

Description

This invention relates to a connector for optical fiber cable, which includes at least one optical fiber and filamentary strength members.

It is very important to prevent the transmittal of tensile forces to the optical fibers of an optical fiber cable. If this is not done, the fibers may be broken or microbending losses in the fiber may occur and degrade the quality of transmission.

In order to avoid such breakage and losses at a connector terminating the cable, the strength members of the cable must be coupled to a housing portion of the connector so that tensile forces are transferred to the housing before the forces reach the optical fiber.

In one prior art connector, polymeric yarn, which serves as the strength members of the cable, is held between cooperating surfaces of internal and external sleeves of the connector. The internal sleeve includes a bore through which the optical fibers extend and the external sleeve includes a conically shaped bore for receiving the internal sleeve. The polymeric yarn strands are passed through the bore of the internal sleeve and retroflected about a peripheral end portion of the internal sleeve whereafter the external sleeve is caused to be disposed over the internal sleeve. This arrangement can lead to abrasion of the polymeric yarn where it engages the peripheral end portion of the internal sleeve. Also, the application of tensile forces to the cable may cause dislocation and an undoing of the terminations of the strength members.

Seemingly, the prior art is devoid of a connector in which non-metallic filamentary strength members are secured to a housing of the connector and maintained as such during the application of forces to the cable while not compromising the integrity of the strength members. Desirably, connection of the strength members to the connector is accomplished in a manner which causes the secured terminations to be enhanced when the cable is subjected to tensile forces. Also, the connector should be one which facilitates alignment of plugs of connectors in sleeves and which prevents the ingress of moisture.

GB-A-2030 723 discloses force transfer means including two conformable conically shaped surfaces which are adapted to be held in mating relationship with each other with portions of a strength system therebetween.

US-A-4 185 586 discloses a hermaphroditic connector, which forms part of the prior art.

According to the present invention, there is provided a cable as defined in claim 1.

The foregoing problems have been solved by the optical fiber connector of an embodiment of

this invention. The optical fiber connector is effective to terminate an optical fiber cable which includes at least one optical fiber and a non-metallic, filamentary strength system. Included in the connector are a housing having a longitudinal axis and force transfer means disposed adjacent to a cable entrance end of the housing and through which the optical fiber extends.

The force transfer means is effective to clamp the non-metallic strength system of the cable to transfer forces from the cable to the housing. Also, the force-transfer means includes two conformable, substantially smooth conically shaped surfaces which are held in mating relationship with each other with portions of the strength member system therebetween. Each surface diverges in a direction from the cable entrance end of the housing toward another end such that an included angle between diametrically opposed lines on each of the surfaces which are disposed in a plane passing through the axis of revolution of each surfaces does not exceed a predetermined value.

Plugs which terminate the optical fibers are disposed adjacent to the other end of the housing with a plug associated with one of the fibers being disposed in an alignment sleeve which in an opposite end thereof is adapted to receive a plug which terminates an optical fiber of another connector to be assembled to this connector. Retaining facilities are disposed at an entrance to the other end of the housing to retain the sleeve in the housing and to guide a sleeve of another connector to cause another plug of this connector to be received in one end of the sleeve of the other connector.

In a preferred embodiment, the force transfer portion of the connector comprises a bushing which includes a flange and a hub connected to the flange. The hub has threads formed externally thereon and has a passageway therethrough which is tapered to cause a small diameter portion to be adjacent to the flange. The passageway through the bushing is defined by a wall having a substantially smooth surface. A wedge having a truncated conical shape is adapted to conform to the wall which defines the tapered passageway of the bushing to capture non-metallic, filamentary strength members of the optical fiber cable between the wedge and the bushing when the optical fibers of the cable extend through the wedge. The outer surface of the wedge which mates with the wall of the bushing also is substantially smooth. As a result of this arrangement, tensile loads applied to the cable are transferred to the bushing to prevent damage to the optical fibers which are to be connected to other optical fibers. A fastener turned onto the hub holds the wedge within the bushing.

Brief Description of the Drawing

FIG. 1 is an elevational view partially in section of a hermaphroditic biconic connector for optical fiber cables which includes an alignment sleeve and two plugs each of which terminates an optical fiber;

FIG. 2 is a partially exploded perspective view of the connector of FIG. 1 at an end portion thereof where an optical fiber cable enters the connector;

FIG. 3 is an exploded elevational view in section of a force transfer portion of the connector of FIG. 1;

FIG. 4 is a side elevational view in section of the force transfer portion of FIG. 3 after it has been assembled with non-metallic filamentary strength members disposed between portions thereof;

FIG. 5 is an exploded view of a plug end of the connector of FIG. 1;

FIG. 6 is an end view of the plug end of the connector of FIG. 1; and

FIG. 7 is an elevational view partially in section which shows the assembly of two of the connectors of FIG. 1.

Referring now to FIG. 1, there is shown a hermaphroditic connector which is designated generally by the numeral 20 and which is used to terminate optical fibers 22-22 of an optical fiber cable 24. Each of the optical fibers 22-22 may include a buffer cover 26 which is made of a plastic material. The optical fibers 22-22 are enclosed with a strength member system 28 (see also FIG. 2) which may be a polymeric yarn material and preferably a KEVLAR® yarn, for example. A jacket 29 which may be made of a plastic material encloses the yarn. In the preferred embodiment, the cable 24 includes two optical fibers. The connector 20, which may be referred to as a first connector, is adapted to cause the optical fibers terminated therein to become connected to optical fibers which are terminated in a second connector, which is identical to the first connector.

