

Multi-Part Optical Fibre Connectors

This invention relates to multi-part optical fibre connectors for detachably optically inter-connecting end-to-end at least two flexible optical guides each comprising at least one optical fibre. Such multi-part
5 optical fibre connectors essentially comprise two separately formed connector-parts, each of which is adapted to be permanently or detachably secured to one of the flexible optical guides to be optically inter-connected, and may include at least one separately
10 formed intermediate connector-part or adaptor for optically inter-connecting two separately formed connector parts. To facilitate detachable inter-connection of two separately formed optical fibre connector-parts, each connector part of a multi-part
15 optical fibre connector constitutes at one or each of two oppositely disposed ends of the connector-part a plug or a socket adapted to effect a detachable plug and socket connection with a socket or a plug at an end of another connector-part. Multi-part optical fibre
20 connectors of this kind are widely used in optical transmission systems.

It is an object of the present invention to provide, for use in a multi-part optical fibre connector of the aforesaid kind, an improved optical fibre
25 connector-part which is of such a construction that an optical transmission system in which a multi-part optical fibre connector is inter-connected can be readily reconfigured or modified.

According to the invention, the improved optical fibre connector-part comprises a housing in the form of a body of moulded plastics material having two oppositely disposed ends, at least one of which ends is adapted to make a plug and socket connection with an end of another optical fibre connector-part; and at least one optical conductor which is disposed within and extends between said two oppositely disposed ends of the body and which has permanently optically connected therein at least one discrete passive integrated optical chip for effecting at least one passive fibre optic function, at least one permanent optical connection between the optical conductor and said optical chip being wholly encapsulated within the moulded plastics material of the body so that an optical signal is accurately transmittable between the optical conductor and said optical chip.

Preferably, the or each integrated optical chip of the improved optical fibre connector-part is so encapsulated in the plastics material of the body that the chip is intermediate of the oppositely disposed ends of the housing and is permanently optically inter-connected between end parts of the optical conductor.

In some circumstances, the integrated optical chip or at least one of the integrated optical chips of the improved optical fibre connector-part may be so

encapsulated in the plastics material that one side face of the chip is positioned at an end of the housing constituting a plug or socket and the chip is permanently optically connected to a part of the optical conductor or of at least one of the optical conductors extending to the other end of the housing.

In all cases, preferably the part or parts of the or each optical conductor of the improved optical fibre connector-part not constituted by the or an integrated optical chip is or are at least one optical fibre.

The or each discrete passive integrated optical chip 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 division multiplexer;
- (iv) a full-duplex wavelength divisions multiplexer;
- (v) an attenuating device;
- (vi) an optical filter;
- (vii) a phase modulator;
- (viii) an access coupler, and
- (ix) an optical Wheatstone bridge.

This list of functions which the or an integrated optical chip of the improved optical fibre connector-part can serve is by no means exhaustive.

The or each integrated optical chip of the
5 improved optical fibre connector-part may be a suitable integrated optical chip obtained from any source.

Where the improved optical fibre connector-part is to constitute one end part of a multi-part optical fibre connector, preferably one of the two oppositely disposed
10 ends of the housing of the improved optical fibre connector-part constitutes a plug or a socket and the other of the two oppositely disposed ends is adapted to be permanently or detachably secured to an end of at least one flexible optical guide comprising at least one
15 optical fibre in such a way that the or each optical fibre of the guide is optically connected to the or an optical conductor of the improved optical fibre connector-part or that the or each optical fibre of the guide extends into the housing of the improved optical
20 fibre connector-part and constitutes a part of the or an optical conductor of the connector-part. The end of the housing constituting a plug or a socket may also constitute at least one additional plug or socket for effecting a plug and socket connection with a socket or
25 plug at an end of a further optical fibre connector-part.

The or each flexible optical guide to which one end of an improved optical fibre connector-end part can be permanently or detachably secured may be an optical cable comprising a single optical fibre or comprising a plurality of optical fibres or it may be an optical fibre ribbon comprising a plurality of optical fibres arranged side-by-side with their axes lying in a substantially common plane.

It will be appreciated that the number of additional plugs or sockets constituted by the housing of the improved optical fibre connector-part will be determined by the function of the or each integrated optical chip disposed within the housing of the connector-part.

