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Goodman

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[54] **WATER-COOLED FLEXIBLE RISER TUBE CABLE TERMINAL**

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[52] **U.S. Cl.** ..... **174/19,** 174/15 C

[51] **Int. Cl.** **H01b 7/34**

[58] **Field of Search** ..... 174/15 R, 15 C, 16 B, 19, 174/20, 21, 47, 74; 339/112; 219/130; 13/15, 16, 32

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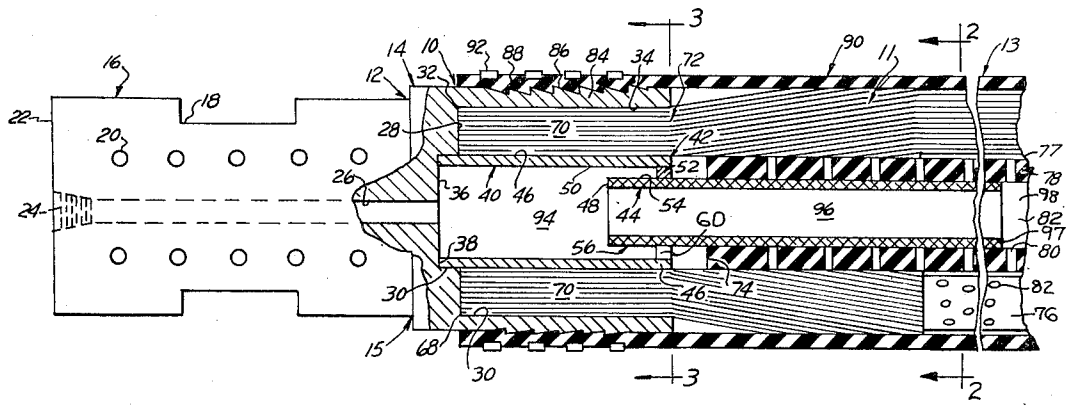
Primary Examiner—Arthur T. Grimley

[57] **ABSTRACT**

This water-cooled electric arc furnace cable terminal consists of a cup-shaped head and a rearwardly-projecting bar-shaped terminal blade containing a cooling water passageway communicating with the interior of the head and opening into a stepped riser tube surrounded by an annular cavity in which are secured, as by solder, the outer ends of the stranded cable conductors or "ropes." A perforated flexible tubular elastomeric core separates the inner sides of the stranded cable conductor from the inner component of the composite riser tube in spaced relationship therewith so as to provide a cooling water passegeway therebetween. The tubular core is provided with perforations enabling the cooling water to pass therethrough into the interstices between the hair-like wires of the so-called cable conductors or "ropes." To prevent clogging of the terminal by splinters of the hair-like wires of which these cable ropes are composed, the riser tube of the terminal is composed of coaxial outer and inner components of different diameters separated from one another by circumferentially-separated spacers so that the cooling water can flow through the arcuate auxiliary ports thus provided between the spacers and thereby flow around the outside of the inner component of the riser tube, as well as through the interior thereof, and thus bypass wire splinter masses which might otherwise clog or plug up the water cooling passageways and cause the cable to "explode" from the pressure of the steam thus produced.