The cable 24 extends through a strain relief portion 30 (see FIGS. 1 and 2) which is disposed at a cable entrance end 34 of the connector and which includes a somewhat conically shaped bend limiter 31. Also, the cable 24 extends through a cable seal 33, which may be made of neoprene, for example, and which is held in tight engagement with the cable 24 by a cable seal wedge 35. A portion 37 of the bend limiter 31 is disposed between the cable 24 and a metallic insert 39 about which has been molded the bend limiter 31.

The cable 24 extends through the strain relief portion 30 and into a main portion 40 of the connector 20. Interposed between the cable seal

wedge 35 and the metallic insert of the strain relief portion is depending portion 44 of an end cap 46. The depending portion 44 of the end cap is threaded externally and is turned into an internally threaded cup-shaped portion 48 of the insert 39.

As may be viewed in FIG. 1, the right side portion of the end cap 46 is threaded internally so that the end cap can be turned onto an end portion 49 of a connector shell or housing 50. In a preferred embodiment, the connector shell 50 is made of a metallic material. The connector shell 50 is adapted to house devices for terminating the optical fibers and a strength member retention system or device 52 which is effective to prevent tensile pulls on the cable from being transferred to the optical fibers and to their being transferred to the optical fibers and to their terminations with bionic plug portions of the connector 20.

Viewing now FIGS. 2 and 3-4, it can be seen that the device 52 includes a bushing 56 having a flange 58 and a hub 59. A passageway 61 is formed through the hub and the flange and is tapered through the hub and in the flange region with the small diameter portion oriented toward the bend limiter 31. The cable 24 extends to a location just within the flange whereafter the jacket 29 of the cable is removed to expose the strength member yarn and the optical fibers.

The optical fibers 22-22 extend through a bore 63 of a wedge 65 which is disposed within the passageway 61 of the bushing 56. Seated between a hexagonal, recessed portion 66 (see FIGS. 1 and 2) of an end of the connector shell 50 and an inner end surface 68 of the end cap is the flange 58 of the bushing 56 of the strength member retention system. Desirably, an included angle, α between diametrically opposed lines on the inner surface of the tapered passageway 61 that appear in a sectional view when a plane is passed through the axis of revolution of that surface which generally is coincident with a longitudinal axis 67 (see FIG. 1) of the shell 50 does not exceed a predetermined value. It has been found that α should not exceed a value of about 6° and preferably is about 3°.

The strength member yarn is disposed between the tapered inner surface 61 of the bushing and a conformable tapered external surface of the wedge. As a result, portions of the strength member system 28 are held between these surfaces and any pull which is imparted to the cable 24 is transferred by the strength member system to the shell 50.

The wedge 65 and the bushing 56 cooperate to provide a self-enhancing locking arrangement for the strength member system 28 of the cable 24. As pulling forces are applied to the cable 24 at the strain relief end, these forces are transferred to the portions of the strength member system 28 which

causes the wedge 65 to move to the left as viewed in FIG. 4. As this occurs, the wedge 65 becomes seated further in the passageway 61 of the bushing thereby further locking the yarn and preventing any strain from being transferred to the optical fibers.

In order to achieve a substantial locking action without damaging the non-metallic strength member system 28, the bushing 56 and the wedge 65 must be further characterized. The conformable surfaces of the wedge 65 and the bushing 56 must be substantially smooth. If not, portions of the non-metallic strength member system 28 conform to the surface roughness. As a result, non-uniform pressure as between portions of the roughened surfaces causes those portions of the strength member system to be crushed and non-effective in the transfer of forces from the cable 24 to the housing shell 50.

Also, the angle α is important in reducing the angle which portions of the strength member system make as they exit the cable 24 and become disposed between the wedge 65 and the bushing 56. The greater the angle which the portions of the strength member system 28 make with the longitudinal axis 67 of the connector, the greater the probability for portions of the strength member system to break about the entrance to the annular conical space between the complimentary surfaces. Further, the intersection between the outer surface is formed with a radius to preclude damage to the non-metallic strength members.

It should be observed that this arrangement is advantageous from several standpoints. First, a locking arrangement which is self-enhancing is provided. The greater the pull, the greater the locking of the portions of the strength member system 28 within the connector 20. Also, unlike prior art connectors, portions of the strength member system 28 need not be retroflexed about a peripheral edge surface of a portion of the connector to secure the portions within the connector. Instead, the force-transfer portions of the strength member system are disposed at a relatively gentle angle to the longitudinal axis 67 of the housing between two substantially smooth surfaces.

The wedge 65 is further secured within the tapered bushing by a thrust nut 70. As can be seen in the drawings, the thrust nut 70 has an internally threaded wall 72 which defines a bore for receiving the hub 59 of the bushing 56 which is threaded externally. The thrust nut 70 also includes a centrally disposed opening 74 in an end portion 76 thereof to allow the optical fibers to extend therethrough. An external surface 78 of the thrust nut is juxtaposed with an inner surface of the shell 50.