The invention also includes an improved multi-part optical fibre connector for detachably inter-connecting end-to-end at least two flexible optical guides each comprising at least one optical fibre, at least one of the connector-parts of the multi-part optical fibre connector being an improved optical fibre connector-part substantially as hereinbefore described.

The improved optical fibre connector-part and the improved optical fibre connector of the present invention have the important advantage that an optical transmission

6.

system of any desired configuration can be readily assembled using one or more than one improved optical fibre connector-part incorporating at least one integrated optical chip designed to effect a designed function and that an existing optical transmission system can be readily reconfigured or modified by replacing one or more than one improved optical fibre connector-part inter-connected in the system with one or more than one improved optical fibre connector-part of which the or each integrated optical chip is designed to effect a function differing from the function of the chip or chips of the connector-part being replaced.

The invention is further illustrated by a description, by way of example, of two preferred forms of multi-part optical fibre connector with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 is an exploded diagrammatic representation of a preferred two-part optical fibre connector, and

Figure 2 is an exploded representation of one preferred form of three-part optical fibre connector.

Referring to Figure 1, the preferred two-part optical fibre connector comprises an optical fibre connector-part 1 having protruding from one of two oppositely disposed ends of its moulded plastics body 2 a pair of transversely spaced parallel rigid pins 3 adapted to effect plug and socket connections in a pair

7.

of transversely spaced parallel holes 13 in one of two oppositely disposed ends of the moulded plastics body 12 of an optical fibre connector-part 11. Encapsulated in one of the two oppositely disposed ends of the moulded body 12 of the optical fibre connector-part 11 is an end of an optical fibre ribbon cable 14 from which protrude

four optical fibres 15 which are centrally disposed between the transversely spaced holes 13 and which extend to the other of the oppositely disposed ends of the body with their axes lying in the same plane as the axes of the holes. Encapsulated in one of the two oppositely disposed ends of the moulded body 2 of the optical fibre connector-part 1 is an end of an optical cable 4 having a single optical fibre 5 and extending between the encapsulated end of the optical cable and the other of the oppositely disposed ends of the body is an optical conductor constituted in part by the optical fibre of the optical cable and in part by an integrated optical chip 6 which is optically connected to the plastics material of the body 2 that one side face of the chip is exposed and centrally disposed between the transversely spaced rigid pins 3. The integrated optical chip 6 functions as a tree coupler constituting a cascaded series of Y-junctions and in the exposed side face of the chip are exposed the end faces of four optical guides whose axes lie in the same plane as the axes of the rigid pins and which are so transversely spaced apart that, when a plug and socket connection is made between the optical fibre connector-parts 1 and 11, the end faces of the optical guides and the end faces of the optical fibres 15 abut to effect optical connections therebetween.

The preferred form of three-part optical fibre connector shown in Figure 2 comprises an optical fibre connector-part 21, an optical fibre connector-part 31 and, adapted to optically interconnect the two optical fibre connector-end parts, a mating adaptor 30. The optical fibre connector-end part 21 comprises a moulded plastics body 22 in one of two oppositely disposed ends of which is encapsulated and end of a multi-fibre optical cable 23, the other end 24 of the moulded body constituting a plug. Encapsulated in the plug 24 of the optical fibre connector-end part 21 is a moulded array connector in an exposed end face of which are exposed the end faces of a plurality of optical fibres optically connected to the optical fibres of the optical cable 23. The axes of the exposed end faces of the optical fibres of the moulded array connector lie in a substantially common plane. The optical fibre connector-end part 31 comprises a moulded plastics body 32 having encapsulated in one of two oppositely disposed ends an end of an optical cable 33, the other of the oppositely disposed ends of the body constituting a plug 34. A moulded array connector 35 is so encapsulated in the plug 34 of the optical fibre connector-end part 31 that one end face of the moulded array connector is exposed. Extending between the optical fibres of the optical cable 33 and the encapsulated moulded array connector 35 are a plurality of optical conductors

