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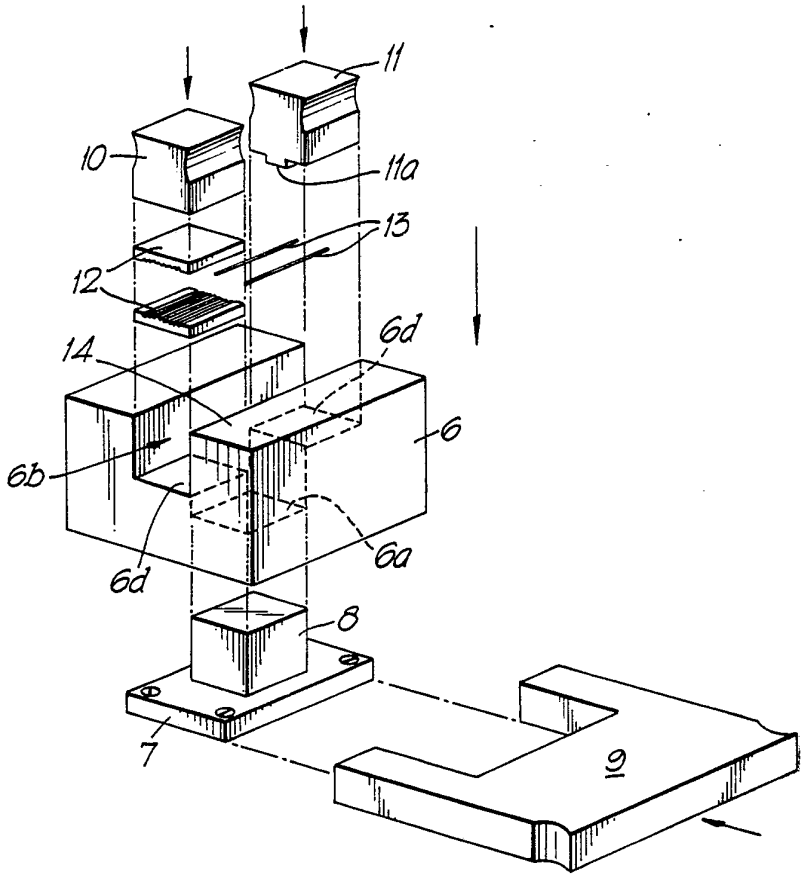
(54) Title: MULTIFIBRE CONNECTORISATION

(57) Abstract

A method of connectorisation of optical fibres includes the formation of an array (15) of parallel optical fibres. The primary coating is then stripped from a pre-determined length (15a) of each optical fibre, and the array (15) of optical fibres is positioned within a mould jig (M) so that at least a portion of the pre-determined length of each fibre extends across a mould cavity (14) defined by the jig. A connector body is then moulded around the optical fibres within the mould cavity (14), with the optical fibres being maintained under tension during the moulding process.



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MULTIFIBRE CONNECTORISATION

This invention relates to a method of, and apparatus for, the connectorisation and termination of optical fibres. Throughout this specification, the term "connectorisation" should be taken to mean the connection of optical fibres into an arrangement which constitutes a connector, thereby allowing termination of the fibres.

Until recently, it has been possible to connectorise optical fibres only singly, for example using individual ceramic ferrules for each optical fibre. However, it is now possible to connectorise an array of optical fibres using either of the two following techniques which have been recently introduced.

In the first of the techniques, the optical fibres of an array are clamped between two silicon wafers to form a connector, the fibres being accurately aligned in parallel disposition by V-grooves micromachined in mutually-opposing surfaces of the wafers. Where such a connector is to be connected to a like connector, a further pair of silicon wafers, which sandwich the pairs of wafers of the connectors, are used to align the connectors. The wafers of the further pair have V-shaped projections which mate with complementary V-grooves formed (by micromachining) in the outer surfaces of the wafers of the two connetors. Connectorisation is completed by mechanically clamping the wafers of the further pair together, or by curing a resin around the wafers. The

disadvantage of this technique is that it is expensive, each connector pair requiring six micromachined silicon wafers. It is also a time-consuming process.

In the second of the recently-introduced techniques, a high precision plastics moulding connector is used. This connector is formed with a plurality of guide apertures for receiving individual optical fibres, alignment apertures for receiving alignment pins, and semi-circular guides for positioning the optical fibres accurately within the connector. Once the fibres are correctly positioned in the connector, connectorisation is completed by filling the moulding connector with epoxy glue and curing. Here again, this type of connector is expensive, and the technique is time-consuming.

The aim of the invention is to provide a method of, and apparatus for, the connectorisation of an array of optical fibres which is cheaper and less time-consuming than known connectorisation techniques.

