OPTICAL CONNECTOR

Technical Field

The present invention relates to an optical connector for optically connecting two optical fibers to each other.

Background Art

In general, an optical connector includes a ferrule for contacting optical fiber end faces with each other while a core wire portion of the optical fiber is being held so that it can not be moved. The core wire portion of the optical fiber held by the ferrule is positioned so that both the ferrules can be aligned with each other and end faces of both the optical fibers can be contacted with each other. In this way, both the optical fibers are connected to each other. When both the ferrules are positioned, a cylindrical sleeve, which is highly accurately formed, is used. When the ferrules are inserted into the sleeve from opening end portions on both sides of the sleeve, both the ferrules are positioned being aligned with each other. Since the ferrules are elastically supported by an elastic member in the connector, the ferrules are contacted with each other by an elastic force generated by the elastic member at the time of connecting the connector, so that the end faces of both the optical fibers can be contacted with each other.

In order to hold the core wire portion of the optical fiber by the ferrule, it is common to use a liquid adhesive agent, the principal component of which is epoxy resin. This method is used at the time of assembling an optical connector by using an optical fiber, which has previously been cut by a predetermined length, in indoor facilities such as factories. However, in the case where an optical connector is assembled in a site such as an outdoor environment, a coating work to coat the adhesive agent between the core wire portion of the optical fiber and the ferrule imposes a burden on a worker. Further, when the worker waits for the hardening of the adhesive agent, the working property is deteriorated. Furthermore, since the optical fiber and the ferrule are fixed to each other by the adhesive agent, even when a failure of working is found, it is impossible to do the adhering work over again.

Another method of holding the optical fiber is provided in which the core wire portion of the optical fiber, which is incorporated into the ferrule being bonded, is connected to the core wire portion of the optical fiber inserted into an extension portion of

the ferrule in a site and these core wire portions are mechanically gripped. An example of this method is described in Patent Document 1. In the paragraph No. 0017 of Patent Document 1, the configuration of the optical connector is explained. In the paragraph No. 0018 of Patent Document 1, the connector body of the optical connector is explained. The connector body is explained as follows. "Connector body 1 includes: ferrule 3 into which optical fiber 34 used for connection has previously been incorporated; grip portion 4 for gripping a state of connection in which protruding portion 34b, which protrudes from a rear end of ferrule 3 of optical fiber 34 used for connection, and optical fiber F are gripped; and housing 2 for accommodating ferrule 3 and grip portion 4". Optical fiber 34 used for connection is fixed to ferrule 3 by an adhesive agent. However, optical fiber F held by anchor clamp 5 is mechanically gripped by a protruding portion of ferrule 3.

On the first to the fourth line of the paragraph No. 0024, the configuration of the grip portion of the connector body is explained as follows. "Grip portion 4 is composed so that another optical fiber F is gripped between a pair of half elements, that is, between element 31c and element 421. Spring 422 is provided with slit 422a formed in the central portion in an axial direction and positioned in the neighborhood of the boundary between two lid side elements 421a, 421b. Therefore, both sides of slit 422a function as independent springs respectively giving an elastic force to two lid side elements 421a, 421b. In this connection, concerning the profile of spring 422, various profiles such as a profile, the cross section of which is a C-shape, can be employed." At the time of gripping optical fiber F by the grip portion, it is necessary that a space between pair of half elements 31c, 421 is spread out by force while resisting a spring force of spring 422. Therefore, tool 6 for a connector having inserting member 9 is used. This tool 6 used for a connector is a different part from the connector.

In the paragraphs Nos. 0034 and 0035, tool 6 for connector 6 is explained. On the first to the fourth line of the paragraph No. 0034, tool 6 for a connector is explained as follows. "Tool 6 for connector 6 is detachably attached to connector body 1 beforehand, for example, in a factory. When tool 6 for a connector is attached to connector body 1, a space between element 31c and element 421 is spread out by force while resisting a spring force generated by spring 422. After the optical fibers have been connected to each other, tool 6 for a connector is detached from connector body 1."

As another method, the following connector is known. "The optical fiber is not previously incorporated into the ferrule. The core wire portion of the optical fiber is inserted into the connector in a site until the core portion reaches the neighborhood of the forward end portion of the ferrule. The core wire portion of the optical fiber is mechanically gripped at an extension portion of the ferrule". An example of this method is described in Patent Document 2. In the paragraph No. 0022, the following explanations are made. "According to the optical connector and the assembling method of the present invention, after an end face of the optical fiber in a site has been cut, until the newly cut end face of the optical fiber elastically comes into contact with a protective member, the optical fiber is inserted into the positioning mechanism and the ferrule and positioned by the positioning mechanism and fixed. In this way, assembling of the optical connector is completed. That is, it is unnecessary to incorporate the optical fiber into the ferrule. Accordingly, there is no possibility of the occurrence of such a problem that an end face of the incorporated optical fiber is damaged when the inserted optical fiber in a site collides with the end face of the incorporated optical fiber." This connector is described as follows. "The connector includes plug housing 7 forming a connector plug assembling body in which ferrule 3 and positioning mechanism 5 connected to a rear end of this ferrule 3 are accommodated (the paragraph No. 0024). "Positioning mechanism 5 is a so-called splice member (the paragraph No. 0027)." In the paragraph No. 0029, the following descriptions are made. "When inserted optical fiber 14 is accommodated being deflected between the rear end of ferrule 3 and the forward end of positioning mechanism 5, optical fiber 14 is provided with deflection space 41 having an elastic force directed onto protective member 17 side." In the paragraph No. 0040, the following descriptions are made. "Only when optical fiber 14 in a site is inserted so that deflection 43 can be generated in deflection space 41, a forward end portion of inserted optical fiber 14 can be contacted with protective member 17 by a predetermined elastic force. Therefore, a stable connecting state can be simply obtained in which the forward end face of optical fiber 14 comes into contact with protective member 17 at all times."

