(12) UK Patent Application (19) GB (11) 2 233 788 (13) A

(43) Date of A publication **16.01.1991**

(21) Application No **9015244.8**

(22) Date of filing **11.07.1990**

(30) Priority data
(31) **8915858** (32) **11.07.1989** (33) **GB**

(71) Applicant
BICC Public Limited Company

(Incorporated in the United Kingdom)

Devonshire House, Mayfair Place, London, W1X 5FH, United Kingdom

(72) Inventor
William McNeil

(74) Agent and/or Address for Service
Edward Lewis Ross Gower
BICC plc, Patents & Licensing Department, Network House, 1 Ariel Way, London, W12 7SL, United Kingdom

(51) INT CL[5]
H01B 11/22, H05B 3/56

(52) UK CL (Edition K)
G2J JGCA1 JG20
G1A AA7 AG6 AG7 AG9 APG AR7 AT15 AT20 AT23 AT5
H5H HAH HAM H111 H154 H157 H175 H230 H232 H233 H275
U1S S1953 S1981 S2166

(56) Documents cited
GB 2122370 A **GB 2106264 A**

(58) Field of search
UK CL (Edition K) **G1A ACD ACJ AMV, G2J JGCA1 JG20, H5H HAH HAM HAX2**
INT CL[5] **G02B, H01B**

(54) A composite mineral insulated electric and optical cable

(57) A composite mineral insulated 2 electric 1 and optical cable, especially suitable for use as a heating cable, has an overall protective layer 9 surrounding the metal cable sheath 3 and, radially outwardly of the metal sheath and directly or indirectly bounded at least in part by the overall protective layer 9, at least one passage 5 which extends lengthwise of the cable and in which is loosely housed at least one optical fibre 6. Preferably, the passage 5 extends helically around the axis of the cable and, preferably, also, the optical fibre 6 has a length greater than that of the passage. The passage may be a bore in a single layer of plastics material surrounding the sheath and constituting the overall protective layer (Fig. 2) or it may be the bore of a separately formed tube disposed radially outwardly of the metal cable sheath and wholly or partially encapsulated in the overall protective layer (Fig. 3).

The cable may be used as a heating cable, to measure temperature or as an optical thermostat.

Fig.1.

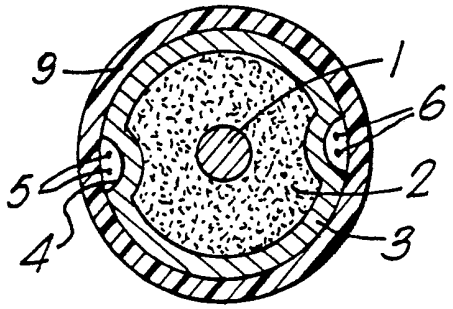

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Fig.1.

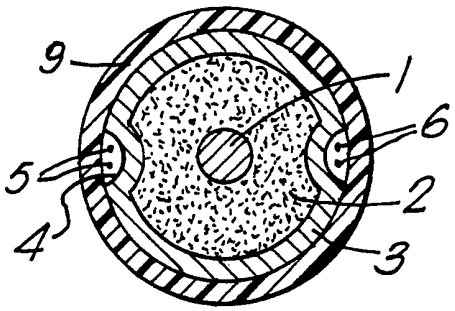


Fig.2.

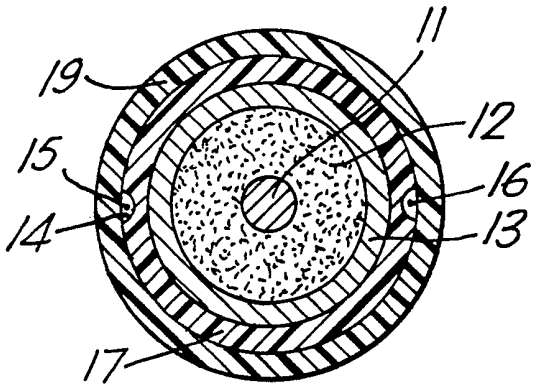
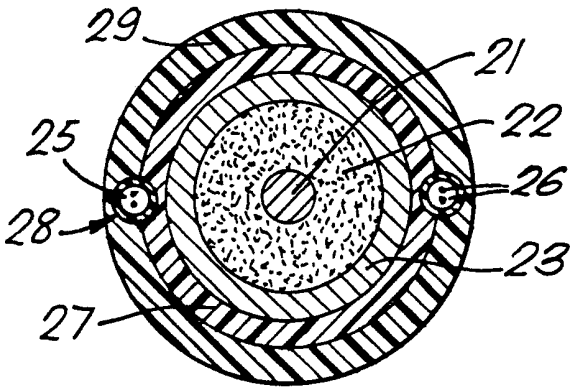


Fig.3.



