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MULTI-COMPONENT METALLIC TUBE AND METHOD OF MAKING SAME

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This invention relates to a metallic tube of the type having a longitudinal passage surrounded by a predetermined non-uniform distribution of the metal in the cross-section of the tube. The invention has particular reference to an improved multi-component tube of this type and to a method of making it.

Metallic tubes of the above-noted type are desired for various purposes, as for high-conductivity copper tubular conductors wound into electric furnace coils or transformer coils, the windings of which require internal cooling for satisfactory performance.

Tubes of this unbalanced wall type can be made (1) in one piece or (2) by inserting a separate component into an outer tubular component having a uniform distribution of metal in the cross-section and securing the two components together in an unsymmetrical relation by brazing. In the first case, it is not possible or practicable, so far as I am aware, to make the tube in the long lengths desired for many purposes. In the second case, the brazing of the components in the desired lengths is so costly that for many purposes this method is economically unfeasible.

The principal objects of the present invention are to provide a tube of the type described which overcomes the above-noted disadvantages, and to provide a simple method of making such a tube.

A tube made according to the present invention is a composite metallic tube comprising a hollow elongated metal shell having a substantially uniform distribution of metal in the cross-section of the shell, and an elongated metal insert in the shell extending lengthwise thereof and occupying only a predetermined part of the hollow interior of the shell. The part of the hollow interior of the shell unoccupied by the insert forms a longitudinal passage around which is the desired non-uniform distribution of metal in the cross-section of the composite tube. The shell has opposed interior surfaces compressed against opposite surfaces of the insert substantially continuouly along the length of the shell, whereby the insert is held securely in position in the shell even when the composite tube is bent, as in winding a coil.

In the composite tube of this invention, the longitudinal passage is partly defined by the metal insert. The insert is embedded in opposed walls of the shell so that the shell has interior longitudinal shoulders facing away from the passage and closely engaging the insert to lock it in position.

According to the method of the present invention, a hollow, elongated, metal shell is made, as by conventional tube fabrication. This shell has a substantially uniform distribution of metal in its cross-section, and its cross-section is substantially larger than that of the final composite tube of which the shell is to form the outer component. An elongated metallic member is inserted loosely into the shell endwise and along the length of the shell, leaving adjacent this inner member a longitudinal passage for loosely receiving a mandrel or plug which

has a cross-section corresponding to that of the passage in the final composite tube. The mandrel is so formed in relation to the insert that when the two abut each other side-by-side in the shell, the insert has a surface overlapping the mandrel. The shell and insert member thus assembled are passed through a drawing zone where they are simultaneously compressed around the mandrel and drawn down to the desired cross-section of the final composite tube. Thus, the composite tube emerging from the mandrel in the drawing zone (which may be a die) has the desired cross-section in which there is a non-uniform distribution of metal around the passage left by the mandrel; and the latter serves the dual functions of determining the cross-section of this passage and locating the insert in the composite tube, the insert being locked in place by shoulders formed by displacement of metal as a result of the overlapping of the mandrel by the insert.

In certain applications, it may be desirable to provide between the insert and the outer shell a bond supplementing the mechanical bond obtained by the above-mentioned compressing or drawing operation. This additional bond can be effected by coating the insert with a brazing material before it is slid into its space in the hollow shell, and subjecting the assembly, after the drawing operation, to a temperature sufficiently high to fuse the brazing material.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which:

FIG. 1 is a perspective view of one form of the elongated tubular shell and the insert, showing the parts aligned for sliding of the insert into the shell;

FIG. 2 is a longitudinal sectional view of the assembled shell and insert as they are passed through a drawing zone to compress the shell and insert against the mandrel;

FIGS. 3 and 4 are sectional views on the lines 3—3 and 4—4, respectively, in FIG. 2;

FIG. 5 is a cross-sectional view of the final composite tube from the drawing zone as shown in FIGS. 2–4, and

FIGS. 6 through 10 are cross-sectional views of modified forms of the new composite metallic tube.

Referring to FIG. 1, the reference numeral **10** designates an elongated tubular metal shell having a longitudinal passage **11** which is adapted to receive loosely a metal insert **12**. The two parts **10** and **12** may be made of any ductile metal or of two different metals, or one or both of them may be an alloy of different metals. The insert **12** may be made by rolling or drawing the metal into the required length, and the tubular shell **10** may be produced in the required length by conventional tube fabricating operations, it being noted that the shell **10** has a substantially uniform distribution of the metal around its hollow interior **11**.

After fabrication of the parts **10** and **12**, as described, the insert **12** is slid endwise into the passage **11** of the shell until the insert extends along the entire length of the shell. With the parts thus loosely assembled, the passage **11** provides space for loosely receiving a mandrel **14** adjacent the insert **12**, the mandrel having a cross-section corresponding to that of the desired passage in the final composite tube. As indicated in FIG. 3, when the mandrel **14** abuts the adjacent insert **12**, the surface of the insert facing the mandrel overlaps the abutting surface of the mandrel.

The mandrel or plug **14** is used in conjunction with a die **16** for subjecting the assembly **10—12** to a drawing