Documents of the Prior Art

Patent Document 1

Japanese Unexamined Patent Publication No. 2007-240943

Patent Document 2

Japanese Unexamined Patent Publication No. 2008-292710

Summary of the Invention

Problems that the Invention is to Solve

In the case of an optical connector in which it is necessary to use a tool for a connector, when an optical fiber is mechanically fixed to the optical connector, the tool for a connector needs to be attached to the connector body.

In the case of an optical connector in which an optical fiber is not previously incorporated into a ferrule and a core wire portion of the optical fiber is inserted into a neighborhood of the forward end portion of the ferrule at a site and the core wire portion of the optical fiber is mechanically gripped at an extension portion of the ferrule, there is a possibility that a state of contact of the end faces of two optical fibers, which are connected to each other by the optical connector, becomes unstable because of a change in the temperature of the environment in which the optical connector is used. In the case where a difference in the amount of thermal expansion or the amount of thermal contraction of the ceramic ferrule or the plastic housing, which is formed out of resin by forming, and the amount of thermal expansion or the amount of thermal contraction of the quartz fiber, the coefficient of linear expansion of which is low, is large, there is a possibility that the contact end faces of the two optical fibers are separated from each other or the end faces of the fibers push each other by a strong force and a loss of connection of the optical connector is greatly changed. It is possible to employ a method in which the optical fiber is deflected inside the connector for generating an elastic force so that a change in the loss of connection can be reduced. However, from the viewpoint of downsizing the optical connector, it is preferable not to provide a space, in which the optical fiber is deflected, inside the optical connector.

In an embodiment of the present invention, an optical connector is provided in which the working property of connecting an optical fiber can be enhanced by a relatively simple constitution.

In an embodiment of the present invention, an optical connector is provided in which a connection loss of the connector is not greatly changed even when a temperature is changed in an environment in which the optical connector is used.

Means for Solving the Problems

An embodiment of the present invention provides an optical connector comprising: a front housing having opening portions in both end portions; and a rear housing engaged with one of the opening portions of the front housing, the front housing including a cantilever-like operation lever having a stationary end, which is fixed to a wall portion, and also having a free end which is continued to the stationary end and extended along the wall portion, the rear housing including a ferrule having a central hole into which a core wire portion of an optical fiber is inserted and also having a fiber grip unit for holding a core wire portion of the optical fiber at an extension portion of the ferrule under the condition that the core wire portion of the optical fiber is inserted into the central hole of the ferrule to a predetermined position, wherein when the operation lever is pushed down, the operation lever operates the fiber grip unit so as to fix the core wire portion of the optical fiber.

An embodiment of the present provides an optical connector comprising a housing, a ferrule, a grip element, a positioning member, an element accommodating chamber and an operation cap, wherein the positioning member is positioned with respect to a position in a longitudinal direction of the element accommodating chamber and the positioning member positions the grip element with respect to a reference face of the element accommodating chamber.

Advantages of the Invention

According to an embodiment of the optical connector of the present invention, the operation lever is integrally provided in the front housing. When the fiber grip unit is operated by this operation lever, it is possible to fix the core wire portion of the optical fiber. Therefore, unlike the conventional case, it becomes unnecessary to use a tool for a connector which is a different part from the connector. Accordingly, it is possible to enhance the assembling working property of the optical connector.

According to an embodiment of the optical connector of the present invention, the core wire portion of the optical fiber is positioned in a longitudinal direction of the element accommodating chamber by the positioning member. Therefore, it is possible to fix a positional relation between the forward end of the core wire portion of the optical fiber and the forward end of the ferrule. Due to the foregoing, the optical connector is provided with a temperature compensation function. Accordingly, even when a

temperature change is caused in the environment in which the optical connector is used, it is possible to prevent the generation of a connection loss in light transmission. Further, it is possible to prevent the occurrence of a change in the light transmission characteristic. Due to the foregoing, it is possible to enhance the connection reliability of light transmission.

Brief Description of the Drawings

Fig. 1 is an exploded perspective view of an optical connector of an embodiment of the present invention.

Fig. 2 is an assembling view of the optical connector shown in Fig. 1.

Fig. 3 is a sectional view of the optical connector shown in Fig. 2 taken on line A-A.

Fig. 4 is a sectional view of a primary portion of the optical connector shown in Fig. 2 taken on line B - B.

Fig. 5 is a schematic illustration for explaining a grip position of a fiber core wire portion.

Fig. 6 is a schematic illustration for explaining a method of setting a grip position.

Fig. 7 is an exploded perspective view showing a variation of the optical connector of the present embodiment.

Fig. 8 is a schematic illustration showing a state in which the fiber grip unit of the optical connector shown in Fig. 7 is assembled to the element accommodating chamber of the rear housing.

Fig. 9 is a schematic illustration for explaining an assembling method of the optical connector shown in Fig. 7. Fig. 9(a) is a view showing a state before the fiber core wire portion is inserted into the connector housing, Fig. 9(b) is a view showing a state when the fiber core wire portion is inserted into the connector housing, Fig. 9(c) is a view showing a state in which the fiber core wire portion is deflected inside the connector housing and the fiber core wire portion is held by the grip elements, Fig. 9(d) is a view showing a state in which the holder connecting member is rotated so that a direction of the optical fiber can be changed, Fig. 9(e) is a view showing a state in which the holder connecting member is rotated so as to change a direction of the optical fiber from a horizontal direction to a vertical direction, and Fig. 9(f) is a view showing a state in which the holder connecting member is engaged with the rear housing.

