United States Patent [19]

Goodman

[11] **3,784,722**

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[54] **WATER-COOLED ELECTRIC FURNACE CABLE**

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[52] **U.S. Cl.** ..... **174/15 C,** 174/19, 219/130

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

[58] **Field of Search** ..... 174/15 R, 15 C, 16 B, 174/19, 20, 21, 47, 74; 13/15, 16, 32; 339/112, 117; 219/130

[56] **References Cited**

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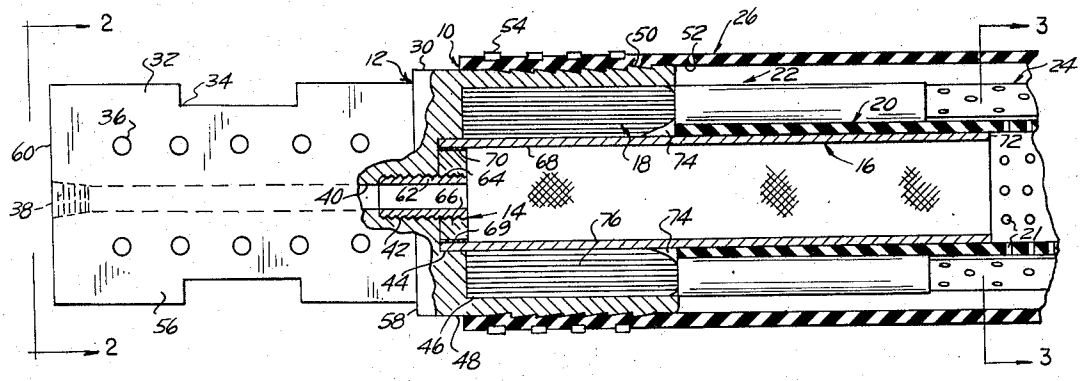
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Primary Examiner—Bernard A. Gilheany
Assistant Examiner—A. T. Grimley
Attorney—Willis Bugbee

[57] **ABSTRACT**

To prevent wear and cutting of the hair-like wires of the stranded conductor wire ropes of a flexible water-cooled electric furnace conductor cable and its tubular jackets and core by their flexing against the end of the riser tubes in the terminals thereof, the riser tube of each terminal is flexible and is constructed from non-ferrous flexible non-magnetic metal such as phosphor bronze, as a short hose portion or as a short tightly-wound coil spring, either of which flexes with the bending of the cable as the furnace is tilted and the cable is consequently stretched while suspended between the furnace and the transformer. The flexible riser tube extends from the cable conductor rope pocket of the terminal head into the interior of the cable so as to prevent the solder used in securing the conductor ropes in the pocket from flowing into the interior of the cable and plugging up the water holes through which the cooling water flows from the terminal end through the riser tube by way of the perforated tubular core into the interior of the cable and into the flexible elastomeric perforated tubular jackets surrounding the cable conductor ropes. The connection between the terminal and the flexible riser tube is made by means of a tubular coupling including a threaded tubular stem or nipple threaded into the inner end of the terminal cooling water bore and carrying a correspondingly internally-threaded annular disc the periphery of which is joined to the inner end of the flexible riser tube by an annular layer of solder. The coupling and disc are of non-magnetic metal such as brass.

