(12) UK Patent Application (19) GB (11) 2 098 354 A

(21) Application No 8213500
(22) Date of filing 10 May 1982
(30) Priority data
(31) 8102309
(32) 12 May 1981
(33) Netherlands (NL)
(43) Application published
17 Nov 1982
(51) INT CL³
G02B 7/26
(52) Domestic classification
G2J GEA
(56) Documents cited
GBA 2054893
GB 1452474
GBA 2062283
(58) Field of search
G2J
(71) Applicants
Philips' Gloeilampenfabrieken NV,
Groenewoudseweg 1,
5621 BH Eindhoven, The Netherlands
(72) Inventors
Giok Djan Khoe,
Lambertus Johan Meuleman,
Johannes Henricus Franciscus Maria Van Leest
(74) Agent
R. J. Boxall,
Mullard House, Torrington Place, London WC1E 7HD

(54) Connector for coupling at least one optical fibre to a further optical element

(57) A connector for the pair-wise coupling of (monomode) optical fibres, comprising a central connection portion *1* with a V-groove 26 and two holders 2 in which a cylindrical envelope 3 of an optical fibre 19 is arranged to be resilient in the longitudinal direction and a pin 4 is secured parallel thereto, the envelope 3 being retained in the groove 26 by a hold-down spring 35 when the envelope 3 and the pin 4 are inserted into the connection portion 1, the envelope being clamped by a clamping spring 33 which is actuated by the pin 4 after the envelope 3 has reached its ultimate position e.g. against an abutment pin 12.

