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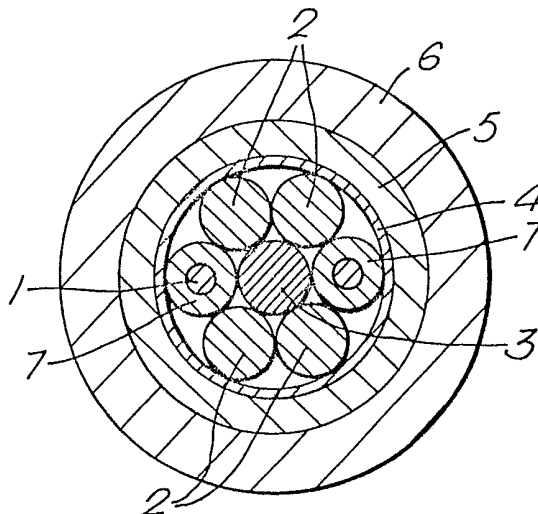
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GB A 2109581 **GB A 2016731**
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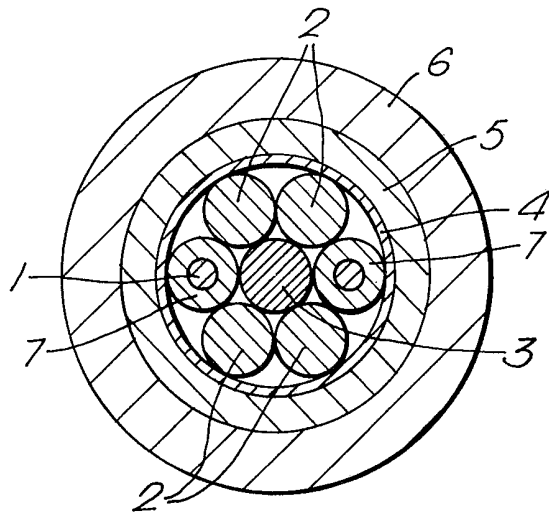
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(54) Optical fibre cables

(57) An optical fibre cable element comprises two optical fibres (1), each having a double-layer on-line coating and is suitable for high temperature, up to 100°C, applications if the coating material comprises, for example, UV epoxy acrylate resin. The innermost layer is of a softer grade than the outer layer; the two layers being applied in tandem. The coated optical fibres are stranded round, or otherwise assembled relative to, a central member (4) together with filler elements (2) and the unit thus produced held together by a heat-resistant tape (4) wrapping. A sheath (6) with or without a strength member layer (5) may be disposed over the tape (4). The fillers (2) may also comprise double-layer on-line coated optical fibres if required.



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SPECIFICATION

Optical fibre cables

- 5 This invention relates to optical fibre cables and optical fibre cable elements for use in such cables and in particular, but not exclusively, to such structures or units for use in high temperature environments.
- 10 According to one aspect of the present invention there is provided an optical fibre cable element comprising an optical fibre having a double layer on-line coating.
- According to another aspect of the present invention there is provided a method of manufacturing an optical fibre cable element comprising on-line coating a bare optical fibre in two coating operations in tandem whereby to provide a double layer on-line coated optical fibre.
- 20 According to a further aspect of the present invention there is provided an optical fibre cable for operation at high temperatures, e.g. above 50°C, comprising at least one optical fibre assembled together with other members to form a unit, the unit being arranged within an outer sheath, and including a layer, disposed between the optical fibre and the outer sheath, which serves to minimise the effects of stress on the fibre due to temperature change.
- 30 Embodiments of the invention will now be described with reference to the accompanying drawing which shows a section through a cable core unit incorporating optical fibres.
- A presently employed cable construction comprises for example six, or up to ten, elements stranded in a single layer around a central member, one or more of the elements comprising an optical fibre with a thin plastics coating (primary coating) of, for example silicone resin, and a secondary coating of, for example, nylon. The fibres and any other elements are secured in position by a core wrap comprising a binding tape of, for example, PETP (Polyethylene terephthalate). A sheath may be applied over the tape. Particularly in the case where the central member is not specifically a strength member, or where additional strength is required, the sheath may comprise a strength member sheath and/or a layer of strength member elements.
- We have found that such a structure will not necessarily stand up to high temperature environments, above 50°C. In particular when such a cable was annealed for a long time (24 hours) at 90°C, excessive incremental optical losses were monitored. These are attributed to the mechanical and structural instability of various of the cable components. For example at high temperatures, a PETP core-wrap exhibited contraction, whilst the nylon secondary coating on the fibres showed signs of "set".
- 60 Therefore, in order to be usable at high temperatures the individual components of the cable should be mechanically, chemically and structurally stable up to the relevant operating temperature and the core-wrap tapes should not have any instability exhibited either as a volume contraction or alternatively

tively as a second order molecular or phase change. This core-wrap tape requirement is essential in order to ensure that stresses are not imparted to the stranded optical fibre core to obviate incremental optical losses.

- The cable structure shown in the drawing includes two optical fibres 1 which are provided with a coating 7 comprising a double layer of polymeric resin, for example two layers of a UV epoxy acrylate.
- 75 To obtain such a coating a bare silica fibre is coated on-line, that is applied to the fibre immediately after pulling as with conventional primary coatings, with a buffer layer of a soft acrylate resin followed in tandem by a second layer of a greater hardness acrylate resin. Such a double layer on-line coating process can be tailored to give an overall outside diameter of the coated fibre of about 0.5 mm. The coatings may be applied by a solution dip coating process. The use of the softer buffer resin coat ensures that the bare fibre is protected from external stresses. The breaking strains of the resin coats should be greater than normal service strains in order to ensure structural stability of the coated fibre. Alternatively, the first layer of the double layer on-line coating may comprise a soft resin, for example silicone rubber or silicone resin, whereas the second layer may comprise a harder coating of UV epoxy acrylate or Kynar resin or other thermosetting materials. The materials chosen will depend at least partially on the proposed use of the finished cable, however the coatings will preferably be thermally stable and possibly heat resistant.
- The two coated fibres 1 are shown stranded together with four filler elements 2 around a central strength member 3 to form a basic unit. The strength member 3 may be comprised of Kevlar 49, which is an aromatic polyamide, a polymer coated steel strand, or another filler element, particularly if the latter are comprised of a glass fibre reinforced plastics material.
- 100 Wrapped around the basic unit thus formed is a heat stabilised tape 4 which serves to maintain the geometrical configuration of the unit. The tape should have a negligibly small shrinkage at high temperatures in order to reduce compressive stress on the fibres of the basic unit and thus keep incremental optical losses (microbending losses) to a minimum. Suitable heat stabilised tapes are FEP (Fluorinated ethene propene) coated Kapton polyamide (as supplied by Du Pont) or PEEK (Polyether-etherketone), or PES (Polyether sulphone), films (as supplied by ICI). An additional advantage of the use of a heat-stabilised tape is that it acts as a stable mechanical barrier to any subsequently applied sheathing material and so prevents any interstitial filling of the strand.
- Whereas only two double-layer on-line coated optical fibres 1 are employed in the illustrated embodiment, one or more of the elements 2 may be replaced by double-layer on-line coated optical fibres 1, therefore up to six optical fibres can be stranded around a member 3 of the same overall outside diameter. Typically the outside diameter of the coated fibre is in the range 0.3 to 0.5 mm. The tape 4 is preferably applied helically with overlap.

In the embodiment illustrated the tape wrapped core is provided with an additional strength member layer 5 comprised by Kevlar strands, for example 1420 denier Kevlar 49 yarns, Kevlar 29 yarns or a Kevlar 49 braid. Over the layer 5 is extruded a sheath 6 of Hytrel, a polyester elastomer, (as supplied by Du Pont).

The sheathed or unsheathed optical fibre units thus formed may be assembled with other cable components of like or unlike type to provide a larger cable structure. Alternatively, the tape wrapped core may be sheathed directly, the strength member layer 5 being omitted.

As well as improving the high temperature performance, the use of the double-layer on-line coated fibre offers other advantages. It removes the need for the conventional secondary coating, thus providing a considerable cost saving for the overall cable making process. In addition, no buffering of the fibres in the cable structure is required. Furthermore, the cable weight per unit length is reduced and fibre splicing is facilitated when employing only one type of coating rather than two of the conventional primary and secondary coated fibres. In submarine applications or other constructions where an optical fibre cable core is disposed within an aluminium, or other material, C-section, which is closed there around, the inventive cable core described above would prove very useful due to its compact and stable structure. By means of the double-layer UV epoxy acrylate coated fibres and the temperature stabilised tape the usable temperature range of an optical fibre cable can be extended up to 100°C.

Whereas the above description refers to stranding coated fibres and other members around a central strength member, the various members may alternatively be assembled together in other ways. For example, the optical fibres and other members may be laid substantially parallel to and in loose form relative to the central strength member, this being followed by the heat stabilised tape wrap. Such a structure is particularly suitable for use in a C-section of a submarine cable as an optical core.

Whereas in the embodiment described above both the heat resistant tape and the double-layer on-line coating are employed, the use of heat stabilised tapes with conventional secondary coated fibres is also advantageous since the tape does not shrink and therefore avoids imposing stress on the optical fibres.

CLAIMS

1. An optical fibre cable element comprising an optical fibre having a double-layer on-line coating.
2. A cable element as claimed in claim 1, wherein one layer of the double layer is softer than the other layer.
3. A cable element as claimed in claim 2, wherein the coating is comprised of a UV epoxy acrylate resin, the inner layer being softer than the outer layer.
4. A cable element as claimed in claim 2, wherein the one layer is comprised of silicone rubber or silicone resin and the other layer is comprised of UV

epoxy acrylate resin, or a thermosetting material.

5. A cable comprising a cable element as claimed in any one of the preceding claims assembled together with other members relative to a central member.

6. A cable as claimed in claim 5 wherein said cable element is stranded together with said other members around said central member.

7. A cable as claimed in claim 5 wherein said cable element and said other members are substantially parallel laid in loose form relative to said central member.

8. A cable as claimed in any one of claims 5 to 7 wherein the element and members are wrapped with a heat stabilised tape.

9. A cable as claimed in claim 8, wherein the heat stabilised tape is comprised of polyether-ether ketone, polyether sulphone or fluorinated ethene propene coated Kapton polyamide.

10. A cable as claimed in claim 8 or claim 9, including a sheath over the heat stabilised tape.

11. A cable as claimed in claim 10, wherein the sheath comprises or includes a strength member.

12. A cable as claimed in any one of claims 5 to 11, wherein the central member comprises a strength member.

13. A cable as claimed in any one of claims 5 to 12, wherein the other members comprise optical fibres having a double-layer on-line coating.

14. A method of manufacturing an optical fibre cable element comprising on-line coating a bare optical fibre in two coating operations in tandem whereby to provide a double layer on-line coated optical fibre.

15. A method as claimed in claim 14, wherein in a first coating operation the bare optical fibre is coated with a first layer comprising a relatively soft grade of a polymeric resin and wherein in a second coating operation the first layer is coated with a second layer comprising a relatively hard grade of a polymeric resin.

16. A method as claimed in claim 15, wherein the first and second layers are comprised of a UV epoxy acrylate resin.

17. A method as claimed in claim 14, wherein one layer is comprised of a UV epoxy acrylate resin or a thermosetting material.

18. A method of manufacturing a cable comprising assembling at least optical fibre cable element as claimed in any one of claims 1 to 4 with other members relative to a central member whereby to form a core unit.

19. A method as claimed in claim 18, including the step of wrapping the core unit with a heat stabilised tape.

20. A method as claimed in claim 19, including the step of providing a sheath over the heat stabilised tape.

21. A method as claimed in claim 20, wherein the sheath providing step includes providing a strength member layer on the tape and extruding a plastics sheath over the strength member layer.

22. An optical fibre cable for operation at high temperatures, e.g. above 50°C, comprising at least one optical fibre assembled together with other

members to form a unit, the unit being arranged within an outer sheath, and including a layer, disposed between the optical fibre and the outer sheath, which serves to minimise the effects of stress on the fibre due to temperature change.

5 stress on the fibre due to temperature change.

23. A cable as claimed in claim 22, wherein the unit is wrapped with a heat stabilised tape comprising said layer.

24. A cable as claimed in claim 23, wherein the heat stabilised tape is comprised of polyether-ether ketone, polyether sulphone or fluorinated ethene propene coated kapton polyamide.

25. A cable as claimed in claim 22, wherein the optical fibre is provided with a double layer on-line coating comprising said layer.

26. A cable as claimed in claim 25, wherein one layer of the double layer is softer than the other layer.

27. A cable as claimed in claim 25 or claim 26, wherein the coating is comprised of a UV epoxy acrylate resin, the inner layer being softer than the outer layer.

28. An optical fibre element or cable substantially as herein described with reference to the accompanying drawing.

29. A method of manufacturing an optical fibre cable or element substantially as herein described with reference to the accompanying drawing.