Forward of the device 52 is a connector cavity 80. In the connector cavity 80, excess lengths of the optical fibers 22-22 are looped and then termi-

nated. Each of the optical fibers 22-22 of the cable 24 is terminated by a biconic connector assembly, designated generally by the numeral 90, in a plug end 91 of the connector 20. The biconic connector assembly 90 which is shown partially disassembled in FIG. 5 includes a retaining plate 92 which is held within the connector shell 50 for receiving two plug assemblies. Each plug assembly 90 includes a plug 94 which terminates one of the optical fibers 22-22 (see FIG. 1). As can be seen in FIGS. 1 and 5, each plug 94 includes a cylindrical portion 96, which includes a bore 98, and an end portion 100. The end portion 100, which is referred to as a primary pedestal, has a truncated conical shape and includes a passageway 102 that communicates with the bore 98.

A coated single optical fiber 22 which has been provided with a buffer comprised of a plastic material such as polyvinyl chloride, for example, and then assembled together with another such optical fiber to form the cable 24 is terminated with the plug 94 (see again FIG. 1). The jacketing material and the coating are removed from an end portion of each buffered fiber. Then, the cable is inserted into the bore 98 until the bared end portion is received in the passageway 102 with an end portion of the fiber 22 extending into a secondary pedestal 106 (see FIG. 5). An end face of the end portion of the fiber 22 is coincident with the end face of the secondary pedestal 106.

Each plug 94 is provided with a retaining ring and a washer adjacent to its end portion 100. As can be seen in FIG. 1, each of the plug assemblies 90-90 includes a retaining ring 100 which is fixedly located about the plug 94 and abuts a washer 117. A compression spring 114 of the plug between the washer 117 and another washer 115 and the retaining plate 92. The plug 94 is positioned in a connector body 120 with the washer 115 in engagement with the retaining plate 92 to hold the plug within the shell. Another retaining ring 118 is positioned on the plug 94 on the opposite side of the retaining plate 92 to hold the plug therein. With this arrangement, the plugs 94-94 in the retaining plate 92 can be moved to the left as viewed in FIG. 1, compressing the springs 114-114 and disengaging each retaining ring 118 from the plate 92.

The connector body 120 which is positioned within the shell (see FIGS. 1 and 5) of the connector 20 is adapted to receive two plugs 94-94. The connector body comprises a cylindrical housing 122 which includes two opposed cavities 121-121 each of which is adapted to receive the cylindrical portion of a plug. An O-ring seal 123 is disposed about the connector body 120 and engages an inner surface of the shell to prevent ingress of moisture into the connector cavity 80. The connector body is provided with a keyway 126 which is

adapted to receive a key 127 of the connector shell to prevent turning of the connector body within the shell 50. Also, the connector body 120 is secured within the shell 50 by an externally threaded retainer member 131.

A radial face of the connector body 120 is provided with an oval shaped recess 124 for receiving a bellows seal 125. The bellows seal 125 is oval-shaped and includes two spaced openings each provided with a funnel-shaped collar 128. Advantageously, each collar 128 is fit snugly about a plug 94 and is capable of permitting longitudinal movement of the plug. The bellows seal which is made of an elastomeric material is adapted to be held in the recess in the connector body 120 by a seal retainer 129.

As can be seen in FIGS. 1 and 5 of the drawings, each plug extends through the connector body and retainer with one adapted to be received in a cavity of an alignment sleeve 130. The alignment sleeve 130 comprises two opposed, conically shaped cavities 132-132 which meet at a common plane 136. Both the plug 94 and the sleeve 130 are made of a crushed silica-filled, transfer molding grade epoxy composition, for example. However, it should be understood that the plug and sleeve could be made of other materials, such as metallic materials, for example.

The alignment sleeve 130 is such that when end portions 100-100 of plugs 94-94 are received in the cavities 132-132, the ends of the secondary pedestals are in the vicinity of the common plane 136. Also, as a connection is made, the plug portions are moved through the openings defined by lips of the openings in the retainer plate 92 to move the retaining rings 118-118 out of engagement with the lips.

The sleeve 130 extends into a sleeve retainer 140 (see FIGS. 1 and 5) which is supported at one end of the connector shell 50. The sleeve retainer 140 is made from an impact-resistant thermoplastic material. Also, the sleeve retainer 140 includes a boss 142 and an opening 143 diametrically opposed thereto (see also FIG. 6). Externally projecting plug-protecting posts 145-145 are disposed on opposite diametrical portions of the opening. The boss 142 is adapted to hold a biconic sleeve 130 in which is seated the truncated conically shaped end portion of one plug. An angled entrance portion 147 of the boss 142 causes the sleeve 130 to be retained in the boss and connector body 120. The opening 143 in the sleeve retainer is adapted to receive a boss of a second connector, that boss also having an alignment sleeve 130 therein.