Embodiments for carrying out the Invention

Although the form of the use of the optical connector of the present invention is not restricted, an example of the use of the optical connector is described as follows. The optical connector of the present invention can be applied to a case in which an optical fiber is connected to the optical connector outdoors when the optical fiber is introduced from the outdoors into a building. The optical connector of the present invention includes: a front housing having opening portions in both end portions; and a rear housing engaged with one of the opening portions of the front housing. The rear housing includes: a ferrule having a central hole into which a core wire portion of the optical fiber is inserted; a fiber grip unit for holding the core wire portion of the optical fiber at an extension portion of the ferrule under the condition that the core wire portion of the optical fiber is inserted into the central hole of the ferrule to a predetermined position; and an element accommodating chamber for accommodating the fiber grip unit. The fiber grip unit includes: a grip element having a pair of holding pieces which rise from both sides of the base portion and hold the optical fiber; an operation cap having a pair of leg portions to hold the pair of holding pieces of the grip element from both sides when the leg portions are pushed into the element accommodating chamber; and a positioning member for positioning the grip element in the element accommodating chamber. The front housing includes: a stationary end fixed to a wall portion so that the operation cap can be pushed into the element accommodating chamber; and a free end which is continued to the stationary end and extended toward the rear housing along the wall portion. The front housing includes a cantilever-like operation lever, the free end of which is deflected round the fulcrum of the stationary end. In the optical connector of the present invention, when a position at which the optical fiber is gripped is determined according to an amount of expansion or an amount of contraction caused by changes of the temperatures of the ferrule, the rear housing, the grip element and the optical fiber, even in the environment of using the optical connector in which the temperature is changed, it is possible to use the optical connector without generating a connection loss in the light transmission and without causing a change in the light transmission.

Referring to the drawings, the optical connector of the present invention will be explained below. In Fig. 1, the optical connector of an embodiment of the present invention is shown. As shown in the drawing, optical connector 1 of the present

embodiment includes: connector housing 3, which is a receptacle connector engaged with single core type plug connector (for example, SC connector) 100 shown in Fig. 3, having ferrule 7; sleeve holder 50 for fixing sleeve 17 to connector housing 3; cable holder 60 for holding cable outer sheath 41 of optical fiber 40; and holder connecting member 70 for pivotally connecting cable holder 60 to connector housing 3. Connector housing 3 includes: front housing 5; and rear housing 6, wherein front housing 5 and rear housing 6 are respectively formed by means of resin forming and longitudinally joined to each other. Front housing 5 includes opening portions 8, 9 in both end portions. Opening portion 8 located in the front portion is formed as a connector engaging portion for receiving plug connector 100. Opening portion 9 located in the rear portion is formed as a housing engaging portion for receiving rear housing 6.

In this case, for the convenience of explaining the optical connector of the present embodiment, in this specification, "a longitudinal direction" is defined as a direction in which both connectors are connected to each other. "The front side" is defined as a side on which opponent plug connector 100 is located. "The rear side" is defined as a side on which the optical fiber is led out from connector 1. "A vertical direction" is defined as a direction in which a deflection is generated when operation lever 12 is rotated round the fulcrum of base portion (the stationary end) 13a. The upper side is defined as a side on which operation lever 12 is located and the lower side is defined as an opposite side to the side on which operation lever 12 is located. "A lateral direction" is defined as a direction which is perpendicular to a longitudinal direction and a vertical direction. Alternatively, "a lateral direction" is defined as a direction in which pair of lock arms 15 for engaging plug connector 100 are opposed to each other in opening portion 8 in the front portion of front housing 5.

Inside front and rear opening portions 8, 9 of front housing 5, a lock mechanism for engaging plug connector 100 and rear housing 6 is provided. In the present embodiment, inside front opening portion 8 for receiving plug connector 100, a pair of lock arms (a lock mechanism) 15, which are opposed to each other, are provided in sleeve holder 50. On both side walls 11c of rear opening portion 9 for receiving rear housing 6, engaging portion (a lock mechanism) 16 is provided which is engaged with forward end portions 20a of pair of lock arms 20 provided on both side walls 21c of rear housing 6. When a plurality of pawls 52 protruding from both side walls 51 are engaged with hole

portions 14 formed on both side walls 11c of front housing 5, sleeve holder 50 is attached to the inside of front housing 5. When plug connector 100 and rear housing 6, which are respectively engaged in front and rear opening portions 8, 9 of front housing 5, are engaged by the respective lock mechanism, plug connector 100 and rear housing 6 can be prevented from coming out from front housing 5, so that a connecting state of optical fiber 40 can be maintained.

Between front and rear opening portions 8, 9, partition wall 10 (shown in Fig. 3) is formed. On partition wall 10, sleeve 17, which holds both ferrules 7, 101 (shown in Fig. 3) in an alignment state and contacts the end faces of the ferrules to each other, is vertically provided through sleeve holder 50. In this connection, in Fig. 1, sleeve 17 is shown being separated. Ferrules 7, 101 are respectively inserted from the opening end portions at both ends of sleeve 17 and the end faces of the ferrules are contacted to each other by an elastic force generated by an elastic member not shown of plug connector 100. Therefore, end faces of the optical fibers are contacted by a predetermined contact pressure relying on the elastic force of the elastic member. A form of the sleeve to be used is not particularly restricted, however, in the present embodiment, split sleeve 17 made of zirconia ceramics, which is the same as the material of the ferrules, is used. Since an inner diameter of sleeve 17 is a little smaller than an outer diameter of ferrule 7, ferrule 7, which is inserted into sleeve 17 so as to spread out sleeve 17, is given an elastic force acting inside in a radial direction from an inner circumferential face of sleeve 17, so that ferrule 7 can be held in sleeve 17.

On upper wall 11a of front housing 5, a cantilever-like operation lever 12 is protruded. This cantilever-like operation lever 12 includes: base portion (a stationary end) 13a which is integrally fixed to upper wall 11a; and forward end portion (a free end portion) 13b which is continued to base portion 13a and extended to rear housing 6 along upper wall 11a. Forward end portion 13b of operation lever 12 is pushed down being rotated round the fulcrum of base portion 13a. When forward end portion 13b of operation lever 12 is pushed down, operation cap 27 of fiber grip unit 25 accommodated in element accommodating chamber 22 of rear housing 6 engaged with rear opening portion 9 of front housing 5 is pushed into element accommodating chamber 22. Due to the foregoing, core wire portion 43 of optical fiber 40 can be gripped by grip element 26 of fiber grip unit 25. The constitution of fiber grip unit 25 will be described later.

Optical fiber 40 will be explained here. In optical fiber 40, core wire portion (the core and clad) 43 made of glass is located at the center and an outer surface of core wire portion 43 is covered with UV hardened resin 42 and the outside of UV hardened resin 42 is protected by cable sheath 41 such as PVC. Accordingly, core wire portion 43 of optical fiber 40 gripped by grip element 26 is a stripped glass fiber from which cable sheath 41 and UV hardened resin 42 are peeled off.

