

Docket Number: 47827PCT5A

ADHESIVELESS CONNECTOR FOR OPTICAL FIBERS

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Background of the Invention

Optical fiber connectors commonly use ferrules to insure alignment of the fibers. Typically two fibers that are to be connected are inserted into housings having matching ferrules attached thereto. The ends of the fibers are then polished to produce a smooth optical finish and the ferrules are inserted into
 10 a central housing that holds them close together and in precise alignment.

The term "connector" is often used in a variety of ways in the field of fiber optics. Sometimes it is used to refer to two of the housings with ferrules as described above along with the central housing. At other times it is used to refer to a single housing with a ferrule. This later definition will be adopted
 15 herein. Thus, in order to connect two optical fibers, two connectors and a central housing are required.

The ferrules used in fiber optic connectors come in many shapes and can be of many of different materials. Typically the ferrules are of a ceramic material, although metallic or plastic materials can also be used. The ferrule may
 20 be cylindrical, as in the widely used ST connector defined by proposed EIA Specification 475E000 or in an SC connector, or it may be a truncated cone as in the case of a biconic connector.

In order to insure a good optical connection, as well as the structural integrity of the connector, the fiber must be tightly bound in the connector.
 25 Typically this is done by use of an adhesive. Most commonly an epoxy is used to hold a fiber in a connector housing and ferrule. Once an epoxy has hardened, it cannot be loosened. Thus, if a fiber is incorrectly installed in a connector housing and ferrule, or is damaged subsequent to such installation, the housing and ferrule cannot be reused. United States Patent 4,984,865 (Lee et al.) describes the
 30 use of a hot melt adhesive to hold a fiber in a fiber optic connector. While this

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☒	Claim(s) : paged ...7... to paged ...8...	
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has the advantage of being reusable, it requires that the assembly be heated above the softening temperature of the adhesive upon either insertion or removal of a fiber.

A disadvantage of both epoxies and hot melt adhesives is that both
5 require a delay from the time the fiber is installed in order to harden the adhesive. In addition a hot melt adhesive always requires the use of a heating fixture. The heating fixture, in turn, must be powered, sometimes causing inconvenience. An epoxy does not necessarily require the use of a heating fixture, but, for the epoxies typically used in fiber optic connectors, the cure period will be several hours if no
10 heat is applied. Thus epoxies offer a tradeoff between the inconvenience of a long cure period and that of the use of a heating fixture. Alternatively some epoxies require a source of ultraviolet radiation for curing. Such a radiation source still has the requirement that it be powered.

United States Patent 4,964,685 (Savitsky et al.) teaches a fiber optic
15 connector in which the fiber is mechanically clamped in the ferrule by a gripping element. In a connector according to the Savitsky et al. patent, however, the gripping element grips the fiber's buffer instead of the fiber itself. Since it is possible for the fiber to move inside of the buffer, it is difficult to precisely align the end of the fiber with the end face of ferrule. This difficulty is increased by
20 the fact that the gripping element is collapsed onto the fiber buffer by moving a nut along the connector in a direction parallel to the fiber. Thus the force and movement required to engage the gripping element are directed parallel to the fiber. This can cause the fiber to move in the ferrule as the gripping element is tightened.

25

Summary of the Invention

According to the present invention, an optical fiber connector includes a connector body and a ferrule attached to one another. Each has a bore through it and the bores are aligned. A gripping element resides in the connector
30 body. When the gripping element is in a disengaged state it will receive an optical



fiber inserted in the bores. In an engaged state it will hold an optical fiber in the connector body and the ferrule. The gripping element is engageable by moving a plug in a direction transverse to the bores.

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Brief Description of the Drawings

Figure 1 is a perspective view of a fiber optic connector according to the invention;

Figure 2 is a perspective view of a gripping element according to the invention;

10

Figure 3 is a cross-sectional view of a fiber optic connector according to the invention along its axis;

Figure 4 is a cross-sectional view of a fiber optic connector according to the invention transverse to its axis with the gripping element disengaged;

15

Figure 5 is a cross-sectional view of a fiber optic connector according to the invention transverse to its axis with the gripping element engaged; and

Figure 6 is a perspective view of a second fiber optic connector according to the invention.

20

Detailed Description of a

Preferred Embodiment

Figure 1 shows an optical fiber connector 10. The optical fiber connector shown in the Figure 1 includes a housing 16 and a ferrule 14. Housing 16 has a bayonet locking mechanism 12. The apparatus of Figure 1 is intended to be used in an ST connector. It utilizes the cylindrical ferrule of the ST design. Those skilled in the art will readily perceive, however, that the present invention could be used in any fiber optic connector utilizing a ferrule, whatever the shape of such ferrule. Typically housing 16 would be of a metal such as aluminum while ferrule 14 would be of a ceramic such as zirconia, alumina, or calcium titanate. Alternatively housing 16 could be of a plastic while ferrule 14 could be



of a metal or a plastic. Additionally, although it is typical for housing 16 and ferrule 14 to be manufactured separately and attached to one another later, it is possible to mold them as a single unit. For purposes herein, a housing and a ferrule molded as a single, unitary object will still be considered to be a housing
5 and a ferrule attached to one another.

Housing 16 and ferrule 14 are joined together to form connector 10. The combined structure 10 has a major axis with a bore 18 for receiving an optical fiber running along the major axis. Housing 16 further includes an alignment pin 17, for use when connector 10 is coupled to a similar connector to form a fiber
10 optic connection. A plug, 20, is press fit into an opening that intersects bore 18. Housing 16 also includes a strain relief 21. Typically, strain relief 21 is of a pliable material and provides protection for an optical fiber exiting housing 16.