When the first connector 20 is assembled with a second connector 20 and the sleeve 130 of the second connector is received in the opening 143, a plug end which is seated in the sleeve of the

second connector is caused to become disposed adjacent to a plug of the first connector having an end portion which extends into the opening. At the same time, a plug of the second connector 20 which extends into the opening 143 of its sleeve retainer 140 extends into and becomes seated in the other end of the alignment sleeve 130 held in the first connector. As the second connector is moved to engage the first connector, its posts 145-145 encompass the boss 142 projecting from the first connector. As a result of this arrangement, the two connectors mate hermaphroditically. The spring 114 of each plug assembly causes the plug end portion 100 to be seated firmly in engagement with the wall of the alignment sleeve.

As seen in FIGS. 1 and 7, a leading end portion 151 of the connector shell 50 is threaded externally. As such, it is adapted to be turned into an internally threaded portion of a coupling nut 153. The coupling nut 153 extends forwardly of the sleeve retainer 140 so that it is adapted to receive the sleeve retainer of a second connector. Each connector 20 is provided with a coupling nut 153 which includes a lip 155 that is adapted to engage an abutment 157 of an end portion of the connector shell. When two connectors 20-20 are assembled together, the coupling nut 153 of a first one of the connectors is withdrawn from the leading end of the connector shell 50. The coupling nut 153 of a second connector is moved forward so that its threaded end engages the externally threaded portion of the first connector to secure together the connectors 20-20. It should be observed from FIG. 1, that prior to the assembly of the connector 20 with another, the secondary pedestal 106 of each biconic plug extends beyond a mating surface 160 of the connector. Therefore, in order for the surfaces 160-160 of the connectors to engage each other, the secondary pedestals and hence the plugs must be capable of moving inwardly into the shell 50. This is accomplished through the hereinbefore-described spring mounting of each plug.

Furthermore, in order to maximize the alignment of the biconic plugs and the axes of the optical fibers therein, it is desirable to minimize the contact of the biconic plugs with supporting surfaces. For example, to avoid bends in the sleeves, interference by the supporting structure is minimized. As can be seen best in FIG. 1, when another connector is assembled to the connector 20, the contact between end portions of the plugs causes each plug to be moved inwardly. This disengages the retaining rings 118-118 from the retaining plate 92 and the cone-shaped external portions of the sleeves from surface 147 of the boss 142. As a result, each plug tends to float within the connector 20.

Also, it should be observed that, advantageously, the bellows seal 125 because of its configuration is able to maintain a seal about each plug notwithstanding longitudinal and/or radial movement of the plugs which extend therethrough. This effectively prevents the ingress of moisture along the plugs whereas the O-ring 123 prevents the ingress of moisture between the connector body 120 and the shell 50.

Additional seals are provided to prevent the ingress of moisture. As can be seen in FIGS. 1 and 7, seals 156-156, which typically are made of rubber, are disposed on ends of the connector shells 50-50 and abut each other when two connectors are mated, thus blocking the ingress of moisture.

Claims

An optical cable (24) which is terminated with a hermaphroditic connector (20) that includes provisions for transferring forces from non-metallic filamentary strength members (28-28) of the cable to the connector, the terminated cable including two optical fibers (22-22) and nonmetallic, filamentary strength members, and

a housing (50) having a cable input end into which the cable extends and a termination end; the terminated cable further including a bushing (56) which is disposed in said housing and which includes a tapered passageway (61) having a smooth surface;

a truncated conically shaped wedging member (65) which is received in said passageway (61) of said bushing (56), said bushing and said wedging member cooperating to receive an end of the cable in a small diameter portion of said passageway with the nonmetallic strength members being disposed between the inner surface of said passageway and said outer surface of said wedging member, said wedging member having a longitudinally extending bore (63) through which optical fibers of the cable extend, said wedging member having a smooth outer surface conformable to said inner surface of the tapered passageway of said bushing;

said bushing and said wedging member cooperating to transfer forces imparted to the cable to the housing to avoid the transmittal of the forces to the connection of the fibers;

fastening means disposed within said housing and secured to said bushing to hold said wedging member (65) in said bushing (56);

termination means being held in said housing adjacent to said termination end and terminating the optical fibers and comprising a first plug, an alignment sleeve (130) for receiving a

leading portion of the first plug and a plug of a corresponding hermaphroditic connector which terminates an optical fiber of another cable and a second plug, which is adapted to be received in a sleeve of the other connector;

characterized in that

the passageway in said bushing and the outer surface of said wedging member diverge in a direction from the cable input of said housing toward the termination end of said housing, that the intersection between an end surface of said wedging member and an outer tapered surface of said wedging member are formed with a rounded surface to prevent damage to the strength members which are pressed therearound;

that the first and second plug haveing truncated conically shaped end portions; and that the alignment sleeve (130) provided on the first plug had a biconical inner surface for receiving a leading portion of the first plug and a plug of a corresponding hermaphroditic connector which terminates an optical fiber the other cable.

2. The terminated cable of claim 1, CHARACTERIZED IN THAT

said fastening means includes a thrust nut (70) turned threadably onto an externally threaded portion of said bushing.

3. The terminated cable of claim 1, CHARACTERIZED IN THAT

the cable also includes an end cap (46) that encloses said bushing and said wedging member.

4. The terminated cable of claim 1, CHARACTERIZED IN THAT

a line disposed on the surface of the wedging member and disposed in a plane that passes through the longitudinal axis of the wedging member making an angle of about 1.5 degrees with the longitudinal axis of the wedging member.

