(19) DANMARK

(10) DK/EP 3141940 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *G 02 B 6/38 (2006.01)*

(45) Oversættelsen bekendtgjort den: **2024-04-29**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2024-01-24**

(86) Europæisk ansøgning nr.: **16195321.1**

(86) Europæisk indleveringsdag: **2008-04-30**

(87) Den europæiske ansøgnings publiceringsdag: **2017-03-15**

(30) Prioritet: **2007-05-04 GB 0708709**

(62) Stamansøgningsnr: **08737141.5**

(84) Designerede stater: **AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR**

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(54) Benævnelse: **OPTICAL FIBRE CONNECTOR**

(56) Fremdragne publikationer:
WO-A1-95/35520
JP-A- 2006 184 271

DESCRIPTION

Description

BACKGROUND

a. Field of the Invention

[0001] The present invention relates to an optical fibre connector, for example an SC-style connector, and to a method of forming and using such a connector. The invention is defined by the appended claims.

b. Related Art

[0002] The mechanical tolerances involved in terminating single mode optical fibre are much tighter than those for multimode optical fibre. Therefore, while it is quite common for multimode optical fibre be terminated at the point of use, for example at a user's premises or at an outside junction box, in most product applications, single mode optical fibre is not terminated in the field. When single mode fibre must be terminated in the field, then it can take a skilled technician between about 15 to 20 minutes to splice fibres together either by using a V-groove clamp or expensive fusion welding equipment.

[0003] Single mode fibre is therefore often provided in a range of different lengths, pre-terminated at both ends with a connector plug ready to plug into a matching receptacle. Commonly, eight or twelve single mode optical fibres may be bundled together in an optical fibre cable having an outer protective tube inside of which the optical fibres run.

[0004] An example of such a connector is the "Subscriber Connector", or SC connector, originally developed by NTT (Reg. TM). SC connectors have convenient push/pull style mating, and are approximately square in cross-section and with a 2.5 mm diameter ferule at the termination of the optical fibre, surrounded by a plastic housing for protection. SC connectors are available in single or duplex configurations. The SC connector latches into a matching socket in a simple push motion. The push-pull design includes a spring against which the ferrule slides within a plastic inner housing. This arrangement provides a reliable contact pressure at the ferrule end and resists fibre end face contact damage of the optical fibre during connection. The connector can be quickly disconnected by first pulling back an outer housing, which is slidable relative to the inner housing, to disengage a latch inside socket between the

socket and the inner housing, before pulling the optical fibre connector from the socket. Until the latch is thus disengaged, the latch prevents withdrawal of the connector when the optical fibre cable is pulled in a direction away from the socket.

[0005] A different type of connector is the ST type connector has a key that prevents rotation of the ceramic ferrule and which connects with a socket using a bayonet lock with an outer shell. All such bayonet type optical fibre connectors are referred to herein for convenience as "ST-type" optical fibre connectors.

[0006] An advantage of the SC connector over this type of bayonet connector is that the SC connector sockets can be more closely packed, as there is no need to get fingers fully around the connector to disengage the connector from the socket.

[0007] Other examples of push/pull type connectors are LC connectors or MU connectors. Often, the fibre-end is angled to reduce back reflections and this is usually described by adding APC (Angled Physical Contact) to the name. All such push/pull type optical fibre connectors are for convenience referred to herein as "SC-type" optical fibre connectors. SC-type LC or MU connectors are also known as small form factor connectors, by virtue of having a 1.5 mm diameter ferrule and a plastic housing.

[0008] it is important to avoid bending optical fibre around curves having too sharp a bend radius, as this will increase optical losses and can permanently damage the optical fibre. Optical fibre cables are therefore often routed inside a protective outer tube or conduit, which can have minimum bend-limiting properties. Protective bend limiting conduits normally have an outer diameter of 8 mm or 10 mm tubes. The cross-section of a standard SC connector has dimensions of about 7 mm x 9 mm, and even a small form factor SC connector is too large to fit inside the inner diameter of a typical protective conduit.

[0009] In one product application involving the provision of a single mode optical connection all the way to a service subscriber, the protective conduit may run for tens or hundreds of meters from a residential home to a curb-side connection box. While it is relatively straightforward to blow or push a non-terminated length of optical fibre cable down the conduit, it is not possible to do this with cable pre-terminated with SC-type connectors owing to the mismatch in the size of the connector with the inner diameter of the conduit.

[0010] While, in principle, it would be possible to provide a length of optical cable pre-terminated at one end only, and then after blowing the cable down the conduit either splice or fuse the optical fibre to a terminated optical fibre stub, this adds significant time and cost to the job of providing a single mode optical fibre connection, particularly in product applications such as the provision of single mode optical fibre connection to a user's home.

[0011] Patent document WO 95/35520 discloses an optical fibre sub-assembly that may be used in an SC-style optical fibre connector as well as in a FC-style optical fibre connector. The sub-assembly has a ferrule holder that holds an optical fibre ferrule and that has a plurality of

tabs disposed circumferentially around the holder. The ferrule holder and a compression spring are retainably received in a cable attachment body to form an assembly. The assembly is then connected within an outer plug body to form the optical fibre connector. The tabs of the ferrule holder extend radially outwards to engage with openings in the cable attachment body in one of a plurality of possible rotational orientations in order to reduce transverse offset loss. The cable attachment body has retention lugs that extend radially outwards to engage with apertures in the outer plug body.

[0012] It is an objection of the present invention to provide a more convenient optical fibre connector and optical fibre communication system and method for providing such a system.

SUMMARY OF THE INVENTION

[0013] According to a first aspect of the invention, there is provided a Subscriber Connection (SC) -type optical fibre connector comprising an optical fibre (8), an optical fibre connector sub-assembly, and an inner housing and an outer housing for assembly about said sub-assembly, the inner and outer housings when assembled about said sub-assembly serving to provide SC-style push/pull engagement/disengagement with a mating optical fibre socket, said sub-assembly comprising:

- a ferrule having an end face at which said optical fibre is terminated;
- a ferrule holder, the ferrule being held within the ferrule holder and extending away from the ferrule holder towards said end face;
- a ferrule holder carrier, the ferrule holder being held within the ferrule holder carrier and said holder and carrier being relatively moveable with respect to each other along a ferrule axis ;
- a spring biasing means acting between the ferrule holder carrier and the ferrule holder to bias the ferrule holder along the ferrule axis in a direction away from the ferrule holder carrier;

wherein:

- the optical fibre connector sub-assembly is insertable along a conduit prior to assembly of the inner and outer housings about said sub-assembly without the sub-assembly coming apart;

characterised in that

- radially outermost surfaces of the ferrule holder carrier define a cylindrical envelope, the ferrule holder carrier having an engagement feature that does not add to the radial dimensions of said envelope and the inner housing having a radially inwardly projecting feature for locating with said engagement feature when the inner housing is assembled to the optical fibre connector sub-assembly.

[0014] Also described herein is an optical fibre connector sub-assembly for an optical fibre connector, comprising an optical fibre, a cylindrical ferrule, a ferrule holder, a spring biasing means, and a ferrule holder carrier; wherein:

- the optical fibre is held within the ferrule along an axis of the ferrule, the optical fibre being terminated at an end face of the ferrule;
- the ferrule is held by the ferrule holder;
- the ferrule holder is engaged within a receiving portion of the ferrule holder carrier, said holder and carrier being relatively moveable with respect to each other along the ferrule axis between limits defined by an interaction between the ferrule holder carrier and the ferrule holder, a portion of the ferrule leading to said end face of the ferrule projecting along the ferrule axis away from the ferrule holder carrier;
- the spring biasing means is provided between the ferrule holder and the ferrule holder carrier so that the projecting portion of the ferrule is spring biased

[0015] along the ferrule axis away from the ferrule holder carrier;

- the ferrule holder includes a base in which the ferrule is seated;
- the optical fibre base has a plurality of crenellations that extend circumferentially around the ferrule, the ferrule holder carrier having at least two separate arms that extend in an axial direction through the crenellations towards the ferrule, said arms including a movement limitation feature that interacts with the ferrule holder base to limit the relative movement of the ferrule holder and the ferrule holder carrier along one direction of movement along the ferrule axis.