Figure 3 is a cross-sectional view of the optical fiber connector 10 of Figure 1. As described previously, a plug 20 is press fit into an opening that
15 intersects with bore 18 as may be seen, bore 18 actually includes two bores aligned with one another. These are bore 25 of ferrule 14 and bore 26 of housing 16. Plug 20 engages with fiber gripping mechanism 22. Fiber gripping mechanism 22 includes a bore 24 in alignment with bore 18. An optical fiber 27 runs through bore 18 and bore 24 where it is tightly gripped. Bore 24 has widened regions 28
20 and 30 at its ends in order to facilitate inserting optical fiber 27. In the preferred embodiment, fiber gripping element 22 grips optical fiber 27 directly rather than its protective buffer. This is accomplished by having gripping element 22 make direct contact with the optical fiber. This avoids the prior art problem of movement of the fiber within the buffer.

25 Figure 2 illustrates fiber gripping element 22 in greater detail. In Figure 2, however, fiber gripping element 22 is shown as it appears prior to being folded for insertion into housing 16. Fiber gripping element 22 has relatively thick side portions 32 and 34 and a relatively thin central portion 36. Thin portion 36 is provided in order to facilitate folding at that location. Fiber gripping element
30 22 is made of a resilient material such that it may be folded until side regions 32 and 34 lie flat against one another. When sides 32 and 34 are folded together



forcing faces 37 and 38 against one another, grooves 24A and 24B come together to form bore 24 with flared regions 28A and 28B and 30A and 30B forming wider regions 28 and 30, respectively. In addition, sides 37 and 38 have beveled edges 40 and 42 respectively. Fiber gripping element 22 may be of any resilient material
5 such as a metal or a plastic is and is preferably of soft aluminum.

Figures 4 and 5 are cross-sectional views of a fiber optic connector according to the invention along section line 4 of Figure 1. As shown in Figure 4, plug 20 has a narrow portion 43 at its top. In Figure 4 plug 20 is partially removed from the opening in which it is inserted. As a result, fiber gripping
10 element 22 is allowed to spring open widening bore 24 of Figure 3. With plug 20, and thus fiber gripping element 22, in the position shown in Figure 4, an optical fiber may easily be inserted or removed from the connector portion.

In Figure 5, plug 20 has been pressed farther down into its opening. As plug 20 is forced into its opening, it presses on beveled edges 40 and 42 of
15 fiber gripping element 22. This forces side regions 32 and 34 into the narrow top portion 43 of plug 20 between the fingers thereof and thus forces side regions 32 and 34 toward one another until faces 37 and 38 meet. When plug 20 has been inserted far enough into its opening that faces 37 and 38 meet, detentes 44, 46, 48, and 50 will engage notches in housing 16. This provides both tactile feedback
20 indicating engagement to the person installing a fiber into connector 10 as well as helping to hold plug 20 in that location. When plug 20 has been inserted to the location shown in Figure 5, the installed fiber will be tightly gripped and held in place.

An important feature of the present invention is that plug 20 slides
25 transverse to the fiber in order to tighten fiber gripping element 22. Thus all of the force and movement required to engage fiber gripping element 22 occur in a direction that will not move the fiber relative to the end face of the ferrule. This feature makes it possible to insert a cleaved fiber into a connector until it strikes a plate held against the end face of the connector. The gripping element may then
30 be engaged, leaving the end faces of the fiber and the connector precisely aligned with one another.



Figure 6 shows another connector according to the invention. In the connector according to Figure 6, however, ferrule 60 is in the form of a truncated cone. Thus the connector of Figure 6 is a biconic connector.

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Claims:

- 5 1. A fiber optic connector comprising:
a connector body (16);
a ferrule (14) attached to said connector body, each of said connector body
and said ferrule having a bore therethrough (25, 26), said bores being in
alignment;
- 10 a plug (20) inserted in said connector body; and
a gripping means (22) for receiving an optical fiber inserted in said bores
with said gripping means in a disengaged state and holding an optical fiber in said
bores with said gripping means in an engaged state, said fiber optic connector
characterized in that
- 15 said gripping means is engageable by moving said plug in a direction
transverse to said bores.
2. A fiber optic connector according to Claim 1 wherein said ferrule is a
cylinder.
- 20 3. A fiber optic connector according to Claim 1 wherein said ferrule is a
truncated cone.
4. A fiber optic connector according to Claim 1 wherein said plug includes
25 first and second fingers for squeezing said gripping means to hold an optical fiber.
5. A fiber optic connector according to Claim 4 wherein said gripping means
is of soft aluminium.
- 30 6. A fiber optic connector according to Claim 5 wherein said ferrule is of a
ceramic material.





- 8 -

7. A fiber optic connector according to Claim 1 wherein said gripping means is of soft aluminium.

8. A fiber optic connector according to Claim 7 wherein said ferrule is of a
5 ceramic material.

9. A fiber optic connector according to Claim 8 wherein said ferrule is of a material selected from the group consisting of alumina, zirconia, and calcium titanate.