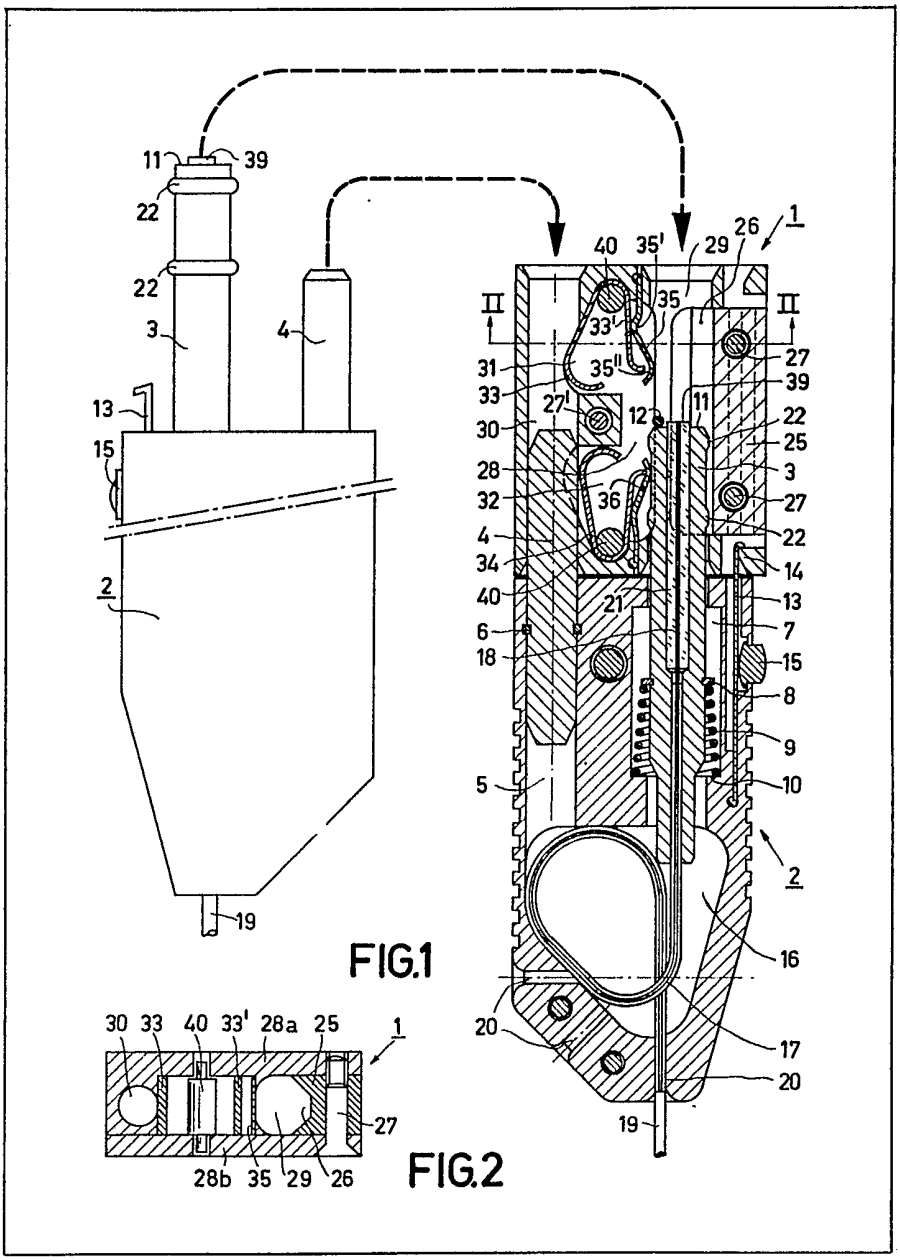

FIG.1

FIG.2

GB 2 098 354 A

1/2

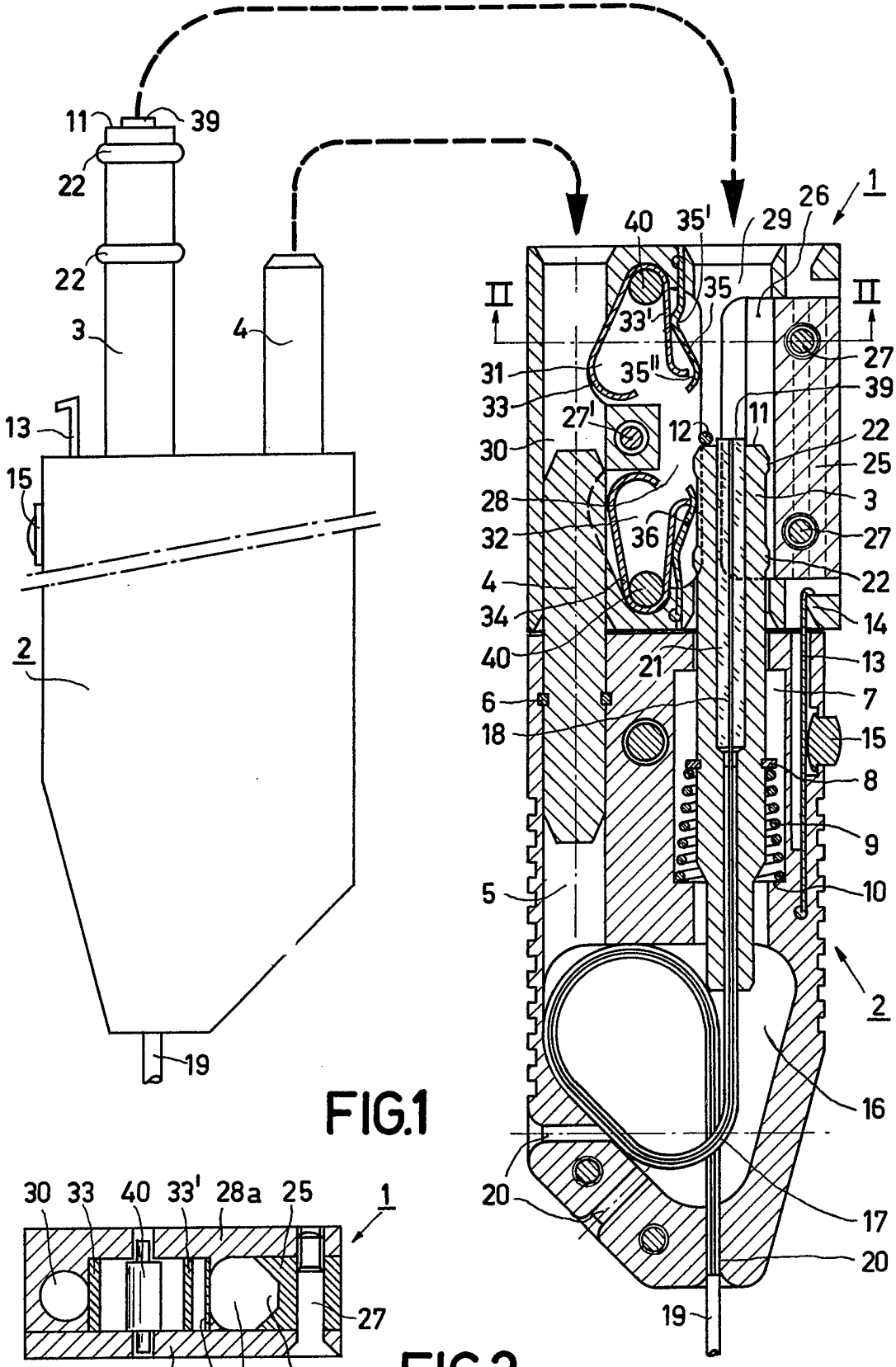
11
39
22
22
3
4
13
15
2
19
1
26
29
40
35'
35
33'
II
II
27
39
31
35''
33
27'
12
11
22
30
25
28
3
32
36
27
4
22
34
14
40
21
13
6
7
18
15
8
9
5
10
2
16
20
17
20
19

