

CASSETTE FOR ENCLOSING OPTICAL FIBRE SPLICES OR JOINTS

This invention relates to cassettes for enclosing joints between optical cables each comprising a multiplicity of optical fibres.

It is the general practice to house protected splices or joints between optical fibres of two optical cables in a plurality of separately formed cassettes or other containers which are assembled together and housed in an overall joint enclosure into which the optical cables are fed, all such containers hereinafter, for convenience, being included in the generic term "cassette". Each cassette usually houses a plurality of protected optical fibre splices or joints and an excess length of each optical fibre of each splice or joint to provide for any necessity to re-splice or re-joint the optical fibres of any splice or joint which develops a fault.

By the expression "protected optical fibre splice or joint" is meant an optical fibre splice or joint which is surrounded by or enclosed within individual means for providing mechanical protection for the splice or joint.

In order to provide for an excess length of each optical fibre of the plurality of protected splices or joints housed within a cassette, it is common practice for a substantial length of optical fibre extending from a protected splice or joint to be coiled within the periphery of the cassette in at least one complete turn before the fibre emerges from the cassette.

Furthermore, in order to avoid or limit the extent of optical signal attenuation and optical fibre fatigue that might otherwise be caused by a bend in an optical

fibre, it is also common practice to ensure that the radius of the or each bend in the excess length of each optical fibre does not fall below a predetermined minimum value, usually in the order of 30mm. As a consequence, the size of a cassette is determined, not by the number of protected optical fibre splices or joints which it houses, but by the minimum radius to which any optical fibre can be bent and a substantial proportion of the space within the cassette serves no useful purpose. Moreover, a plurality of such cassettes assembled together occupies a substantial volume with the consequential serious disadvantage that an overall optical cable joint enclosure which is to house one or more than one assembly of such cassettes is unnecessarily large and expensive and would occupy substantial space in a jointing bay or cabinet.

It is an object of the present invention to provide, for use in effecting an optical connection between optical fibres of two or more optical cables, a cassette by use of which the volume of an overall optical cable joint enclosure housing a multiplicity of protected optical fibre splices or joints can be substantially reduced as compared with an overall optical cable joint enclosure hitherto used to house a like number of protected optical fibre splices or joints, without eliminating the provision of an excess length of each optical fibre to accommodate for any re-splicing or re-jointing of the optical fibres of a splice or joint that may be required.

According to the invention, there is provided a cassette for enclosing an optical connection between

optical fibres of two or more optical cables, the cassette containing:

- (i) a preformed component comprising a housing in which at least one optical conductor is so disposed that opposite end parts of the or each conductor protrudes from the housing at an angle to one another lying in the range 0° to 90° , each of the protruding parts of the or each optical conductor consisting of a length of optical fibre, and
- (ii) a splice or joint between one protruding length of optical fibre and an optical fibre of one of the optical cables, and a splice or joint between the other protruding length of optical fibre and an optical fibre of the other optical cable, the splices or joints being provided with mechanical protection;

the preformed component and the optical fibre splices or joints being so disposed in the cassette that the protected optical fibre splices or joints are spaced from the preformed component and that the preformed component and/or the protected optical fibre splices or joints are so detachably mounted in the cassette that the distance between the protected optical fibre splices or joint and the preformed component can be reduced.

Preferably, opposite end parts of the or each optical conductor protrude from the housing in substantially the same direction.

In using the preformed component to effect an optical connection between optical fibres of two optical

cables, one of two protruding lengths of optical fibre of the or each optical conductor of the preformed component is spliced or jointed to one of two optical fibres to be optically connected and the other of said two protruding lengths of optical fibre of said optical conductor is spliced or jointed to the other of said two optical fibres, and mechanical protection is provided for each optical fibre splice or joint. Preferably, the protruding lengths of optical fibre of the or each optical conductor of the preformed component are spliced or jointed concurrently to the optical fibres to be optically connected. Each optical fibre splice or joint may be provided with individual mechanical protection or, alternatively, two or more optical fibre splices or joints may be provided with mechanical protection common to said splices or joints. By virtue of the fact that the distance between the protected optical fibre splices or joints and the preformed component can be reduced, re-splicing or re-jointing of any splice or joint can be accommodated. Usually the plurality of protected optical fibre splices or joints in the cassette will be arranged side-by-side so that the protruding lengths of optical fibre of the or each optical conductor of the preformed component over at least parts immediately adjacent the protected optical fibre splices or joints are arranged to extend in the same direction and substantially parallel to one another, the protruding lengths of optical fibre providing the excess length of optical fibre available to accommodate any re-splicing or re-jointing of any optical fibre splice or joint that may be required.