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ADHESIVELESS CONNECTOR FOR OPTICAL FIBERS

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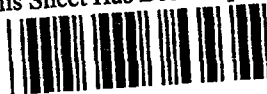
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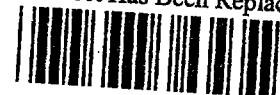
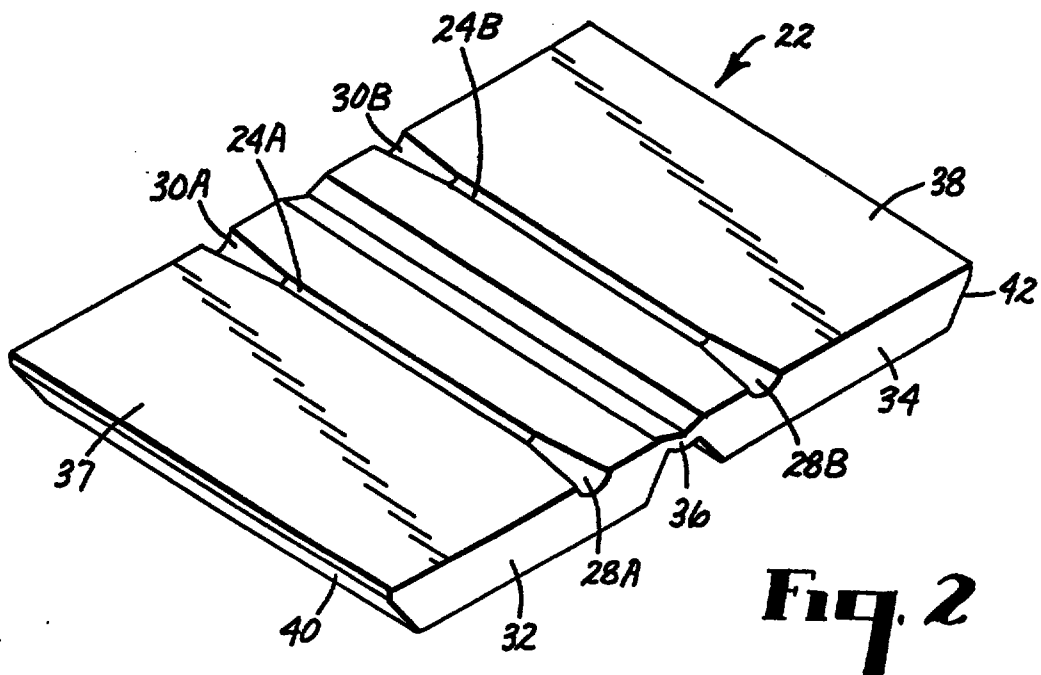
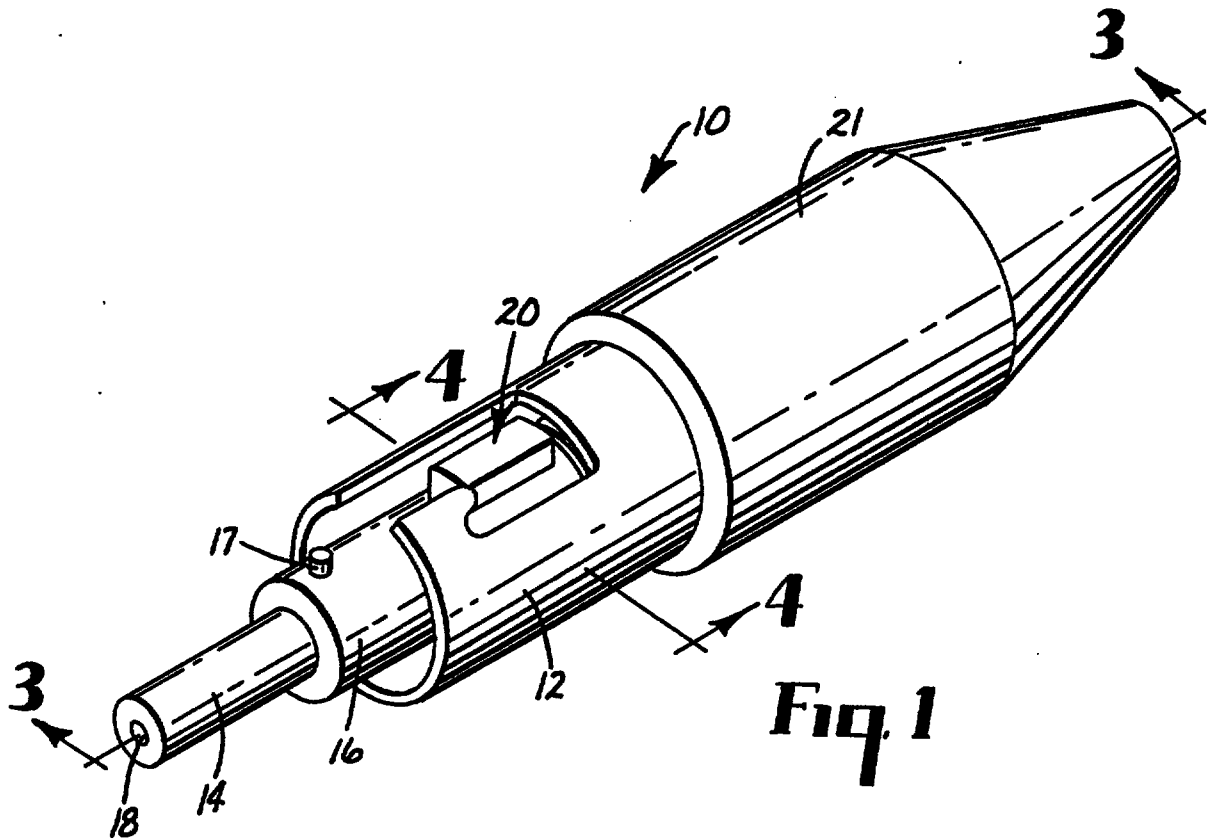
An adhesiveless optical fiber connector utilizes a mechanical gripping element 22 to hold the fiber in place. The gripping element will receive an optical fiber when it is disengaged and hold the fiber when engaged. It is
10 engageable by moving a plug 20 in a direction transverse to the fiber.

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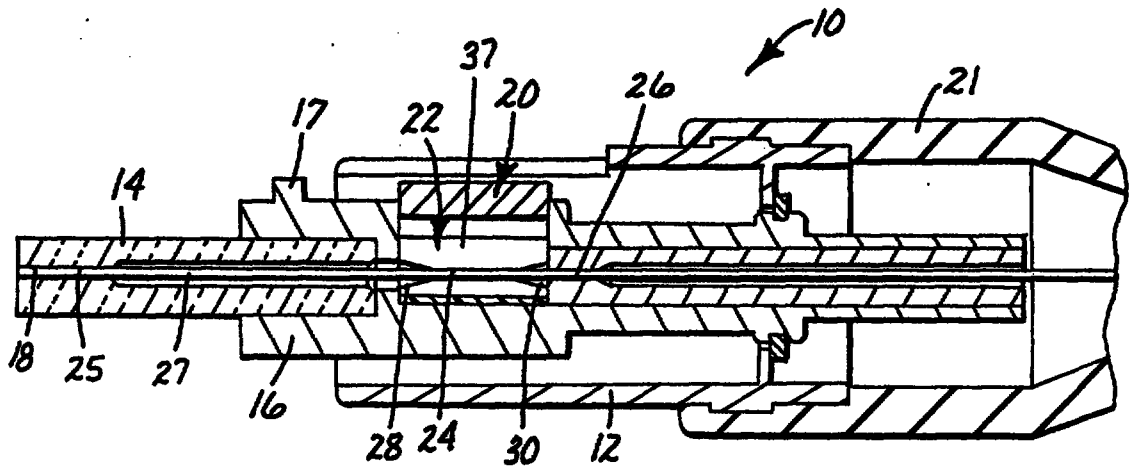