5. The terminated cable of claim 1, CHARACTERIZED IN THAT

said bushing includes a Range (58) and a hub (59) connected to said Range, said hub having threads formed externally thereon and having a passageway (61) therethrough which is tapered to cause a small diameter portion to be adjacent to said flange, said passageway being defined by a wall having a substantially smooth surface; and



Also, it should be observed that, advantageously, the bellows seal 125 because of its configuration is able to maintain a seal about each plug notwithstanding longitudinal and/or radial movement of the plugs which extend therethrough. This effectively prevents the ingress of moisture along the plugs whereas the O-ring 123 prevents the ingress of moisture between the connector body 120 and the shell 50.

Additional seals are provided to prevent the ingress of moisture. As can be seen in FIGS. 1 and 7, seals 156-156, which typically are made of rubber, are disposed on ends of the connector shells 50-50 and abut each other when two connectors are mated, thus blocking the ingress of moisture.

Claims

An optical cable (24) which is terminated with a hermaphroditic connector (20) that includes provisions for transferring forces from non-metallic filamentary strength members (28-28) of the cable to the connector, the terminated cable including two optical fibers (22-22) and nonmetallic, filamentary strength members, and

a housing (50) having a cable input end into which the cable extends and a termination end; the terminated cable further including a bushing (56) which is disposed in said housing and which includes a tapered passageway (61) having a smooth surface;

a truncated conically shaped wedging member (65) which is received in said passageway (61) of said bushing (56), said bushing and said wedging member cooperating to receive an end of the cable in a small diameter portion of said passageway with the nonmetallic strength members being disposed between the inner surface of said passageway and said outer surface of said wedging member, said wedging member having a longitudinally extending bore (63) through which optical fibers of the cable extend, said wedging member having a smooth outer surface conformable to said inner surface of the tapered passageway of said bushing;

said bushing and said wedging member cooperating to transfer forces imparted to the cable to the housing to avoid the transmittal of the forces to the connection of the fibers;

fastening means disposed within said housing and secured to said bushing to hold said wedging member (65) in said bushing (56);

termination means being held in said housing adjacent to said termination end and terminating the optical fibers and comprising a first plug, an alignment sleeve (130) for receiving a

leading portion of the first plug and a plug of a corresponding hermaphroditic connector which terminates an optical fiber of another cable and a second plug, which is adapted to be received in a sleeve of the other connector;

characterized in that

the passageway in said bushing and the outer surface of said wedging member diverge in a direction from the cable input of said housing toward the termination end of said housing, that the intersection between an end surface of said wedging member and an outer tapered surface of said wedging member are formed with a rounded surface to prevent damage to the strength members which are pressed therearound;

that the first and second plug haveing truncated conically shaped end portions; and that the alignment sleeve (130) provided on the first plug had a biconical inner surface for receiving a leading portion of the first plug and a plug of a corresponding hermaphroditic connector which terminates an optical fiber the other cable.

2. The terminated cable of claim 1,

CHARACTERIZED IN THAT

said fastening means includes a thrust nut (70) turned threadably onto an externally threaded portion of said bushing.

3. The terminated cable of claim 1,

CHARACTERIZED IN THAT

the cable also includes an end cap (46) that encloses said bushing and said wedging member.

4. The terminated cable of claim 1,

CHARACTERIZED IN THAT

a line disposed on the surface of the wedging member and disposed in a plane that passes through the longitudinal axis of the wedging member making an angle of about 1.5 degrees with the longitudinal axis of the wedging member.

5. The terminated cable of claim 1,

CHARACTERIZED IN THAT

said bushing includes a Range (58) and a hub (59) connected to said Range, said hub having threads formed externally thereon and having a passageway (61) therethrough which is tapered to cause a small diameter portion to be adjacent to said flange, said passageway being defined by a wall having a substantially smooth surface; and



said wedging member (65) having a truncated conical shape which conforms to the tapered passageway of said bushing to capture the non-metallic, filamentary strength members of the optical fiber cable between the wedging member and the bushing with the optical fibers of the cable extended through the wedging member to cause tensile loads applied to the cable to be transferred to the bushing to prevent damage to the optical fibers which are terminated by said termination means.

6. The terminated cable of claim 5,
CHARACTERIZED IN THAT

each of said plugs (94-94) extends through are retaining plate (110) and a connector body (120) which are secured within said housing, said connector body includes a recess provided in an externally facing surface thereof and a bellows seal (125) which is received in said recess, said seal including two spaced openings in each of which is received a plug and said seal further including a protruding entrance portion which grips a plug which extends therethrough to allow longitudinal and transverse movement of said plug while preventing the ingress of moisture.

7. The terminated cable of claim 3,
CHARACTERIZED IN THAT

the cable also includes a seal (33) which is disposed about the cable adjacent to said end cap, said seal being held in compressed engagement with the cable by a wedge which is held in engagement with said seal by a metallic insert having an internally threaded cavity which is in threaded engagement with threads formed about an outer wall of said end cap, the insert being enclosed by a bend limiter which has been assembled to the cable.