The present invention provides a method of connectorisation of optical fibres, the method comprising the steps of forming an array of parallel optical fibres, stripping the primary coating from a pre-determined length of each optical fibre, positioning the array of optical fibres within a mould jig so that at least a portion of the pre-determined length of each fibre extends across a mould cavity defined by the jig, and moulding a connector body around the optical fibres within the mould cavity, wherein the optical fibres are maintained under tension during the moulding process.

Advantageously, the array of optical fibres is constituted by a fibre ribbon, and the primary coating is stripped from each fibre of the ribbon over a pre-determined length of the ribbon and in a single step.

Preferably, the connector body is formed by the curing of an ultra violet (UV) curable resin.

In a preferred embodiment, the array of optical fibres is positioned within the jig by a pair of V-groove clamps positioned adjacent to the mould cavity, the V-groove clamps each having a respective V-groove for each of the optical fibres, the V-grooves being shaped and sized so that each V-groove co-operates with a respective V-groove of the other clamp to hold an associated optical fibre therewithin.

The method may further comprise the step of forming alignment means within the connector body during the moulding process. Conveniently, the V-groove clamps are provided with additional V-grooves for receiving alignment pins which extend therefrom across the mould cavity, whereby said alignment means are formed in the connector body in the moulding process.

Advantageously, the method further comprises forming the array of optical fibres into a fibre ribbon prior to the positioning of the array within the mould jig. Preferably, the method of forming the array of optical fibres into a fibre ribbon comprises the steps of positioning the optical fibres, under tension, in a parallel closely-packed configuration, and fixing the optical fibres together to form a fibre ribbon. Conveniently, the optical fibres are positioned one-by-one in a pair of aligned slots formed in a pair of fibre supports, and the optical fibres are formed into a loose ribbon, prior to being fixed together, by compacting them against one another using shims inserted into the slots in the fibre supports.

The optical fibres may be tensioned using a pair of fibre clamps positioned outboard of the fibre supports. Advantageously, the optical fibres are formed into a fibre

ribbon by coating the optical fibres positioned between the fibre supports with a UV curable resin and curing the resin with UV light. Alternatively, the optical fibres are formed into a fibre ribbon by applying an aluminium tape or a temporary gelling agent (such as toothpaste) to the optical fibres positioned between the fibre supports.

The invention also provides apparatus for connectorisation of optical fibres, the apparatus comprising a moulding jig defining a mould cavity, means for positioning an array of parallel optical fibres so that the optical fibres extend through the mould cavity, and means for tensioning the optical fibres, whereby a connector body can be moulded around the optical fibres within the mould cavity.

Preferably, the jig has a body formed with a generally U-shaped channel, the mould cavity being defined by a pair of mould side blocks positioned within the channel in a spaced relationship.

The apparatus may further comprise alignment means for accurately aligning the optical fibres in a parallel relationship within the mould cavity. Conveniently, the alignment means comprises a pair of V-groove clamps positioned beneath one of the mould side blocks adjacent to the mould cavity, each clamp having a respective V-groove for each of the optical fibres, the V-grooves being sized and shaped so that each V-groove co-operates with a respective V-groove of the other clamp to hold associated optical fibre therewithin. Advantageously, the clamps are provided with additional V-grooves, alignment pins being positioned within respective pairs of complementary additional V-grooves, the alignment pins extending, in use, across the mould cavity, whereby alignment apertures are formed in the connector body which is subsequently moulded in the mould cavity.

In a preferred embodiment, each clamp is a silicon wafer, and the V-grooves are micromachined V-grooves. Conveniently, each silicon wafer is a (100) silicon wafer, and the V-grooves are formed by an anisotropic etching process using an etchant such as EDP or KOH.

The apparatus may further comprise means for forming an array of optical fibres into a fibre ribbon, said fibre ribbon forming means comprising a pair of fibre supports which are formed with aligned slots for receiving the optical fibres, and a pair of fibre clamps for tensioning the optical fibres, the fibre supports being positioned between the fibre clamps. Preferably, the fibre supports and the fibre clamps are mounted on a rod which is mounted, for rotation through 90° about its own axis, on a base plate. Advantageously, the moulding jig is mounted on the base plate, and is positioned so that rotation of the rod will move the fibre supports into positions in which a fibre ribbon formed therebetween is positioned in the channel of the jig with portions of the optical fibres within the mould cavity.

Conveniently, the apparatus further comprises shims for insertion into the slots in the fibre supports for compacting the optical fibres into a loose ribbon.