[0016] The optical fibre connector sub-assembly may be suitable for inclusion in any type of optical fibre connection, for example, an ST-type optical fibre connector. In preferred embodiments of the invention the optical fibre connector sub-assembly is for an SC-type optical fibre connector.

[0017] In a preferred embodiment of the invention, the movement limitation feature is one or more projecting fingers at an end of the arms. The arms may terminate with circumferentially extending features that engage with the base to limit the relative movement along the ferrule axis of the ferrule holder away from the receiving portion of the ferrule holder carrier. The movement limitation feature may be one or more projecting fingers that extend in a circumferential direction relative to the ferrule axis.

[0018] Preferably, the movement limitation feature engages with a side of the crenellations nearest the end face of the ferrule. The crenellations may have alternating radially high and low regions, the movement limitation feature engaging with a radially high region of the

crenellations.

[0019] The spring biasing means is preferably a coil spring provided between the ferrule holder base and the receiving portion of the ferrule holder carrier, one end of said spring coil being engaged with a side of the crenellations furthest the end face of the ferrule.

[0020] Most preferably, the outermost surfaces of the ferrule holder carrier and ferrule holder, relative to the ferrule axis, lie on a common cylindrical envelope. This helps to minimise the size of the sub-assembly in a radial direction, making it easier to insert the sub-assembly down a conduit or to pass the sub-assembly through a restricted space, prior to completing the assembly to create an SC-type optical fibre connector assembly.

[0021] The ferrule holder may include a base having a socket in which the ferrule is seated, and a hollow stem that projects axially from the base in a direction away from said projecting portion of the ferrule. The ferrule holder carrier receiving portion then extends around at least a portion of the stem and includes a feature that interacts with the ferrule holder base to limit the relative movement of the ferrule holder and the ferrule holder carrier along one direction of movement along the ferrule axis.

[0022] The optical fibre will normally lead to the ferrule through the stem.

[0023] The spring biasing means may be provided between the ferrule holder base and the receiving portion of the ferrule holder carrier.

[0024] The spring biasing means is preferably a coil spring that is concentrically seated around the stem of the ferrule holder.

[0025] The optical fibre base may have a plurality of crenellations that extend circumferentially around the ferrule. The ferrule holder carrier can have at least two arms that slideably engage with the crenellations.

[0026] The arms may terminate with circumferentially extending features that engage with the base to limit the relative movement along the ferrule axis of the ferrule holder away from the receiving portion of the ferrule holder carrier.

[0027] The ferrule holder and ferrule holder carrier may be adapted to be assembled by a press-fitting operation in which the ferrule holder moves along the ferrule axis into the receiving portion of the ferrule holder carrier.

[0028] The optical fibre will usually include a length of optical fibre extending away from the ferrule, the ferrule holder and the ferrule holder carrier. This length can be surrounded by a material for protection and/or reinforcement, in which case the ferrule holder carrier advantageously includes means for attaching said cladding to this material.

[0029] The sub-assembly is mechanically integral in the sense of being a physically complete unit, or a whole, which is secure enough to be inserted inside a length of conduit, for example being blown or pushed down a length of bend-limiting conduit, without coming apart in the process. The sub-assembly can be formed with an outer diameter or other maximum external cross-sectional dimension significantly smaller than a corresponding dimension of the completed SC-type optical fibre connector, and can therefore be small enough to fit inside a wide range of commercially available conduits, for example 8 mm or 10 mm external diameter bend-limiting conduits. Then after insertion of the sub-assembly down the length of conduit, the inner and outer housings can be assembled about the sub-assembly to complete the SC-type optical fibre connector.

[0030] In a preferred embodiment of the invention, the inner housing and then the outer housing in turn are inserted over the projecting ferrule and sub-assembly by press-fitting along an axial direction.

[0031] Also described herein is a Subscriber Connection (SC) -type optical fibre connector comprising an optical fibre connector sub-assembly, an inner housing, and an outer housing, the optical fibre connector sub-assembly being according to the invention, wherein:

- the inner housing is fixedly connected to the ferrule holder carrier, the inner housing comprising a portion which coaxially extends around said projecting portion of the ferrule to define a receptacle for a socket to receive the projecting ferrule portion;
- the spring biasing means is provided between the ferrule holder and the ferrule holder carrier so that the projecting portion of the ferrule is spring biased along the ferrule axis towards the receptacle portion of the inner housing; and
- the inner housing is engaged within the outer housing, the inner housing and the outer housing being relatively moveable with respect to each other along the ferrule axis between limits defined by an interaction between the inner housing and the outer housing in order to provide SC-style push/pull engagement/disengagement with a mating optical fibre socket.

[0032] The ferrule housing assembly serves as an inner housing in relation to the outer housing in the provision of the SC-style push/pull engagement/disengagement.

[0033] The ferrule is preferably rotationally fixed with respect to the ferrule holder about the ferule axis, with the ferrule holder bring rotationally aligned by means of one or more rotational keys with respect to the outer housing so that the rotational orientation of the ferrule with respect to the outer housing can be set during assembly of the connector at one of one or more predefined rotational orientations.

[0034] A first rotational key may be provided between the ferrule holder and the ferrule holder carrier. A second rotational key may then be provided between the ferrule holder carrier and the inner housing. The ferrule holder and the ferrule holder carrier may have aligned features

which provide a combined rotational key between, on the one hand, the ferrule holder and the ferrule holder carrier, and, on the other hand, the inner housing.

[0035] A further rotational key may be provided between the ferrule holder sub-assembly and the outer housing.

[0036] The ferrule holder and ferrule holder carrier may be adapted to be assembled by a press-fitting operation in which the ferrule holder moves along the ferrule axis into the receiving portion of the ferrule holder carrier.

[0037] The inner housing is adapted to be assembled to the ferrule holder and the ferrule holder carrier by a press-fitting operation in which the inner housing moves along the ferrule axis over the projecting portion of the ferrule towards the ferrule holder carrier.

[0038] Also described herein is a method of making an optical fibre connection using a Subscriber Connection (SC) -type optical fibre connector, the connector comprising an optical fibre, an optical fibre connector sub-assembly and assembled about said sub-assembly an inner housing and an outer housing, the inner housing having a radially inwardly projecting feature, the method comprising the steps of:

- inserting the optical fibre in the ferrule along an axis of the ferrule, and terminating the optical fibre at an end face of the ferrule;
- using the ferrule holder to hold the ferrule so that the ferrule extends away from the ferrule holder towards said end face;
- engaging the ferrule holder within a receiving portion of the ferrule holder carrier and placing the spring biasing means between the ferrule holder and ferrule holder carrier to form said sub-assembly such that said holder and carrier are spring biased apart and relatively moveable with respect to each other along the ferrule axis between limits defined by an interaction between the ferrule holder carrier and the ferrule holder and such that radially outermost surfaces of said sub-assembly define a cylindrical envelope of said sub-assembly, the ferrule holder carrier having a groove in said envelope;
- inserting the optical fibre connector sub-assembly down a length of protective conduit;
- after said inserting, assembling the inner housing to said sub-assembly by engaging the inner housing to said sub-assembly while locating said radially inwardly projecting feature within said groove and then forming an SC-type optical fibre connector by engaging the outer housing around the inner housing, said inner and outer housings being movable relative to each other to provide SC-style push/pull engagement/disengagement functionality; and
- mating said SC-type optical fibre connector with a matching optical fibre socket.