8. The terminated cable of claim 1,
CHARACTERIZED IN THAT

the cable also includes a sleeve retainer (140) which includes a boss that is disposed over said alignment sleeve to facilitate entry of a plug of another connector and to hold said alignment sleeve in said housing and an opening aligned with said second plug for receiving an alignment sleeve of the other connector, said sleeve retainer also including two posts (145-145) which are disposed adjacent to said opening to guide a boss of the other connector over said second plug with posts of the other connector becoming disposed about the boss of said connector, each of said posts including an arcuate surface which conforms to and is adapted to become juxtaposed to an external

surface of a boss of another connector with which said connector is to be assembled.

Patentansprüche

1. Optisches Kabel (24), das mit einem Zwitterstecker (20) abgeschlossen ist, mit folgenden Merkmalen:
der Stecker umfaßt Einrichtungen zur Übertragung von Kräften von nichtmetallischen, faserartigen Verstärkungsgliedern (28-28) vom Kabel auf den Stecker; das abgeschlossene Kabel umfaßt zwei optische Fasern (22-22) und nichtmetallische, faserartige Verstärkungsglieder;
ein Gehäuse (50) weist ein Kabeleingangsende auf, in das sich das Kabel und ein Abschlußende erstrecken;
das abgeschlossene Kabel umfaßt ferner eine Buchse (56), die in dem Gehäuse angeordnet ist und einen konischen Kanal (61) mit einer glatten Oberfläche aufweist;
ein konisches Keilglied (65) sitzt in dem Kanal (61) der Buchse (56);
die Buchse und das Keilglied arbeiten zusammen, um ein Ende des Kabels in einem Teil kleinen Durchmessers des Kanals aufzunehmen, wobei die nichtmetallischen Verstärkungsglieder zwischen der inneren Oberfläche des Kanals und der äußeren Oberfläche des Keilgliedes angeordnet sind;
das Keilglied weist eine sich längserstreckende Bohrung (63) auf, durch welche sich die optischen Fasern des Kabels erstrecken;
das Keilglied besitzt eine glatte äußere Oberfläche, die sich der inneren Oberfläche des konischen Kanals der Buchse anschmiegt;
die Buchse und das Keilglied arbeiten zusammen, um auf das Kabel ausgeübte Kräfte auf das Gehäuse zu übertragen, um die Übertragung der Kräfte auf die Verbindung der Fasern zu vermeiden;
eine Befestigungseinrichtung ist in dem Gehäuse angeordnet und an der Buchse befestigt, um das Keilglied (65) in der Buchse (56) zu halten;
eine Abschlußeinrichtung wird in dem Gehäuse benachbart zu dem Abschlußende gehalten, schließt die optischen Fasern ab und weist einen ersten Stecker, eine Ausrichthülse (130) zur Aufnahme eines vorderen Teils des ersten Steckers und eines Steckers eines entsprechenden Zwillingssteckerverbinders auf, welcher eine optische Faser eines anderen Kabels und eines zweiten Steckers abschließt, der zur Aufnahme in einer Hülse des anderen Verbinders aufgenommen werden kann;
dadurch gekennzeichnet,



daß der Kanal in dem Gehäuse und die äußere Oberfläche des Keilgliedes in Richtung von dem Kabeleinlaß des Gehäuses zum Abschlußende des Gehäuses sich erweitert, daß die Schnittstelle zwischen einer Endoberfläche des Keilgliedes und einer äußeren Konusfläche des Keilgliedes mit einer abgerundeten Oberfläche ausgebildet sind, um die Beschädigung der Verstärkungsglieder zu vermeiden, die darum herumgepreßt werden; daß der erste und der zweite Stecker konisch geformte Endteile aufweisen und daß die auf dem ersten Stecker vorgesehene Ausrichthülse (130) eine bikonische innere Oberfläche aufweist, um ein vorderes Teil des ersten Steckers und einen Stecker eines korrespondierenden Zwillingssteckerverbinders aufzunehmen, der die optische Faser des anderen Kabels abschließt.

2. Abgeschlossenes Kabel nach Anspruch 1, dadurch gekennzeichnet, daß die Befestigungseinrichtung eine Druckmutter (70) aufweist, die auf einem äußeren Schraubteil der Buchse aufgeschraubt ist.

3. Abgeschlossenes Kabel nach Anspruch 1, dadurch gekennzeichnet, daß das Kabel noch eine Endkappe (46) umfaßt, welche die Buchse und das Keilglied umschließt.

4. Abgeschlossenes Kabel nach Anspruch 1, dadurch gekennzeichnet, daß eine Linie auf der Oberfläche des Keilgliedes angeordnet und in einer Ebene gelegen ist, die durch die Längsachse des Keilgliedes hindurchgeht und einen Winkel von ungefähr 1,5° zur Längsachse des Keilgliedes einnimmt.