FIG.1

30
33
40
33'
28a
25
1
27
28b
35
29
26

FIG.2

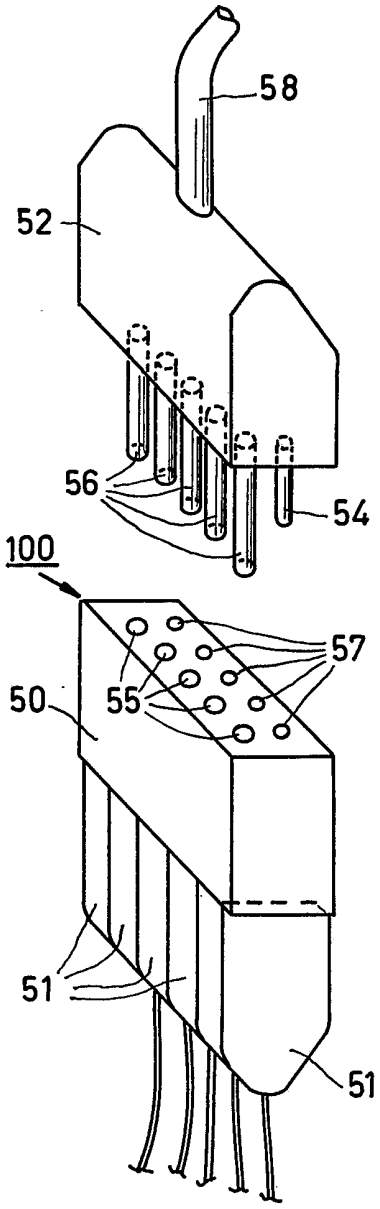

FIG.3a

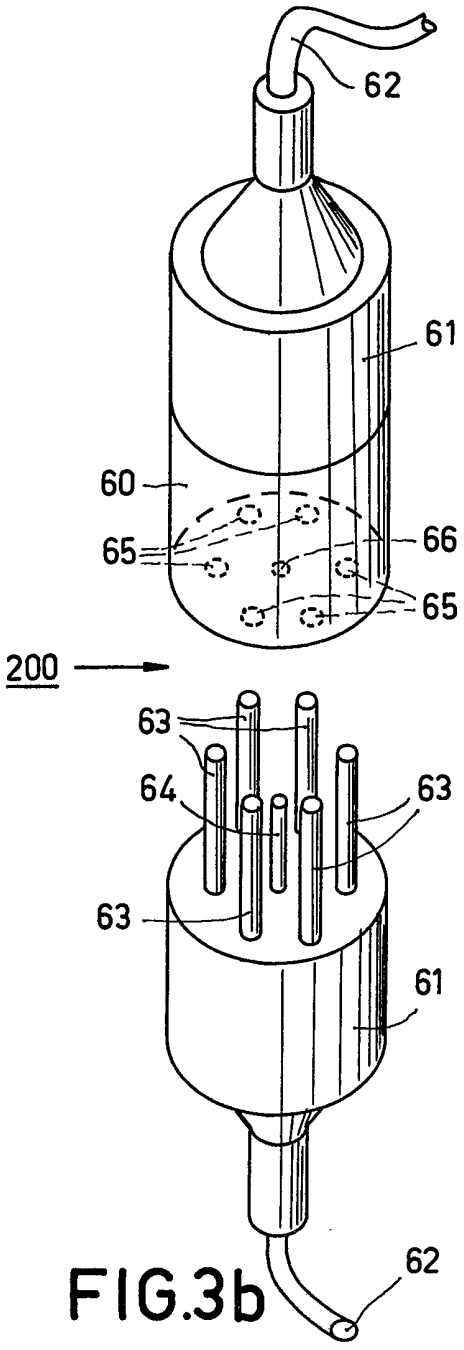

FIG.3b

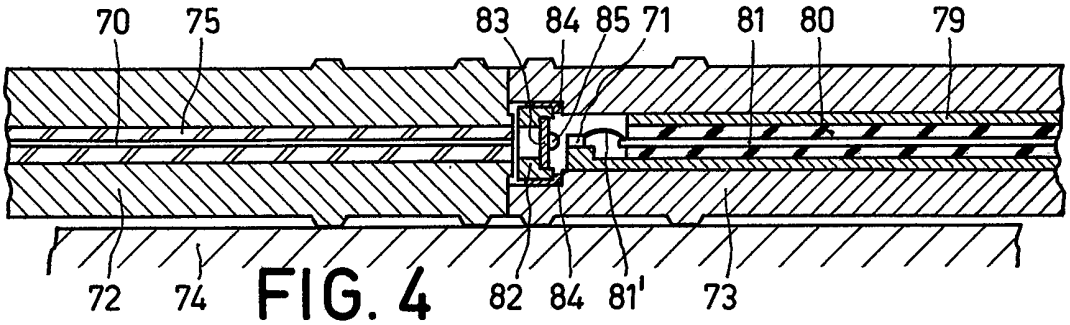

FIG. 4

SPECIFICATION

Connector for coupling at least one optical fibre to a further optical element

The invention relates to an optical fibre coupling connector for coupling at least one optical fibre to a further optical element, such as a light source, a light detector or a further optical fibre, the further optical element and the end of the first mentioned optical fibre each being secured in a corresponding cylindrical member, said connector comprising two holders, at least one cylindrical member being arranged to be resiliently displaceable in the longitudinal direction in each holder, said connector being provided with registration means in the form of at least one V-groove and resilient clamping means which clamp the cylindrical members in the V-groove in a coupled condition of the optical fibre and the further optical element, said resilient clamping means being actuated by a pin which is secured to one of the holders.

A connector of this kind is known from the published British Patent Application No. 2 054 893. The connector described therein comprises resilient clamping means which consist of a curved spring which is pressed onto the cylindrical members in the connector by the pin as soon as the cap secured to a first holder slides over a projecting portion of a pin which is secured to the second holder. The two cylindrical members must be pressed into and clamped in the V-groove by the spring, the holders being further slid into one another in order to achieve the necessary alignment of the fibres secured in the cylindrical members. Because the end faces of (the optical fibres in) the cylindrical members are pressed against one another while engaging the coupling, the following situations can occur due to the friction thus produced:

1) the cylindrical members are not accurately positioned in the V-groove ("retain one another"), or

2) the end faces slide over one another (leading to damage) as the cylindrical members assume the desired relative positions in the V-groove. In the former case, loss of light occurs (notably in the case of a coupling between monomode optical fibres) and in the second case the end faces will be damaged, which also leads to loss of light (*inter alia* also due to contamination by abrasion products from burrs on the end faces).