The invention further provides a method of forming an array of optical fibres into a fibre ribbon, the method comprising the steps of positioning the optical fibres one-by-one in a pair of aligned slots formed in a pair of fibre supports, tensioning the optical fibres using a pair of fibre clamps positioned outboard of the fibre supports, forming the optical fibres into a loose ribbon by compacting them together using shims inserted into the slots in the fibre supports, and forming a fibre ribbon between the fibre supports by fixing the optical fibres together.

The invention also provides apparatus for forming an array of optical fibres into a fibre ribbon, the apparatus comprising a pair of fibre supports which are formed with aligned slots for receiving the optical fibres, a pair of fibre clamps for tensioning the optical fibres, and means for compacting the optical fibres into a loose ribbon.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:-

- Figure 1 is a perspective view of a fibre ribbon maker and multifibre mould jig for use in the connectorisation method of the invention;
- Figure 2 is an enlarged perspective view of the fibre moulding jig of Fig.1;
- Figure 3 is a plan view of the jig of Figs 1 and 2; and
- Figure 4 is a side elevation, on an enlarged scale, of one of the clamps of the jig.

Referring to the drawings, Fig.1 shows a fibre ribbon maker and mould jig having a base 1 which supports a fibre ribbon making assembly, indicated generally by the reference R, and a fibre moulding jig, indicated generally by the reference M.

The fibre ribbon making assembly R includes a steel bar 2 mounted, for rotation about the central longitudinal axis, on the base 1 by means of two supports 3. The bar 2 supports a pair of fibre support blocks 4 which are positioned adjacent to, and between, the supports 3. The upper (as shown in Fig.1) surface of each block 4 is formed with a slot 4b of width 250μm. In use, the slots 4b receive optical fibres (not shown) which are held in place by metal shims 4c and plastic screws 4d. The shims 4c have a thickness of 250μm, and are positioned in the

slots 4b above the optical fibres, the shims being held firmly in position by tightening the screws 4d (as described below). The supports 3 allow the bar 2 to rotate through 90° from the position shown in Fig.1 (where the slots 4b are vertical) to a position in which the slots are horizontal and pointing towards the jig M, rotation of the bar being restricted by pins 2a on the bar and notches 3a in the supports.

Fibre clamps 5 are fixed to the bar 2 adjacent to each end thereof. Each fibre clamp 5 includes a fixed jaw 5a, a movable jaw 5b, and a threaded bolt 5c for moving the jaw 5b towards, and away from, the jaw 5a.

The fibre moulding jig M has a main body 6 which is made of polytetrafluoroethylene and is supported on the base 1 by a mounting plate 7 and a pillar 8. The pillar 8 is fixed to the mounting plate 7 which is screwed to the base 1 (see Fig.2). The pillar 8 is a sliding fit within a complementary aperture 6a formed in the base of the main body 6, thereby permitting relative vertical movement between the main body and the base 1. A removable base 9, whose height is greater than that of the mounting plate 7, normally supports the main body 6 in spaced relation to the mounting plate. The aperture 6a extends into the main body 6 so as to meet a central, longitudinal V-shaped channel 6b. When the main body 6 is supported on the removable base 9, the upper surface 8a of the pillar 8 is contiguous with the surfaces 6d forming the base of the channel 6b.

A respective mould side block 10,11 is associated with each of the surfaces 6d, each mould side block being a sliding fit within the channel 6b. The mould side block 10 is also associated with a pair of V-groove chips 12. As shown in Fig.4, each chip 12 is formed with eight spaced parallel V-grooves 12a for receiving optical fibres

(not shown), and a pair of larger V-shaped grooves 12b, for receiving steel alignment pins 13. The chips 12 are identical, and are arranged so that their grooves 12a and 12b face one another in alignment. The side block 11 has a rib 11a extending centrally along the base thereof, so that the alignment pins 13 can be accommodated beneath the side block 11 on either side of the rib. The side blocks 10 and 11 and the surface 8a of the pillar 8 define a mould cavity 14.

In use, the bar 2 is positioned in its "normal" position, with the clamps 5 and the fibre support blocks 4 in the vertical position. The shims 4c are removed from the slots 4b , and the jaws 5b of the clamps 5 are moved away from the jaws 5a to open the clamps. Eight primary coated optical fibres (not shown) are then positioned, one by one, so as to lie within the slots 4b and between the jaws 5a and 5b of the clamps 5. The fibres can be either from single fibre cable, blown fibre unit or ribbon fibre unit. Each of the optical fibres has an outer diameter of 250μm with its primary coating in place, and a cladding outer diameter of 125μm. The optical fibres are, therefore, a sliding fit within the slots 4b. Once all eight fibres are in place (one above another), the shims 4c are positioned within the slots 4b and pressed lightly down onto the optical fibres. The optical fibres are then tensioned, and held firmly in the tensioned condition by tightening the jaws 5b against the jaws 5a using the bolts 5c. The screws 4d are then tightened to hold the shims 4c firmly in place on top of the optical fibres, thereby ensuring that the fibres remain in a closely-packed "ribbon". The fibres can then be formed into a permanent ribbon 15 (see Fig.4) by coating the fibres between the blocks 4 with a thin coat of UV curable resin and then curing the resin, or by using aluminium tape.