In connector housing 3 of the present embodiment, rear housing 6 is detachably attached to front housing 5. It is possible to join rear housing 6 to front housing 5 upside down. Rear housing 6 is detached from front housing 5 and then attached to front housing 5 upside down. Then protruding end portion 27a of operation cap 27 protruding from a pair of through-holes 23b formed in bottom wall 23a (shown in Fig. 4) of element accommodating chamber 22 of rear housing 6 is pushed by forward end portion 13b of operation lever 12. In this way, operation cap 27 can be detached from element accommodating chamber 22. In the case where a failure of working is made, it is possible to do the assembling work over again when operation cap 27 is removed.

Rear housing 6 is formed into an L-shape by means of resin molding. Rear housing 6 includes: housing engaging portion 19 to be engaged with front housing 5; and fiber leading out portion 18 by which a leading out direction of the fiber is changed from a longitudinal direction to a lateral direction. Ferrule 7, which is a different part, is integrally fixed onto front wall 23d of housing engaging portion 19 as shown in Fig. 3. To fiber leading out portion 18, cable holder 60 for holding cable sheath 41 of optical fiber 40 is attached through holder connecting member 70 pivotally supported by rear housing 6.

Cable holder 60 is attached to fiber leading out portion 18 of rear housing 6 under the condition that holder connecting member 70 is arranged in a longitudinal direction. Core wire portion 43 of the optical fiber 40 is inserted into the central hole 7a of ferrule 7 to a predetermined position and mechanically gripped by fiber grip unit 25. Holder connecting member 70 is rotated by about 90 round pivotal shaft 71 which is engaged in a shaft hole of rear housing 6. Holder connecting member 70 is engaged with fiber leading out portion 18. When cable holder 60 is rotated through holder connecting member 70, even if no space is provided at the rear of rear housing 6, optical connector 1 of the present embodiment can be used. Optical connector 1 of the present embodiment does not occupy a large space. Therefore, it can be attached into a small space. In this

connection, when holder connecting member 70 is rotated by about 90°, a leading out direction of optical fiber 40 is also changed by about 90°. However, holder connecting member 70 includes guide piece 72 for guiding core wire portion 43 of optical fiber 40, which is led out from cable holder 60, to fiber grip unit 25 along guide face 72a (shown in Fig. 9(a)). Therefore, the radius of curvature of core wire portion 43 of optical fiber 40 is partially reduced. Accordingly, it is possible to prevent the light transmission characteristic from being deteriorated.

As shown in Figs. 2 and 3, the profile of optical fiber 40 held by cable holder 60 is not particularly restricted. Cable sheath 41, the profile of which is rectangular, is held by cable holder 60 of the present embodiment. When cable sheath 41 is held by cable holder 60, core wire portion 43 of fiber 40 is led out from the front side of cable holder 60 as shown in Fig. 3. Cable sheath 41 is pushed into holding groove 61, on groove wall of a plurality of serrate protrusions 62 are formed, and the plurality of serrate protrusions 62 bite into cable sheath 41. In this way, optical fiber 40 is engaged with cable holder 60. An opening end portion of holding groove 61 is covered with cover 65 (shown in Fig. 1) connected to the wall portion of cable holder 60 through hinge 66. Therefore, cable sheath 41 is not disconnected from holding groove 61.

In cable holder 60, a pair of guide grooves 64 (Only one of guide grooves 64 is shown in Fig. 1) are formed which are engaged with a pair of protrusions 73 (Only one of protrusions 73 is shown in Fig. 1) protruding onto the opposed inner walls of holder connecting member 70. Accordingly, when pair of protrusions 73 of holder connecting member 70 are engaged with pair of guide grooves 64 of cable holder 60 and cable holder 60 is pushed into holder connecting member 70, cable holder 60 can be smoothly attached to holder connecting member 70. In this connection, pair of guide grooves 64 can be formed on outer walls 63, which are formed being perpendicular to each other, of cable holder 60. Due to the foregoing, a direction of optical fiber 40, the profile of which is rectangular, can be changed by 90°. Therefore, it is possible to enhance the handling property of optical fiber 40, the cross section of which is a rectangle having two directions, one direction is strong when bending is given to the cross section and the other is weak when bending is given to the cross section. Holder connecting member 70 and rear housing 6 are firmly engaged with each other when engaging pawls 74 formed on the

vertically opposed wall portions of holder connecting member 70 are engaged with engaging holes 24 formed in the wall portions of rear housing 6.

As shown in Fig. 3, on a front end face of housing engaging portion 19 of rear housing 6, ferrule 7 is vertically protruded. Ferrule 7 has central hole 7a formed all over the length of ferrule 7. In ferrule 7, central hole 7a is formed all over the length, into which core wire portion 43 of optical fiber 40, from which the cable sheath 41 and UV hardened resin 42 are stripped off, can be inserted. Central hole 7a of ferrule 7 is communicated with hole 23e formed on front wall 23d of element accommodating chamber 22 of housing engaging portion 19. A predetermined length of fiber core portion 43 is inserted into central hole 7a of ferrule 7. Under the condition that a forward end portion of fiber core portion 43 is protruded to the substantially same position as that of the forward end face of ferrule 7 or under the condition that a forward end portion of fiber core portion 43 is protruded from the forward end face of ferrule 7 by a predetermined length, fiber core portion 43 is mechanically gripped by grip element 26 of fiber grip unit 25 as shown in Fig. 4. After fiber core wire portion 43 has been mechanically gripped by grip element 26, when necessary, fiber core wire portion 43 is subjected to the forward end portion treatment. In the present embodiment, front housing 5 can be detached from rear housing 6. Therefore, when front housing 5 is detached from rear housing 6, a forward end portion of ferrule 7 can be exposed. For example, when an end face of ferrule 7 exposed in this way is polished by a polishing film or when a forward end portion of fiber core wire portion 43 protruding from the forward end portion of ferrule 7 is cut off by a creeper for an optical fiber, the forward end portion of fiber core wire portion 43 and the forward end face of ferrule 7 can be subjected to an arbitrary forward end portion treatment. Due to the foregoing, a connection loss of connector 1 and an amount of damping caused by reflection can be reduced. In this connection, it is possible to insert fiber core wire portion 43 into connector 1 after the forward end portion of fiber core wire portion 43 has been subjected to the well known cutting treatment, heating treatment or polishing treatment.

