United States Patent

Goodman

[15] **3,652,797**

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[54] SAFETY ANCHORED MULTICONDUCTOR CABLE FOR ELECTRIC ARC FURNACES

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[52] **U.S. Cl.** .....**174/15 C,** 174/19, 174/74 R, 219/130, 339/112

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

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

[56] **References Cited**

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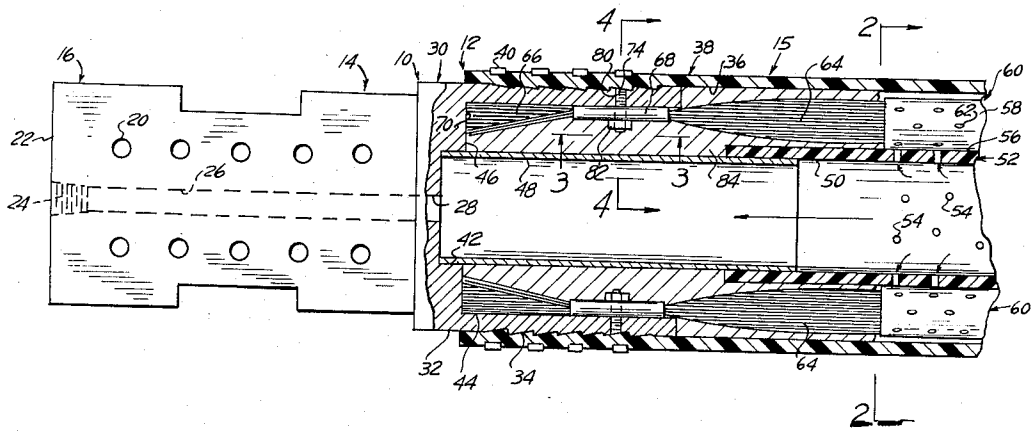
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Assistant Examiner—A. T. Grimley
Attorney—Barthel & Bugbee

[57] **ABSTRACT**

This multiconductor water-cooled electric arc furnace cable has the majority of its conductors secured within the terminal cup by means of solder. In order to prevent the conductors from dropping out of the terminal cup upon a failure of the water-cooling system causing the solder to melt, two of the conductors are additionally bolted to the inner side of the outer wall of each of the terminal cups. This bolted anchorage prevents the cable from leaving the terminal cup and dropping upon melting of the solder and provides the maximum space for the largest possible central tubular cooling water conduit. It consequently prevents serious damage to the furnace or surroundings and possible injury or deaths of workmen resulting from their coming into contact with the high-voltage high-amperage current thus released, since the conductors still remain connected to the transformer.