The overall dimensions of the fibre ribbon maker R are not critical, except for the width of the slots 4b and the thickness of the shims 4c, both of which should be the same size as the fibre primary coating plus 10μm.

In order to connectorise the fibre ribbon, it is necessary to remove the primary coating from a small area 15a (see Fig. 3) of the ribbon by the application of a proprietary stripping agent. The area 15a to be stripped is that between the fibre support blocks 4, and in alignment with the V-groove chips 12 and the mould cavity 14 in the fibre moulding jig M. The fibre moulding jig M is prepared for operation by removing the mould side blocks 10 and 11, the top V-groove chip 12 and the steel pins 13. The ribbon maker bar 2 is rotated through 90° to seat the stripped fibres into the grooves 12a of the bottom V-groove chip 12 located in the channel 6b of the mould main body 6 (see Fig.4). The steel alignment pins 13 are coated with a releasing agent, and positioned in the grooves 12b of the bottom V-groove chip 12. The pins 13 are positioned such that they protrude across the mould cavity 14. The top V-groove chip 12 and the mould side blocks 10 and 11 are then installed, and the mould cavity 14 thus formed is filled with UV resin and cured. After curing, the mould side blocks and 10 and 11 and the top V-groove chip 12 are removed leaving a connector (not shown) made of UV cured resin. This connector houses eight optical fibres which are parallel and equispaced to a tolerance of 1μm. Also, the alignment pins 13 are aligned relative to the fibres to a tolerance of 1μm. The removable base 9 is then slid away from underneath the main body 6 which can then be pushed downwards, thus releasing the connectorised fibres and the steel alignment pins 13. The connectorised ribbon is then removed from the jig M, and the steel alignment pins 13 are removed.

The fibre ribbon is then cut at that side of the connector body remote from the V-groove chips 12, and the free ends of the connectorised fibres are polished using standard techniques.

The chips 12 can be made in any convenient manner. Preferably, however, each chip 12 is a silicon chip (see Fig. 4) in which the grooves 12a and 12b are formed by micromachining. Thus, the grooves 12a and 12b would be formed in (100) silicon by an anisotropic etching process using an etchant such as ethylene diamine pyrocatechol and water (EDP) or KOH. Fig 4 shows the dimensions (in μm) of the grooves 12a and 12b of one of the chips 12. Each chip 12 has a length of 12 000 μm, a width of 10 000 μm and a height of 500 μm. The flat bases of the grooves 12b are formed by accurately limiting the etching time for these grooves.

A fibre ribbon connectorised in this way can easily be connected to another fibre ribbon or to an optical device via another connector. In either case, steel alignment pins (such as the pins 13) would be inserted into the apertures formed in the connector by the pins 13, and these newly-positioned pins would be used to align the optical fibres in the connector with optical fibres in a associated connector by positioning these pins in apertures in the associated connector. In the simplest case, the associated connector would be an identical connector.

The main advantage of the connectorisation method described above is that it is not expensive and the process is easy to perform. Thus, instead of using expensive high precision moulded connectors or micromachined silicon wafers for the connectors, the method of the invention uses simple UV cured resin connectors, and the micromachined V-groove chips are

re-usable a large number of times. Moreover, by using micromachined silicon chips, optical fibres can be accurately spaced at 1μm, and the alignment pins 13 can also be accurately positioned to a tolerance of 1μm, and this permits single mode operation of the fibres.

It will be apparent that the connectorisation method described above could be modified in a number of ways, for example, where the optical fibres do not need to be spaced quite so accurately, the V-groove chips 12 could be replaced by simple glass plates which would be clamped together to hold an array of fibres therebetween. In addition, it may be beneficial to clamp the V-groove chips using a torsion clamp fastened to the body of the mould to ensure no movement of the fibre or alignment pins during the curing of the resin. Other amendments that would be beneficial are the use of other light cured resins in place of UV glues: for example aromatic methacrylate resin with 50% silica loading. Also, it would be advantageous to cure the resin from all sides to ensure a linear curing of the material thereby reducing shrinkage effects on the position of the suspended fibres and alignment pins.