9 Claims, 5 Drawing Figures



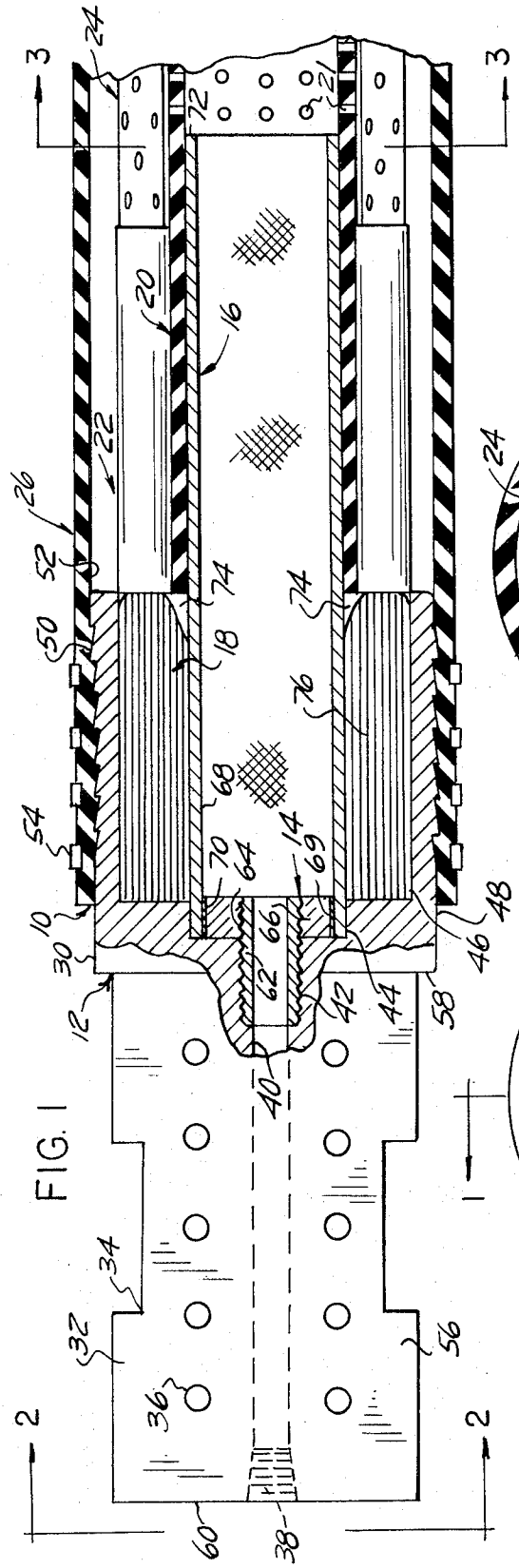


FIG. 1

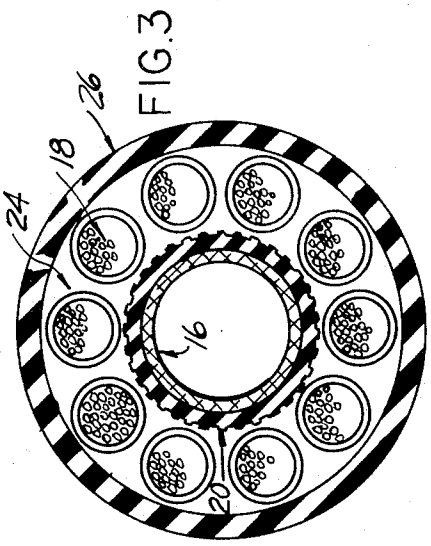


FIG. 3

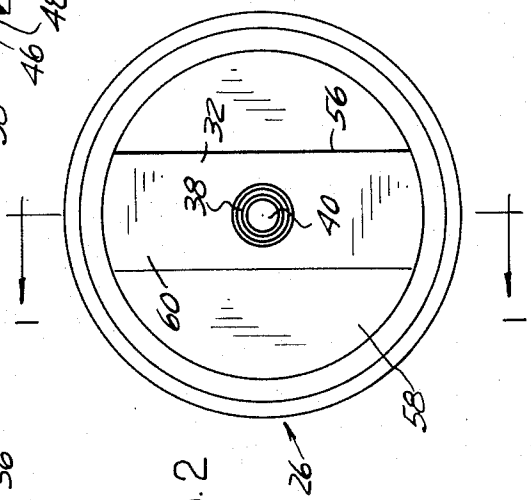


FIG. 2

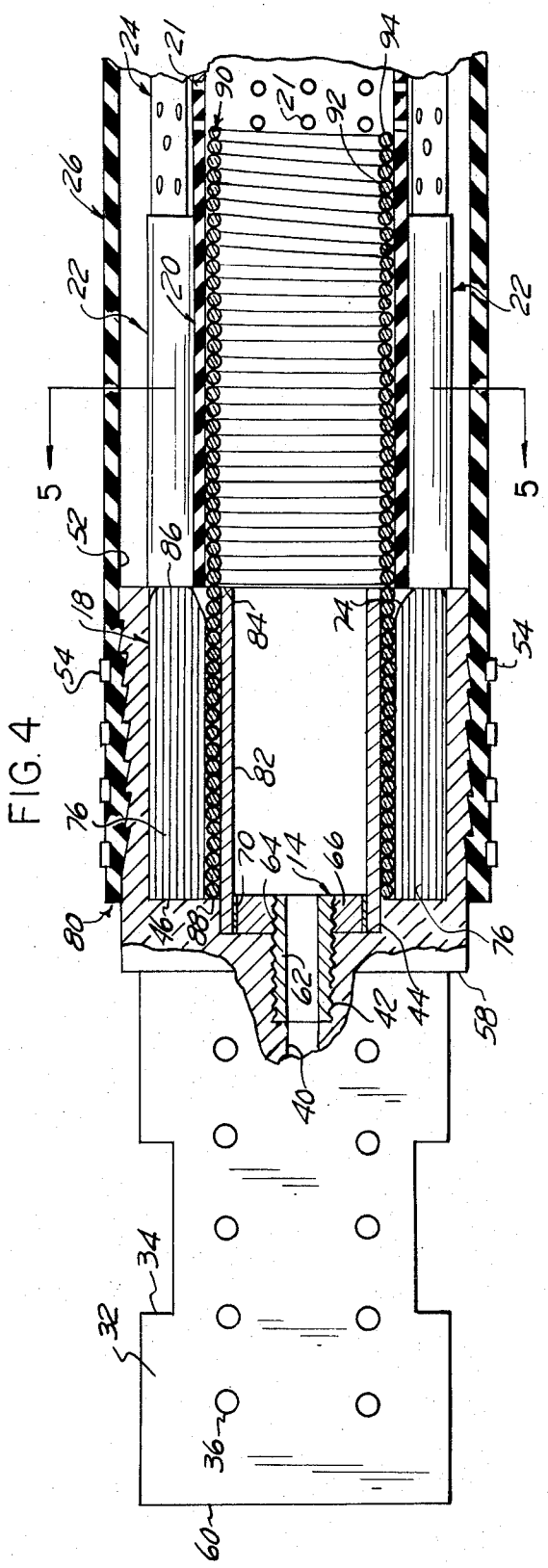

24
21
90
92
94
26
22
120
5
5
52
86
18
84
54
82
76
70
64
114
66
80
88
62
42
44
58
40
34
32
36
60

FIG. 4

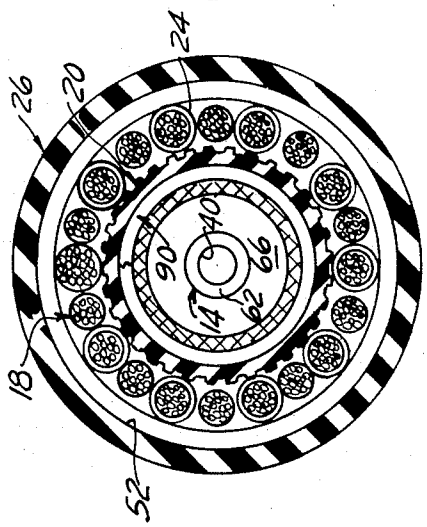

24
26
120
40
90
66
14
62
18
52

FIG. 5

WATER-COOLED ELECTRIC FURNACE CABLE

BACKGROUND OF THE INVENTION

Hitherto, electric furnace cables have been provided with terminals containing rigid metallic riser tubes, usually of copper, extending axially from a socket in the terminal through a counterbore forming a so-called pocket into which the ends of the conductor wire ropes are secured by solder. The conductor ropes are formed of fine hair-like wires and are surrounded by tubular perforated eleastomeric jackets which, when sliding with the tubular elastomeric core back and forth along the inner end of the riser tube previously became eventually cut as the cable was flexed while suspended between the furnace and the transformer while the furnace was tilted during operation. This cutting action resulted in extreme wear upon the conductor wire ropes and in turn greatly shortened the working lives of such furnace cables. The present invention solves this problem in the manner described above and in more detail below.