As shown in Fig. 3, fiber grip unit 25 is accommodated in element accommodating chamber 22 of rear housing 6. Fiber grip unit 25 includes: grip element 26 for holding fiber core wire portion 43; operation cap 27 pushed into element accommodating chamber 22 by forward end portion 13b of operation lever 12, operation cap 27 having a pair of leg

portions 27b for holding a pair of grip pieces 26a of grip element 26 from both sides; and positioning member 28 for positioning grip element 26 when rear end faced 26c of grip element 26 is contacted with inner wall face 22a of accommodating chamber 22. Grip element 26 is formed in such a manner that an element piece is punched out by a press from a sheet material such as an aluminum sheet having ductility and then the element piece is bent so that a pair of holding pieces 26a can be raised from both sides of the base portion. On an inner surface of at least one holding piece 26a, receiving groove 26f for receiving fiber core wire portion 43 is formed in substantially parallel with the base portion. Grip element 26 can be moved between a non-operation position and an operation position. In this case, the non-operation position is defined as a state in which a size of the cross section of the fiber receiving passage composed by pair of holding pieces 26a and receiving groove 26f is larger than the outer diameter of fiber core wire portion 43 under the condition that pair of holding pieces 26a are opened. The operation position is defined as a state in which a size of the cross section of the fiber receiving passage composed by pair of holding pieces 26a and receiving groove 26f is smaller than the outer diameter of fiber core wire portion 43 under the condition that pair of holding pieces 26a are moved so that they can come close to each other as compared with the non-operation position. When grip element 26 is arranged in element accommodating chamber 22, the center of the fiber receiving passage substantially agrees with center 7a of ferrule 7. In an intermediate portion of holding piece 26a, cutout portion 26e engaged with positioning member 28 is formed. Grip element 26 is arranged in element accommodating chamber 22 so that a longitudinal direction (a direction in which receiving groove 26f is provided) of grip element 26 can substantially agree a longitudinal direction of connector 1.

Positioning member 28 includes: a pair of leg portions 28b extending from ceiling plate 28a (shown in Fig. 1) in a substantially vertical direction; and connecting portion 28c (shown in Fig. 3) extending from ceiling plate 28a in a substantially horizontal direction for connecting a pair of leg portions 28b on one side of leg portions 28b, connecting portion 28c being shorter than leg portions 28b (shown in Fig. 3). Positioning member 28 includes dovetail tenon portion 28d (Refer to dovetail tenon portion 81d in Fig. 8.), the profile of which is formed into a dovetail, provided on the rear side of connector 1. Therefore, positioning member 28 can be inserted into dovetail groove portion 22b (Refer to Figs. 2 and 8.) of element accommodating chamber 22 of rear housing 6. Concerning

positioning member 28, while pair of leg portions 28b are being made substantially parallel with holding piece 26a of grip element 26, connecting portion 28c is engaged with cutout portion 26e of grip element 26 and dovetail tenon portion 28d is arranged in dovetail groove portion 22b of element accommodating chamber 22. When positioning member 28 is pushed toward element accommodating chamber 22 in the above arrangement, inner face 28e of connecting portion 28c, which is a positioning face of positioning member 28, comes into contact with a vertical face of cutout portion 26c which is a contact face of grip element 26. At the same time, dovetail tenon portion 28d of positioning member 28 is inserted into dovetail groove portion 22b of element accommodating chamber 22. Therefore, positioning member 28 is positioned on the rear side of connector 1 and grip element 26 is moved backward. As a result, rear end face 26c of grip element 26 comes into contact with inner wall face 22a on rear side of the connector which is a reference face of element accommodating chamber 22 as shown in Fig. 3. That is, grip element 26 is positioned on the rear side of element accommodating chamber 22. Positioning member 28 prevents grip element 26 from being disconnected from element accommodating chamber 22. Further, positioning member 28 prevents the occurrence of a case in which grip element 26 is moved in element accommodating chamber 22 and in which the fiber receiving passage and central hole 7a of ferrule 7 positionally deviate from each other. When positioning member 28 is pushed into element accommodating chamber 22, it is engaged in element accommodating chamber 22 without being disengaged. In the state in which positioning member 28 is pushed into element accommodating chamber 22, grip element 26 is at the non-operation position. Therefore, fiber core wire portion 43 described later can be received in the fiber receiving passage. It is typical that positioning member 28 is previously assembled in a factory being pushed into element accommodating chamber 22.

Operation cap 27 includes a pair of leg portions 27b to hold a pair of holding pieces 26a of grip element 26 from both sides. When operation cap 27 is pushed by forward end portion 13b of operation lever 12, it is pushed into element accommodating chamber 22. Operation cap 27 pushed into element accommodating chamber 22 is engaged in element accommodating chamber 22 by an engaging means, so that operation cap 27 can not be disengaged from element accommodating chamber 22. As described before, when protruding end portion 27a of pair of leg portions 27b protruding from pair

of through-holes 23b formed on bottom wall 23a of element accommodating chamber 22 is pushed by forward end portion 13b of operation lever 12, operation cap 27 can be disconnected from element accommodating chamber 22. A distance between pair of leg portions 27a of operation cap 27 is long on the forward end of leg portion 27a and short on the root side. Concerning operation cap 27, the forward end of pair of leg portions 27a is previously arranged at the first position which is opposed to the forward end (the most distant portion from the base portion) of pair of holding pieces 26a of grip element 26. In this state, operation cap 27 protrudes from an upper face of rear housing 6 of connector 1 as shown in Fig. 3. In this state, grip element 26 is at the non-operation position. Therefore, in the fiber receiving passage, a space, into which fiber core wire portion 43 can be inserted, is provided. After fiber core wire portion 13 has been inserted into the fiber receiving passage, operation cap 27 is pushed into element accommodating chamber 22 by forward end portion 13b of operation lever 12 and arranged at the second position. Then, pair of holding pieces 26a of grip element 26 are held on the root side of leg portion 27a as shown in Fig. 4. Due to the foregoing, grip element 26 is moved in a direction so that pair of holding pieces 26a can come close to each other. Therefore, grip element 26 is displaced from the non-operation position to the operation position. Fiber core wire portion 43 is mechanically fixed by grip element 26. In this connection, a positional relation between operation cap 27 and positioning member 28 with respect to a longitudinal direction is not particularly limited to the relation described above. Depending upon grip position G described later, positioning member 28 may be arranged in the front of operation cap 27.