CLAIMS

1. A method of connectorisation of optical fibres, the method comprising the steps of forming an array of parallel optical fibres, stripping the primary coating from a pre-determined length of each optical fibre, positioning the array of optical fibres within a mould jig so that at least a portion of the pre-determined length of each fibre extends across a mould cavity defined by the jig, and moulding a connector body around the optical fibres within the mould cavity, wherein the optical fibres are maintained under tension during the moulding process.

2. A method as claimed in claim 1, wherein the array of optical fibres is constituted by a fibre ribbon, and the primary coating is stripped from each fibre of the ribbon over a pre-determined length of the ribbon and in a single step.

3. A method as claimed in claim 1 or claim 2, wherein the connector body is formed by the curing of a UV curable resin.

4. A method as claimed in any one of claims 1 to 3, wherein the array of optical fibres is positioned within the jig by a pair of V-groove clamps positioned adjacent to the mould cavity, the V-groove clamps each having a respective V-groove for each of the optical fibres, the V-grooves being shaped and sized so that each V-groove co-operates with a respective V-groove of the other clamp to hold an associated optical fibre therewithin.

5. A method as claimed in any one of claims 1 to 4, further comprising the step of forming alignment means within the connector body during the moulding process.

6. A method as claimed in claim 5 when appendant to claim 4, wherein the V-groove clamps are provided with additional V-grooves for receiving alignment pins which extend therefrom across the mould cavity, whereby said alignment means are formed in the connector body in the moulding process.

7. A method as claimed in any one of claims 1 to 6, further comprising forming the array of optical fibres into a fibre ribbon prior to the positioning of the array within the mould jig.

8. A method as claimed in claim 7, wherein the method of forming the array of optical fibres into a fibre ribbon comprises the steps of positioning the optical fibres, under tension, in a parallel closely-packed configuration, and fixing the optical fibres together to form a fibre ribbon.

9. A method as claimed in claim 8, wherein the optical fibres are positioned one-by-one in a pair of aligned slots formed in a pair of fibre supports.

10. A method as claimed in claim 9, wherein the optical fibres are formed into a loose ribbon, prior to being fixed together, by compacting them against one another using shims inserted into the slots in the fibre supports.

11. A method as claimed in claim 9 or claim 10, wherein the optical fibres are tensioned using a pair of fibre clamps positioned outboard of the fibre supports.

12. A method as claimed in any one of the claims 9 to 11, wherein the optical fibres are formed into a fibre ribbon by coating the optical fibres positioned between the fibre supports with a UV curable resin and curing the resin with UV light.

13. A method as claimed in any one of the claims 9 to 11, wherein the optical fibres are formed into a fibre ribbon by applying an aluminium tape or a temporary gelling agent (such as toothpaste) to the optical fibres positioned between the fibre supports.

14. Apparatus for connectorisation of optical fibres, the apparatus comprising a moulding jig defining a mould cavity, means for positioning an array of parallel optical fibres so that the optical fibres extend through the mould cavity, and means for tensioning the optical fibres, whereby a connector body can be moulded around the optical fibres within the mould cavity.

15. Apparatus as claimed in claim 14, wherein the jig has a body formed with a generally U-shaped channel, the mould cavity being defined by a pair of mould side blocks positioned within the channel in a spaced relationship.

16. Apparatus as claimed in claim 14 or claim 15, further comprising alignment means for accurately aligning the optical fibres in a parallel relationship within the mould cavity.

17. Apparatus as claimed in claim 16 when appendant to claim 15, wherein the alignment means comprises a pair of V-groove clamps positioned beneath one of the mould side blocks adjacent to the mould cavity, each clamp having a respective V-groove for each of the optical fibres, the V-grooves being sized and shaped so that each V-groove co-operates with a respective V-groove of the other clamp to hold associated optical fibre therewithin.

18. Apparatus as claimed in claim 17, wherein the clamps are provided with additional V-grooves, alignment pins being positioned within respective pairs of complementary additional V-grooves, the alignment pins extending, in use, across the mould cavity, whereby alignment apertures are formed in the connector body which is subsequently moulded in the mould cavity.

19. Apparatus as claimed in claim 17 or claim 18, wherein each clamp is a silicon wafer, and the V-grooves are micromachined V-grooves.

20. Apparatus as claimed in claim 19, wherein each silicon wafer is a (100) silicon wafer, and the V-grooves are formed by an anisotropic etching process using an etchant such as EDP or KOH.

21. Apparatus as claimed in any one of claims 12 to 20, further comprising means for forming an array of optical fibres into a fibre ribbon, said fibre ribbon forming means comprising a pair of fibre supports which are formed with aligned slots for receiving the optical fibres, and a pair of fibre clamps for tensioning the optical fibres, the fibre supports being positioned between the fibre clamps.