Fig. 3

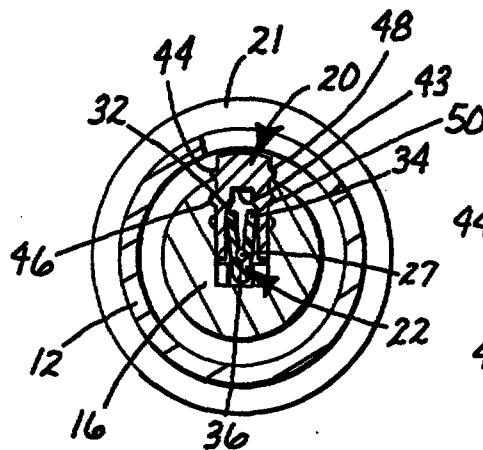


Fig. 4

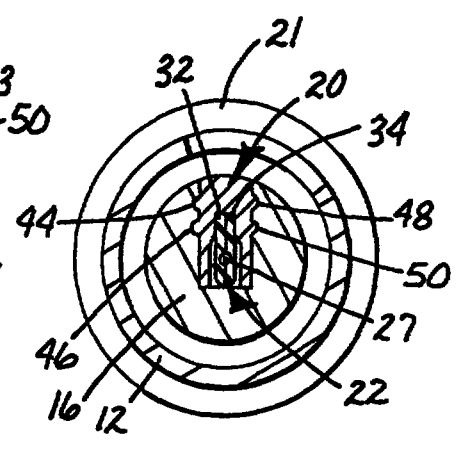


Fig. 5

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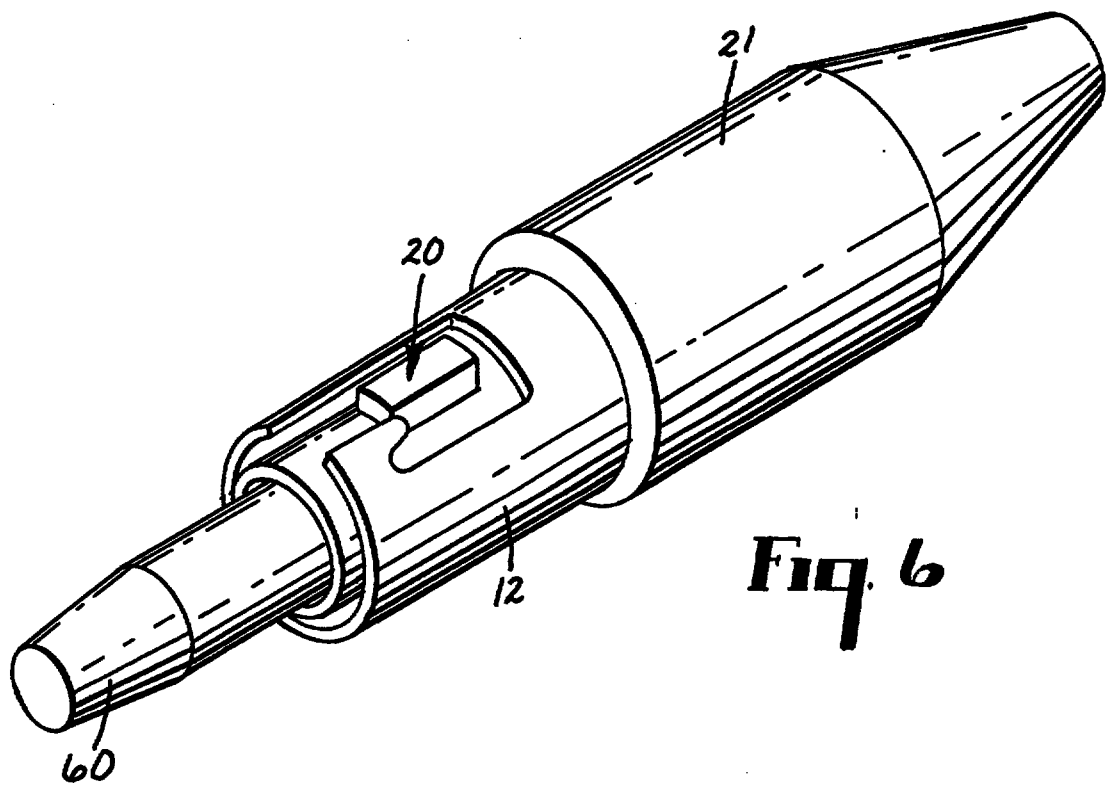


Fig. 6

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- 1 -

ADHESIVELESS CONNECTOR FOR OPTICAL FIBERS

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Background of the Invention

Optical fiber connectors commonly use ferrules to insure alignment of the fibers. Typically two fibers that are to be connected are inserted into housings having matching ferrules attached thereto. The ends of the fibers are then polished to produce a smooth optical finish and the ferrules are inserted into
10 a central housing that holds them close together and in precise alignment.

The term "connector" is often used in a variety of ways in the field of fiber optics. Sometimes it is used to refer to two of the housings with ferrules as described above along with the central housing. At other times it is used to refer to a single housing with a ferrule. This later definition will be adopted
15 herein. Thus, in order to connect two optical fibers, two connectors and a central housing are required.