It is an object of the invention to provide an improved connector for coupling an optical fibre to a light source, a light detector or a further optical fibre, which is also suitable for coupling monomode optical fibres, and in which the cylindrical members can be held substantially stationary during the operation fo clamping the cylindrical members in the V-groove, in correct positions which had already been attained.

According to the invention there is provided an optical fibre coupling connector for coupling at least one optical fibre to a further optical element, such as a light source, a light detector or a further optical fibre, the further optical element and the end of the first mentioned optical fibre each being secured in a corresponding cylindrical member, said connector comprising two holders, at least one cylindrical member being arranged to be resiliently displaceable inthe longitudinal direction in each holder, said connector being provided with registration means in the form of at least one V-groove and resilient clamping means which clamp the cylindrical members in the V-groove in a coupled condition of the optical fibre and the further optical element, said resilient clamping means being actuated by a pin which is secured to one of the holders, characterized in that in the unactuated condition of said resilient clamping means and in the absence of corresponding cylindrical member, the resilient clamping means is arranged relative to said V-groove so that the maximum diameter of a notional circle which can be inscribed in a plane at right angles to the longitudinal direction of the V-groove between the surfaces of the V-groove and a clamping surface of the resilient clamping means, is less than the diameter of the corresponding cylindrical member at that point when fully engaged the arrangement being such that while engaging the connector each cylindrical member is maintained in contact with the V-groove by the unactuated resilient clamping means before the end faces of the cylindrical members or the optical fibre or optical element secured therein, are brought into contact with one another. The resilient clamping means in a connector in accordance with the invention ensure that the cylindrical member reaches its final position in the V-groove before the cylindrical member is clamped.

A preferred embodiment of a connector in accordance with the invention is characterized in that the resilient clamping means comprises a hold-down spring and a clamping spring, the hold-down spring being arranged between the V-groove and the clamping spring, the clamping spring bearing forcibly on the hold-down spring when it is actuated by the pin, thus clamping the cylindrical member into the V-groove. The cylindrical member is lightly pressed into the V-groove by the hold-down spring (preferably a leaf spring), the force of the comparatively heavy clamping spring being applied only after the cylindrical member has assumed its final position. This construction is advantageous because a light hold-down spring can be more readily pushed aside by the cylindrical member than a stiff clamping spring.

A further embodiment of a connector in accordance with the invention is characterized in that several cylindrical members are arranged substantially parallel to one another in a holder. Such a holder enables several pairs of optical fibres to be coupled simultaneously in a single coupling operation, which is an advantage.

Embodiments in accordance with the invention will now be described by way of example, with reference to the accompanying drawings, of which;

Figure 1 is a longitudinal sectional view of a central connecting portion and two connector holders one in side elevation,

Figure 2 is a cross-sectional view of the central coupling portion,

Figures 3a and b show connectors for the simultaneous coupling of several pairs of optical fibres in accordance with the invention, and

Figure 4 is a longitudinal sectional view of abutting portions of two cylindrical members in one of which a light source is arranged.

The connector shown in Figure 1 comprises a central connection portion *1* and two holders *2* (one of which is shown in a cross-sectional view and the other one in a side elevation) from which a cylindrical member in the form of an envelope 3, and a pin 4 project, which are respectively slid into the central connection portion *1* from corresponding sides. Each holder *2* compries a first recess 5 in which the pin 4 is secured by means of a spring clip 6. The envelope 3 is resiliently mounted in a second recess 7. To achieve this, the envelope 3 is provided with a retaining ring 8 on which one end of a helical spring 9 bears. The other end of the helical spring 9 bears against an abutment 10 formed in the recess 7 and urges the end face 11 of the envelope 3 against a pin 12 which is located in the central connection portion *1*. The holder 2 is furthermore provided with a resilient claw 13 which engages the reverse face of retaining part 14 of the connection portion *1* when the holder *2* is coupled to the connection portion *1* in order to guard against an accidental displacement of the holder *2* from engagement with the portion *1*. The holder 2 is provided with a push-button 15 whereby the claw 13 can be disengaged from the retaining part 14, after which the holder *2* can be removed from the connection portion *1*.