22. Apparatus as claimed in claim 21, wherein the fibre supports and the fibre clamps are mounted on a rod.

23. Apparatus as claimed in claim 22, wherein the rod is mounted, for rotation through 90^0 about its own axis, on a base plate.

24. Apparatus as claimed in claim 23, wherein the moulding jig is mounted on the base plate, and is positioned so that rotation of the rod will move the fibre supports into positions in which a fibre ribbon formed therebetween is positioned in the channel of the jig with portions of the optical fibres within the mould cavity.

25. Apparatus as claimed in any one of claims 21 to 24, further comprising shims for insertion into the slots in the fibre supports for compacting the optical fibres into a loose ribbon.

26. A method of forming an array of optical fibres into a fibre ribbon, the method comprising the steps of positioning the optical fibres one-by-one in a pair of aligned slots formed in a pair of fibre supports, tensioning the optical fibres using a pair of fibre clamps positioned outboard of the fibre supports, forming the optical fibres into a loose ribbon by compacting them together using shims inserted into the slots in the fibre supports, and forming a fibre ribbon between the fibre supports by fixing the optical fibres together.

27. Apparatus for forming an array of optical fibres into a fibre ribbon, the apparatus comprising a pair of fibre supports which are formed with aligned slots for receiving the optical fibres, a pair of fibre clamps for tensioning the optical fibres, and means for compacting the optical fibres into a loose ribbon.

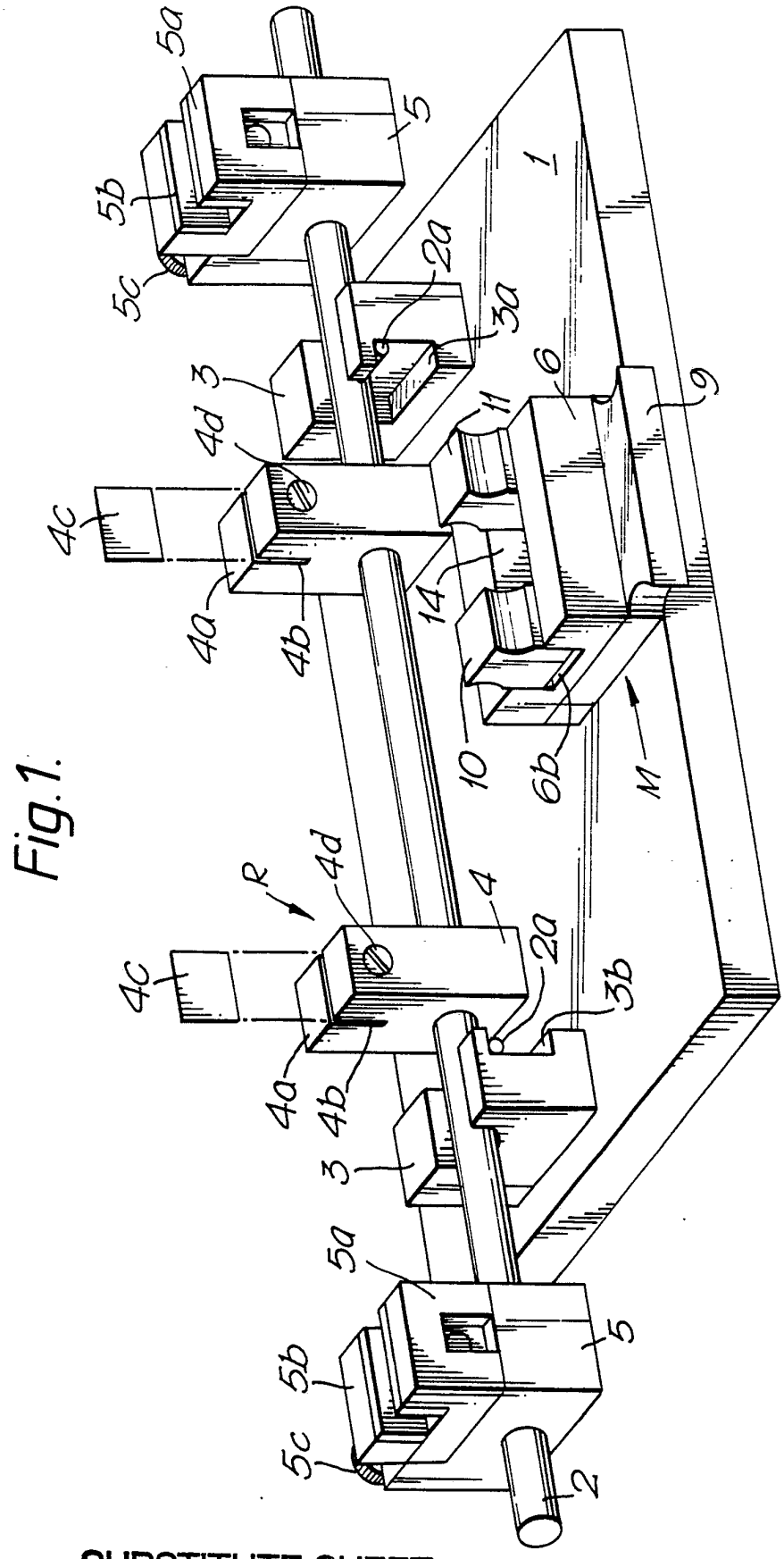

Fig.1.

Fig. 2.

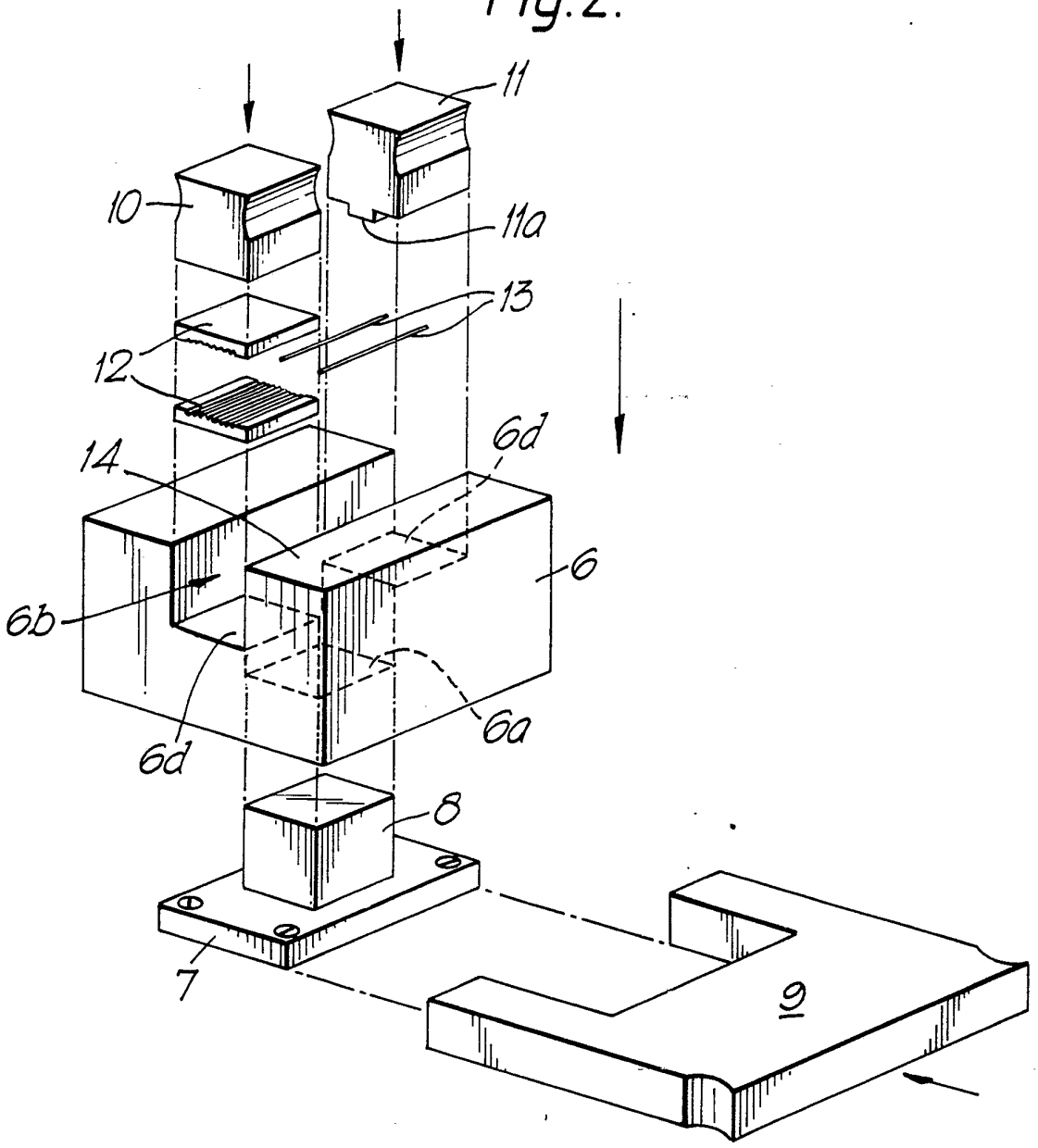

Fig.3.