Although two protected optical fibres splices or joints are required to effect an optical connection between two optical fibres of the optical cables, doubling of the number of protected optical fibre splices or joints required to effect optical connections between optical fibres of two optical cables does not necessitate any increase in the size of the cassette that might otherwise be employed and, in fact, because the protruding lengths of optical fibre of the preformed component provide the excess lengths of fibre available for effecting any re-splicing or re-jointing that may be required, the overall size of a cassette required to house the protected optical fibre splices or joints and preformed component interconnecting the optical fibres of the optical cables can be substantially less than that of the cassette hitherto employed to house the protected optical fibre splices or joints, and the coiled excess lengths of optical fibre protruding therefrom, interconnecting the optical fibres of optical cables of the same construction.

In order to provide for opposite end parts of the or each optical conductor of the preformed component to protrude from the housing of the component at an acute angle to one another lying in the range 0° to 90° , and preferably in substantially the same direction, an intermediate portion of the length of the or each optical conductor disposed in the housing either sweeps through an angle lying in the range 90° to 180° , preferably an angle of approximately 180° (so that the angle between the ingoing and outcoming fibres is approximately 0°), or has optically interconnected

therein and forming a part thereof at least one means for causing an optical signal entering the optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other of said protruding lengths of optical fibre. Where an intermediate portion of the length of the or each optical conductor disposed in the housing sweeps through an angle lying in the range 90° to 180° and the optical conductor is an optical fibre, then the radius of the bend in the optical fibre will be such that the extent of any attenuation of an optical signal and of any optical fibre fatigue caused by the bend are acceptable; since there is only a single bend in the optical fibre, the radius of the bend can be substantially less than the minimum radius of bends in excess lengths of optical fibres coiled in cassettes hitherto used and can be in the region of 15mm or even less. By using optical fibre designed to have strong guiding of an optical signal at the operating wavelength and by employing an annealed fibre or a hermetically coated fibre to reduce any fibre fatigue, a bend of very small radius, e.g. 5mm, may be used. Where means for causing an optical signal entering the optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other of said protruding lengths of optical fibre is interconnected in said intermediate part of and forms a part of the optical conductor, said means may comprise a reflector or refractor or an integrated optical chip. The integrated optical chip, or another integrated optical chip disposed within the housing and constituting at

least part of the or an optical conductor of the preformed component, may be designed to effect any one of a plurality of fibre-optic functions included among which are:-

- (i) a tree coupler constituting a cascaded series of Y-junctions;
- (ii) a star coupler incorporating a mixing region intermediate of a plurality of input points and a plurality of output points;
- (iii) a wavelength selector such as a wavelength division multiplexor or a band-pass filter.

This list of functions which the or an integrated optical chip of the preformed component can serve is by no means exhaustive.

The housing of the preformed component may be a moulded body of plastics insulating material in which the or each optical conductor, and when present the or each integrated optical chip or other means for causing an optical signal entering the or an optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other said protruding lengths of optical fibre, may be at least partially encapsulated.

The invention also includes an improved method of effecting an optical connection between optical fibres of two or more optical cables by means of the cassette hereinbefore described, which optical fibres may be components of optical fibre ribbons.

The invention further includes an optical connection between optical fibres of two or more optical cables effected by the improved method hereinbefore described.

The invention is further illustrated by a description, by way of example, of two preferred preformed components for use in effecting an optical connection between optical fibres of two or more optical cables and of two cassettes in which a preferred preformed component and a plurality of protected optical fibre splices are disposed, with reference to the accompanying diagrammatic drawings, in which:-

Figures 1 and 2 are diagrammatic cross-sectional views of the two preferred preformed components, and

Figures 3 and 4 are diagrammatic cross-sectional views of the two preferred cassettes.