The holder *2* includes a chamber 16 in which a portion 17 of an optical fibre 19 is stored in the form of a loop in order to ensure unobstructed movement of the envelope 3 in which an end 18 of the optical fibre 19 is secured. The coated fibre 19 is glued or clamped in a passage 20, so that the portion 17 of the fibre 19 cannot be pulled out of the chamber 16. The holder *2* comprises several openings 20 for feeding the fibre 19 into the holder *2* from alternative directions as desired.

The fibre end 18 is glued in a glass capilary 21 which in its turn is secured in the envelope 3. The envelope 3 is provided with two abutment rims 22, the outer circumference of which is concentric with the light conductive core of the fibre end 19. Such an envelope 3 with concentric abutment rims 22 and its manufacture are described *inter alia* in Netherlands Patent Application 78 09 725.

The central connection portion *1* (see also Fig. 2) includes a rigid block 25 with a V-groove 26. The block 25 is secured in a housing 28 by means of two bolts 27. The housing 28 is formed with two bores 29, 30 and two chambers 31, 32. The block 25 with the V-groove 26 projects into the first bore 29. The two chambers 31 and 32 are adjacently situated between the two bores 29 and 30. In each chamber 31, 32 there are secured a U-shaped clamping spring 33, 34 and a hold-down spring 35, 36, the hold-down spring 35, 36 being a leaf spring situated between the V-groove 26 and the clamping spring 33, 34. In the unengaged condition of the coupling the maximum diameter of a notional circle which can be inscribed in a plane at right angles to the longitudinal direction of the V-groove 26, between the engagement surface of the hold-down spring 35, 36 and the surfaces of the V-groove 26 is slightly less than the diameter of the envelope 3 in the region between the abutment rims 22.

When a first holder *2* is coupled to the central connection portion *1*, the envelope 3 is slid in the bore 29, under the hold-down spring 35 or 36 and in the V-groove 26. A light pressure from the hold-down spring 35 or 36 presses the abutment rims 22 into the groove 26 (for example, with a force at the most 1 N). The envelope 3 is slid into the bore 29 so far that the end face 11 of the envelope 3 abuts against the pin 12. The envelope 3 is then held stationary, the helical coil 9 being compressed when the holder *2* is moved further towards the connection portion *1*. The pin 4 then enters the bore 30 and actuates the clamp by engaging and deflecting the U-shaped clamping spring 33 or 34, so that the latter pivots about the pin 40 and is urged towards the V-groove 26. The hold-down spring 35 preferably is a leaf spring which is secured at one end to the central connection portion *1* and comprises, viewed from the secured end, a first curved portion 35′ which is remote from the V-groove 26 and a second curved portion 35″ which faces the V-groove. A limb 33′ of the U-shaped clamping spring 33, bears against the first curved portion 35′ of the leaf spring 35. When the clamping spring 33 is being actuated by the pin 4, the clamping spring 33 pivots about the pin 40 and presses the first curved portion 35′ of the leaf spring 35 towards the V-groove 26. Consequently, the portion of the leaf spring 35 which is not secured (i.e. the curved portion 35″) will move in the direction of the pin 12 and will thus tend to slide the corresponding envelope 3 now present in the V-groove, in a direction towards the pin 12. Subsequently (when the clamping spring 33 is further compressed by the pin 4), the end of the limb 33′ engages the leaf spring 35 between the first and the second curved portion 35″. The end preferably engages near the second curved portion 35″ where the latter is already in contact with the envelope 3. The stationary envelope 3 which has already been accurately positioned in the groove 26 by the hold-down spring 35 or 36, is thus clamped. As the holder *2* continues to move towards the portion *1*, the claw 13 ultimately engages the reverse face of the retaining part 14 in the housing 28, and the coupling between the holder *2* and the portion *1* is completed.