SUMMARY OF THE INVENTION

The flexible riser tube in the electric arc furnace cable of the present invention substantially eliminates this wearing and cutting action of the prior art rigid riser tubes upon the hair-like wires by bending with the cable conductors as the cable flexes during tilting of the furnace and at the same time takes the strain off the conductor wire ropes. This flexible riser tube also adapts itself to the stretching of the furnace cable in its suspended position between the transformer and the furnace while the furnace is tilted during operation.

In the drawing,

FIG. 1 is a side elevation, mainly in central longitudinal section, taken along the line 1—1 in FIG. 2, of a furnace cable equipped at each end with an improved terminal, according to one form of the invention;

FIG. 2 is a left-hand elevation of FIG. 1, looking in the direction of the arrows 2—2 in FIG. 1;

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

FIG. 4 is a side elevation, mainly in longitudinal section, similar to FIG. 1, of a furnace cable equipped with a modified terminal or cable head, according to another form of the invention; and

FIG. 5 is a cross-section taken along the line 5—5 in FIG. 4.

Referring to the drawing in detail, FIG. 1 shows an electric arc furnace cable, generally designated 10, according to one form of the invention, having at each end a terminal 12 bored, threaded and counter-bored for the reception of a threaded coupling device 14 to which a flexible non-ferrous metal riser tube 16 is secured. Around the riser tube 16, the inner ends of conductor cable wire ropes 18 are secured to the terminal 12 as by solder. Mounted upon the inner end of the riser tube 16 is a fluted perforated tubular core 20 of elastic deformable material such as rubber having coolant flow ports 21 therethrough. Adjacent their soldered inner ends, the conductor wire ropes 18 are surrounded by short constriction tubes 22 which in turn surround the ends of perforated tubular jackets 24 of elastic deformable material such as rubber extending lengthwise of the conductor cable wire ropes 18. Surrounding and enclosing the previously mentioned elements of the

cable 10 is a flexible casing or hose 26 of elastic deformable material such as rubber.

The terminal 12, of which there is one at each end of the furnace cable 10, consists of a cup-shaped head 30 from which a bar-shaped terminal blade or connection portion 32 projects, FIGS. 1 and 2. The blade 32 is notched at 34 for locking it to the transformer terminals or furnace terminals as the case may be, and is provided with multiple holes 36 adapted to receive conventional fasteners, such as bolts, for that purpose. The outer end of the blade 32 is provided with a threaded port 38 for the connection of the correspondingly threaded fitting of a cooling water supply source (not shown). Extending inward from the threaded port 38 is a cooling water passageway 40 terminating in an internally-threaded bore 42 opening into a socket or inner counterbore 44 which in turn opens into an outer counterbore 46 in the terminal head 30.

The outer surface 48 of the terminal head 30 is provided with annular sharp edged ratchet ridges 50 indenting and tightly interlocking with the inner surface 52 of the hose 26, which is tightly secured thereto by annular hose clamps 54. The terminal blade 32 as its bar-shaped description indicates, has flat parallel opposite sides 56 and joins the terminal head 30 at a perpendicular shoulder 58, FIG. 2. Its threaded port 38 extends inward from the flat end surface 60 of the terminal blade 32.

Threaded into the threaded bore 42 is an externally-threaded tubular stem or nipple 62, FIG. 1, of non-ferrous non-magnetic metal, such as brass, the exposed end of which has threaded thereon the internally threaded bore 64 of an annular cylindrical disc 66 or transversely-extending portion also of non-ferrous non-magnetic metal such as brass. The nipple 62 and disc 66 collectively form the coupling device 14. The inner surface 68 of the outer end of the flexible riser tube 16 is secured to the cylindrical peripheral surface 69 of the disc 66 by a layer 70 of solder. The flexible riser tube 16 has an inner end 72 and comprises a flexible metal hose such as flexible phosphor bronze metal hose which forms, with the counterbore 46 in the terminal head 30, an annular cavity 74.

