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(54) FIBRE–OPTIC ELEMENTS AND THEIR USE

(71) We, AKTIESELSKABET NORDISKE KABEL– OG TRAADFABRIKER, a body corporate organised and existing under the laws of Denmark, of La Cours Vej 7, DK–2000 Copenhagen F, Denmark, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to an optical element for use in optical transmission means, for example in tele-cables, which element is of the type comprising one or more optical fibres, each of which is possibly provided with a protective layer applied around the fibre and which furthermore comprises a strength member. The invention further relates to optical transmission means comprising such optical elements.

It is known to produce tele-cables with optical fibres where the fibres are placed in the cables in longitudinal spaces with cross-sectional dimensions considerably bigger than the fibre diameter.

It is also known to establish a twisted placing of the fibres in such spaces. Moreover, it is known to adhere fibres in undulated paths between two plastic bands which then are wound around a central reinforcing member, *cf.* U.S. Patent No. 3937959. Furthermore, cables are known too where the fibres are wound helically around a soft support layer being placed around a massive support wire, *cf.* U.S. Patent No. 3883218. It is a common aim of these known cable types to prevent as far as possible the mechanical impacts at tension or bending from affecting the optical fibres, and especially to prevent detrimental tensile impacts.

Further, it is universally known to provide the cables with strength members which serve the function of absorbing the tensile effects to which the cable is exposed, for example during handling and laying out, *cf.* for example the above U.S. Patent No. 3887265 and U.S. Patent No. 3865466.

According to the present invention in one aspect there is provided an optical element for use in optical transmission means and comprising a strength member and at least one optical fibre wherein said optical fibre or fibres are provided with a tight-fitting coating and the strength member is provided with a tight-fitting coating, both coatings being of the same material, each of said coatings having a circular cross-section, the coating on the optical fibre or fibres further being connected with the coating on the strength member by connection means of the same material as the coatings, and whose thickness is substantially smaller than the diameter of the coatings and where further the fibre or fibres are given a curve or wave shaped course with respect to the course of the strength member.

According to the present invention in another aspect there is provided an optical transmission means comprising at least one optical element located in a sheath, in which said optical element comprises at least one optical fibre which is provided with a tight-fitting coating and a strength member provided with a tight-fitting coating, both coatings being of the same material, each of said coatings having a circular cross-section, the coating on the optical fibre or fibres further being connected with the coating on the strength member by a connection means of the same material as the coatings, and whose thickness is substantially smaller than the diameter of the coatings and where further the fibre or fibres are given a curve or wave shaped course with respect to the course of the strength member.

The present invention provided constructional characteristics whereby it is possible to a greater extent than heretofore to avoid deterioration or destruction of the optical fibres in respect of their transmission capability as a consequence of mechanical impacts, such as tension, bending and torsion. In This connection it must be remembered that deterioration or even destruction of an otherwise perfect fibre can be expected if due to one or more defects its light conducting interior is narrowed or bended even at an extremely small part of a cable section where the magnitude of the extent of the defect is only a fraction of a millimeter for which reason such defects are referred to as microcracks or microbendings. It is obvious that a tensile force affecting the optical fibre will

increase the possibility of cracks the more the bigger the tensile force is. In the heretofore known constructions of tele-cables with optical fibres efforts have been made, as previously stated, to reduce the size and risk of tensile stresses in the optical fibres, for example by the mentioned forms of twisted or helical placing of the fibres in the jacket possibly in combination with more or fewer strength members.

Some embodiments of the invention will now be described, by way of examples, with reference to the accompanying drawings, in which:-

Figure 1 is a longitudinal section through a part of an optical element according to the invention, comprising one optical fibre and a strength member,

Figures 2A-2C show a cross-section through three different embodiments of an element according to the invention, Figure 2A corresponds to Figure 1, while Figure 2B shows a wider fin and Figure 2C several optical fibres with common coating.

Figure 3 shows, seen from the side, a part of an optical element according to the invention, comprising a central strength member and two optical fibres in wave shape,

Figure 4 is a cross-section taken along line A-A indicated on Figure 3,

Figure 5 is a cross-section taken along line B-B indicated on Figure 3,

Figure 6 is a cross-section of a tele-cable having optical elements of the type shown in Figure 1, and

Figure 7 is a cross-section of a tele-cable having two optical elements of the type shown in Figure 1 and one element of the type shown in Figure 3.

The present invention departs from the conventional principle as it is characteristic of the invention that the fibre or fibres, which may be provided with protective layer, and the strength member are provided with an essentially tight-fitting coating of the same material applied separately or commonly around one or more fibres and around the strength member with an essentially circular cross-section, the coating or coatings on the optical fibre or fibres being firmly connected with the coating on the strength member of means of connection means, such as a continuous or locally broken fin whose thickness is substantially smaller than the diameter of the coatings, and where further the fibre or fibres are given a curve or wave shaped course in relation to the straight course of the strength member.

This curved course can according to the invention be established for example for exposing the strength member during application of the coatings, which can be done with advantage of extrusion, to a tensile impact giving the strength member an elastic elongation while the optical fibre or fibres during this is essentially free from tension. During the subsequent relief and contraction of the strength member the part or parts of the element containing optical fibre or fibres will assume a curve or wave shaped course because of the connecting fin.

Further, by means of a suitable shaping of the extrusion tool it can be achieved according to the invention that the part or parts of the lement containing optical fibres will become longer than the part containing the strength member. The optical fibres will then assume a curve or wave shaped course.

The thickness and width of the fin depend especially on the properties of the coating material, the intended use of the element and the consequent, desired curve or wave shape. The thickness must however, be of such a nature that the fin can withstand and the twisting to which it is exposed without cracking, and the width must be so large that the established curve or wave shape can accommodate the overlength of the fibre in relation to the strength member. Therefore, the width is preferably larger than the diameter of the coatings.

It will be understood that an element according to the invention, if it contains several optical fibres, either can have these joined in more or frewer common coatings, or can have a separate coating for each fibre.

The coating used can for example consist of a natural or synthetic polymer material, such as polyethylene, polypropylene or copolymers thereof, polyvinylchloride or a polyamide, such as polyamide 11 or 12, where the latter group of material is preferred because of its good adhesive properties. However, this ennumeration should not be construed as limitary since the choice of coating material is not critical to the invention.

If desired, the coating can further comprise an additive, for example a reinforcement material such as longitudinal fibres. Other additives are for example arbitrarily orientated fibres, inorganic or organic fillers, cross-linkers, pigments, dyes, etc.

If one or more of the subject elements are placed in a sheath to form for example a tele-cable without being exposed to tensile forces during this process, the elements will maintain their curve or wave shape. It will be seen that a cable containing such elements withstands tensile impacts to an exceptionally high degree.

The invention is illustrated in greater detail in the accompanying drawings where:-

Figures 1 and 2A show an optical element having an optical fibre 1, a coating 7, which for example can be of a polymer material, and a strength member 6 produced from a material with a high elasticity modulus, for example a synthetic fibre material or a metal. The fin 8 contributes to the curved course of the element.

Figure 2B shows a preferred embodiment where the fin 8 is wider than the diameter of the coatings 7. Figure 2C shows an embodiment having five optical fibres 1 provided with a common coating 7 having a larger diameter than the coating 7 of the strength member 6. The same numerals are used in the various

figures.

Figures 3-5 show an embodiment having two optical fibres 1, the same numerals being used as in Figures 1 and 2. The optical fibres 1 are situated diametrically opposite in relation to the strength member 6, but can in principle form any conceivable angle with this.

Figure 6 shows a tele-cable having five optical elements of the subject type with one optical fibre 1, strength member 6, coating 7 and fin 8. The elements are placed in spaces 9, which can possibly be provided with a filler, for example vaseline, in a tubular jacket 10, which for example can be a polymer sheath.

Figure 7 shows a similar cable where there are two optical elements each having one optical fibre 1 and one element with two optical fibres 1 of the type shown in Figure 3. The numerals are the same as in Figure 6.

WHAT WE CLAIM IS:—

1. An optical element for use in optical transmission means and comprising a strength member and at least one optical fibre wherein said optical fibre or fibres are provided with a tight-fitting coating and the strength member is provided with a tight-fitting coating, both coatings being of the same material, each of said coatings having a circular cross-section, the coating on the optical fibre or fibres further being connected with the coating on the strength member by connection means of the same material as the coatings, and whose thickness is substantially smaller than the diameter of the coatings and where further the fibres are given a curve or wave shaped course with respect to the course of the strength member.

2. An optical element as claimed in claim 1, in which the optical fibres are provided with an intermediate protective layer.

3. An optical element as claimed in claim 1 or 2, in which said connection means is a continuous fin.

4. An optical element as claimed in claim 1 or claim 2, in which said connection means is a locally broken fin.

5. An optical element as claimed in any preceding claim, in which a plurality of optical fibres are embedded in at least one common coating.

6. An optical element as claimed in any of claims 1 to 4, in which two or more optical fibres are provided which are embedded in separate coatings.

7. An optical element as claimed in any preceding claim, in which the width of the connection means is larger than the diameter of the coatings.

8. An optical element as claimed in any preceding claim, in which the curved course of the fibres is established by subjecting the strength member to a tensile force during application of the coating and subsequently relieving the force.

9. An optical element as claimed in any of claims 1 to 7, in which the curved course of the fibre or fibres is established by applying the coating in such a way that the length of the coated optical fibre or fibres exceeds the length of the strength member.

10. An optical element as claimed in any preceding claim, in which the coating comprises a polymer material.

11. An optical element as claimed in claim 10, in which the polymer material comprises a polyethylene, polypropylene or copolymers thereof, polyvinylchloride or polyamide.

12. An optical element as claimed in claim 8, in which the coating further comprises a reinforcement material.

13. An optical transmission means comprising at least one optical element located in a sheath, in which said optical element comprises at least one optical fibre which is provided with a tight-fitting coating and a strength member provided with a tight-fitting coating, both coatings being of the same material, each of said coatings having a circular cross-section, the coating on the optical fibre or fibres further being connected with the coating on the strength member by a connection means of the same material as the coatings, and whose thickness is substantially smaller than the diameter of the coatings and where further the fibre or fibres are given a curve or wave shaped course with respect to the course of the strength member.

14. Optical transmission means as claimed in claim 11, in which said connection means is a continuous fin.

15. Optical transmission means as claimed in claim 11, in which said connection means is a locally broken fin.

16. A fibre-optic element substantially described with reference to and as illustrated in the accompanying drawings.

17. A tele-cable comprising a fibre-optic element according to claim 16.

18. A process for preparing a fibre-optic element according to claim 1, substantially as hereinbefore described with reference to any one of the embodiments illustrated by the accompanying drawings.

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1591129 COMPLETE SPECIFICATION
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Sheet 1

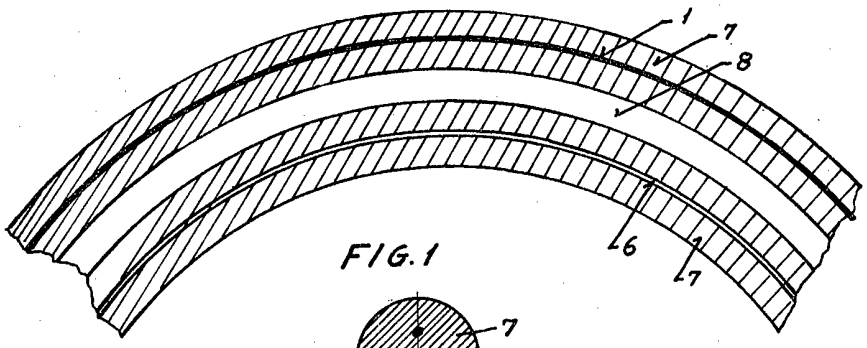

FIG. 1

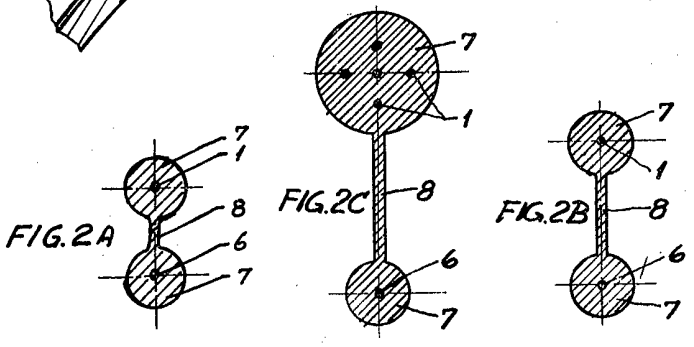

FIG. 2A

FIG. 2C

FIG. 2B

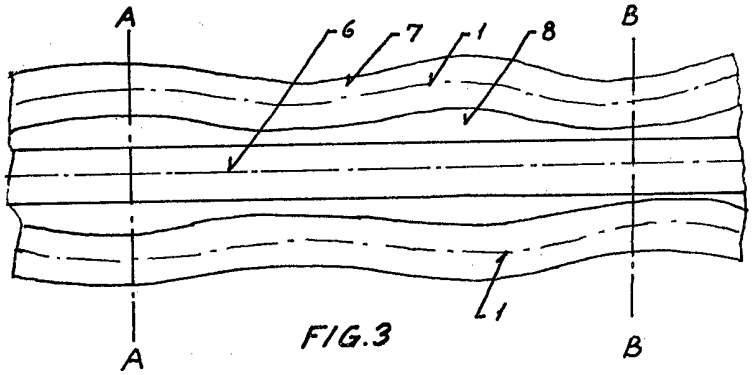

FIG. 3

1591129 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

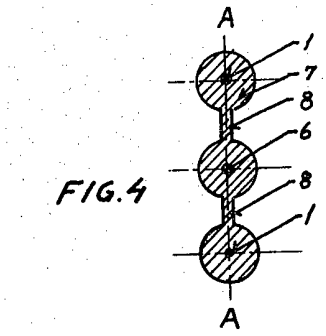

FIG.4

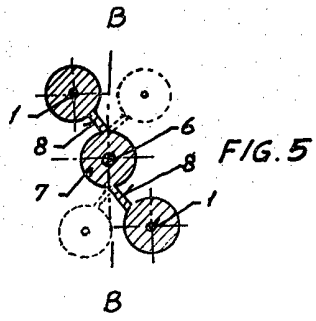

FIG.5

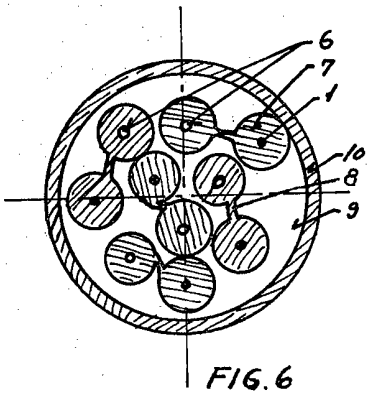

FIG.6

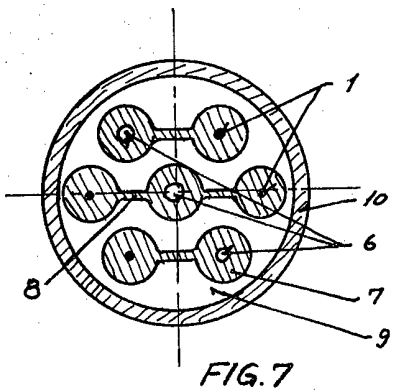

FIG.7