A Composite Mineral Insulated Electric & Optical Cable

In the specification of our British Patent No. 2106264B, there is described and claimed a mineral insulated electric cable comprising at least one conductor insulated from a surrounding metal sheath, and where there is more than one conductor from the other conductor or conductors, by compacted insulating powder, wherein the conductor or at least one of the conductors has a bore extending throughout the length of the conductor and has, loosely housed in the bore, at least one separate optical fibre and/or at least one optical fibre bundle.

Although the composite mineral insulated electric and optical cable of our aforesaid patent is suitable for use in many applications, it is of limited use as a heating cable for pipe line tracing because a control device associated with the optical fibre or fibres of the cable will be within a heat generating conductor and because temperature differentials between the or a cable conductor and the cable sheath and between the cable sheath and fluid in the pipe being heated will reduce the effectiveness of the control.

It is an object of the present invention to provide an improved composite mineral insulated electric and optical cable which is especially, but not exclusively, suitable for use as a heating cable and which can be readily manufactured using conventional techniques.

According to the invention, the improved composite cable comprises at least one conductor insulated from a surrounding metal sheath, and where there is more than one conductor from the other conductor or conductors, by compacted insulating powder, an overall protective layer surrounding the metal sheath and, radially outwardly of the metal sheath and directly or indirectly bounded at least in part by said overall protective layer, at least one passage which extends lengthwise of the cable and in which is loosely housed at least one optical fibre.

Preferably, the or each optical fibre has a length greater than that of the passage in which it is loosely housed.

The or each passage preferably extends helically around the axis of the cable.

In a first aspect of the invention, the or each passage is a space directly or indirectly bounded by the metal sheath and by the overall protective layer surrounding the sheath. Where the metal sheath in part directly bounds the or each passage, the passage may comprise in part a groove formed in the outer surface of the metal sheath. Where the or each passage in part is indirectly bounded by the metal sheath, an inner layer of plastics material may surround the metal sheath and the or each passage may comprise a space bounded in part by said inner layer of plastics material and in part by another layer of plastics material which surrounds said

inner layer and constitutes the overall protective layer.

In a second aspect of the invention, the or each passage is a bore in a single layer of plastics material surrounding the metal sheath and constituting the overall protective layer.

In a third aspect of the invention, the or each passage is constituted by the bore of a separately formed tube which extends lengthwise with respect to the cable radially outwardly of the metal sheath and which is at least in part encapsulated in a layer of plastics material constituting the overall protective layer surrounding the sheath. An inner layer of plastics material may surround the metal sheath and the or each separately formed tube may be partially encapsulated in the plastics material of said inner layer and partially encapsulated in the plastics material of the layer constituting the overall protective layer. Preferably, the or each separately formed tube is of plastics material.

In all cases, the or each passage in which an optical fibre is loosely housed may be filled throughout its length with a water-impermeable material of a grease-like nature which permits relative movement of the or each optical fibre with respect to the cable.

The optical fibre or at least one of the optical fibres of the improved composite mineral insulated

electric and optical cable may have a cladding of plastics material which is, or which by the incorporation of a dopant is rendered, so temperature sensitive that the refractive index of the cladding will change when the temperature to which the optical fibre is subjected changes. In one embodiment, the plastics material of the cladding may be so temperature sensitive that, at a predetermined temperature, the refractive index of the cladding becomes equal to or greater than the refractive index of the core of the fibre. In this case, light transmitted along the core of the fibre will leak out of the fibre and be lost and substantially no signal will be detected at an end of the fibre. In a second embodiment, the plastics material of the cladding is so sensitive to change in temperature that the intensity of the light signal transmitted along the core of the fibre will be an indication of the temperature to which the optical fibre is subjected. One suitable dopant for incorporation in the plastics material of the cladding for this purpose is a fluorescent dye whose fluorescence changes as it is heated. An improved composite mineral insulated electric and optical cable of the present invention incorporating one or more than one optical fibre having a temperature sensitive plastics cladding is suitable for use as an optical thermostat and/or, when incorporating conductors and/or a metal sheath of appropriate metals or metal alloys, as a thermocouple.

The improved composite mineral insulated electric and optical cable of the present invention has the very important advantage that the cable can be manufactured readily using conventional techniques and that any control device associated with the optical fibre or fibres is not within a cable conductor generating heat.

The invention is further illustrated by a description, by way of example, of three preferred forms of composite mineral insulated electric and optical cable with reference to the accompanying drawings, in which:-

Figure 1 is a transverse cross-sectional view of a first preferred form of composite mineral insulated electric and optical cable, and

Figures 2 and 3, respectively, are similar views of second and third preferred forms of such composite cable.

The first preferred form of composite electric and optical mineral insulated cable shown in Figure 1 comprises a copper conductor 1 electric insulated from a surrounding copper sheath 3 by compacted mineral insulating powder 2. The copper sheath 3 is surrounded by a sheath 9 of plastics material constituting an overall protective layer. Formed in the outer surface of the copper sheath 3 are two circumferentially spaced grooves 4, each extending helically around the sheath, the parts of the outer surface of the metal sheath

forming the grooves and the plastics sheath 9 bounding passages 5 in each of which two optical fibres 6 are loosely housed.