As shown in Fig. 5, on an inner face on the root side of pair of leg portions 27b of the operation cap 27, a pair of protrusions 27c, which are opposed to each other, are protruded. When a pair of holding pieces 26a of the grip element 26 are held by a pair of leg portions 27b of the operation cap 27 at the operating position, at a position of the fiber receiving passage corresponding to pair of protrusions 27c (at the substantially same position in the fiber receiving passage as the position of the protrusion 27c with respect to a longitudinal direction of the connector), a holding force given to the fiber core wire portion 43 is maximized. As a result, the position of pair of protrusions 27c is prescribed to be the grip position G at which the optical fiber 40 is held. The grip position G is determined according to amounts of expansion and contraction caused by changes of the

temperatures of the ferrule 7, the rear housing 6, the glass fiber and the grip element 26. In the case where pair of protrusions 27c are not formed not being protruded onto the inner face of pair of leg portions 27b of the operation cap 27, a center of the length of the grip element 26 holding the fiber core wire portion 43 can be prescribed to be the grip position G. However, when pair of protrusions 27c is formed being protruded, the grip position G can be formed at an arbitrary position.

In optical connector 1 of the present embodiment, as described before, under the condition that fiber core wire portion 43 inserted from one end of the optical connector has reached a neighborhood of the other end (the forward end portion) of the optical connector, fiber core wire portion 43 is fixed to optical connector 1. That is, fiber core wire portion 43 is neither fixed to ferrule 7 nor connected to a short optical fiber previously built in ferrule 7 in grip element 26. Therefore, when connector 1, in which optical fiber 40 is fixed, is put in a temperature different from the temperature at which optical fiber 40 was assembled, optical fiber 40 and optical fiber connector 1 are respectively expanded and contracted according to the coefficients of linear expansion of the respective members. As a result, there is a possibility that a position of the forward end portion of fiber core wire portion 43 is relatively changed with respect to the position of the forward end face of ferrule 7. In connector 1 of the present embodiment, when the coefficient of linear expansion and grip position G of each member are selected as described later, it is possible to make an amount of expansion of optical fiber 40 and an amount of expansion of optical connector 1 substantially agree with each other. Therefore, a positional relation between the forward end position of fiber core wire portion 43 and the forward end face of ferrule 7 can be maintained to be substantially the same in a desired temperature range.

Reference marks used in this specification are defined as follows. Coefficients of thermal expansion (1/K) of ferrule 7 made of ceramics, housing 6 made of plastics, grip element 26 and glass fiber are respectively $\alpha_{ferrule}$, $\alpha_{housing}$, α_{grip} and α_{glass}. A difference in temperature between the maximum temperature and the minimum temperature in the environment of using the connector is ΔT. An amount of allowed positional deviation of the forward end portion of fiber core wire portion 43 with respect to the forward end face of ferrule 7 is ΔL. Then, grip position G can be found by the following expression in which an amount of expansion and an amount of contraction generated by a change in the

temperature are blanched with each other. As shown in Fig. 6, L1 is a length of the ceramic ferrule, L2 is a length from inner wall face 22a at the rear of element accommodating chamber 22, which is the reference position, to the rear end face of ferrule, L3 is a length from the reference position to grip position G and L4 is a length from grip position G to the forward end portion of the fiber. It is decided that the reference position is a position at which rear end face 26c of grip element 26 comes into contact with inner wall face 22a of element accommodating chamber 22.

Expression 1

$$|(\alpha_{ferrule} \times L1 + \alpha_{housing} \times L2)\Delta T - (\alpha_{grip} \times L3 + \alpha_{glass} \times L4) \times \Delta T| \leq \Delta L$$

When grip position G is found by the above expression, a coefficient of thermal expansion of an actually used member is used. However, in the case where zirconia ferrule 7, plastic housing 6 and aluminum grip element 26 are used, $\alpha_{ferrule} = 11 \times 10^{-6}$, $\alpha_{housing} = 6 \times 10^{-6}$, $\alpha_{grip} = 19 \times 10^{-6}$ and $\alpha_{glass} = 7 \times 10^{-7}$ can be used as values of the coefficients of thermal expansion (1/K). For example, 120K can be used as ΔT. In this case, the outside air temperature is changed in the range from -40° to 80°. Since grip element 26 is restrained by positioning member 28, the coefficient of linear expansion of grip element 26 might be another value different from the coefficient of linear expansion of grip element 26.

Expression 1 assumes that a difference, which is between the total of the change in the length of ferrule 7 and the change in the length of housing 6 caused by a temperature change and the total of the change in the length of grip element 26 having length L3 to grip position G and the change in the length of fiber core wire portion 43, is not more than allowed value ΔL. When a temperature change is generated, changes in the lengths of ferrule 7 and housing 6 are generated in a longitudinal direction. However, a change in the length of grip element 26 is also generated. Therefore, a gap between the ferrule end face and the fiber end face is canceled to each other. Accordingly, a positional relation between the ferrule end face and the fiber end face can be maintained substantially constant. In this connection, the meaning of the sentence that a positional relation between the ferrule end face and the fiber end face can be maintained substantially constant includes the meaning that the positional relation between the ferrule end face and the fiber end face is changed so that a change in the optical characteristic of the connector

can be suppressed in a predetermined allowable range. For example, an allowable amount of the change in the optical characteristic of the connector is an amount of the change not more than 0.5 dB as a loss caused when the connector is inserted. In this connection, a value of ΔL, which is capable of reducing an amount of change in the insertion loss of the connector, depends upon the size of each portion of the connector including the length of L4 and the coefficient of linear expansion of each member.