[0039] According to a second aspect of the invention, there is provided a method of making a Subscriber Connection (SC) -type optical fibre connector, said connector comprising a length of optical fibre, an optical fibre connector sub-assembly, said sub-assembly comprising a

spring-biased ferrule holder held within a ferrule holder carrier, the ferrule holder holding a ferrule that terminates said length of optical fibre, and assembled about said sub-assembly an inner housing and an outer housing, the method comprising the steps of:

- inserting the optical fibre connector sub-assembly down a length of protective conduit; and
- after said inserting, forming said SC-type optical fibre connector from the optical fibre connector sub-assembly by engaging around said sub-assembly an inner housing and an outer housing, said inner and outer housing being movable relative to each other to provide SC-style push/pull engagement/disengagement functionality and the inner housing being connected to an engagement feature of the ferrule older carrier;
- wherein the optical fibre connector sub-assembly does not come apart during the insertion of said sub-assembly down said length of protective conduit; characterised in that
- radially outermost surfaces of the ferrule holder carrier define a cylindrical envelope, and the engagement feature does not add to the radial dimensions of said envelope, whereby said insertion of the sub-assembly down said length of conduit is facilitated.

[0040] According to a third aspect of the invention, there is provided an optical fibre connector sub-assembly for use in a method according to the second aspect of the invention, comprising:

- a ferrule having an end face at which said optical fibre is terminated;
- a ferrule holder, the ferrule being held within the ferrule holder and extending away from the ferrule holder towards said end face;

- a ferrule holder carrier, the ferrule holder being held within the ferrule holder carrier and said holder and carrier being relatively moveable with respect to each other along a ferrule axis;
- a spring biasing means between the ferrule holder carrier and the ferrule holder to bias the ferrule holder along the ferrule axis away from the ferrule holder carrier;
- the ferrule holder carrier has an engagement feature for connecting an inner housing of a Subscriber Connection (SC) -type optical fibre connector to the ferrule holder carrier; and
- the optical fibre connector sub-assembly is insertable along a conduit prior to said connection of the inner housing to the ferrule holder carrier without the optical fibre connector sub-assembly coming apart;

characterised in that

- radially outermost surfaces of the ferrule holder carrier define a cylindrical envelope and the engagement feature does not add to the radial dimensions of said envelope and is configured to locate with a radially inwardly projecting feature of the inner housing when the inner housing is to be assembled to the optical fibre connector sub-assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The invention will now be further described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is an exploded perspective view of a prior art SC connector, comprising an optical fibre cable, optical fibre connector sub-assembly (including an inner housing) and an outer housing to provide SC-style push/pull engagement/disengagement with a mating optical fibre socket;

Figure 2 is an exploded perspective view of the optical fibre connector sub-assembly of Figure 1;

Figure 3 is a perspective view of the optical fibre connector sub-assembly of Figure 1 when assembled;

Figure 4 is a perspective view of the SC connector of Figure 1 when assembled;

Figure 5 is an exploded perspective view of an SC connector according to the invention, comprising an optical fibre cable, an optical fibre connector sub-assembly, and an inner housing and an outer housing to provide SC-style push/pull engagement/disengagement with a mating optical fibre socket;

Figure 6 is a perspective view of the optical fibre connector sub-assembly of Figure 5 when assembled;

Figure 7 is a perspective view of the SC connector of Figure 5 when assembled;

Figures 8 and 9 show in perspective the components forming the fibre connector sub-assembly of Figure 5, namely a ferrule holder carrier, an optical ferrule held by a ferrule holder, and a helical spring;

Figure 10 is another perspective view of the optical fibre connector sub-assembly of Figure 5 when assembled;

Figure 11 is a perspective view of the inner housing of Figure 5;

Figure 12 is a perspective view of a ferrule housing sub-assembly formed when the inner housing is press-fitted over the ferrule holder carrier;

Figure 13 is another perspective view of the ferrule holder carrier of Figure 8, showing how the holder has a number of cylindrical or concentric surfaces;

Figure 14 is a cross-sectional view along a central axis of the ferrule holder carrier of Figure 13;

Figure 15 is another cross-sectional view along the central axis of the ferrule holder carrier taken along line XV-XV of Figure 14;

Figure 16 is a perspective view of an alternative embodiment of ferrule holder carrier, showing how the holder has a number of cylindrical or concentric surfaces;

Figure 17 is a cross-sectional view along a central axis of the ferrule holder carrier of Figure 16;

Figure 18 is another cross-sectional view along the central axis of the ferrule holder carrier, taken along line XVIII-XVIII of Figure 17;

Figures 19 to 21 illustrate the insertion of the partially assembled SC connector of Figure 5 through and out from a protective conduit;

Figure 23 is a cross-sectional view through the ferrule holder carrier of Figure 10;

Figure 24 is a cross-sectional view of the ferrule holder carrier of Figure 23, including also a terminated optical fibre cable inside the ferrule and the inner housing connected about the ferrule holder carrier; and

Figure 25 is a cross section at right angles to that of Figure 24.

DETAILED DESCRIPTION

[0042] Figures 1 to 4 show a prior art SC connector 1, comprising an optical fibre cable 2, a ferrule housing sub-assembly 4, and an outer housing 40 to provide SC-style push/pull engagement/disengagement with a mating optical fibre socket (not shown).

[0043] The cable 2 holds a single strand of 125 μm diameter single mode optical fibre 8, protected by primary and secondary buffering layers 10, about 900 μm in diameter and an outer sheath 12, typically 3 mm to 5 mm in diameter. The optical fibre 8 is terminated by the ferrule in a manner well-known to those skilled in the art, and defines a ferrule axis 5 which extends centrally through the SC connector 1.

[0044] The ferrule housing sub-assembly 4 includes a cylindrical ceramic ferrule 14, a ferrule holder 16 having a base 15 with a socket in which the ferrule is seated, a helical spring 17, a generally cylindrical cup 18 and an inner housing 20. The ferrule holder 16 has a cylindrical stem 22 which extends in an axial direction away from the ferrule 14 towards the cup 18. The spring 17 is seated around the stem 22 between an annular shoulder 24 on the ferrule holder 16 and a similar annular surface (not shown) within the cup. During assembly, the inner housing 20 is passed axially over the ferrule holder 16 and a forward part of the cup, and then rotated by 90° until a pair of slots 26 on opposite sides of the inner housing engage with a pair

of ribs 28 projecting on opposite sides of the cup 18. This engagement fixes the inner housing 20 in an axial direction, while at the same time leaving the spring 17 trapped under compression between the ferrule holder and the cup 18.

[0045] The inner housing has a forwards portion 30 which coaxially extends around the axially projecting ferrule 14 to define a receptacle 32 for a socket (not shown) to receive a projecting portion of the ferrule 14.

[0046] The connected cup 18 and inner housing 20 serve as a ferrule holder carrier inside of which the ferrule holder 16 is free to move backwards when an end face 34 of the ferrule 14 comes into contact with a similar end face (not shown) of another optical fibre ferrule when making an optical connection.

[0047] The cup 18 has a central aperture (not shown) through which the optical fibre and buffering 10 pass, and has in a rear-most portion a sleeve 36 sized to receive and be crimped to the cable sheathing 12.

[0048] Unusually a strain-relief sleeve 38 is provided around the junction of the optical fibre cable 2 and the ferrule housing sub-assembly 4.

[0049] The outer housing 40 is press-fitted axially over the assembled ferrule housing sub-assembly 4. Once the inner housing 20 and outer housing 40 are engaged together, the inner and outer housings are relatively moveable with respect to each other along the ferrule axis 5 between limits defined by an interaction between the inner housing and the outer housing provided by projections 42 on a pair of opposite sides of the inner housing and a pair of apertures 44 in the outer housing. The projections 42 and apertures 44 interact with sprung features inside a matching socket (not shown) to provide SC-style push/pull 46 engagement/disengagement with a mating optical fibre socket.