In the second preferred form of composite mineral insulated electric and optical cable shown in Figure 2, a copper conductor 11 is electrically insulated from a copper sheath 13 by compacted mineral insulating powder 12. The copper sheath 13 is surrounded by an inner sheath 17 of plastics material and the inner sheath is itself surrounded by an outer sheath 19 of plastics material constituting an overall protective layer of the composite cable. Formed in the outer surface of the inner sheath 17 are two circumferentially spaced grooves 14, each extending helically around the cable, the parts of the outer surface of the inner sheath forming the grooves and the outer sheath bounding passages 15 in each of which an optical fibre 16 is loosely housed.

The third preferred form of composite mineral insulated electric and optical cable shown in Figure 3 comprises a copper conductor 21 electrically insulated from a surrounding copper sheath 23 by compacted mineral insulating powder 22. The copper sheath 23 is surrounded by an inner sheath 27 of plastics material which is itself surrounded by an outer sheath 29 of plastics material constituting an overall protective layer of the composite cable. Encapsulated in part in the inner sheath 27 and in part in the outer sheath 29

are two circumferentially spaced preformed tubes 28 of plastics material which extend helically around the composite cable, the bore 25 of each tube constituting a passage in which two optical fibres 26 are loosely housed.

In each of the preferred forms of composite mineral insulated electric and optical cable illustrated in Figures 1 to 3, each passage of the cable may be filled throughout its length with a water-impermeable material of a grease-like nature which permits relative movement of the or each optical fibre loosely housed in the passage with respect to the cable.

CLAIMS:

1. A composite mineral insulated electric and optical cable comprising at least one conductor insulated from a surrounding metal sheath, and where there is more than one conductor from the other conductor or conductors by compacted mineral insulating powder, an overall protective layer surrounding the metal sheath and, radially outwardly of the metal sheath and directly or indirectly bounded at least in part by said overall protective layer, at least one passage which extends lengthwise of the cable and in which is loosely housed at least one optical fibre.

2. A composite cable as claimed in Claim 1, wherein the or each optical fibre has a length greater than that of the passage in which it is loosely housed.

3. A composite cable as claimed in Claim 1 or 2, wherein the or each passage extends helically around the axis of the cable.

4. A composite cable as claimed in any one of the preceding Claims, wherein the or each passage is a space directly or indirectly bounded by the metal sheath and by the overall protective layer surrounding the sheath.

5. A composite cable as claimed in Claim 4 in which the metal sheath in part directly bounds the or each passage, wherein the passage comprises in part a groove formed in the outer surface of the metal sheath.

6. A composite cable as claimed in Claim 4 in which the or each passage in part is indirectly bounded by the metal sheath, wherein an inner layer of plastics material surrounds the metal sheath and the or each passage comprises a space bounded in part by said inner layer of plastics material and in part by another layer of plastics material which surrounds said inner layer and constitutes the overall protective layer.

7. A composite cable as claimed in any one of Claims 1 to 3, wherein the or each passage is a bore in a single layer of plastics material surrounding the metal sheath and constituting the overall protective layer.

8. A composite cable as claimed in any one of Claims 1 to 3, wherein the or each passage is constituted by the bore of a separately formed tube which extends lengthwise with respect to the cable radially outwardly of the metal sheath and which is at least in part encapsulated in a layer of plastics material constituting the overall protective layer surrounding the sheath.

9. A composite cable as claimed in Claim 8, wherein an inner layer of plastics material surrounds the metal sheath and the or each separately formed tube is partially encapsulated in the plastics material of said inner layer and partially encapsulated in the plastics material of the layer constituting the overall protective layer.

10. A composite cable as claimed in Claim 8 or 9, wherein the or each separately formed tube is of plastics material.

11. A composite cable as claimed in any one of the preceding Claims, wherein the or each passage in which an optical fibre is loosely housed is filled throughout its length with a water-impermeable material of a grease-like nature which permits relative movement of the or each optical fibre with respect to the cable.

12. A composite cable as claimed in any one of the preceding Claims, wherein the optical fibre or at least one of the optical fibres has a cladding of plastics material which is, or which by the incorporation of a dopant is rendered, so temperature sensitive that the refractive index of the cladding will change when the temperature of the optical fibre changes.

13. A composite cable as claimed in Claim 12 in which the plastics cladding of the or each optical fibre is rendered temperature sensitive by the incorporation of a dopant, wherein the dopant is a fluorescent dye.

14. A composite mineral insulated electric and optical cable substantially as hereinbefore described with reference to and as shown in Figure 1, 2 or 3 of the accompanying drawing.

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