According to the value of the coefficient of linear expansion of the member to be used, the mark of the value and the length of each portion, an inner wall face on the front side of the connector of element accommodating chamber 22 can be a positioning face and a front end face of the grip element can be pushed onto the inner wall face on the front side of the connector. That is, a normal line direction of the contact face or the positioning face includes an opposite direction to a direction of the above embodiment with respect to a longitudinal direction of the connector,

Grip position G may be prescribed in such a manner that protrusion 27c is provided inside leg portion 27b of operation cap 27 like the present embodiment. For example, a protruding portion may be provided on an outer surface of grip element 26. The thickness of grip element 26 may be made locally maximum at grip position G when the thickness is continuously changed. Alternatively, when the width or depth of the groove for holding fiber core wire portion 43 provided in grip element 26 is continuously changed, fiber core wire portion 43 may be fixed by a locally maximum force at grip position G. Alternatively, when operation cap 27 is divided into a portion corresponding to protrusion 27c and a portion except for that and a distance between the opposed leg portions and/or a material is changed, a difference in the force generated in operation cap 27 may be made between grip position G and the position before or behind grip position G.

Next, referring to Figs. 7 to 9, a variation of the optical connector of the present embodiment will be explained below. The optical connector of the variation is the same as optical connector 1 shown in Figs. 1 to 6 except for that the constitution of the fiber grip unit is different. Fiber grip unit 25A includes: grip element 26A for holding core wire portion 43 of optical fiber 40 by pair of holding pieces 27b; and operation cap 27 pushed into forward end portion 13b of operation lever 12. That is, fiber grip unit 25A includes: operation cap 27 having pair of leg portions 27b for holding pair of holding pieces 26b of

grip element 26A from both sides; and positioning member 80, the profile of which is a substantial rectangular parallelepiped, for making rear end face 26c of grip element 26A come into contact with inner wall face 22a of accommodating chamber 22.

Fig. 8 is a view showing a state in which positioning member 80 is pushed into element accommodating chamber 22. Core wire portion 43 of optical fiber 40 is inserted into the fiber receiving passage, which is composed between pair of holding pieces 26a of grip element 26A, from fiber introducing end portion 19a of rear housing 19. Positioning member 80 is a member, the profile of which is a substantial rectangular parallelepiped, having a space inside for accommodating grip element 26A. Positioning member 80 includes: first opening 81a formed on a face which becomes an upper face of connector 1A when it is incorporated into connector 1A; and second opening 81b formed on an end face which faces fiber inserting portion 19a side when it is incorporated into connector 1A. First opening 81a is formed into a size so that operation cap 27 can be received. In this variation, operation cap 27 is incorporated into positioning member 80 so that it can be moved between the first and the second position. Second opening 81b is formed into a size so that grip element 26A can be inserted into it in a direction of arrow Z. Under a condition that grip element 26A is previously inserted into positioning member 80, positioning member 80 is incorporated into rear housing 6. Positioning member 80 includes same dovetail tenon portion 81d as dovetail tenon portion 28d of positioning member 28 shown in Fig. 1. Therefore, when positioning member 80 is incorporated into rear housing 6, dovetail tenon portion 81d is engaged with dovetail groove portion 22b of element accommodating chamber 22. Therefore, positioning member 80 is positioned on the rear side of connector 1A in element accommodating chamber 22. Grip element 26A is made to be on the substantial same face as the end face of positioning member 80 through second opening 81b or alternatively grip element 26A is made to protrude a little from the end face of positioning member 80. Accordingly, front end face 26d, which is a contact face of grip element 26A, comes into contact with front inner wall 82a which is a positioning face of positioning member 80. Rear end face 26c of grip element 26A is pushed to the inner wall face (the reference face) of element accommodating chamber 22 and positioned. First opening 81a of positioning member 80 is formed into a size so that grip element 26A can not be disconnected. Therefore, it is possible to prevent grip element 26A from falling off from connector 1. Further, it is possible to prevent the

occurrence of a positional shift between the fiber receiving passage and central hole 7a of ferrule 7 when grip element 26A is moved in element accommodating chamber 22.

On a bottom face of positioning member 80, third opening 81c (shown in Fig. 7) is provided. When operation cap 27 is moved to the second position at which grip element 26A is closed, pair of leg portions 27b of operation cap 27 pass through third opening 81c and also pass through pair of openings 23b provided on the bottom face of rear housing 6 and protrude from the bottom face of rear housing 6. Pair of holding pieces 26b of grip element 26A are formed into a substantial rectangle in a side view in which pair of holding pieces 26b are viewed in a lateral direction of connector 1A. As described before, in the present variation, front end face 26d of grip element 26A comes into contact with inner wall 82a of positioning member 80. Therefore, cutout portion 26e provided in grip element 26 shown in Fig. 1 is not formed. At other points, grip element 26A is the same as grip element 26. Since core wire portion 43 of optical fiber 40 is held between pair of holding pieces 26a of grip element 26A, operation cap 27 is used in the same manner as that described before.

Next, explanations will be made into an assembling method of optical connector 1A. As shown in Fig. 9(a), under the condition that holder connecting member 70 is arranged in a longitudinal direction of cable holder 60, cable holder 60 is attached to fiber leading out portion 18 of rear housing 6. In a working site, optical fiber 40 is subjected to terminal treatment in such a manner that the cable sheath 41 and UV hardened resin 42 are stripped off core wire portion 43 and core wire portion 43 is cleaned and then cut by a predetermined length. As shown in Figs. 9(b) and (c), core wire portion 43 of optical fiber 40 is inserted into a predetermined position in central hole 7a of ferrule 7. At this time, it is possible to cause a deflection in core wire portion 43. Under the condition that the deflection is caused in core wire portion 43, core wire portion 43 of optical fiber 40 is mechanically gripped by grip element 26A. As shown in Figs. 9(d), 9(c) and 9(f), holder connecting member 70 is rotated round pivotal shaft 71 (shown in Fig. 2) by an angle of about 90° and engaged with fiber leading out portion 18.