5. Abgeschlossenes Kabel nach Anspruch 1, dadurch gekennzeichnet, daß die Buchse einen Flansch (58) und eine mit dem Flansch verbundene Nabe (59) aufweist, daß die Nabe mit äußerlich angeformten Verschraubungen versehen ist und einen hindurchtretenden Kanal (61) aufweist, der sich so verjüngt, daß ein Teil kleinen Durchmessers benachbart dem Flansch zu liegen kommt, daß der Kanal durch eine Wandung mit im wesentlichen glatter Oberfläche definiert wird und daß das Keilglied (65) eine konische Form besitzt, die zu dem konischen Kanal der Buchse paßt, um die nichtmetallischen, faserartigen Verstärkungsglieder des optischen Faserkabels zwischen dem Keilglied und der Buchse zu

fassen, wobei die optischen Fasern des Kabels sich durch das Keilglied erstrecken, damit an dem Kabel anliegende Zuglasten auf die Buchse übertragen werden und Beschädigungen der optischen Fasern vermieden werden, welche durch die Abschlusseinrichtung abgeschlossen sind.

6. Abgeschlossenes Kabel nach Anspruch 5, dadurch gekennzeichnet, daß jeder der Stecker (94-94) sich durch eine Rückhalteplatte (110) und ein Verbindergehäuse (120) erstreckt, die innerhalb des Gehäuses befestigt sind, daß das Verbindergehäuse eine Aussparung in einer nach außen blickenden Oberfläche und eine Balgabdichtung (125) aufweist, die in der Aussparung aufgenommen ist, daß die Abdichtung zwei im Abstand voneinander angeordnete Öffnungen aufweist, in welche jeweils ein Stecker aufgenommen wird, und daß die Dichtung ferner ein vorspringendes Eintrittsteil umfaßt, welches einen sich hindurch erstreckenden Stecker ergreift, um Längs- und Querbewegung des Steckers zu ermöglichen, während der Eintritt von Feuchtigkeit verhindert wird.

7. Abgeschlossenes Kabel nach Anspruch 3, dadurch gekennzeichnet, daß das Kabel noch eine Dichtung (33) aufweist, die um das Kabel benachbart der Endkappe angeordnet ist, daß die Abdichtung in zusammengepreßtem Eingriff mit dem Kabel durch einen Keil gehalten wird, der in Eingriff mit der Dichtung mittels eines metallischen Einsatzes gehalten wird, der einen Hohlraum mit Innenverschraubung aufweist, die im Schraubeingriff mit Verschraubungen auf der äußeren Wandung der Endkappe steht, und daß der Einsatz durch einen gebogenen Begrenzer umschlossen ist, der an das Kabel angebaut ist.

8. Abgeschlossenes Kabel nach Anspruch 1, dadurch gekennzeichnet, daß das Kabel noch eine Hülsenrückhalteeinrichtung (140) aufweist, die einen Vorsprung umfaßt, der über der Ausrichthülse angeordnet ist, um den Eintritt eines Steckers eines anderen Verbinders zu erleichtern und die Ausrichthülse in dem Gehäuse zu halten, daß eine mit dem zweiten Stecker ausgerichtete Öffnung zum Empfang einer Ausrichthülse eines anderen Verbinders vorgesehen ist, daß die Hülsenhalteeinrichtung noch zwei Pfosten (145-145) umfaßt, die benachbart der Öff-



nung angeordnet sind, um einen Vorsprung eines anderen Verbinders über den zweiten Stecker zu führen, wobei die Pfosten des anderen Verbinders um die Vorsprünge des Verbinders zu liegen kommen, und daß jeder der Pfosten eine bogenförmige Oberfläche aufweist, die zu einer äußeren Oberfläche eines Vorsprungs eines anderen Verbinders paßt und auf dieser zu liegen kommt, mit welcher der Verbinder zusammenzubauen ist.

Revendications

1. Un câble optique (24) qui est terminé par un connecteur hermaphrodite (20) qui comprend des moyens prévus pour transférer des forces vers le connecteur à partir d'éléments de renfort non métalliques sous forme de filaments (28-28) du câble, le câble équipé de sa terminaison comprenant deux fibres optiques (22-22) et des éléments de renfort non métalliques sous forme de filaments, et un boîtier (50) ayant une extrémité d'entrée de câble dans laquelle s'étend le câble, et une extrémité de terminaison;

le câble équipé de sa terminaison comprenant en outre une bague (56) qui est disposée dans le boîtier et qui contient un passage tronconique (61) ayant une surface lisse;

un élément de coincement de forme tronconique (65) qui est reçu dans le passage (61) de la bague (56), cette bague et l'élément de coincement coopérant de façon à recevoir une extrémité du câble dans une partie de faible diamètre du passage, avec les éléments de renfort non métalliques disposés entre la surface intérieure du passage et la surface extérieure de l'élément de coincement, cet élément de coincement comportant un alésage (63) s'étendant en direction longitudinale, à travers lequel passent des fibres optiques du câble, cet élément de coincement ayant une surface extérieure lisse qui est capable de se conformer à la surface intérieure du passage tronconique de la bague;

la bague et l'élément de coincement coopérant de façon à transférer au boîtier des forces qui sont communiquées au câble, afin d'éviter la transmission des forces à la connexion des fibres;

des moyens d'assemblage disposés à l'intérieur du boîtier et fixés à la bague pour maintenir l'élément de coincement (65) dans la bague (56);

des moyens de terminaison qui sont maintenus dans le boîtier en position adjacente à l'extrémité de terminaison, et qui constituent la terminaison des fibres optiques et compren-

