containing the metal to be applied suspended in finely divided powdered form, removing the excess flux, heating the tube to a temperature sufficient to melt the suspended metal, slowly rotating the tube during the heating operation, quenching the heated tube in cold water, and removing the excess foreign material substantially as and in the manner set forth. 85
7. That improvement in the art of lining a metal conduit with a second metal which comprises slushing the conduit with a flux containing suspended therein a metal in finely divided powdered form and heating the said conduit to a temperature of substantially 600-630° F. 90
8. That improvement in the art of lining a metal conduit with a second metal which comprises slushing the conduit with a flux containing the metal in finely divided powdered form, slowly rotating the said conduit, and heating the said conduit to a temperature of substantially 600-630° F. as described. 95
9. A method of lining a metal conduit comprising, applying to the inner side of the conduit a flux containing suspended therein a metal to be applied, in finely divided powdered form, heating the conduit to melt the suspended metal, rotating the conduit to evenly apply the lining, quenching and cooling the heated conduit and re- 100
- moving the excess foreign material from the lined conduit substantially as described. 105
- In testimony whereof we hereto affix our signatures. 110
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