When a second holder 2 is coupled to the portion *1*, the procedure is identical, although the end face 11 of the envelope 3 may not then abut against the pin 12. It is preferable at this stage for

the end faces 39 of the glass capillaries 21 to abut first against one another, the two envelopes 3 at this point already being correctly positioned by the groove 26. It is to be noted that the clamping springs 33, 34, also clamp the pins 4 in the housing 28 and that the locking of the holders *2* by means of the claw 13 which engages the retaining part 14, is a protection against an accidental displacement of the holders *2*.

Figure 2 is a cross-sectional view of the central connection portion *1*. The housing 28 comprises a box-shaped portion 28a and a lid 28b which are interconnected by means of bolts 27s and 27 (see Figure 1). The block 25 in which there is formed a V-groove 26 is also secured between the portion 28a and the lid 28b by means of the bolts 27. The cross-sectional view also clearly shows the bores 29 and 30. The bore 29 is bounded on one side by the hold-down spring 35. The bore 30 is bounded on one side by the clamping spring 33; the Figure shows a cross-section of the clamping spring 33 at two locations because of its U-shape, the curved central portion of said clamping spring extending behind the pin 40 in the Figure.

The connector *100* in accordance with the invention which is shown in Figure 3a comprises a central connection portion 50, a plurality of individual holders 51 and a multiple holder 52. The form of connector *100* enables the simultaneous establishment of several couplings (five in the embodiment of Figure 3a) between optical fibres, each of which is secured in a corresponding individual holder 51, and five further optical fibres brought together to form a bundle 58 and secured in the holder 52.

The single holders 51 are identical to the holders *2* shown in Figure 1. The multiple holder 52 and the central connection portion 50 are in fact formed by a parallel arrangement of connection assemblies each corresponding to those of the single holders *2* and to the corresponding parts of the central connection portions 1, respectively, as shown in Figures 1 and 2.

However, it is not necessary for the central connection portion 50 to comprise five separately acting clamping springs (actuated by pins 54 on the holder 52). After inserting and positioning the envelopes 56 in the bores 55, the envelopes 56 can be respectively clamped in the portion 50 by the corresponding pins 54 when they are inserted into the bores 57. However, instead of five separate clamping springs, use can alternatively be made of one or two clamping springs which clamp five or two and three envelopes respectively. In that case the number of pins 54 need not correspond to the number of envelopes 56 secured in a multiple holder 52.

The connector *200* in accordance with the invention which is shown in Figure 3b comprises a central connection portion 60 and two holders 61. To each holder 61 there is connected a cable 62 which comprises six optical fibres (not visible in the Figure). In each holder 61 six envelopes 63 in which ends of the optical fibres are secured, are resiliently arranged about a central pin 64. The envelopes 63 are simultaneously inserted into bores 65 formed in the central connection portion 60, each of said bores being provided with a corresponding V-groove (not shown). The pin 64 fits in a hole 66 and simultaneously actuates six clamping springs (not visible in the Figure) in order to clamp the six envelopes 63 in said V-grooves.

Figure 4 shows a coupling between an optical fibre and a further optical element in the form of a semi-conductor laser, each element being secured in a cylindrical envelope 72, 73 which engages a wall 74 of a V-groove (not shown) in which the envelopes 72 and 73 are arranged. The optical fibre 70 is secured in a glass capillary 75 which in its turn is glued into the envelope 72.

The semiconductor laser 71 is mounted on an end of an electrically and thermally conductive bush 79. In the bush 79 there is secured an electrical conductor 81 which is surrounded by an insulating mass 80 (for example, glass) and which is electrically connected to the semi-conductor laser 71 via the wire 81'. A hermetically sealed space is formed for the laser 71 by means of a glass plate 83 which is secured in a ring 82, the ring 82 being mounted in the envelope 73 by means of a soft and readily deformable metal alloy 84 (for example, indium-tin). As a result of the use of a soft metal alloy 84, the ring, 82 can be displaced with respect to the laser 71, together with the glass plate 83, so that a lens 85 mounted on the glass plate 83 can be aligned with respect to the laser 71.