7 Claims, 5 Drawing Figures



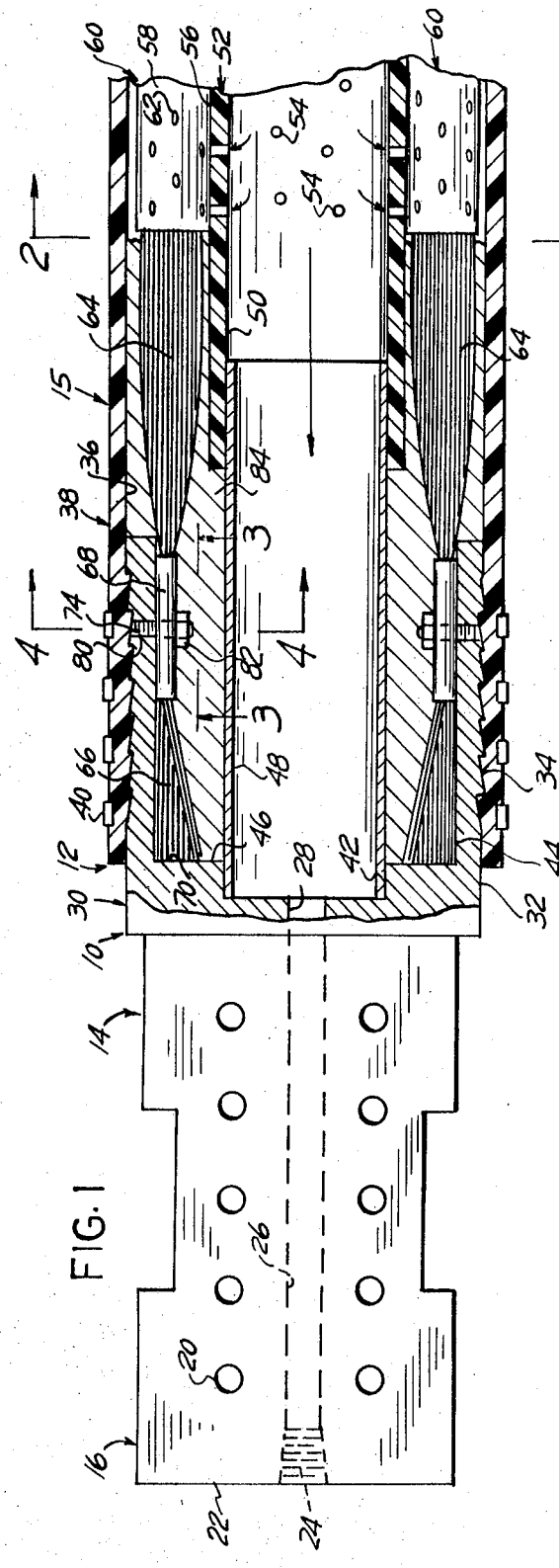


FIG. 1

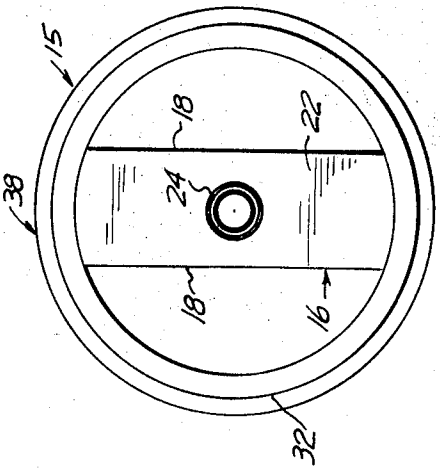


FIG. 5

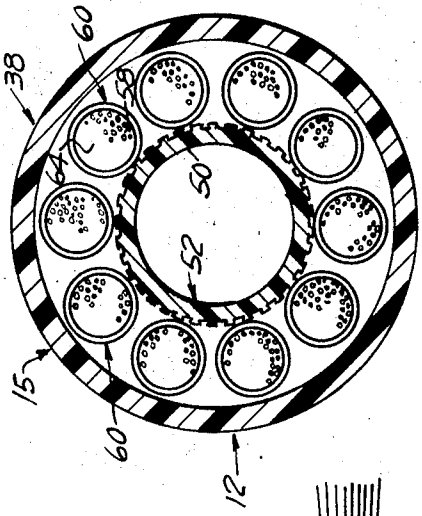


FIG. 2

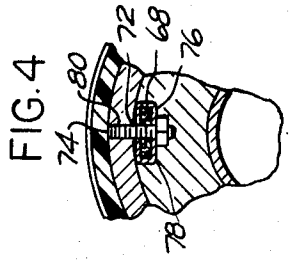


FIG. 4

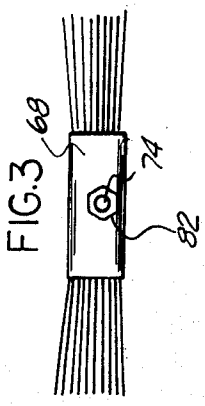


FIG. 3

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SAFETY ANCHORED MULTICONDUCTOR CABLE FOR ELECTRIC ARC FURNACES

In the drawings,

FIG. 1 is a side elevation, partly in central longitudinal section, of one end of a water-cooled electric arc furnace cable, showing the safety anchorage construction, according to one form of the invention;

FIG. 2 is a cross section through the cable rearwardly of the terminal, taken along the line 2—2 in FIG. 1;

FIG. 3 is a fragmentary bottom plan view of one of the cable anchoring devices, with the conductor-securing solder omitted, looking in the direction of the line 3—3 in FIG. 1;

FIG. 4 is a fragmentary cross section taken along the line 4—4 in FIG. 1, with the solder present; and

FIG. 5 is a front end elevation of the cable shown in FIG. 1.