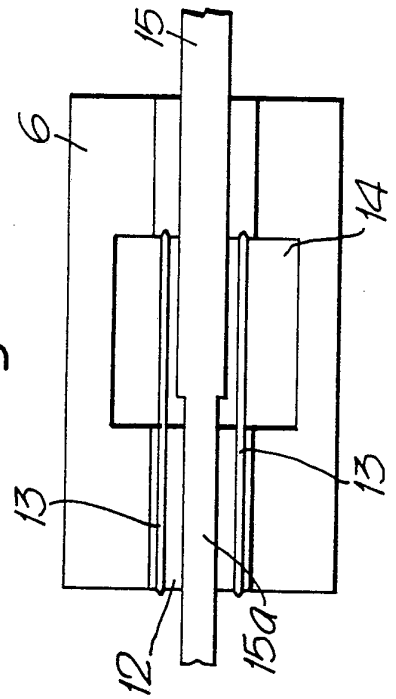
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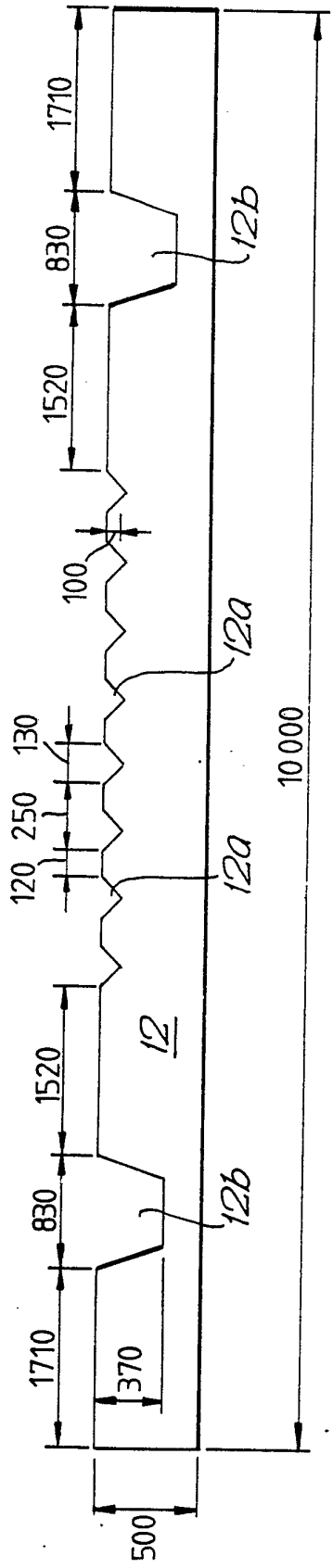
Fig.4.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INTERNATIONAL SEARCH REPORT

PCT/GB 90/01132

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: G 02 B 6/38, G 02 B 6/36, B 29 C 3/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	G 02 B 6/00, B 29 C 33/00, B 29 C 67/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	FR, A, 2524653 (COMMISSARIAT A L'ENERGIE ATOMIQUE) 7 October 1983 see figures 2,2A,3; page 8, lines 13-35; pages 9-11; page 12, lines 1-26 --	1,3,7,8,9, 10,12,14,21
A	Journal of Lightwave Technology, volume LT-4, no. 8, August 1986, IEEE, (New York, US), Y. Tamaki et al.: "Field-installable plastic multifiber connector", pages 1248-1254 see figures 2,5,6,7; sections I,III,IV --	1,4,5,6,14, 16
A	Patent Abstracts of Japan, volume 12, no. 16 (P-656)(2363), 19 January 1988, & JP, A, 62172309 (SUMITOMO) 29 July 1987 see the abstract --	1,14

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
3rd October 1990	30 OCT. 1990
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MISS T. TAZELAAR

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3871935 (D.CH. Gloge et al.) 18 March 1975 see figures 2,3,4,5; column 1, lines 40-61; column 2, lines 34-67; column 3, lines 1-48 --	1,4,14,16
A	US, A, 4818058 (R. BONANNI) 4 April 1989 see the whole document --	1,14,20
A	US, A, 4721586 (T. KAKII et al.) 26 January 1988 see figures 2A-F; column 1, lines 46-66; column 2, lines 29-51 ----	1,2,5,14

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9001132

SA 38813

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/10/90
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2524653	07-10-83	None	
US-A- 3871935	18-03-75	None	
US-A- 4818058	04-04-89	EP-A- 0331334	06-09-89
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