[0050] Figure 5 is an exploded perspective view of an SC connector 101 according to the invention, in which features corresponding with those of Figures 1 to 4 are indicated with the same reference numerals.

[0051] The connector 101 comprises an optical fibre cable 2, a ferrule housing sub-assembly 104, and an outer housing 40 to provide SC-style push/pull engagement/disengagement 46 with a mating optical fibre socket (not shown).

[0052] The cable 2 holds a single strand of 125 μm diameter single mode optical fibre 8, protected by primary and secondary buffering layers 10, about 900 μm in diameter and an outer sheath 12, typically 3 mm to 5 mm in diameter. The optical fibre 8 is terminated by the ferrule in a manner well-known to those skilled in the art, and defines a ferrule axis 5 which extends centrally through the SC connector 101.

[0053] The ferrule housing sub-assembly 104 includes a cylindrical ceramic ferrule 14, a

ferrule holder 16 in which the ferrule is seated, a helical spring 17, a ferrule holder carrier 50 and an inner housing 120. The ferrule holder 16 has a cylindrical stem 22 which extends in an axial direction away from the ferrule 14 towards a sleeve 136 of the ferrule holder carrier 50 used to make a crimp connection around the optical fibre cable sheathing 12. With reference now also to Figures 8 and 9, the spring 17 is seated around the stem 22 between an annular shoulder 24 on the ferrule holder 16 and a similar annular surface 52 within the a cylindrical recess 54 of the ferrule holder carrier 50. As shown most clearly in Figures 23 - 25, the stem 22 is slideably seated in a closely fitting bore 55 of the ferrule holder carrier.

[0054] During assembly, the ferrule holder 16 and seated ferrule 14 are inserted axially into the recess 54 of the ferule holder carrier 50. The carrier 50 has a pair of arms 56 around a portion of the stem 22 nearest the ferrule 14 which extend axially forwards of the stem on opposite sides of the base 15 of the ferrule holder. Two pairs of curved fingers 58 are provided, each pair extending in opposite circumferential directions at the end of each arm 56. The fingers 58 extend transversely to the length of the arms 56 partially around the circumference of a portion of the ferrule nearest the base 15. The ferrule base 15 has four cycles of crenellations 62 spaced symmetrically around the circumference of the base and which provide four corresponding channels that extend parallel to the optical fibre axis. These crenellations are in the form of alternating radially high 65 and low 66 cylindrically shaped regions with the circumferential and axial extent of each of the high and low regions being the same. The high and low regions are separated by steps 67 that extend in a radial direction. The arms 56 are seated in opposite radially low regions 66 in a sliding fit with the adjacent high regions 65, and reach axially forwards of the base 15 and crenellations 62 so that the fingers 58 engage with the intervening radially high regions 65 on a side 61 of the base 15 opposite the annular surface 24 against which the spring 17 is engaged. The arrangement permits a degree axial movement of the ferrule holder 50, with movement being therefore limited in one direction by the compression of the spring 17 between the two annular surfaces 24, 52 and in the other axial direction by the contact of the fingers 58 with the radially high regions 65 of the crenellations 62 on the base 15 of the ferrule holder 16. As can be seen from the drawings, the ferrule holder base 15 and ferrule holder carrier 50 also have a common cylindrical outer envelope.

[0055] The arrangement described above has the benefit of minimising the extent of the ferrule holder base 15 and ferrule holder carrier 50 in a radial direction so that this sub-assembly may be blown down a conduit or passed through other constricted spaces when installing an SC-type optical fibre communications link.

[0056] The rotational orientation of the ferrule holder carrier 50 may be set at one of four orientations relative to the ferrule 14 in the ferrule holder 16 owing to the seating of the arms 56 in the crenellations. In this way, a first rotational key is provided between the ferrule holder 16 and the ferrule holder carrier 50.

[0057] The optical fibre 8 is therefore terminated in a sub-assembly referred to herein as an optical fibre connector sub-assembly 60. As can be appreciated by an inspection of Figures 8

to 10, during assembly of the optical fibre connector sub-assembly 60 the arms 56 and fingers 58, which each have a chamfered taper 64 on an inner forwards surface, flex outwardly over the base 15 of the ferrule holder 14 until the fingers 58 snap radially inwards into engagement with the forwards surface 61 of the ferrule holder base 15.

[0058] Figures 13 to 15 show various views of the ferrule holder carrier 50 described above.

[0059] Figures 16 to 18 show similar views of a variant design of the ferrule holder carrier 150, which works in the same way as that described above, but which has a smaller diameter sleeve 236 over which an outer sheath 12 of the optical fibre cable may be crimped.

[0060] In both cases, the resulting optical fibre connector sub-assembly 60 is therefore mechanically whole or integral, both as regards the components forming the sub-assembly and as regards the mechanical connection of the sub-assembly to the optical fibre cable 2. The sub-assembly cannot come apart without first prising the fingers 58 back over the ferule holder base 15. The ferrule holder carrier has an outer diameter which is preferably no more than that of the widest portion of the ferrule holder 14, i.e. the ferrule holder base 15.

[0061] With reference now also to Figures 19 to 22, the benefit of this arrangement is that the optical fibre connector sub-assembly 60 is thin enough in a radial direction to be inserted down a length of protective conduit 72, as shown in Figure 19, even after first placing over the optical fibre connector sub-assembly 60 a temporary protective outer sleeve 74, in order to prevent damage to the optical fibre connector sub-assembly 60. The outer sleeve is preferably formed in a low friction material, such as PTFE, in order to facilitate smooth insertion of the sub-assembly down the length of conduit 72.

[0062] Optionally, the projecting end of the ferrule 14 may be additionally protected by a disposable end cap 76.

[0063] After the insertion has been performed, the assembly of the SC-type optical fibre connector is completed as follows. With reference to Figures 11, 12, 23 and 24, an inner housing 120 is inserted in an axial direction over the projecting ferrule 14 and surrounding ferrule holder carrier 50. The ferrule holder carrier 50, 150 has an annular groove 78 within the cylindrical envelope defined by the radially outermost surfaces of the ferrule holder carrier. The inner housing has a pair of arms 80 each having at an end a radially inwardly projecting detent 82. The detents 82 are initially deflected radially outwards and then snap into engagement with the groove 78 as the inner housing is slid over the sub-assembly 60. This engagement prevents relative axial movement of the inner housing and the sub-assembly 60 in one direction. The advantage of this arrangement is that the groove 78 provides an engagement feature for the inner housing which does not add to the radial dimensions of the optical fibre connector sub-assembly, which makes it much easier to insert the sub-assembly down a narrow conduit or into other constricted spaces.

[0064] Relative movement in the opposite direction is prevented by abutting of surface 52 and

an end surface 83 of a rib 84 that engages as a rotational key with an inner radial region of the crenellations 62. in this way, a second rotational key is provided between the ferrule holder carrier 50, 150 and the inner housing 120.

[0065] The external shape of the inner housing 120 where this interacts with the outer housing 6 is the same as with the prior art. The outer housing therefore is snap-fitted over the inner housing, after which the SC-type connector 101 is fully compatible with the prior art connector 1.

[0066] it should be noted that although the specific example described above relate to an SC-type connector, the optical fibre connector sub-assembly can be adapted for use with other types of optical fibre connector systems, for example the ST-type connectors.

[0067] The invention therefore provides a convenient optical fibre connector and optical fibre communication system and method for providing such a system.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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Patent documents cited in the description

- WO9535520A [0011]

OPTISK FIBERSTIK

Patentkrav

1. Optisk fiberstik (101) af Subscriber Connection (SC)-typen, der omfatter en optisk fiber (8), en optisk fiberstikdelsamling (60) samt et indre hus (120) og et ydre hus (40) til samling omkring nævnte delsamling, hvilke indre og ydre huse, når de samles omkring nævnte delsamling, tjener til at tilvejebringe SC-lignende skub/træk-sammenkobling/frakobling med en modsvarende optisk fiberfatning, idet nævnte delsamling omfatter:

   - et terminalrør (14), der har en endeflade (34), ved hvilken nævnte optiske fiber (8) afsluttes,
   - en terminalrørsholder (16), idet terminalrøret (14) holdes inde i terminalrørsholderen og strækker sig væk fra terminalrørsholderen mod nævnte endeflade (34),
   - en terminalrørsholderbærer (50), idet terminalrørsholderen (16) holdes inde i terminalrørsholderbæreren, og nævnte holder og bærer er relativt bevægelige i forhold til hinanden langs en terminalrørsakse (5),
   - et fjederforspændingsmiddel (17), der virker mellem terminalrørsholderbæreren (50) og terminalrørsholderen (16) for at forspænde terminalrørsholderen (16) langs terminalrørsaksen (5) i en retning væk fra terminalrørsholderbæreren (50),

   hvor:

   - den optiske fiberstikdelsamling (60) kan indføres langs en kanal inden samling af de indre og ydre huse (120, 40) omkring nævnte delsamling, uden at delsamlingen falder fra hinanden,

   kendetegnet ved, at

   - radialt yderste overflader af terminalrørsholderbæreren (50) definerer en cylindrisk omslutning, idet terminalrørsholderbæreren (50) har et sammenkoblingselement (78), der ikke øger nævnte omslutnings radiale dimensioner, og idet det indre hus (120) har et radialt indadragende element til lokalisering med nævnte sammenkoblingselement (78), når det indre hus samles med den optiske fiberstikdelsamling (60).

2. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge krav 1, hvor sammenkoblingselementet omfatter en rille (78).

3. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge krav 2, hvor sammenkoblingselementet omfatter en ringformet rille (78).

4. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, i hvilket fjederforspændingsmidlet (17) forspænder terminalrørsholderen (16) mod en bevægelsesgrænse, der er defineret af en interaktion mellem terminalrørsholderen (16) og terminalrørsholderbæreren (50).

5. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, i hvilket den optiske fiberstikdelsamling (60) er mekanisk integreret før samling af de indre og ydre huse (120, 40) omkring nævnte delsamling (60).

6. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, hvor:

   - det indre hus (120) kan forbindes fast til terminalrørsholderbæreren (50),
   - en del af terminalrøret, der fører til nævnte endeflade (34) af terminalrøret (14), rager ud langs terminalrørsaksen (5) væk fra terminalrørsholderbæreren (50),
   - det indre hus (120) omfatter en del, der koaksialt strækker sig omkring nævnte udragende del af terminalrøret (14) for at definere en beholder til en fatning til modtagelse af terminalrørens udragende del, når det indre hus (120) er forbundet med den optiske fiberdelsamling (60),
   - fjederforspændingsmidlet (17) er tilvejebragt mellem terminalrørsholderen (16) og terminalrørsholderbæreren (50), således at terminalrørets (14) udragende del er fjederforspændt langs terminalrørsaksen (5) mod det indre hus' (120) nævnte beholder, og
   - det indre hus (120) kan sammenkobles inde i det ydre hus (40), idet det indre hus og det ydre hus er relativt bevægelige i forhold til hinanden langs terminalrørsaksen (5) mellem grænser, der er defineret af en interaktion mellem det indre hus og det ydre hus med henblik på at tilvejebringe SC-lignende skub/træk-

sammenkobling/frakobling med en modsvarende optisk fiberfatning.

7. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, hvor terminalrøret (14) er rotationsmæssigt fastgjort i forhold til terminalrørsholderen (16) omkring terminalrørsaksen (5), og terminalrørsholderen er rotationsmæssigt bragt på linje ved hjælp af én eller flere rotationsnøgler i forhold til det ydre hus (40), således at terminalrørens (14) rotationsretning i forhold til det ydre hus kan indstilles under samling af stikket ved én af én eller flere foruddefinerede rotationsretninger.

8. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge krav 7, hvor en første rotationsnøgle (56, 62) er tilvejebragt mellem terminalrørsholderen (16) og terminalrørsholderbæreren (50).

9. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge krav 8, hvor en anden rotationsnøgle (62, 84) er tilvejebragt mellem terminalrørsholderbæreren (50) og det indre hus (120).

10. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, hvor det indre hus (120) har et første radialt indadragende element til lokalisering med nævnte sammenkoblingselement (78) og et andet radialt indadragende element til lokalisering med nævnte sammenkoblingselement (78), når det indre hus (120) samles med den optiske fiberstikdelsamling (60), idet nævnte sammenkoblingselement er en ringformet rille inden for nævnte cylindriske omslutning, og nævnte første og anden radialt indadragende elementer hver især er et radialt indadragende fasthold (82) for enden af en tilsvarende af et par arme (80) på modstående sider af det indre hus (120).

11. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, hvor terminalrørsholderen (16) er i sammenkobling inden for en modtagedel (54) af terminalrørsholderbæreren (50), og terminalrørsholderen og terminalrørsholderbæreren er indrettet til at blive samlet ved en trykmonteringsoperation, i hvilken terminalrørsholderen (16) bevæger sig langs terminalrørsaksen (5) ind i terminalrørsholderbærerens (50) modtagedel (54).

12. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge krav 11, hvor det indre hus (120) er indrettet til at blive samlet med terminalrørsholderen (16) og terminalrørsholderbæreren (50) ved en trykmonteringsoperation, i hvilken det indre hus bevæger sig langs terminalrørsaksen (5) over terminalrørets (14) udragende del mod terminalrørsholderbæreren (50).

13. Det optiske fiberstik (101) af Subscriber Connection (SC)-typen ifølge et hvilket som helst af de foregående krav, hvor nævnte optiske fiber (8) omfatter et stykke optisk fiber, der strækker sig væk fra terminalrøret (14), terminalrørsholderen (16) og terminalrørsholderbæreren (50), hvilket stykke er omgivet af et materiale til beskyttelse og/eller forstærkning, idet terminalrørsholderbæreren omfatter midler til fastgørelse af beklædning til nævnte materiale.

14. En fremgangsmåde til fremstilling af et optisk fiberstik af Subscriber Connection (SC)-typen, hvilket stik omfatter et stykke optisk fiber (8), en optisk fiberstikdelsamling (60), hvilken delsamling omfatter en fjederforspændt terminalrørsholder (16), der holdes inde i en terminalrørsholderbærer (50), hvilken terminalrørsholder holder et terminalrør (14), som afslutter nævnte stykke optisk fiber, og samlet omkring nævnte delsamling et indre hus (120) og et ydre hus (40), hvilken fremgangsmåde omfatter følgende trin:

    - indføring af den optiske fiberstikdelsamling (60) langs et stykke beskyttelseskanal, og
    - efter nævnte indføring, dannelse af nævnte optiske fiberstik af SC-typen ud fra den optiske fiberstikdelsamling (60) ved omkring nævnte delsamling at bringe et indre hus (120) og et ydre hus (40) i sammenkobling, hvilke indre og ydre huse er bevægelige i forhold til hinanden med henblik på at tilvejebringe SC-lignende tryk/træk-sammenkoblings-/frakoblingsfunktionalitet, og idet det indre hus er forbundet med et sammenkoblingselement (78) af terminalrørsholderbæreren (50),
    - hvor den optiske fiberstikdelsamling (60) ikke falder fra hinanden under indføring af nævnte delsamling langs nævnte stykke beskyttelseskanal,

    kendetegnet ved, at

    - radialt yderste overflader af terminalrørsholderbæreren (50) definerer en cylindrisk omslutning, og sammenkoblingselementet (78) ikke øger nævnte omslutnings radiale dimensioner, hvorved nævnte indføring af delsamlingen langs nævnte stykke kanal lettes.

15. Fremgangsmåden ifølge krav 14, hvor nævnte terminalrør (14) har en endeflade (34), ved hvilken nævnte optiske fiber (8) afsluttes, og nævnte delsamling endvidere omfatter:

- en terminalrørsholder (16), idet nævnte terminalrør (14) holdes inde i terminalrørsholderen og strækker sig væk fra terminalrørsholderen mod nævnte endeflade (34),
- en terminalrørsholderbærer (50), idet terminalrørsholderen (16) holdes inde i terminalrørsholderbæreren, og nævnte holder og nævnte bærer er relativt bevægelige i forhold til hinanden langs en terminalrørsakse (5), idet terminalrørsholderbæreren har et sammenkoblingselement (78) i nævnte omslutning, og idet det indre hus (120) har et radialt indadragende element (82),
- hvor fremgangsmåden efter nævnte indføring omfatter samling af det indre hus (120) med nævnte delsamling (60) ved at bringe det indre hus i sammenkobling med nævnte delsamling, mens nævnte radialt indadragende element (82) lokaliseres inde i nævnte sammenkoblingselement (78).

16. Fremgangsmåden ifølge krav 15, hvilken fremgangsmåde før nævnte indføring omfatter samling af den optiske fiberstikdelsamling (60) ved:

- afslutning af den optiske fiber ved en endeflade (34) af terminalrøret (14),
- anvendelse af terminalrørsholderen (16) til at holde terminalrøret (14), således at terminalrøret strækker sig væk fra terminalrørsholderen mod nævnte endeflade,
- placering af et fjederforspændingsmiddel (17) mellem terminalrørsholderen (16) og terminalrørsholderbæreren (50) til dannelse af den optiske fiberstikdelsamling (60), således at nævnte holder og nævnte bærer er fjederforspændt fra hinanden og relativt bevægelige i forhold til hinanden langs terminalrørsaksen (5).

17. Fremgangsmåden ifølge et hvilket som helst af kravene 14 til 16, hvilken fremgangsmåde omfatter placering af en midlertidig beskyttelsesydermuffe (74) over den optiske fiberstikdelsamling (60) eller en midlertidig endehætte (76) over terminalrørets (14) udragende del inden indføring af den optiske fiberstikdelsamling (60) langs nævnte stykke beskyttelseskanal, og derefter fjernelse af nævnte ydermuffe eller nævnte endehætte efter nævnte indføring og før nævnte samling af det indre hus (120) med den optiske fiberstikdelsamling.

18. En optisk fiberstikdelsamling (60) til anvendelse i en fremgangsmåde ifølge et hvilket som helst af kravene 14 til 17, hvilken delsamling omfatter:

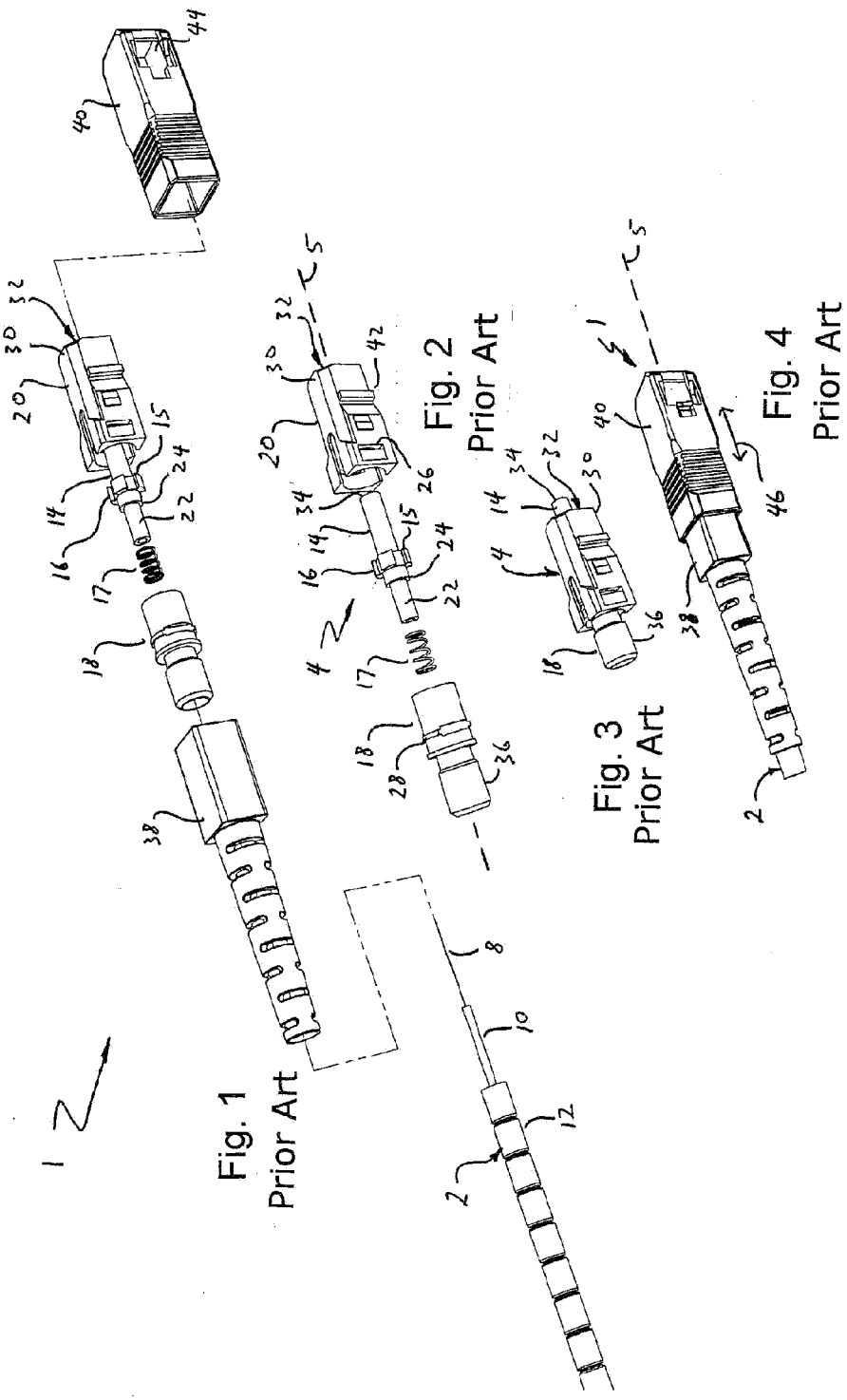
- et terminalrør (14), der har en endeflade (34), ved hvilken nævnte optiske fiber (8) afsluttes,
- en terminalrørsholder (16), idet terminalrøret (14) holdes inde i terminalrørsholderen og strækker sig væk fra terminalrørsholderen mod nævnte endeflade (34),
- en terminalrørsholderbærer (50), idet terminalrørsholderen (16) holdes inde i terminalrørsholderbæreren, og nævnte holder og bærer er relativt bevægelige i forhold til hinanden langs en terminalrørsakse (5),
- et fjederforspændingsmiddel (17) mellem terminalrørsholderbæreren (50) og terminalrørsholderen (16) til forspænding af terminalrørsholderen (16) langs terminalrørsaksen (5) væk fra terminalrørsholderbæreren (50)
- idet terminalrørsholderbæreren (50) har et sammenkoblingselement (78) til forbindelse af et indre hus (120) af et optisk fiberstik (101) af Subscriber Connection (SC)-typen med terminalrørsholderbæreren (50), og
- idet den optiske fiberstikdelsamling (60) kan indføres langs en kanal inden nævnte forbindelse af det indre hus (120) med terminalrørsholderbæreren (50), uden at den optiske fiberstikdelsamling går fra hinanden,

kendetegnet ved, at

- radialt yderste overflader af terminalrørsholderbæreren (50) definerer en cylindrisk omslutning, og sammenkoblingselementet (78) ikke øger nævnte omslutnings radiale dimensioner og er konfigureret til at lokaliseres med et radialt indadragende element af den indre hus (120), når det indre hus skal samles med den optiske fiberstikdelsamling (60).

DRAWINGS

Drawing



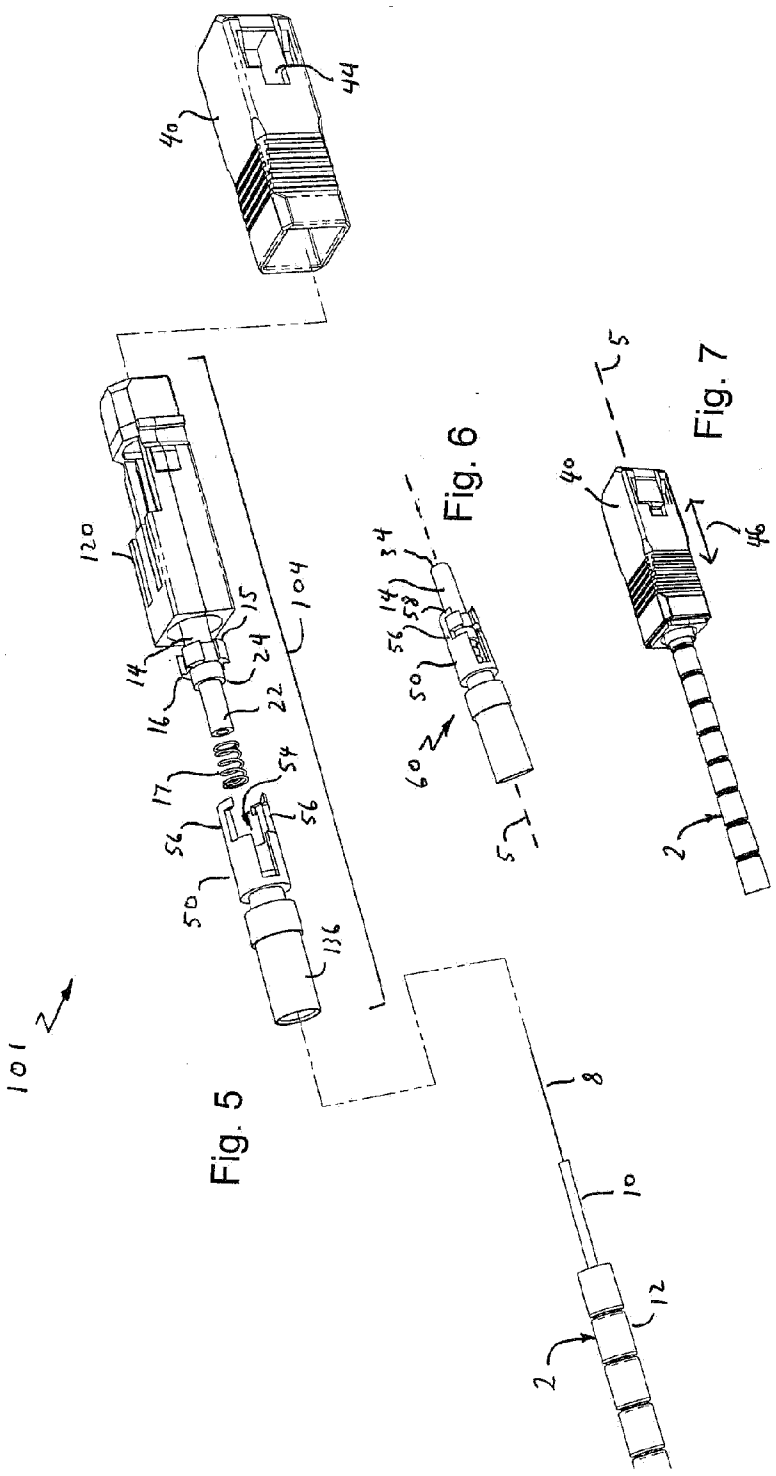


Fig. 5

Fig. 6

Fig. 7

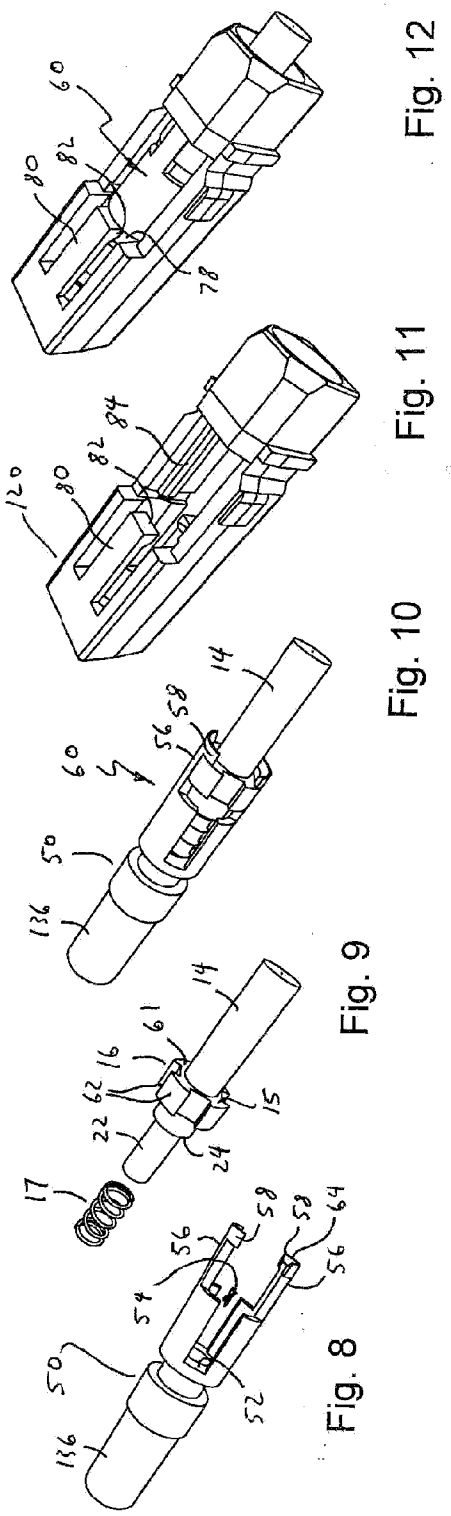


Fig. 12

Fig. 11

Fig. 10

Fig. 9

Fig. 8

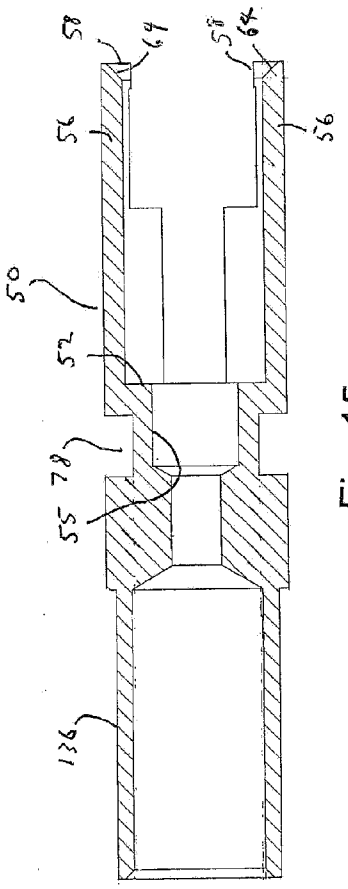


Fig. 15

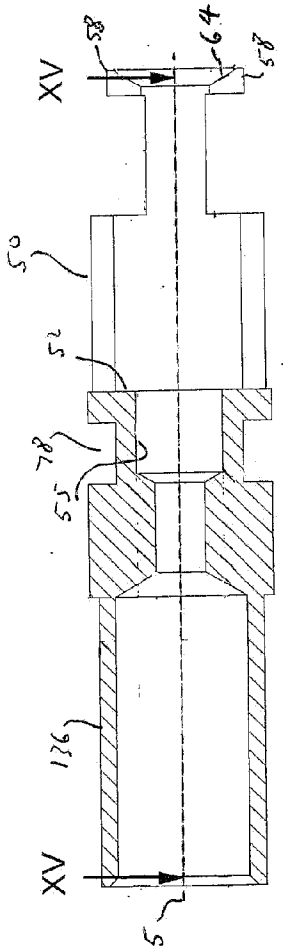


Fig. 14

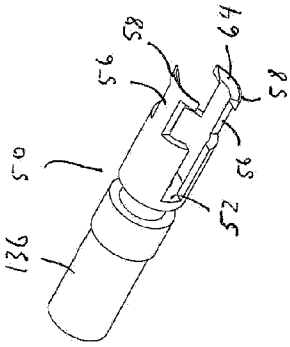


Fig. 13

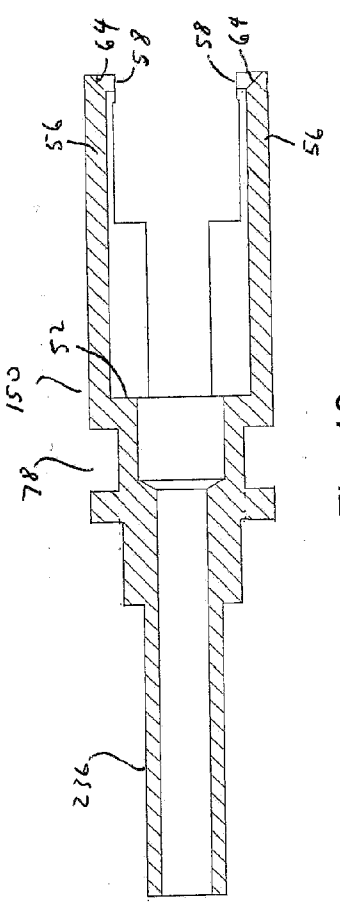


Fig. 18

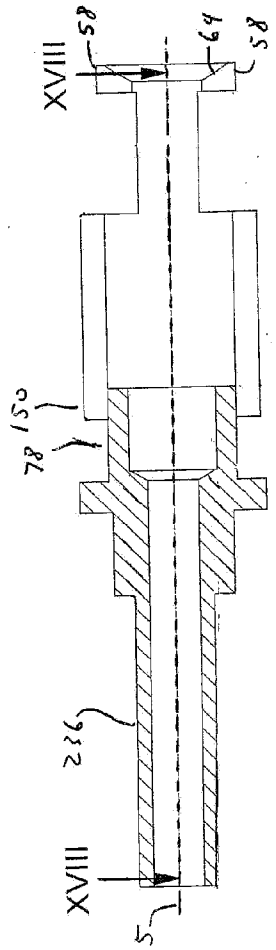


Fig. 17

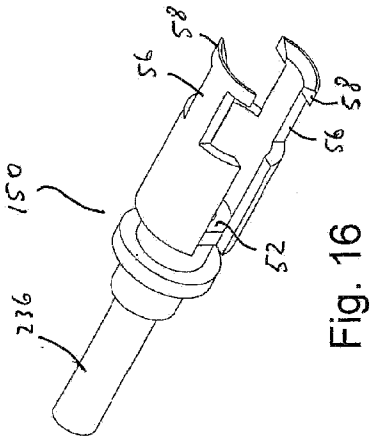
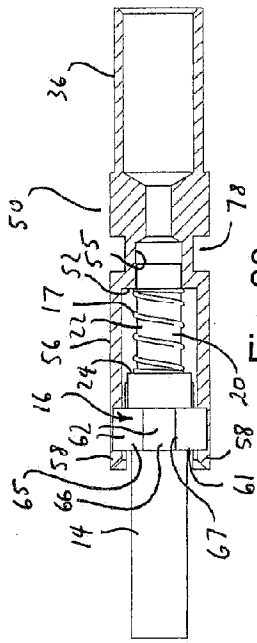


Fig. 16



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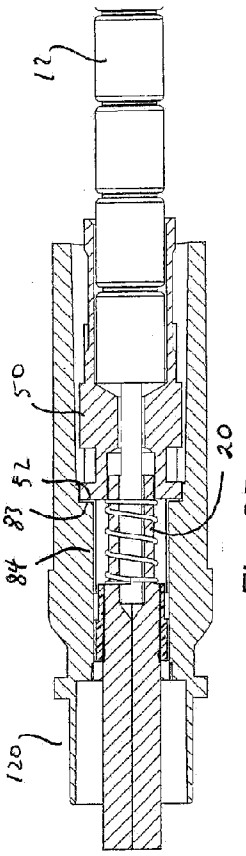

Fig. 25

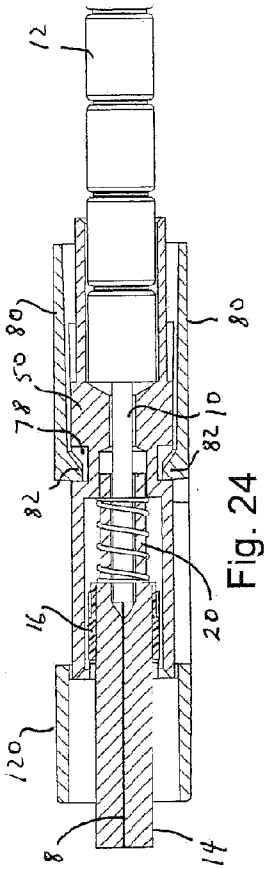

Fig. 24

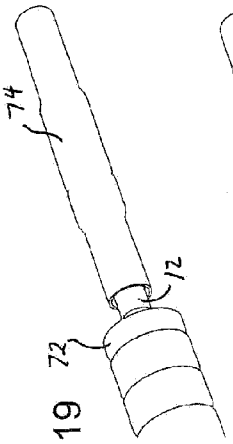

Fig. 19

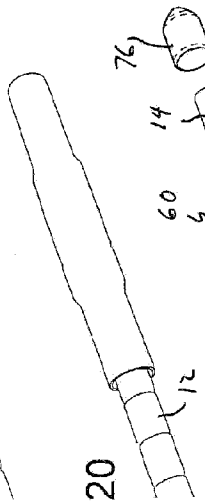

Fig. 20

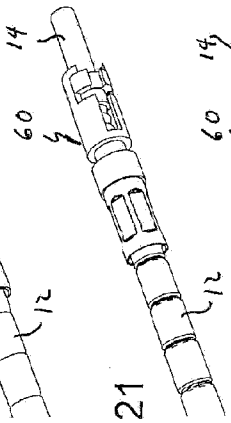

Fig. 21

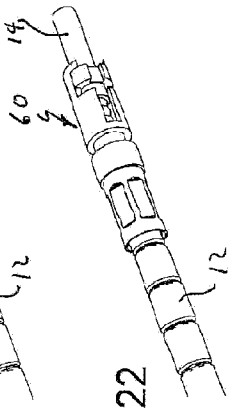

Fig. 22