The first preferred preformed component shown in Figure 1 comprises a moulded body 1 of plastics insulating material in which is encapsulated a plurality of optical conductors 2 disposed one above or below and spaced from another, of which only one optical conductor is shown. Each optical conductor 2 comprises a length of hermetically coated optical fibre which, over an intermediate part 3 of its length encapsulated in the moulded body 1 sweeps through an angle of approximately 180° with a bend in said intermediate length of fibre of a radius of approximately 5mm, and which has opposite end parts 4 that protrude from the moulded body 1 in

substantially the same direction. The protruding end parts 4 of the optical conductor each has a length of several centimetres, e.g. 20cm, and constitutes excess length of optical fibre available to accommodate any re-splicing or re-jointing of an optical fibre splice or joint of which a protruding end part of the optical conductor forms a part.

The second preferred preformed component shown in Figure 2 comprises a moulded body 6 of plastics insulating material in which is encapsulated a plurality of optical conductors 7 disposed one above or below and spaced from another, of which only one optical conductor is shown. Each optical conductor 7 has an integrated passive optical chip 8 optically interconnected in and forming a part of the conductor, which optical chip is wholly encapsulated in the moulded body 6. Opposite end parts 9 of the optical conductor 7 each consist of a length of optical fibre and protrude from the moulded body 6 at an acute angle to one another of approximately 70°. Over a part of the length of each protruding end part 9 of the optical conductor 7 intermediate of its free end and the moulded body 6, the protruding end part can be smoothly bent as shown so that portions of the protruding end parts remote from the moulded body extend substantially parallel to one another. As in the case of the first preferred preformed component shown in Figure 1, a protruding end part 9 of each optical conductor 6 each has a length of several centimetres,

e.g. 20cm, and constitutes excess length of optical fibre available to accommodate any re-splicing or re-jointing of an optical fibre splice or joint of which a protruding end part of the optical conductor forms a part.

As will be seen on referring to Figure 3, the cut-back ends of two optical cables C whose optical fibres are to be optically interconnected protrude into a cassette 11 of rectangular shape through cable entries in one of its ends. A preformed component 12 as described with reference to Figure 1 is detachably mounted in the cassette 11 adjacent the end of the cassette remote from the optical cables C and one protruding part 4 of each optical conductor 2 of the preformed component is spliced to an optical fibre F of one of the optical cables and the other protruding part of said optical conductor is spliced to an optical fibre F of the other of the optical cables as generally indicated at 14, each optical fibre splice being provided with individual mechanical protection. The mechanically protected optical fibre splices 14 associated with the protruding parts 4 of each optical conductor 2 are each detachably mounted in the cassette. The preformed component 12 and the mechanically protected optical fibre splices 14 are so detachably mounted in the cassette 11 that the distance between the protected optical fibre splices and the preformed component can be reduced to accommodate for any re-splicing of any splice that may be required.

The second preferred cassette shown in Figure 4 is substantially identical to the first preferred cassette described with reference to Figure 3 with the exception that the optical fibre splices associated with the protruding parts 4 of each optical conductor 2 of the preformed component 12 are provided with mechanical protection 16 common to the splices. The protected optical fibre splices 16 and the preformed component 12 are detachably mounted in the cassette 11 so that the distance between the protected optical fibre splices and the preformed component can be reduced to accommodate for re-splicing of any splice that may be required.

It will be appreciated that in each of the cassettes shown in Figures 3 and 4, protruding parts 4 of each optical conductor 2 of the preformed component 12, and a plurality of protected optical fibre splices 14 or 16, are disposed one above or below and spaced from another.

CLAIMS:

1. A cassette for enclosing an optical connection between optical fibres of two or more optical cables, the cassette containing:

- (i) a preformed component comprising a housing in which at least one optical conductor is so disposed that opposite end parts of the or each conductor protrudes from the housing at an angle to one another lying in the range 0° to 90° , each of the protruding parts of the or each optical conductor consisting of a length of optical fibre, and
- (ii) a splice or joint between one protruding length of optical fibre and an optical fibre of one of the optical cables, and a splice or joint between the other protruding length of optical fibre and an optical fibre of the other optical cable, the splices or joints between provided with mechanical protection;

the preformed component and the optical fibre splices or joints being so disposed in the cassette that the protected optical fibre splices or joints are spaced from the preformed component and that the preformed component and/or the protected optical fibre splices or joints are so detachably mounted in the cassette that the distance between the protected optical fibre splices or joints and the preformed component can be reduced.



2. A cassette as claimed in Claim 1, wherein opposite end parts of the or each optical conductor protrude from the housing in substantially the same direction.

3. A cassette as claimed in Claim 1 or 2, wherein an intermediate part of the length of the or each optical conductor disposed in the housing is an optical fibre which sweeps through an angle lying in the range 90° to 180° .

4. A cassette as claimed in Claim 1 or 2, wherein an intermediate portion of the length of the or each optical conductor disposed in the housing has optically interconnected therein and forming a part thereof at least one means for causing an optical signal entering the optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other of said protruding lengths of optical fibre.

5. A cassette as claimed in Claim 4, wherein said means for causing an optical signal entering the optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other of said protruding lengths of optical fibre comprises a reflector or refractor or an integrated optical chip.

6. A cassette as claimed in Claim 5, wherein the integrated optical chip, or another integrated optical chip disposed within the housing and constituting at least a part of the or an optical conductor of the preformed component, is designed to effect a fibre-optic



function.

7. A cassette as claimed in Claim 6, wherein the fibre optic function designed to be effected by said integrated optical chip is any one of

- (i) a tree coupler constituting a cascaded series of Y junctions;
- (ii) a star coupler incorporating a mixing region intermediate of a plurality of input points and a plurality of output points, and
- (iii) a wavelength selector.

8. A cassette ~~component~~ as claimed in any one of the preceding Claims, wherein the housing of the preformed component is a moulded body of plastics insulating material in which the or each optical conductor, and when present the or each integrated optical chip or other means for causing an optical signal entering the or an optical conductor along one of said protruding lengths of optical fibre to leave the optical conductor along the other of said protruding lengths of optical fibre, is or are at least partially encapsulated.

9. A method of effecting an optical connection between optical fibres of two or more optical cables by means of a cassette as claimed in any one of the preceding claims, which method comprises:

- (i) splicing or jointing one of two protruding lengths of optical fibre of the or each optical conductor of the preformed component to one of two optical fibres to be optically connected and splicing or jointing the other of said two protruding lengths



of optical fibre of said optical conductor to the other of said two optical fibres;

- (ii) providing mechanical protection for each optical fibre splice or joint; and
- (iii) so disposing the preformed component and the protected optical fibre splices or joints in a cassette that the protected optical fibre splices or joints are spaced from the preformed component and that the preformed component and/or the protected optical fibre splices or joints are so detachably mounted in the cassette that the distance between the protected optical fibre splices or joints and the preformed component can be reduced.

10. A method as claimed in Claim 9, wherein the protruding lengths of optical fibre of the or each optical conductor of the preformed component are spliced or jointed concurrently to the optical fibres to be optically connected.

11. A method as claimed in Claim 9 or 10, wherein two or more optical fibre splices or joints are provided with mechanical protection common to said splices or joints.

12. A method as claimed in any one of Claims 9 to 11, wherein the plurality of protected optical fibre splices or joints are disposed side-by-side in the cassette and the protruding lengths of optical fibre of the or each optical conductor of the preformed component over at least parts immediately adjacent the protected optical splices or joints are arranged to extend in the same



direction and substantially parallel to one another.

13. A method as claimed in any one of Claims 9 to 12, wherein the optical fibres of said optical cables are components of optical fibre ribbons.

14. A method of effecting an optical connection between optical fibres of two or more optical cables substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.

15. An optical connection between optical fibres of two or more optical cables effected by the method claimed in any one of Claims 9 to 13.

16. A cassette substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