In the assembly of the cable head 12 the nipple 62 is threaded into the bore 42 and the riser-tube-attached disc 66 threaded onto the exposed inner end of the nipple 62 thereby seating it in the socket or inner counterbore 44. The outer ends 76 of the conductor cable wire ropes 18 are then inserted in the annular cavity 74 and secured therein by pouring solder, preferably silver solder, into the cavity 74 so as to fill the interstices between the individual hair-like wires of the cable conductor ropes 18 with solder, and thereby secure their ends to the terminal 12. The outer end of the tubular core 20 is at the same time pushed over the inner end of the flexible riser tube 16. The hose 26 is then pushed over the jagged annular ribs 50 of the terminal head 30, which indent and interlock therewith. The annular cable clamps 54 are then placed in position and tightened in the usual manner.

In the operation of the conductor cable 10, let it be assumed that the cable 10 has been provided with terminals 12 at both of its opposite ends, that one of these terminals 12 has been connected to the proper terminal of the conventional transformer (not shown). Let it also be assumed that the other terminal 12 has been connected to the proper terminal of the conventional

electric arc furnace (not shown) and that cooling water has been supplied to the port **38** and thence flows through the terminal passageway **40** into the interior of the hose **26** by way of the nipple **62,** the riser tube **16,** the perforated tubular core **20** and the perforated cable rope jackets **24** into the interstices of the hair-like wires composing the conductor ropes **18.** It will of course be understood that ordinarily each such electric furnace employs more than a single cable and that all such cables are suspended between the transformer or transformers and the electric arc furnace which they serve.

If now the electrical current source, such as a transformer or transformers, is caused to energize the cable or cables **10,** it consequently renders molten the charge of the electric arc furnace. At the same time, the cooling water flowing through each cable **10** carries away the heat arising within the cable, thereby preventing the cable from "burning up" during operation. As the furnace is tilted during operation in order to pour out the completely-processed charge, it flexes each cable **10** suspended between it and the transformer terminals. As such flexing occurs, however, and with it a certain amount of stretching of the cable cutting and other damage to the tubular core **20,** the jackets **24** and the hair-like wires which make up the conductor cable ropes **18** by their engagement with the end **72** of the riser tube **16** is prevented by the flexing of the flexible riser tube **16.**

The modified electric furnace cable, generally designated **80,** shown in FIGS. **4** and **5,** is almost identical in construction to the furnace cable **10** and similar parts are designated with the same reference numerals. In the furnace cable **80,** however, the elongated flexible riser tube **16** of FIGS. **1, 2** and **3** is replaced by a short flexible riser tube **82** of similar construction to the riser tube **16** but terminating at its outer or free end **84** adjacent the inner ends **86** of the cable rope construction tubes **22.** Interposed between the short flexible riser tube **82** and the end portions **76** of the conductor cable wire ropes **18** is the inner end portion **88** of an elongated flexible tubular connector, generally designated **90,** in the form of a tightly-wound phosphor bronze helical spring, the outer end portion **92** of which extends beyond the outer end **84** of the abbreviated flexible riser tube **82** into the tubular core **20** and terminates at its own outer end **94** adjacent the innermost row of coolant flow ports **21** in the tubular core **20.**

The assembly of the modified electric furnace cable **80** follows a similar procedure to that described above for the assembly of the furnace cable **10,** except that the inner end portion **88** of the elongated flexible tubular connector **90** is pushed over the short flexible riser tube **82** until it engages the end wall of the outer counterbore **46** of the terminal head **30.** The exposed end of the tubular core **20** is then pushed over the similarly-exposed outer end portion **92** of the flexible tubular connector **90.** The hose **26** is then pushed over the assembly thus formed as in the assembly of the furnace cable **10.**