constituted in part by optical fibres and in part by an integrated optical chip 36 encapsulated in the moulded body 32 intermediate of its ends and permanently optically connected between the optical fibres constituting the optical conductors. The integrated optical chip 36 functions as a star coupler incorporating a mixing region intermediate of a plurality of input points and a plurality of output points. The end faces of the optical fibres extending from the integrated optical chip 36 are exposed at the end face of the moulded array connector 35 with their axes lying in a substantially common plane. The plugs 24 and 34 at the ends of the optical fibre connector-end parts 21 and 31 are adapted to effect plug and socket connections in sockets at the opposite ends of the mating adaptor 30. To this end, each of the plugs 24, 34 has a rib 27, 37 adapted to engage in a groove 29 in the mating adaptor 30, the arrangement being such that when the plugs 24, 34 are fully engaged in the mating adaptor the exposed end faces of the moulded array connector 25, 35 abut with the exposed end faces of the optical fibres in axial alignment.



11.

CLAIMS:

1. For use in a multi-part optical fibre connector, an optical fibre connector-part comprising a housing in the form of a body of moulded plastics material having two oppositely disposed ends, at least one of which ends is adapted to make plug and socket connection with an end of another optical fibre connector-part; and at least one optical conductor which is disposed within and extends between said two oppositely disposed ends of the body and which has permanently optically connected therein at least one discrete passive integrated optical chip for effecting at least one passive fibre optic function, at least one permanent optical connection between the optical conductor and said optical chip being wholly encapsulated within the moulded plastics material of the body so that an optical signal is accurately transmittable between the optical conductor and said optical chip.
2. An optical fibre connector-part as claimed in Claim 1 wherein the or each integrated optical chip is so encapsulated in the plastics material of the body that the chip is intermediate of the oppositely disposed ends of the housing and is permanently optically interconnected between end parts of the optical conductor.
3. An optical fibre connector-part as claimed in Claim 1 wherein the integrated optical chip or at least one of the integrated optical chips or so encapsulated in the plastics material of the housing that one side face of



12.

the chip is positioned at an end of the housing constituting a plug or socket and is permanently optically connected to a part of the optical conductor or of at least one of the optical conductors extending to the other end of the housing.

4. An optical fibre connector-part as claimed in any one of the preceding Claims, wherein the part or parts of the or each optical conductor not constituted by the or an integrated optical chip is or are at least one optical fibre.

5. An optical fibre connector-part as claimed in any one of the preceding Claims which is to constitute one end part of a multi-part optical fibre connector, wherein one of the two oppositely disposed ends of the housing constitutes a plug or a socket and the other of the two oppositely disposed ends is adapted to be permanently or detachably secured to an end of at least one flexible optical guide comprising at least one optical fibre in such a way that the or each optical fibre of the guide is optically connected to the or an optical conductor of the optical fibre connector-part or that the or each optical fibre of the guide extends into the housing and constitutes a part of the or an optical conductor of the connector-part.

6. An optical fibre connector-part as claimed in Claim 5, wherein the end of the housing constituting a plug or a socket also constitutes at least one additional plug or socket for effecting a plug and socket connection



13

with a socket or plug at an end of a further optical fibre connector-part.

7. An optical fibre connector-part as claimed in any one of Claims 1 to 4 which is to constitute the end part of a multi-part optical fibre connector, wherein one of the two oppositely disposed ends of the housing constitutes a plug or a socket and the other of the two oppositely disposed ends is permanently or detachably secured to an end of at least one flexible optical cable comprising a single optical fibre or comprising a plurality of optical fibres, or to an end of an optical fibre ribbon comprising a plurality of optical fibres arranged side-by-side with their axes lying in a substantially common plane, in such a way that the or each optical fibre is optically connected to the or an optical conductor of the optical fibre connector-part or that the or each optical fibre extends into the housing and constitutes a part of the or an optical conductor of the connector-part.

8. A multi-part optical fibre connector for detachably inter-connecting end-to-end at least two flexible optical guides each comprising at least one optical fibre, wherein at least one of the connector-parts of the multi-part optical fibre connector is an optical fibre connector-part as claimed in any one of the preceding Claims.



14.

9. A multi-part optical fibre connector substantially hereinbefore described with reference to and as shown in Figure 1 or Figure 2 of the accompanying drawings.
