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(56) Documents cited

GB 2253715 A	GB 2174506 A	GB 2144239 A
GB 2143650 A	GB 2136147 A	GB 1602587 A
GB 1500026 A	EP 0381766 A1	EP 0171614 A2
US 4662962 A	US 3681164 A	US 3455625 A

(58) Field of search
UK CL (Edition L) G2J JGDB JGEA
INT CL[5] G02B

(54) Splicing optical waveguides using solidifiable refractive index matching gel

(57) A solidifiable refractive-index matching means 4 is used to splice optical waveguides 1. The index-matching means is applied between the ends of the two waveguides in a support arrangement 2 and is then solidified to form a splice having optical, ageing and temperature characteristics substantially corresponding to those of the waveguides. The temperature at which solidification is effected can be such that the refractive index-matching means is sintered to form a glass splice. The index-matching means 4 is preferably a silica gel which can be solidified either chemically or by the application of heat. Groove 12 and cover 13 are shown.

Fig. 1

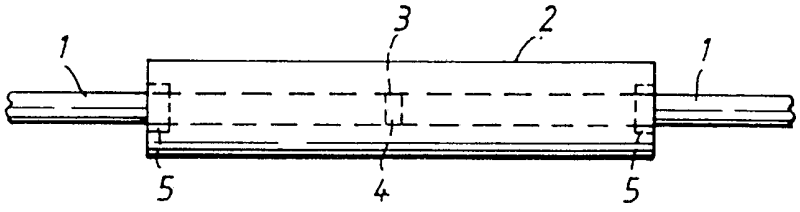
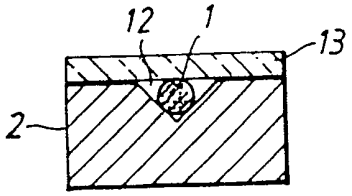


Fig. 2



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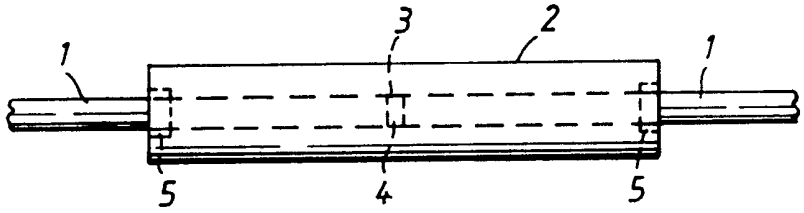
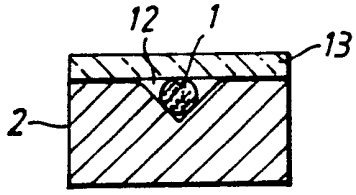
Фиг. 1



Фиг. 2



A METHOD AND AN ARRANGEMENT FOR SPLICING OPTICAL WAVEGUIDES

The invention relates to a method and an arrangement for splicing optical waveguides and, more specifically, for effecting such splicing under field conditions i.e. directly in cable pits where the waveguides requiring splicing are housed.

It is known to splice optical waveguides, such as optical fibres, by means of automatic welding. However, automatic welding requires a high temperature, approximately 2000° C, and a clean environment. The welding must, therefore, be carried out in an enclosed environment, such as a special caravan which is transported to the site where the optical fibres requiring splicing are located. It is a requirement of such an arrangement that the optical fibres which are usually housed in a cable pit in the ground, have sufficiently long loops so that they can be drawn into the caravan for splicing. Even though a good splice is obtained with this arrangement, the technology is expensive because of the need to use special equipment. Furthermore, it is not always possible to transport the special caravan to all possible locations where the splicing of optical fibres needs to be effected.

Purely mechanical splices have also already been used, that is to say, the ends of the two optical fibres requiring splicing are enclosed within a capsule and placed against one another with an air gap therebetween. This arrangement can cause losses in the splice because in cutting the ends of the fibres in readiness for splicing, the cut surfaces at the ends of the fibres are not quite perfect and this creates reflection and attenuation with each change in the refractive

index at the splice. It is known to alleviate these problems by filling the air gap with refractive index-matching means, for example, silicon oils or epoxy cements. With silicon oils which are free flowing, leakage can occur. Moreover, the silicon oils and the optical fibre waveguides have different temperature characteristics. There are also problems with different ageing characteristics. The use of epoxy cements for splicing optical waveguides which give rise to similar problems to the ones outlined above for silicon oils, can be a health hazard in that they emit vapours that can be damaging to health.

It is an object of the present invention to overcome the foregoing problems with known splicing arrangements by the provision of a method and an arrangement for splicing optical waveguides, such as optical fibres, that can be effected in the field, for example, in the cable pits in which the waveguides are housed and that produces splices which have good refractive index matching and thereby relatively low losses and which have optical, ageing and temperature characteristics similar to those of the optical waveguides.