Referring to the drawing in detail, FIG. 1 shows a multiconductor water-cooled electric cable generally designated **10** for electric arc furnaces, the cable **10** being one of a plurality of such cables extending between a conventional transformer (not shown) and an electric arc furnace (not shown). At least three such cables are ordinarily employed, one for each phase of the three-phase current usually used. Due to the heavy current load demand of such furnaces, however, two to four or more cables **10** may be employed for each phase thus often resulting in a total of six to twelve or more of such cables per furnace. The primary voltage of such a transformer is in the neighborhood of 13,000 volts and the secondary output 230 to 800 volts, with a secondary circuit at 10,000 amperes per phase. Such cables are made in various sizes, one such single cable in a 9,000 MCM size being capable of carrying 21000 amperes and another in an 18,000 MCM size from 45,000 to 50,000 amperes.

In particular, the multiconductor cable **10**, of which only the furnace connection end unit **12** is shown, consists of a forward terminal **14** and multiconductor cable unit **15** secured thereto as described below. The forward terminal **14** is constructed of heavy copper having a forward connection portion or blade **16** adapted to be connected to the furnace. A rearward terminal (not shown) of similar construction is connected to the rearward end of the cable unit **15** and connected to the transformer (not shown). The forward portion **16** has flat opposite sides **18** (FIG. 5) by which it is bolted to the connection with the furnace or transformer, as the case may be. It is also provided with multiple-spaced holes **20** extending transversely therethrough. The forward end **22** of the blade **16** is provided with a threaded port **24** leading to the forward end of a cooling water passageway **26**, the opposite end of which is provided with a rearward port **28** opening into the rearward portion or cup **30** of the terminal **14**.

The terminal cup **30**, as its name suggests, is of hollow cylindrical shape with an outer generally cylindrical surface **32** provided with multiple annular frustoconical teeth **34** which engage and penetrate the inner surface **36** of a hose **38** of synthetic rubber such as that known commercially by the name of neoprene. The forward end of the hose **38** is encircled by multiple longitudinally spaced annular hose clamps **40** which tightly grip and indent the hose **38** and in a watertight connection, and force its inner surface **36** into interlocking engagement with the annular teeth **34** on the terminal cup **32**.

The terminal cup **30** is provided adjacent the inner or rearward port **28** with a bore **42** opening into a counterbore **44** with an annular shoulder **46** extending therebetween. Seated in the bore **42** is the forward end of a riser tube **48**, preferably of copper, the rearward end of which is seated in and snugly engages the inner cylindrical surface **50** of a flute perforated core tube **52** of elastic deformable material, such as rubber or synthetic rubber, having multiple spaced perforations **54** therethrough for the flow of cooling water. The fluted outer surface **56** is engaged by the perforated tubular jacket **58** of each jacketed conductor **60**, the perforations **62** of which lead to the conductor itself, or so-called rope **64** of fine copper wire, so-called because of its resemblance to a hemp or manila rope.

The perforated forward end of the jacket **58** extends rearwardly for a distance of approximately 2 feet, beyond which its wall becomes imperforate. At this point it is provided with a tubular plastic plug (not shown) held in place by suitable fasteners such as by four brass screws. The rearward terminal (not shown) as stated above, is similar to the forward terminal **14** except that the blade thereof corresponding to the blade **16** is disposed at right angles to the forward blade **16**. The construction of the jacketed cable unit **15** and its conductors **60** themselves, together with that of the perforated fluted central tube **52**, is conventional and its details rearwardly of the section line **2—2** forms no part of the present invention.

The forward end portion **66**, of a plurality, preferably two, of the individual conductors **64**, is enclosed in a tubular conductor clamp **68** a short distance rearwardly of its forward end **70**, which abuts the annular shoulder **46**. The tubular clamp **68** is of rectangular cross section (FIG. 4) and is drilled at **72** to receive the shank of an anchor bolt or stud **74** which also passes through a hole **76** in the flattened portion **78** of the conductor end portion **66** into a threaded hole **80**. Threaded onto the inner end of the bolt or stud **74** is a nut **82**. The remaining jacketed conductors **60** have their forward ends **70** also abutting the annular shoulder **46** within the terminal cup **30**, but are not secured by the anchor bolts **74**, nuts **82** and conductor clamps **68**.

The non-anchored conductors **64** are secured within the counterbore **44** by a soft solder filling **84** which is poured into the counterbore **42** in a molten condition after the two anchored conductors **64** have been bolted into place. The assembly of the various parts of the conductor cable **10** is believed to be clearly disclosed by the foregoing description of the construction thereof. The forward end portions **56** of the jacketed conductors **60** which are to be anchored, are originally of circular cross section. Their forward end portions **56**, however, are passed through short tubes of circular cross section (not shown) and these tubes and the conductor end portions **66** within them are then swaged into rectangular cross section and become the tubular clamps **68** as shown in FIGS. 3 and 4. The swaging action tightly clamps the cable end portion **66** firmly and nonremovably therein, after which the drilling of the clamping tube **68** and the conductor portion therein can be carried out. Anchoring is then performed in the manner described above, after which the remaining cable ends **66** of the unanchored conductors **64** are then inserted in the counterbore **44**. This assembly is then placed in an upright position and molten soft solder is then poured into the cup **30** so as to substantially fill the counterbore **44** and also the interior of the cable hose **38** substantially back to the forward end of the perforated conductor jackets **58**.

In operation, the rearward cable terminal (not shown) of each cable **10** is connected to the transformer while the forward blade **16** of the forward terminal **14** is bolted to its connection at the furnace. The port **24** is connected to its corresponding pipe at the furnace while the corresponding rearward terminal port is connected to a source of cooling water. As a result, while the furnace is in operation, the heat generated by the flow of electric current thru each cable **10** and also by the heat of the furnace itself is dissipated by the cooling water flowing through the perforated fluted core **52** and thence around the jacketed conductors **60** by way of the perforations **54** and **62** respectively.

If, for any reason, the flow of water through the cable **10** is interrupted or shut off completely, the temperature rapidly rises within the cable **10** causing the solder filling **84** within the terminal cup **30** to melt. At this point, however, the anchored conductors **64** are held firmly in the cup **30** by means of the clamping bolts or studs **74**, clamping nuts **82** and the tubular conductor clamps **68**. The thus-anchored conductors **64** now serve mechanically as safety cables and prevent the remaining conductors **60** of the cable unit **15** from dropping out of the terminal cup **30**. In so doing, this prevents damage by its falling against the furnace casing or injuring adjacent workmen, either by their falling weight or, more seriously and per-

haps fatally, by the tremendous electric current thus released, especially if water has fallen or is standing upon the floor of the furnace room.

I claim:

1. A safety anchored electrical cable construction for electric arc furnaces, said construction comprising

a multiconductor electric cable having a hose with an array of flexible electrical conductors of the same polarity encased therein and with a tubular liquid coolant conducting conduit extending through the center thereof,

an electric arc furnace connection terminal having a furnace connection portion at its forward end and having a cable conductor connection portion extending rearwardly from said furnace connection portion,

said cable conductor connection portion having a hollow cylindrical outer wall disposed within said hose in liquid-tight relationship therewith and defining a conductor receiving cavity therewithin,

the forward end portions of said conductors being disposed within said cavity,

a heat-resistant mechanical conductor-clamping device disposed in said cavity in engagement with the forward end portion of one of said conductors and securing the same to the inner side of said outer wall in electrical conducting relationship therewith,

and a fusible electrically conducting filler material also disposed in said cavity and electrically connecting said cable conductor end portions to said cable conductor connection portion.

2. A safety anchored electrical cable construction, according to claim 1, wherein an additional heat-resistant mechanical conductor-clamping device of similar construction and arrangement to said first-mentioned conductor clamping device is disposed in circumferentially spaced relationship thereto and engages the forward end portion of a second electrical conductor and secures the same to said outer wall in electrical conducting relationship therewith.

3. A safety anchored electrical cable construction, according to claim 1, wherein said conductor-clamping device includes a conductor-anchorage member secured to said outer wall and projecting inwardly therefrom into said cavity and wherein means is provided for securing said forward end portion of said one conductor to said conductor-anchorage member.

4. A safety anchored electrical cable construction, according to claim 3, wherein said forward end portion of said one conductor has a hole therethrough, wherein said conductor-anchorage member passes through said hole, and wherein a locking element is secured to said member on the opposite side of said conductor end portion from said outer wall.

5. A safety anchored electrical cable construction, according to claim 4, wherein said inwardly projecting member has a threaded portion thereon and wherein said locking element has a correspondingly threaded portion threadedly engaging said threaded portion of said inwardly projecting member.

6. A safety anchored electrical cable construction, according to claim 1, wherein said filler material surrounds said conductor end portions and said conductor-clamping device.

7. A safety anchored electrical cable construction, according to claim 6, wherein said filler material substantially fills the space in said cavity between said intermediate conduit and said outer wall and the interstices of the individual wires of said conductor end portions exclusive of the space therein occupied by the individual wires of said conductor end portions and said clamping device.

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