The ferrules used in fiber optic connectors come in many shapes and can be of many of different materials. Typically the ferrules are of a ceramic material, although metallic or plastic materials can also be used. The ferrule may
20 be cylindrical, as in the widely used ST connector defined by proposed EIA Specification 475E000 or in an SC connector, or it may be a truncated cone as in the case of a biconic connector.

In order to insure a good optical connection, as well as the structural integrity of the connector, the fiber must be tightly bound in the connector.
25 Typically this is done by use of an adhesive. Most commonly an epoxy is used to hold a fiber in a connector housing and ferrule. Once an epoxy has hardened, it cannot be loosened. Thus, if a fiber is incorrectly installed in a connector housing and ferrule, or is damaged subsequent to such installation, the housing and ferrule cannot be reused. United States Patent 4,984,865 (Lee et al.) describes the
30 use of a hot melt adhesive to hold a fiber in a fiber optic connector. While this

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has the advantage of being reusable, it requires that the assembly be heated above the softening temperature of the adhesive upon either insertion or removal of a fiber.

A disadvantage of both epoxies and hot melt adhesives is that both
5 require a delay from the time the fiber is installed in order to harden the adhesive. In addition a hot melt adhesive always requires the use of a heating fixture. The heating fixture, in turn, must be powered, sometimes causing inconvenience. An epoxy does not necessarily require the use of a heating fixture, but, for the epoxies typically used in fiber optic connectors, the cure period will be several hours if no
10 heat is applied. Thus epoxies offer a tradeoff between the inconvenience of a long cure period and that of the use of a heating fixture. Alternatively some epoxies require a source of ultraviolet radiation for curing. Such a radiation source still has the requirement that it be powered.

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15 connector in which the fiber is mechanically clamped in the ferrule by a gripping element. In a connector according to the Savitsky et al. patent, however, the gripping element grips the fiber's buffer instead of the fiber itself. Since it is possible for the fiber to move inside of the buffer, it is difficult to precisely align the end of the fiber with the end face of ferrule. This difficulty is increased by
20 the fact that the gripping element is collapsed onto the fiber buffer by moving a nut along the connector in a direction parallel to the fiber. Thus the force and movement required to engage the gripping element are directed parallel to the fiber. This can cause the fiber to move in the ferrule as the gripping element is tightened.

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Summary of the Invention

According to the present invention, an optical fiber connector includes a connector body and a ferrule attached to one another. Each has a bore through it and the bores are aligned. A gripping element resides in the connector
30 body. When the gripping element is in a disengaged state it will receive an optical

fiber inserted in the bores. In an engaged state it will hold an optical fiber in the connector body and the ferrule. The gripping element is engageable by moving a plug in a direction transverse to the bores.

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Brief Description of the Drawings

Figure 1 is a perspective view of a fiber optic connector according to the invention;

Figure 2 is a perspective view of a gripping element according to the invention;

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Figure 3 is a cross-sectional view of a fiber optic connector according to the invention along its axis;

Figure 4 is a cross-sectional view of a fiber optic connector according to the invention transverse to its axis with the gripping element disengaged;

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Figure 5 is a cross-sectional view of a fiber optic connector according to the invention transverse to its axis with the gripping element engaged; and

Figure 6 is a perspective view of a second fiber optic connector according to the invention.

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Detailed Description of a

Preferred Embodiment

Figure 1 shows an optical fiber connector 10. The optical fiber connector shown in the Figure 1 includes a housing 16 and a ferrule 14. Housing 16 has a bayonet locking mechanism 12. The apparatus of Figure 1 is intended to be used in an ST connector. It utilizes the cylindrical ferrule of the ST design. Those skilled in the art will readily perceive, however, that the present invention could be used in any fiber optic connector utilizing a ferrule, whatever the shape of such ferrule. Typically housing 16 would be of a metal such as aluminum while ferrule 14 would be of a ceramic such as zirconia, alumina, or calcium titanate. Alternatively housing 16 could be of a plastic while ferrule 14 could be

of a metal or a plastic. Additionally, although it is typical for housing 16 and ferrule 14 to be manufactured separately and attached to one another later, it is possible to mold them as a single unit. For purposes herein, a housing and a ferrule molded as a single, unitary object will still be considered to be a housing
5 and a ferrule attached to one another.

Housing 16 and ferrule 14 are joined together to form connector 10. The combined structure 10 has a major axis with a bore 18 for receiving an optical fiber running along the major axis. Housing 16 further includes an alignment pin 17, for use when connector 10 is coupled to a similar connector to form a fiber
10 optic connection. A plug, 20, is press fit into an opening that intersects bore 18. Housing 16 also includes a strain relief 21. Typically, strain relief 21 is of a pliable material and provides protection for an optical fiber exiting housing 16.

Figure 3 is a cross-sectional view of the optical fiber connector 10 of Figure 1. As described previously, a plug 20 is press fit into an opening that
15 intersects with bore 18 as may be seen, bore 18 actually includes two bores aligned with one another. These are bore 25 of ferrule 14 and bore 26 of housing 16. Plug 20 engages with fiber gripping mechanism 22. Fiber gripping mechanism 22 includes a bore 24 in alignment with bore 18. An optical fiber 27 runs through bore 18 and bore 24 where it is tightly gripped. Bore 24 has widened regions 28
20 and 30 at its ends in order to facilitate inserting optical fiber 27. In the preferred embodiment, fiber gripping element 22 grips optical fiber 27 directly rather than its protective buffer. This is accomplished by having gripping element 22 make direct contact with the optical fiber. This avoids the prior art problem of movement of the fiber within the buffer.

25 Figure 2 illustrates fiber gripping element 22 in greater detail. In Figure 2, however, fiber gripping element 22 is shown as it appears prior to being folded for insertion into housing 16. Fiber gripping element 22 has relatively thick side portions 32 and 34 and a relatively thin central portion 36. Thin portion 36 is provided in order to facilitate folding at that location. Fiber gripping element
30 22 is made of a resilient material such that it may be folded until side regions 32 and 34 lie flat against one another. When sides 32 and 34 are folded together

forcing faces 37 and 38 against one another, grooves 24A and 24B come together to form bore 24 with flared regions 28A and 28B and 30A and 30B forming wider regions 28 and 30, respectively. In addition, sides 37 and 38 have beveled edges 40 and 42 respectively. Fiber gripping element 22 may be of any resilient material
5 such as a metal or a plastic is and is preferably of soft aluminum.

Figures 4 and 5 are cross-sectional views of a fiber optic connector according to the invention along section line 4 of Figure 1. As shown in Figure 4, plug 20 has a narrow portion 43 at its top. In Figure 4 plug 20 is partially removed from the opening in which it is inserted. As a result, fiber gripping
10 element 22 is allowed to spring open widening bore 24 of Figure 3. With plug 20, and thus fiber gripping element 22, in the position shown in Figure 4, an optical fiber may easily be inserted or removed from the connector portion.

In Figure 5, plug 20 has been pressed farther down into its opening. As plug 20 is forced into its opening, it presses on beveled edges 40 and 42 of
15 fiber gripping element 22. This forces side regions 32 and 34 into the narrow top portion 43 of plug 20 between the fingers thereof and thus forces side regions 32 and 34 toward one another until faces 37 and 38 meet. When plug 20 has been inserted far enough into its opening that faces 37 and 38 meet, detentes 44, 46, 48, and 50 will engage notches in housing 16. This provides both tactile feedback
20 indicating engagement to the person installing a fiber into connector 10 as well as helping to hold plug 20 in that location. When plug 20 has been inserted to the location shown in Figure 5, the installed fiber will be tightly gripped and held in place.

An important feature of the present invention is that plug 20 slides
25 transverse to the fiber in order to tighten fiber gripping element 22. Thus all of the force and movement required to engage fiber gripping element 22 occur in a direction that will not move the fiber relative to the end face of the ferrule. This feature makes it possible to insert a cleaved fiber into a connector until it strikes a plate held against the end face of the connector. The gripping element may then
30 be engaged, leaving the end faces of the fiber and the connector precisely aligned with one another.

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Date: 28 FEB 1997

- 6 -

Figure 6 shows another connector according to the invention. In the connector according to Figure 6, however, ferrule 60 is in the form of a truncated cone. Thus the connector of Figure 6 is a biconic connector.

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Date: 28 FEB 1997



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Claims:

- 5 1. A fiber optic connector comprising:
a connector body (16);
a ferrule (14) attached to said connector body, each of said connector body
and said ferrule having a bore therethrough (25, 26), said bores being in
alignment;
- 10 a plug (20) inserted in said connector body; and
a gripping means (22) for receiving an optical fiber inserted in said bores
with said gripping means in a disengaged state and holding an optical fiber in said
bores with said gripping means in an engaged state, said fiber optic connector
characterized in that
- 15 said gripping means is engageable by moving said plug in a direction
transverse to said bores.
2. A fiber optic connector according to Claim 1 wherein said ferrule is a
cylinder.
- 20 3. A fiber optic connector according to Claim 1 wherein said ferrule is a
truncated cone.
4. A fiber optic connector according to Claim 1 wherein said plug includes
25 first and second fingers for squeezing said gripping means to hold an optical fiber.
5. A fiber optic connector according to Claim 4 wherein said gripping means
is of soft aluminium.
- 30 6. A fiber optic connector according to Claim 5 wherein said ferrule is of a
ceramic material.



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Date: 28 FEB 1997

7. A fiber optic connector according to Claim 1 wherein said gripping means is of soft aluminium.

8. A fiber optic connector according to Claim 7 wherein said ferrule is of a
5 ceramic material.

9. A fiber optic connector according to Claim 8 wherein said ferrule is of a material selected from the group consisting of alumina, zirconia, and calcium titanate.

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ADHESIVELESS CONNECTOR FOR OPTICAL FIBERS

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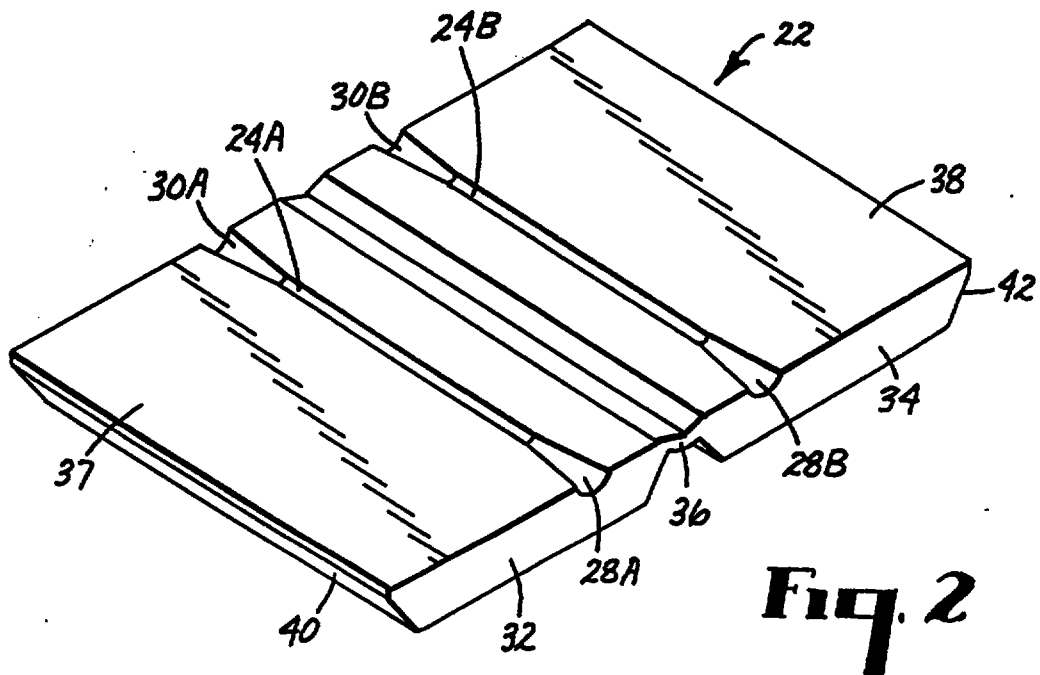
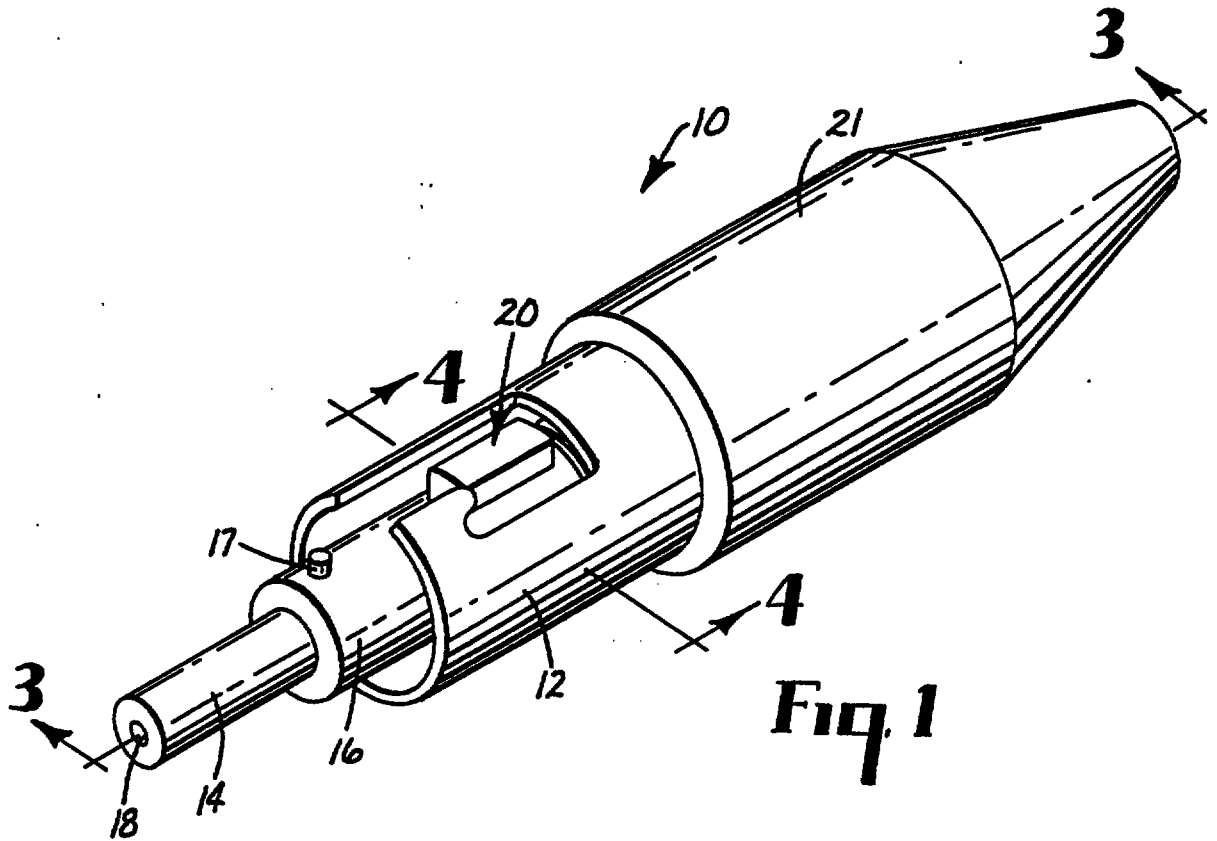
Abstract of the Disclosure

An adhesiveless optical fiber connector utilizes a mechanical gripping element 22 to hold the fiber in place. The gripping element will receive an optical fiber when it is disengaged and hold the fiber when engaged. It is
10 engageable by moving a plug 20 in a direction transverse to the fiber.

FIGURE 4 AND 5

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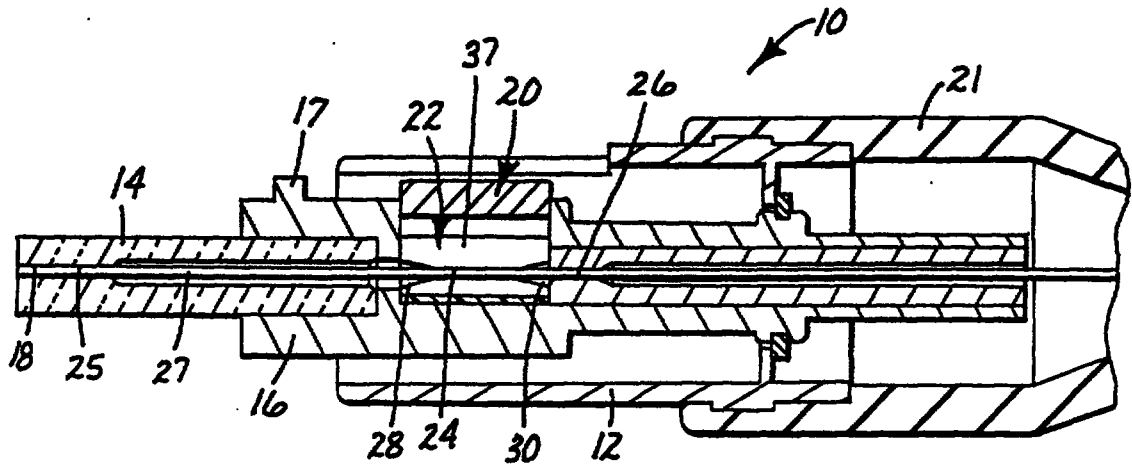


Fig. 3

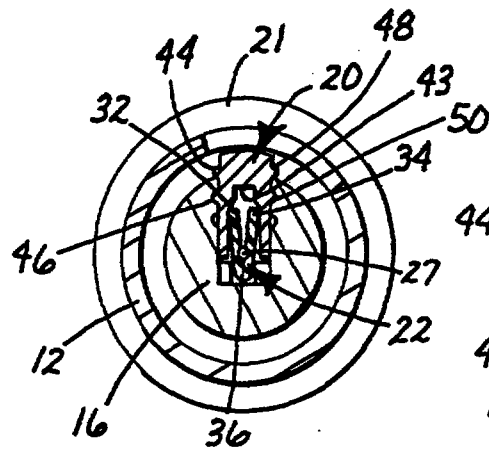


Fig. 4

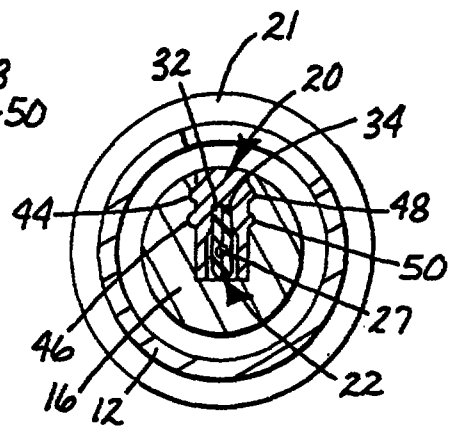


Fig. 5

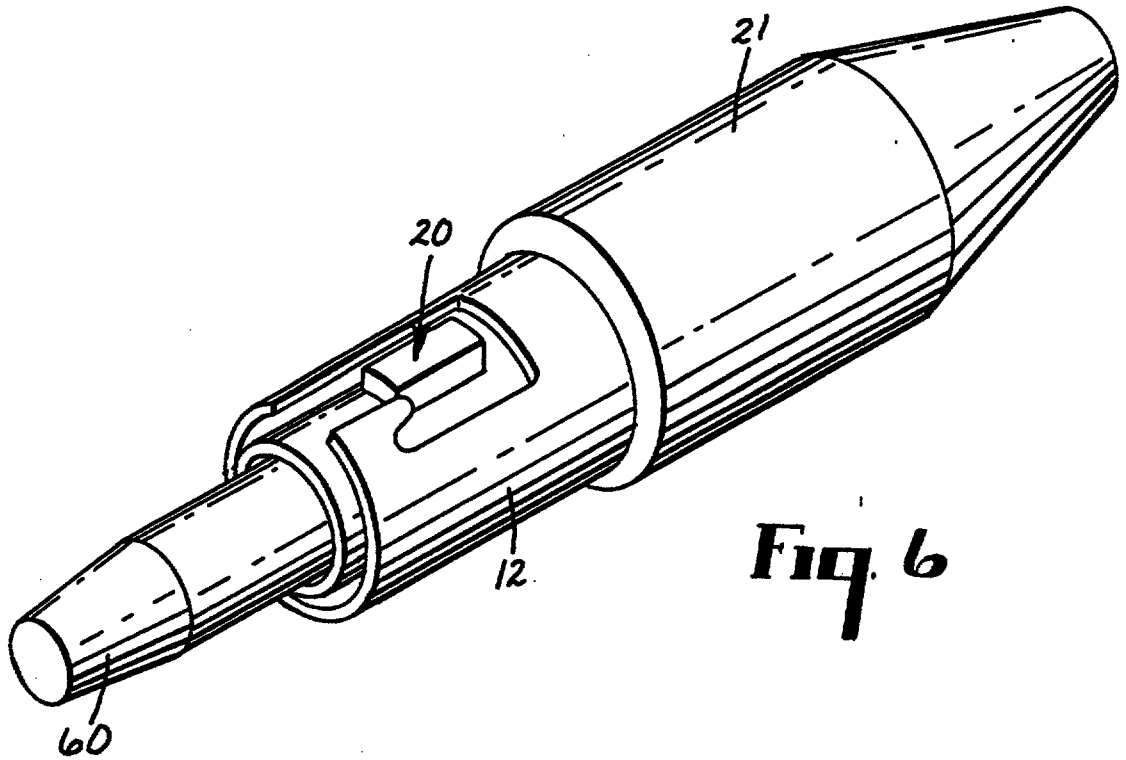
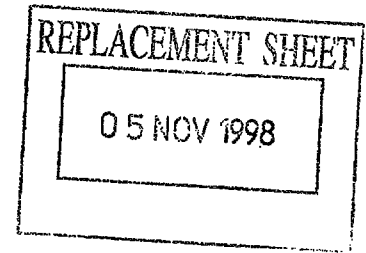


Fig. 6

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Claims:

- 5 1. A fiber optic connector comprising:
a connector body (16);
a ferrule (14) attached to said connector body, each of said connector body
and said ferrule having a bore therethrough (25, 26), said bores being in
substantially co-axial alignment;
10 a plug (20) inserted in said connector body; and
a gripping means (22) for receiving an optical fiber inserted in said bores
with said gripping means in a disengaged state and holding an optical fiber in said
bores with said gripping means in an engaged state, said fiber optic connector
characterized in that
15 said gripping means is engageable by moving said plug in a direction
transverse to said bores.
2. A fiber optic connector according to Claim 1 wherein said ferrule is a
cylinder.
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3. A fiber optic connector according to Claim 1 wherein said ferrule is a
truncated cone.
4. A fiber optic connector according to Claim 1 wherein said plug includes
25 first and second fingers for squeezing said gripping means to hold an optical fiber.
5. A fiber optic connector according to Claim 4 wherein said gripping means
is of soft aluminium.
- 30 6. A fiber optic connector according to Claim 5 wherein said ferrule is of a
ceramic material.