nent une première fiche, une douille d'alignement (130) qui est destinée à recevoir une partie avant de la première fiche, et une fiche d'un connecteur hermaphrodite correspondant qui constitue la terminaison d'une fibre optique d'un autre câble, et une seconde fiche, qui est destinée à être reçue dans une douille de l'autre connecteur;

caractérisé en ce que

le passage dans la bague et la surface extérieure de l'élément de coincement divergent dans une direction allant de l'entrée de câble du boîtier vers l'extrémité de terminaison du boîtier,

en ce que l'intersection entre une surface d'extrémité de l'élément de coincement et une surface tronconique extérieure de l'élément de coincement est formée avec une surface arrondie pour éviter d'endommager les éléments de renfort qui sont pressés sur cette surface;

en ce que les première et seconde fiches ont des parties d'extrémités de forme tronconique; et

en ce que la douille d'alignement (130) qui se trouve sur la première fiche comporte une surface intérieure biconique qui est destinée à recevoir une partie avant de la première fiche, et une fiche d'un connecteur hermaphrodite correspondant qui constitue la terminaison d'une fibre optique de l'autre câble.

2. Le câble équipé d'une terminaison de la revendication 1,

CARACTERISE EN CE QUE

les moyens d'assemblage comprennent un écrou de poussée (70) qui est vissé sur une partie filetée extérieurement de la bague.

3. Le câble équipé d'une terminaison de la revendication 1,

CARACTERISE EN CE QUE

le câble comprend également un chapeau d'extrémité (46) qui enferme la bague et l'élément de coincement.

4. Le câble équipé d'une terminaison de la revendication 1,

CARACTERISE EN CE QUE

une ligne formée sur la surface de l'élément de coincement et se trouvant dans un plan qui passe par l'axe longitudinal de l'élément de coincement, fait un angle d'environ 1,5 degré avec l'axe longitudinal de l'élément de coincement.

5. Le câble équipé d'une terminaison de la revendication 1,

CARACTERISE EN CE QUE



la bague comprend un collet (58) et une partie tubulaire (59) reliée au collet, cette partie tubulaire comportant un filetage formé sur sa surface extérieure, et comportant un passage (61) qui la traverse et qui a une forme tronconique de façon qu'une partie de faible diamètre soit adjacente au collet, ce passage étant défini par une paroi qui a une surface pratiquement lisse; et

l'élément de coincement (65) présente une forme tronconique qui se conforme au passage tronconique de la bague pour emprisonner les éléments de renfort non métalliques, sous forme de filaments, du câble à fibres optiques entre l'élément de coincement et la bague, les fibres optiques du câble traversant l'élément de coincement pour faire en sorte que des charges de traction qui sont appliquées au câble soient transférées à la bague, afin d'éviter un endommagement des fibres optiques qui aboutissent aux moyens de terminaison.

6. Le câble équipé d'une terminaison de la revendication 5,

CARACTERISE EN CE QUE

chacune des fiches (94-94) traverse une plaquette de retenue (110) et un corps de connecteur (120) qui sont fixés à l'intérieur du boîtier, ce corps de connecteur comporte une cavité formée dans sa surface orientée vers l'extérieur, et un joint d'étanchéité à soufflet (125) qui est reçu dans la cavité précitée, ce joint comportant deux ouvertures espacées dans chacune desquelles est reçue une fiche, et le joint d'étanchéité comprenant en outre une partie d'entrée en saillie qui enserre une fiche qui la traverse, pour permettre un mouvement longitudinal et transversal de la fiche, tout en empêchant la pénétration d'humidité.

7. Le câble équipé d'une terminaison de la revendication 3,

CARACTERISE EN CE QUE

le câble comprend également un joint d'étanchéité (33) qui est disposé autour du câble en position adjacente au chapeau d'extrémité, ce joint d'étanchéité étant maintenu en contact avec le câble, dans une condition comprimée, au moyen d'une cale qui est maintenue en contact avec le joint d'étanchéité par un insert métallique ayant une cavité filetée intérieurement qui est vissée sur un filetage formé autour d'une paroi extérieure du chapeau d'extrémité, l'insert étant enveloppé par un limiteur de courbure qui a été assemblé au câble.

dication 1,

CARACTERISE EN CE QUE

le câble comprend également un élément de retenue de douille (140) qui comprend un bossage disposé sur la douille d'alignement, pour faciliter l'entrée d'une fiche d'un autre connecteur, et pour maintenir la douille d'alignement dans le boîtier, et une ouverture alignée avec la seconde fiche pour recevoir une douille d'alignement de l'autre connecteur, cet élément de retenue de douille comportant également deux plots (145-145) qui sont disposés dans des positions adjacentes à l'ouverture, pour guider un bossage de l'autre connecteur sur la seconde fiche, tandis que des plots de l'autre connecteur viennent se disposer autour du bossage du connecteur précité, chacun de ces plots comprenant une surface courbe qui se conforme à une surface extérieure d'une bossage d'un autre connecteur avec lequel le connecteur précité doit être assemblé, cette surface courbe étant conçue pour prendre une position juxtaposée à la surface externe du bossage de l'autre connecteur.

8. Le câble équipé d'une terminaison de la reven-