The invention provides a method for splicing optical waveguides comprising the steps of providing a support arrangement for the waveguides, supporting the ends of the waveguides requiring splicing in the support arrangement with a solidifiable refractive index-matching means applied between the ends of the waveguides, and solidifying the refractive index-matching means to form a splice having optical, ageing and temperature characteristics substantially corresponding to those of the optical waveguides.

The invention also provides an arrangement for splicing optical waveguides comprising a support arrangement for supporting, and fixing the position of, the ends of the waveguides requiring splicing and a solidifiable refractive-index matching means applied between the ends of the waveguides in the support arrangement wherein the optical, ageing and temperature characteristics of the waveguides substantially correspond to those of the refractive index-matching means after solidification.

The solidification of the refractive index-matching means can be effected chemically by the use of a catalyst or by the application of heat.

The refractive index-matching means can be provided by silica gel which can be solidified by the application of heat and which can be sintered to form a glass splice.

The foregoing and other features according to the present invention will be better understood from the following description with reference to the accompanying drawings, in which:-

Figure 1 illustrates, in a side elevation, an arrangement according to the present invention for splicing two optical fibre waveguides, and

Figure 2 illustrates, in a cross-sectional elevation, an alternative arrangement according to the present invention for splicing two optical fibre waveguides.

As illustrated in Figure 1 of the drawings, an arrangement according to the present invention for splicing two optical fibre waveguides includes a support arrangement 2 which is preferable in the form of a tube and which has a through hole into each end of which respective ones of two optical fibres 1 are inserted. The

intermediate space 3 between the ends of the optical fibres 1 is filled with a refractive index-matching gel 4. The same gel is also used to effect the sealing of the optical fibres 1 in the support arrangement 2 at the ends 5 thereof.

With this arrangement, the gel is placed in the through hole of the support arrangement 2 and the ends of the optical fibres 1 are then inserted into the hole, one in each end thereof. This causes the gel to file the space 3 between the ends of the optical fibres 1 and to seal the fibres in the support arrangement 2 at the ends 5 thereof. The gel is then suitably solidified in the manner outlined below to form a splice.

An alternative arrangement according to the present invention for splicing two optical fibre waveguides is illustrated in Figure 2 of the drawings and includes a support arrangement 2 having a V-shaped groove 12 formed in one surface thereof. The optical fibres 1 are located, in alignment, in the groove 12 with the space between the ends of the fibres filled with a refractive index-matching gel (not shown). The gel can be applied either before or after the optical fibres 1 are located in the groove 12. After the two optical fibres 1 and the gel 4 are placed in the groove 12, a cover 13 which can be made of thin glass, is then placed over the groove 12 to enclose the ends of the optical fibres 1 and the gel located therebetween. The cover 13 is held in position by adhesion to the gel. Alternatively, a snap-on cover could be used in place of the illustrated cover 13. Furthermore, the cross-section of the groove 12 could be of a shape other than V-shaped. After the cover 13 is in place, the gel is then suitably solidified in the manner outlined below to form a splice.

With the arrangement according to the present invention, the refractive index-matching means can be provided by a gel, namely, silica gel, which can be solidified i.e. hardened, to form a splice between the ends of the optical waveguides by the application of heat. Alternatively, refractive index-matching gels can be used which can be solidified i.e. hardened, chemically by means of a catalyst, for example, alkoxide.

With silica gels, solidification can, as mentioned above, be effected by the application of heat. In one embodiment of the invention, the silica gel is heated to a temperature at which the moisture content of the silica gel is evaporated and a non-flowing splice is formed between the ends of the optical fibre waveguides 1. This splice has a refractive index and other characteristics that substantially correspond to those of the material from which the optical fibre waveguides are formed. For the silica gel to solidify, no especially high temperature is required and approximately 100°C is sufficient to effect solidification. Thus, the heating of the silica gel can be effected with a simple burner or an electrical heating arrangement.

To obtain a splice of even higher quality, the silica gel can be heated to a higher temperature i.e. in the range 200°C to 1000°C. By this means, the silica gel is sintered into quartz. By selecting a suitable silica gel, a splice can be obtained which will have the same characteristics as the material from which the spliced optical fibres is formed.

There are, as stated above, refractive index-matching gels which can be solidified by the addition of a catalyst to the gel. With

this arrangement, the hardening of the gel is effected chemically and the application of heat to the splice is not required.

Naturally, the invention does not need to be applied outside in the field but can also be applied, for example, in equipment with fibre optics where the space in which splicing is to be effected is limited and a simple splice is required. Furthermore, the arrangement according to the present invention can also be used for the splicing of optical waveguides, for example, optical fibres, having different cross-sectional dimensions.

The method and arrangement according to the present invention for splicing optical waveguides provides may advantages. The use of a support arrangement 2 results in a splice that is mechanically rigid and due to the presence of the hardened index-matching means cannot readily come apart. Furthermore, no leakage is possible since the index-matching means is not free flowing. By selecting a gel which, when it is sintered, is of the same material as the optical fibre, optimum matching of optical, ageing and temperature characteristics can be obtained. The invention does not make any special demands on the environment but can be carried out in existing cable pits with uncomplicated, inexpensive and reliable equipment.

CLAIMS

1. A method for splicing optical waveguides comprising the steps of providing a support arrangement for the waveguides, supporting the ends of the waveguides requiring splicing in the support arrangement with a solidifiable refractive index-matching means applied between the ends of the waveguides, and solidifying the refractive index-matching means to form a splice having optical, ageing and temperature characteristics substantially corresponding to those of the optical waveguides.

2. A method as claimed in claim 1 wherein the solidification of the refractive index-matching means is effected chemically.

3. A method as claimed in claim 1 wherein the solidification of the refractive index-matching means is effected by the application of heat.

4. A method as claimed in claim 3 wherein the refractive index-matching means is a silica gel and wherein solidification is effected by heating the silica gel to a temperature at which the moisture content of the gel is evaporated and a non-flowing splice is formed between the ends of the optical waveguides.

5. A method as claimed in claim 4 wherein the silica gel is heated to a temperature of approximately 100° C.

6. A method as claimed in claim 3 wherein the refractive index-matching means is a silica gel and wherein solidification is effected by heating the silica gel to a temperature at which the gel is sintered and a glass splice is formed between the ends of the optical waveguides.

7. A method as claimed in claim 6 wherein the silica gel is heated to a temperature in the range 200°C to 1000°C.

8. A method for splicing optical waveguides substantially as hereinbefore described with reference to the accompanying drawings.

9. An arrangement for splicing optical waveguides comprising a support arrangement for supporting, and fixing the position of, the ends of the waveguides requiring splicing and a solidifiable refractive-index matching means applied between the ends of the waveguides in the support arrangement wherein the optical, ageing and temperature characteristics of the waveguides substantially correspond to those of the refractive index-matching means after solidification.

10. An arrangement as claimed in claim 9 wherein the refractive index-matching means is a silica gel which can be sintered to form a glass splice by the application of heat.

11. An arrangement as claimed in claim 9 wherein the refractive index-matching means is a gel which can be solidified chemically with the aid of catalyst.

12. An arrangement as claimed in claim 11 wherein the catalyst is an alkoxide.

13. An arrangement as claimed in any one of the preceding claims 9 to 12 wherein the support arrangement comprises a member having a groove formed in one surface thereof, the ends of the waveguides being located, in alignment, in the groove, a cover for enclosing the ends of the waveguides and the refractive index-matching means in the groove, and means for retaining the cover in position.

14. An arrangement as claimed in claim 13 wherein the cover is retained in position by adhesion to the refractive index-matching means.

15. An arrangement as claimed in claim 13 or claim 14, wherein the cross-section of the groove is V-shaped.

16. An arrangement as claimed in any one of the preceding claims 9 to 12 wherein the support arrangement comprises a tube in which the ends of the waveguides and the refractive index-matching means are enclosed.

17. An arrangement for splicing optical waveguides substantially as hereinbefore described with reference to the accompanying drawings.

18. A spliced optical waveguide wherein the splicing of the waveguide is effected by a method as claimed in any one of the claims 1 to 8 or by an arrangement as claimed in any one of the claims 9 to 17.

.ts Act 1977
.niner's report to the Comptroller under
.ction 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition K) G2J (JGEA, JGDB)

(ii) Int Cl (Edition 5) G02B

Search Examiner

MR C J ROSS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

3 FEBRUARY 1993

Documents considered relevant following a search in respect of claims 1 TO 18

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
P,X	GB 2253715 A	(CARL ZEISS) 16 September 1992 see especially pages 12-13	1 and 9 at least
X	GB 2174506 A	(STC) see especially page 3 line 84 on	1 and 9 at least
X	GB 2144239 A	(RAYCHEM) see especially page 4 line 67 on	1 and 9 at least
X	GB 2143650 A	(ISEC)	1 and 9 at least
X	GB 2136147 A	(RAYCHEM) see especially page 1 line 120 on	1 and 9 at least
X	GB 1602587	(LES CABLES DE LYON) see especially page 2 line 111 on	1 and 9 at least
X	GB 1500026	(POST OFFICE) see especially page 4 line 105 on	1 and 9 at least
X	EP 0381766 A1	(N.E.G.) see especially page 9 line 5 on	1 and 9 at least
X	EP 0171614 A2	(SUMITOMO) see especially page 8 line 10 on	1 and 9 at least
X	US 4662962	(A.T.I.)	1 and 9 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9224782.4

Relevant Technical fields

(i) UK Cl (Edition) Contd. from page 1

(ii) Int Cl (Edition)

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

MR C J ROSS

Date of Search

3 FEBRUARY 1993

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	US 3681164	(BAZINET) see especially column 1 line 65 on	1 and 9 at least
X	US 3455625	(BRUMLEY) see especially column 3 line 11 on	1 and 9 at least

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