CLAIMS

1. An optical fibre coupling connector for coupling at least one optical fibre to a further optical element, such as a light source, a light detector or a further optical fibre, the further optical element and the end of the first mentioned optical fibre each being secured in a corresponding cylindrical member, said connector comprising two holders, at least one cylindrical member being arranged to be resiliently displaceable in the longitudinal direction in each holder, said connector being provided with registration means in the form of at least one V-groove and resilient clamping means which clamp the cylindrical members in the V-groove in a coupled condition of the optical fibre and the further optical element, said resilient clamping means being actuated by a pin which is secured to one of the holders, characterized in that in the unactuated condition of said resilient clamping means and in the absence of corresponding cylindrical members, the resilient clamping means is arranged relative to said V-groove so that the maximum diameter of a notional circle which can be inscribed in a plane at right angles to the longitudinal direction of the V-groove between the surfaces of the V-groove and a clamping surface of the resilient clamping means, is less than the diameter of the corresponding cylindrical member at that point when fully engaged, the arrangement being such that while engaging the connector

each cylindrical member is maintained in contact with the V-groove by the unactuated resilient clamping means before the end faces of the cylindrical members or the optical fibre or optical element secured therein, are brought into contact with one another.

2. A connector as claimed in Claim 1, characterized in that the resilient clamping means comprise a hold down spring and a clamping spring, the hold-down spring being arranged between the V-groove and the clamping spring, the clamping spring bearing forcibly on the hold-down spring when it is actuated by the pin, thus clamping the cylindrical member in the V-groove.

3. A connector as claimed in Claim 2, characterized in that the hold-down spring is a leaf spring which is secured at one end and which comprises, viewed from the secured end, a first curved portion which is displaced away from the V-groove and a second curved portion which is displaced towards the V-groove, the clamping spring being U-shaped and a first limb of the clamping spring bearing against the first curved portion of the leaf spring.

4. A connector as claimed in Claim 3, characterized in that when the clamping spring is operated by the pin, the first limb of the clamping spring urges the first curved portion of the leaf spring in the direction of the V-groove, the end of the first limb subsequently engaging the leaf spring at a position between the first and second curved portion, preferably near the second curved portion.

5. A connector as claimed in Claim 3 or 4, characterized in that a said cylindrical member is provided with two abutment rims for locating the envelope relative to the surfaces of the V-groove, the hold-down spring bearing on the surface of the cylindrical member at a point between the abutment edges, *via* said second curved portion, in the coupled condition of the holders.

6. A connector as claimed in Claim 2, 3, 4 or 5, characterized in that the connector comprises a central connection portion which includes the V-groove, and two U-shaped clamping springs arranged adjacent the V-groove, a first end of each of said springs projecting into a bore parallel to the V-groove whilst the second end is situated facing the V-groove and behind the hold-down spring, a pin being rigidly connected in each holder, said pin extending in the same direction as the cylindrical member, the pin being inserted into the bore and being pressed against the first end of one of the clamping springs when the corresponding cylindrical member is inserted into the central connection portion.

7. A connector as claimed in any one of Claims 2, 3, 4, 5 and 6, characterized in that, viewed in the longitudinal direction of the V-groove, an abutment pin is arranged substantially halfway along the V-groove between the two clamping springs, the cylindrical member abutting, before the actuating pin contacts the clamping spring, against the abutment pin or against a further cylindrical member already clamped in the V-groove when the first mentioned cylindrical member is inserted into the V-groove and the actuating pin is inserted into the bore.

8. A connector as claimed in any one of Claims 1 to 7, characterized in that several cylindrical members are arranged substantially parallel to one another in a single holder.

9. A connector as claimed in Claim 8, characterized in that the number of cylindrical members arranged in a given holder is larger than the number of pins secured to the holder, a connection portion being provided comprising as many V-grooves as there are envelopes in a holder, the connection portion further comprising at least one clamping spring for clamping at least two envelopes.

10. An optical fibre coupling connector of the kind specified, substantially as herein described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained