COATED WIRE AND METHOD

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ABSTRACT

This invention is directed to a method of coating copper with a flexible borate glaze and the product obtained thereby.

3 Claims, 2 Drawing Figures
COATED WIRE AND METHOD

BACKGROUND OF THE DISCLOSURE

1. Field of the Invention
We have discovered a method for coating a copper product, particularly such products as tape, wire, and sheet, with a flexible, adherent, electrically-resistant borate glass. The resultant products are useful in those applications where very thin, medium-resistant insulation is required, such as selenoid windings on travelling wave tubes or windings for transformers. 2. Description of the Prior Art
The borate coating of copper by plunging hot parts of copper into a borax solution is a well-known technique and is employed in Housekeeper seals for radar tubes. The adherent coatings thus obtained, however, have not always been uniform.

SUMMARY OF THE INVENTION
We have discovered that by passing a red hot copper part such as tape, sheeting, wire or copper pieces through a vapor phase consisting essentially of steam, sodium borate and sufficient oxygen to convert the surface layer of copper to CuO and then passing the vapor-coated copper part when it is near a dull red heat into a solution of sodium borate, the copper part is coated with a flexible borate glass insulation of outstanding adhesiveness.

BRIEF DESCRIPTION OF THE DRAWING
FIG. 1 is a partial schematic view diagrammatically illustrating our method of applying a borate coating to copper.
FIG. 2 is a top view of the structural arrangement of FIG. 1 in partial cross-section illustrating the relative arrangement of the heating elements in relation to the vapor coating chamber.

DESCRIPTION OF THE PREFERRED EMBODIMENTS
As illustrated in FIG. 1, copper tape 10 is drawn from reel 8 over pulley 9 and through restricted opening 11 downwardly through quartz tube 12. Quartz tube 12 is preferably made from transparent quartz because it does not absorb the infrared energy from glowing heated wires 15. Wires 15 are supported by ceramic wire carrier 22. As shown in FIG. 1, tube 12 is positioned in a pair of furnaces 13 and 14 through concentric openings 16, 17, and 18. Heating wires 15 are arranged in the furnace to provide sufficient heat in order to bring the copper to a red hot temperature, e.g., approximately 850° C to about 900° C, in furnaces 13 and 14 before entry into saturated borax solution 19 in tank 20. Bottom end 21 of quartz tube 12 is critically situated above the level of solution 19 at a distance which, combined with the constriction in slot 11, results in a deficient oxygen concentration within the tube. The reduced oxygen content allows the copper surface to oxidize to CuO. It is important to prevent the copper from oxidizing to CuO because this greatly impairs the adhesion of the resultant borate coating.

Although FIG. 1 illustrates an embodiment of this invention utilizing two furnaces end on end, other furnace arrangements may be utilized provided they are capable of heating the copper in a short distance to red hot temperature in an atmosphere of steam, entrained sodium borate, and deficient oxygen. Due to the heat transfer property of copper, it is approximately at a dull red heat when it is quenched in solution 19. In addition, the manner for passing the copper through the zone will vary depending upon the nature of the product. Unless it is intended to change the length and shape of the product, heating and pulling of the copper must be controlled so that the copper does not reach the softening point. Otherwise, it will be torn under stress.

Since the tape enters solution 19 at least at a dull red heat, it causes some vaporization of the solution to take place. As a result, quartz tube 12 eventually has a vapor consisting essentially of steam and entrained sodium borate and as previously noted, a deficient oxygen supply. After the copper surface is oxidized to CuO, it reacts with the entrained sodium borate to form borate glass, having an approximate formula of CuO·Na2B4O7. This glass coating is increased as the copper passes through the saturated borax solution 19.

The treated copper is drawn through borax solution 19 over pulleys 24, 25, and 26 by means not shown, passed through a spray rinse (not shown) and wiped dry (not shown). The thickness of the coating on the wire, tape, etc., will be on the order of 0.1 mil to about 0.2 mil after a single path through the furnace and solution. If needed, the thickness can be increased by multiple passes.

FIG. 2 shows the relative arrangements of restricted opening 11, quartz tube 12, upper furnace 13, ceramic wire carrier 22, heater wires 15, and lead 23.
The size of restricted opening 11 and the diameter of quartz tube 12 will vary somewhat, primarily depending upon the shape of the copper piece being treated.
The opening should be large enough to allow the copper piece to slide through with ease and narrow enough to prevent an effective chimney effect from sweeping through the length of quartz tube 12. This is necessary to retard the amount of oxygen entering the tube at the lower end. There will, however, be some chimney effect at the upper end and the outgoing gases from slot 11 will effectively reduce the amount of oxygen entering through that slot.

When one wishes to coat copper tape about 1 inch wide and from about 0.001 inch to about 0.01 inch thick, a slit approximately 1½ inches in width and one-eighth inch in thickness is adequate to permit the tape to slide through with ease. Quartz tube 12, in this case, will preferably have a diameter of approximately 1½ inches, a length of approximately 2 feet, and bottom end 20 will be approximately one-eighth inch to about one-fourth inch above the level of solution 19. Under these conditions, the tape will be drawn into the quartz tube at a rate from about 10 feet per minute to about 60 feet per minute. The rate will depend to some extent on the thickness of the copper in that the thicker copper needs a longer residence time to reach red heat.
The coated copper products of the present invention are particularly useful for selenoid windings for travelling wave tubes.

We claim:
1. A method of coating copper with copper borate glass comprising the steps of:
a. heating the copper to approximately red heat in a quartz chamber, said chamber having a vapor phase consisting essentially of steam, entrained sodium borate, and oxygen, said oxygen content
being sufficient to convert the copper to Cu₂O and insufficient to convert copper to CuO; and
b. passing the copper into a saturated borax solution while the copper is at least at approximately dull red heat.

2. The method of claim 1 wherein a copper strand is passed into said chamber through an opening slightly larger than the dimensions of the copper, said chamber having a heating zone wherein the copper is heated to a temperature from about 850°C to about 900°C, and the copper is at approximately dull red heat when it passes into a saturated solution of borax.