7 Claims, 3 Drawing Figures



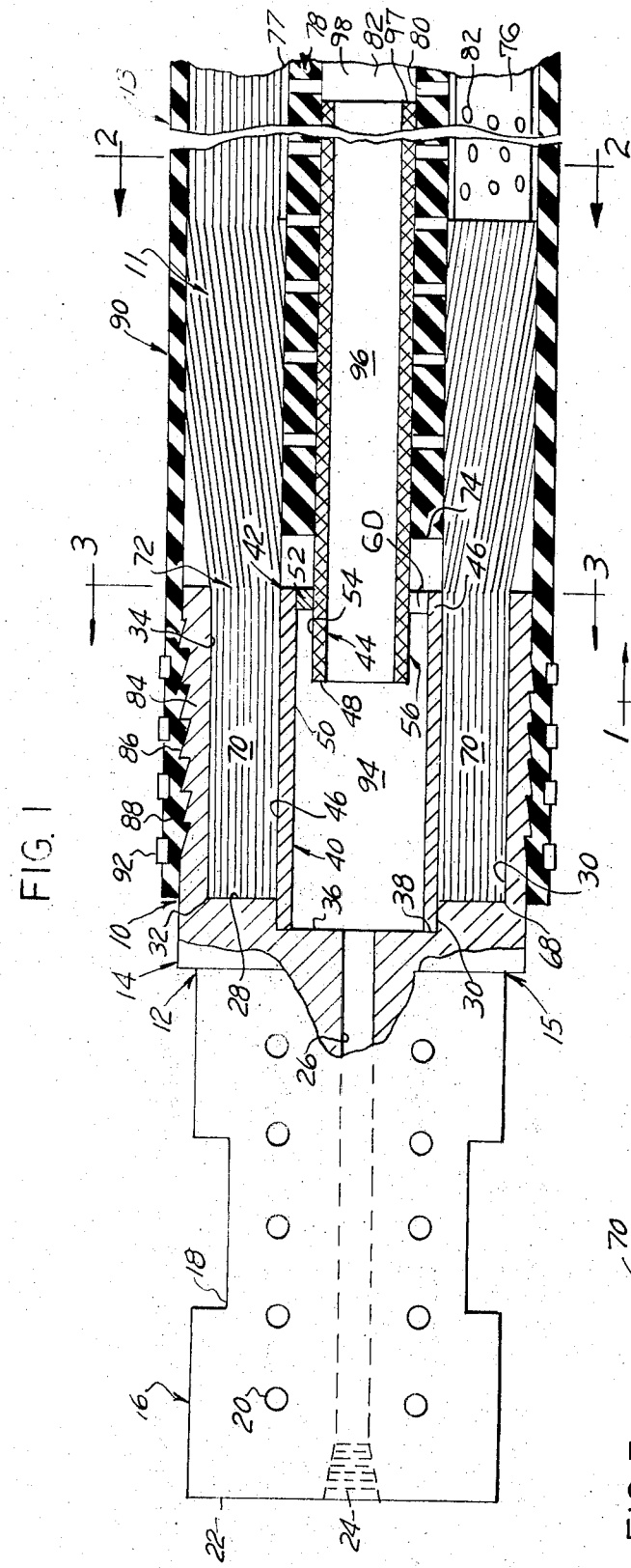


FIG. 1

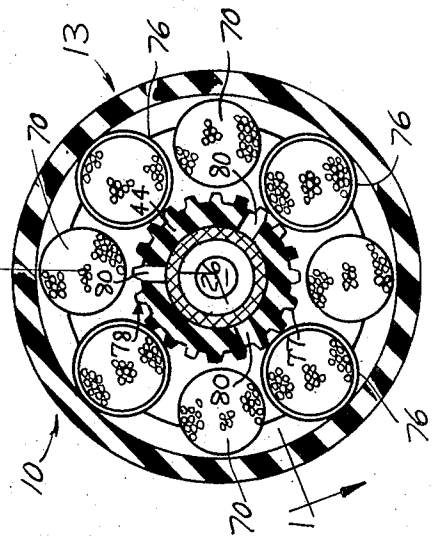


FIG. 2

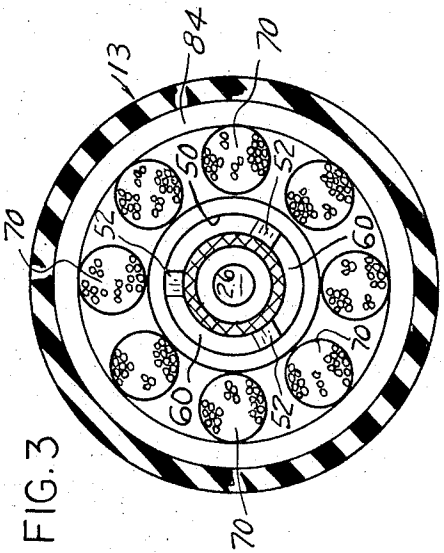


FIG. 3

WATER-COOLED FLEXIBLE RISER TUBE CABLE TERMINAL

SUMMARY OF THE INVENTION

The riser tube mounted within the cup-shaped head of the cable terminal consists of an outer component of larger diameter than an inner component joined thereto by circumferentially separated spacers which define arcuate auxiliary cooling water ports therebetween. These auxiliary cooling water ports are of sufficient size to enable the cooling water to pass therethrough and bypass collections or masses of cable wire splinters which may break off as a result of the flexing of the cable during use, and which might otherwise clog the cable and prevent the flow of the cooling water, with consequent accumulation of high pressure steam and eventual bursting of the cable hose as a result thereof.

BACKGROUND OF THE INVENTION

Clogging of the water passageways in a water-cooled electric furnace cable, with consequent cutting off of the cooling water by tiny splinters or fragments of the hair-like wires making up the stranded cable conductors or ropes has been a serious hazard constantly facing users of such cables. Such clogging of the water passageways by such splinters, by cutting off the cooling water circulation, causes the generation of steam, the pressure of which eventually causes the cable to burst. Furthermore, the consequent cutting off of the cooling water causes the cable to be destroyed by the heat generated in the uncooled cable. In my U.S. Pat. No. 3,784,722, issued Jan. 8, 1974 upon my application Ser. No. 272,579, filed July 17, 1972, for Water-Cooled Electric Furnace Cable, an improvement of this condition was achieved by the provision of a flexible riser tube of non-ferrous metal in place of the rigid riser tubes previously employed, the flexible riser tube enabling the stranded cable conductors to flex more easily without the abrupt fulcrum set up by the ends of the previously used rigid riser tubes. As a result, the production of wire splinters was considerably reduced, but not completely eliminated.

The present invention reduces the likelihood of cable explosions resulting from the clogging of the water passageways by wire splinters by providing additional water channels resulting from the use of outer and inner riser tube components of different diameters interconnected by spacers so that cooling water can flow around the outside of the smaller-diameter component as well as through it, and thus can bypass portions of the cable clogged by wire splinters.

In the drawing,

FIG. 1 is a central longitudinal section, taken along the line 1—1 in FIG. 2 and partly in side elevation, of a water-cooled electric furnace cable terminal equipped with the safety non-clogging riser tube of the present invention;

FIG. 2 is a cross-section taken along the line 2—2 in FIG. 1; and

FIG. 3 is a cross-section taken along the line 3—3 in FIG. 1.

Referring to the drawing in detail, FIGS. 1 to 3 show a water-cooled electric arc furnace cable, generally designated **10**, according to a preferred form of the invention, including generally a furnace cable conductor

assembly **11** disposed within a flexible tubular elastomeric casing or hose **13** and a terminal **12** joined thereto in the manner set forth below. Each cable **10** is provided with a pair of the terminals **12**, one at each end, and as these two terminals **12** are of similar construction, only one is shown in the drawing.

Each terminal **12** includes a body **15** having a cup-shaped head **14** from which projects a bar-shaped blade or connection portion **16**, notched out at **18** and drilled with multiple fastener holes **20** for the purpose of bolting or otherwise securing it to the transformer or furnace terminals (not shown). The blade **16** at its outer end **22** is provided with a threaded port **24** for the coupling thereto of the correspondingly threaded fitting of a cooling water supply conduit (not shown). A cooling water passageway **26** extends inward from the threaded port **24** and opens into a counterbore **30** from which an annular end surface **28** extends radially outward to a bore **34** in the cup-shaped socket **32** of the terminal head **14.** Soldered or otherwise secured in the counterbore **30** against the end wall **36** thereof is the rearward end **38** of the elongated outer component **40** of an elongated stepped composite riser tube, generally designated **42,** including an elongated flexible inner riser tube component **44** of smaller diameter having its rearward end **48** mounted in radially spaced overlapping relationship to the forward end **46** of the outer component **40.** Soldered or otherwise secured in circumferentially spaced relationship around the inner cylindrical surface **50** of the outer riser tube component **40** are the outer sides of several spacers **52,** three being shown in FIG. **2.** Similarly secured to the inner sides of the spacers **52** is the outer surface **54** of the elongated inner riser tube component **44** near the outer end **48** thereof. The inner riser tube component **44** is preferably in the form of a flexible metal hose, such as flexible phosphor bronze metal hose. The terminal head **14,** blade **16,** and outer riser tube component **42** are also preferably made from nonferrous metal, such as copper or bronze. The inner and outer riser tube components **44** and **40** and their spacers **52** collectively form the composite flexible riser tube **42.** Since the inner riser tube component **44** is of smaller diameter than the outer riser tube component **40** and is separated therefrom by the spacers **52,** this arrangement provides a plurality of arcuate cooling water bypass ports **60** between the spacers **52.**

The outer surface **46** of the outer riser tube component **40,** the inner surface **34** of the cup-shaped socket **32** in the terminal head **14** and the annular end surface **28** thereof collectively define an annular stranded conductor or wire rope pocket or cavity **68.** Secured, as by solder, in the annular cavity **68** are the outer end portions **70** of stranded cable conductors or wire ropes **72** which inwardly beyond their outer end portions **70** are surrounded by perforated elastomeric tubular jackets **76,** these jackets extending lengthwise of the stranded conductors or wire ropes **72.** Mounted between the composite flexible riser tube **58** and the end portions **70** of the stranded conductors or wire ropes **72** is the end **74** of a perforated elastomeric tubular core **78** having a fluted or longitudinally grooved outer surface **77** containing cooling water flow ports **80** adjacent the perforations **82** of the perforated jackets **76.** The flexible riser tube component **44** extends partway into the core **78.** The hollow cylindrical side wall **84** of the terminal head **14** is provided with an annularly toothed or jagged outer surface **86** over which is drawn the end

portion **88** of the elastomeric casing or hose **13** tightly secured thereto by annular hose clamps **92.**

In the assembly of the furnace cable **13,** the rearward end **38** of the outer component **40** of the previously assembled composite flexible riser tube **42** is soldered or otherwise secured in the counterbore **30.** The outer end portions **70** of the stranded wire conductors or wire ropes **72** are then inserted in the annular cavity **68** and secured therein by pouring solder, such as silver solder, therein so as to fill the interstices between the individual hair-like wires of the stranded conductors or ropes **72** and thus secure the end portions **70** thereof within the annular cavity **68.** At the same time, the end **74** of the fluted elastomeric tubular core **78** is slipped over the flexible perforated inner riser tube component **44** into the position shown in FIG. **1,** after which the end portion **88** of the casing or hose **13** is pulled over the annularly jagged outer surface **86** of the terminal head **14** and secured in position by tightening the annular cable hose clamps **92** therearound.

In the operation of the water-cooled electric furnace conductor cable **10,** let it be assumed that the blades **16** of the terminals **12** thereof have been bolted or otherwise secured to the proper terminals of the conventional transformer and furnace respectively (not shown), and that cooling water has been supplied to the threaded port **24** whence it flows through the passageway **26** into the chamber **94** of the outer riser tube component **40.** The major portion of the cooling water flows onward through the chamber **96** of the flexible inner riser tube component **44** and emerges at its inner end **97** into the passageway **98** through the core **78** beyond the inner end **97** of the flexible inner riser tube component **44.** It then flows through the perforations **80** of the tubular core **78** around the jackets **76** of the cable conductors or ropes **70** and thence through the jacket perforations **82** into the interstices between the hair-like wires of the cable conductors or ropes **70** so as to cool them.

At the same time, the remaining portion of the cooling water which does not flow through the chamber **96** of the flexible inner riser tube component **44** passes through the arcuate cooling water ports **60** between the spacers **52** and around the outer end **74** of the tubular elastomeric core **78** and through the channels provided by its fluted external surface **77,** whence it flows in a similar manner through the perforations **82** into the tubular cable conductor jackets **76** and cools the hair-like wires thereof of the stranded conductors or wire ropes **72.**

Subsequently, when the transmission of electric current through the cable or cables **10** to the electric furnace heats the stranded conductors or wire ropes **72,** the cable conductor assemblies are cooled by the cooling water flowing through each perforated tubular jacket **76** around the hair-like wires of the stranded conductors or wire ropes **72** of each such rope **72** in the manner described above so as to carry away the heat arising within the cable and thus prevent the cable from "burning up" during operation. Since the conventional electric arc furnace used in making steel is tilted in order first to pour out the slag and then the molten steel beneath it, such tilting flexes each cable **10** suspended between it and the terminals of the transformer to which the other end of the cable **10** is connected. Breaking or splintering of the hair-like wires of the stranded conductors or wire ropes **72** during such flexing, together with some stretching of the cable during such tilting, is minimized by the bending of the flexible inner component **44** of the composite riser tube **42.** Any formation of wire splinters, however, which would otherwise tend to obstruct the flow of cooling water is likewise minimized by the additional cooling water flowing through the arcuate auxiliary water cooling ports **60** between the spacers **52** over and outside the cooling water flowing through the chamber **96** of the inner flexible riser tube component **44,** according to the present invention.

I claim:

1. A cable terminal adapted to be connected to a cable conductor assembly including a multiplicity of flexible stranded wire conductor ropes surrounding a central flexible coolant conduit within the flexible tubular casing of a water-cooled electric arc furnace cable, said terminal comprising

a terminal body having a cup-shaped head portion containing a socket and having an electrical connection portion projecting outward from one end of said head portion away from said socket,

and an elongated riser tube structure having an outer component with an outer end secured to said body centrally within said socket and defining with said socket an annular cavity adapted to receive the outer ends of the conductor ropes and also adapted to receive means for securing the conductor ropes to said head portion,

said body having a coolant passageway therethrough communicating with said outer end of said riser tube structure,

said riser tube structure having an inner component disposed in coaxial end-to-end relationship with said outer component and adapted to be inserted in the outer end portion of the central flexible coolant conduit,

said riser tube structure having connecting means joining the outer end portion of said inner component with the inner end portion of said outer component and having coolant bypass means disposed adjacent said connecting means and effecting coolant bypass flow from said outer component exteriorly of said inner component and also exteriorly of the flexible coolant conduit into the flexible tubular casing.

2. A cable terminal, according to claim **1,** wherein said inner component is composed of flexible metallic material.

3. A cable terminal, according to claim **2,** wherein said outer component is composed of substantially rigid metallic material.

4. A cable terminal, according to claim **1,** wherein said connecting means are disposed substantially in the plane of the inner end of said cup-shaped head, said coolant bypass means comprising coolant outlet port means disposed between the interconnected end portions of said outer and inner components.

5. A cable terminal, according to claim **1,** wherein said inner component is of smaller diameter than said outer component and wherein said connecting means secures said components to one another in radially spaced relationship, said coolant bypassing means being disposed in the space between said outer and inner components.

6. A cable terminal, according to claim **5,** wherein said connecting means are secured in circumferentially

spaced relationship to one another between said outer and inner components, said coolant bypass means being disposed adjacent said connecting means.

7. A cable terminal, according to claim **6,** wherein said outer and inner components are disposed in end-to-end overlapping relationship, and wherein said connecting means comprise spacers disposed in circumferentially spaced relationship between the overlapping end portions of said components.

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