As described above, according to the present embodiment, operation lever 12 is integrally incorporated into front housing 5 and operation cap 27 of fiber grip unit 25 is pushed into element accommodating chamber 22 by this operation lever 12. Due to the foregoing, core wire portion 43 of optical fiber 40 can be held by pair of holding pieces

26a of grip elements 26, 26A. Accordingly, it becomes unnecessary to use a tool for a connector which is a different part. In the present invention, grip position G, at which core wire portion 43 of optical fiber 40 is held, is determined according to amounts of expansion or contraction caused by the change in the temperature of ferrule 7, rear housing 6, grip element 26 and optical fiber 40. Therefore, even when a temperature change is caused in an environment in which optical connector 1 is used, it is possible to prevent the occurrence of a connection loss of light transmission. It is also possible to prevent the light transmission characteristic from being changed.

The optical connector is explained above in the specification. However, it should be noted that the present invention is not restricted by the specific embodiments disclosed before. Variations and improvements of the embodiments can be made. In the present embodiments, an optical fiber, the profile of the cross-section of which is rectangular, is used. However, it is possible to use an optical fiber, the profile of the cross-section of which is circular. That is, the form of the optical fiber is not particularly restricted. In the present embodiment, no connecting point is provided in the optical connector, however, it is possible apply the present invention to an optical connector having a connecting point. The object of the present embodiment is a single core connector. However, it is possible to apply the present embodiment to a multiple core connector. That is, the form of the connector is not particularly restricted.

As described in Patent Document 1, the invention, in which the front housing functions as a tool, can be applied to a type of connector in which a short fiber has previously been made to adhere to a ferrule and a connecting point with a fiber, which is inserted into the connector at a site, is provided in the grip element. Fiber grip units 25, 25A are not limited to the type described in the embodiment. It is possible to use a well known fiber grip unit in which when operation lever 12 is pushed, fiber core wire portion 43 can be fixed in fiber grip units 25, 25A. Operation lever 12 may be provided in a direction so that it can be separate from rear housing 6.

Description of the Reference Numerals and Signs

1, 1A	Optical connector
3	Connector housing
5	Front housing
6	Rear housing

7	Ferrule
12	Operation lever
13a	Base portion (Stationary end)
13b	Forward end portion (Free end)
17	Sleeve
25, 25A	Fiber grip unit
26, 26A	Grip element
27	Operation cap
28, 80	Positioning member
40	Optical fiber
41	Cable sheath
42	UV hardened resin
43	Core wire portion
60	Cable holder
70	Holder connecting member
72	Guide piece

What is claimed is:

1. An optical connector comprising:

a front housing having opening portions in both ends; and

a rear housing engaged with one of said opening portions of said front housing,

said front housing including a cantilever-like operation lever having a stationary end which is fixed to a wall portion, and also having a free end which is continued to said stationary end and extended along said wall portion,

said rear housing including a ferrule having a central hole into which a core wire portion of an optical fiber is inserted and also having a fiber grip unit for holding a core wire portion of said optical fiber at an extension portion of said ferrule under a condition that said core wire portion of said optical fiber is inserted into said central hole of said ferrule to a predetermined position,

wherein when said operation lever is pushed down, said operation lever operates said fiber grip unit so as to fix said core wire portion of said optical fiber.

2. The optical connector according to claim 1,

wherein said rear housing includes an element accommodating chamber for accommodating said fiber grip unit and said fiber grip unit includes a grip element having a pair of holding pieces rising from both sides of a base portion and holding said core wire portion of said optical fiber and said fiber grip unit also includes an operation cap which is pushed into said element accommodating chamber when it is pushed by said free end of said operation lever and which has a pair of leg portions for holding said pair of holding pieces from both sides when said operation cap is pushed into said element accommodating chamber.

3. The optical connector according to claim 2,

wherein said rear housing can be engaged with said front housing upside down, on said upper wall of which the operation lever is formed,

a through-hole, into which a forward end portion of at least one of said leg portions of said operation cap is inserted, is formed on a bottom wall of said element accommodating chamber, said front housing and said rear housing are engaged with each

other so that said free end portion of said operation lever can be opposed to a protruding end portion of said leg portion protruding from said through-hole, and when said protruding end portion of said leg portion is pushed by said free end portion of said operation lever, said operation cap is pushed out from said element accommodating chamber.

4. An optical connector comprising:

a housing having a ferrule into which a core wire portion of an optical fiber is inserted; and

a fiber grip unit for holding said core wire portion of said optical fiber in front of said ferrule,

said fiber grip unit including:

a grip element, which is accommodated in an element accommodating chamber of said housing, having a pair of holding pieces for holding said core wire portion of said optical fiber;

an operation cap having a pair of leg portions for holding said pair of holding pieces from both sides when said operation cap is pushed into said element accommodating chamber; and

a positioning member for positioning said grip element in a longitudinal direction of said element accommodating chamber.

5. The optical connector according to claim 4,

wherein said positioning member includes a positioning face coming into contact with a contact face of said grip element.

6. The optical connector according to claim 4 or 5,

wherein said positioning member includes a first opening for receiving said operation cap and a second opening for receiving said grip element.

7. The optical connector according to one of claims 4 to 6,

wherein said operation cap and said grip element are configured so that a force to hold said optical fiber at a predetermined position in a longitudinal direction of said connector can be locally maximized in a case where said grip element and said operation

cap are cooperated with each other to fix said core wire portion of said optical fiber, and a position is prescribed at which said holding force is locally maximized so that a relative relation between a position of a forward end portion of said core wire portion of said optical fiber and a position of a forward end portion of said ferrule can be maintained substantially the same with each other when a temperature is changed in a environment in which said connector is used.

8. The connector according to claim 7,

wherein a protrusion is formed on an inner face of at least one of said leg portions of said operation cap and a holding force of holding said core wire portion of said optical fiber is locally maximized at a position corresponding to a position at which the protrusion is formed.