The operation of the modified furnace cable **80** is similar to that described above for the furnace cable **10,** including the flexing which each cable **80** undergoes during the tilting of the electric furnace during operation in order to pour out the completely-processed furnace charge. The modified cable **80** undergoes similar flexing and stretching thereof, but cutting of the tubular core **20,** the jackets **24** of the conductor cable rope **18** and the breakage of the hair-like wires which make up the conductor cable rope **18** relatively to the end **84** of the riser tube **82** acting as a fulcrum are prevented not only by the flexing of the flexible riser tube **82** but also by the flexing of the tightly-wound tubular spring connector **90.**

The purpose of the perforated tubular jackets **24** of elastic deformable material encasing the conductor cable wire ropes **18** is to prevent chafing and resulting fraying or breakage of the tiny hair-like copper wires which make up the cable ropes **18.** When such tiny wires rub against one another as the cable swings back and forth with the tilting of the electric furnace which it connects to the transformer, fracture of these wires eventually occurs, with consequent emission of splinters of such wire. These splinters are carried along by the cooling water current and occasionally clog the water channels, with disastrous results. When such clogging occurs, shutting off the cooling water, the resulting overheating of the cable causes fusion and parting of its cable ropes, with resulting severing occurs the cable. If this ocurs near the furnace, the electricity discharged from the severed end as it hits the building floor causes grave danger to bystanders because of the tremendous amperage carried by such cables. With the provision of the jacket **24** of rubber-like material, this fraying and splintering is greatly reduced, if not entirely prevented. Satisfactory results can be obtained by encasing only alternate cable ropes **18** in elastic deformable jackets **24,** as shown in FIG. **5,** the intervening cable ropes being left there and unjacketed. For the utmost safety and prevention of chafing, however, each cable rope **18** may be jacketed, as shown in FIG. **3.**

I claim:

1. A cable terminal adapted to be inserted in the flexible tubular casing of an electric furnace cable and therein connected to a multiplicity of flexible stranded wire conductor ropes surrounding a central flexible coolant conduit, said terminal comprising;

a terminal body having a head portion and an electrical connection portion projecting outward from one end of said head portion,

said head portion having a central bore and counterbore facing in the opposite direction from said connection portion,

said head portion having a coolant passageway therethrough communicating with said bore,

a riser tube of flexible material disposed centrally in said counterbore and defining with said counterbore 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,

said riser tube being adapted to be placed in communication with the coolant conduit,

and a riser tube coupling device disposed in said bore between said terminal body and said riser tube and secured to the inner end of said riser tube and to said terminal body in interconnecting supporting relationship therewith.

2. A cable terminal, according to claim **1,** wherein said coupling device includes a transversely-extending portion and wherein means is provided for securing said transversely-extending portion to said riser tube.

3. A cable terminal, according to claim **1,** wherein said coupling device at its forward end has a tubular

stem connecting said bore to the interior of said riser tube.

4. A cable terminal, according to claim **3,** wherein the forward end of said tubular stem is seated in said bore.

5. A cable terminal, according to claim **3,** wherein the rearward end of said bore is threaded and wherein the forward end of said tubular stem is correspondingly threaded and threadedly engages said rearward end of said bore.

6. A cable terminal, according to claim **5,** wherein the rearward end of said tubular stem is also threaded, and wherein said coupling device also includes a transversely-extending portion secured to said riser tube and has a threaded hole therein threadedly engaging the threaded rearward end of said stem.

7. A cable terminal, according to claim **2,** wherein said securing means includes an annular layer of metal adherently joining said transversely-extending portion to said riser tube.

8. A cable terminal, according to claim **1,** wherein an elongated flexible tubular connector is interposed between said riser tube and the central flexible coolant conduit and extends beyond said riser tube into the interior of the flexible coolant conduit.

9. A cable terminal, according to claim **8,** wherein said elongated flexible tubular connector comprises a tightly-wound helical spring.

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