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(54) **CABLE ASSEMBLY FOR USE WITH OPTO-ELECTRONIC EQUIPMENT ENCLOSURES**

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(57) **ABSTRACT**

Light, flexible tubes are placed around optical fibers extending from the end of a cable jacket. A water impervious plug encases the end of the cable jacket and a portion of the flexible tubes. Couplers are attached to the light waveguide terminal ends and the optical couplers and the plug are placed in an opto-electronic equipment closure. The assembly is designed for use with cable television system aerial closures.

**16 Claims, 5 Drawing Sheets**

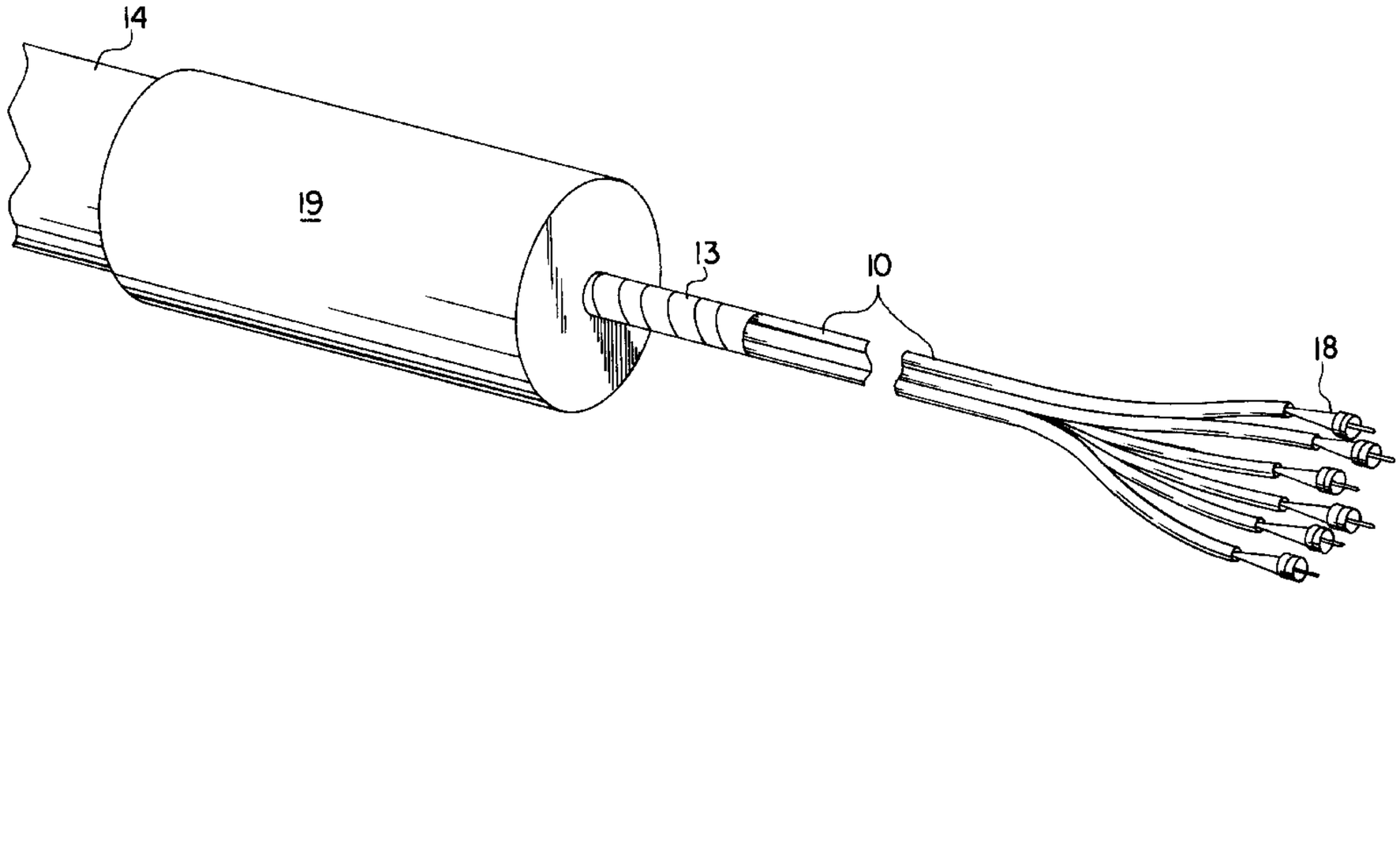

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FIG. 1

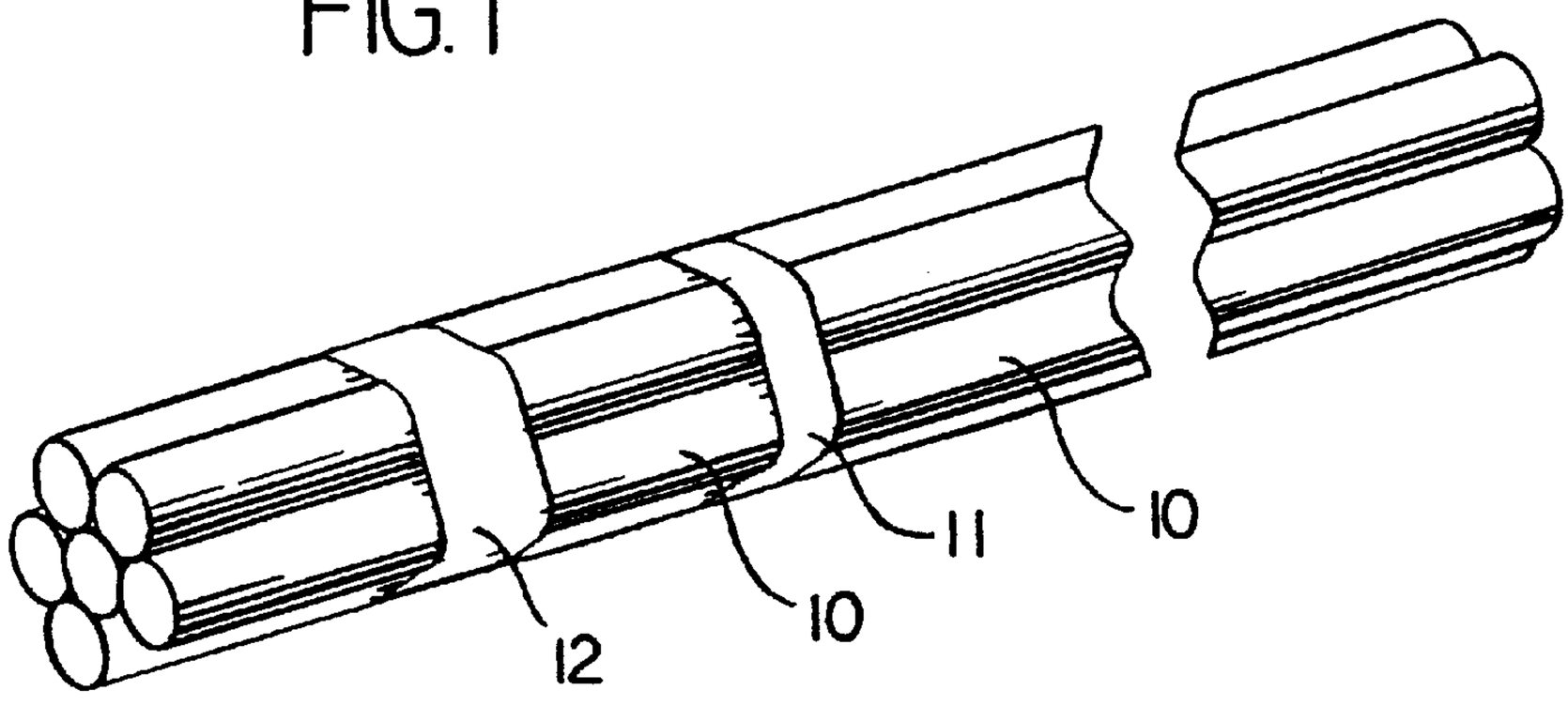
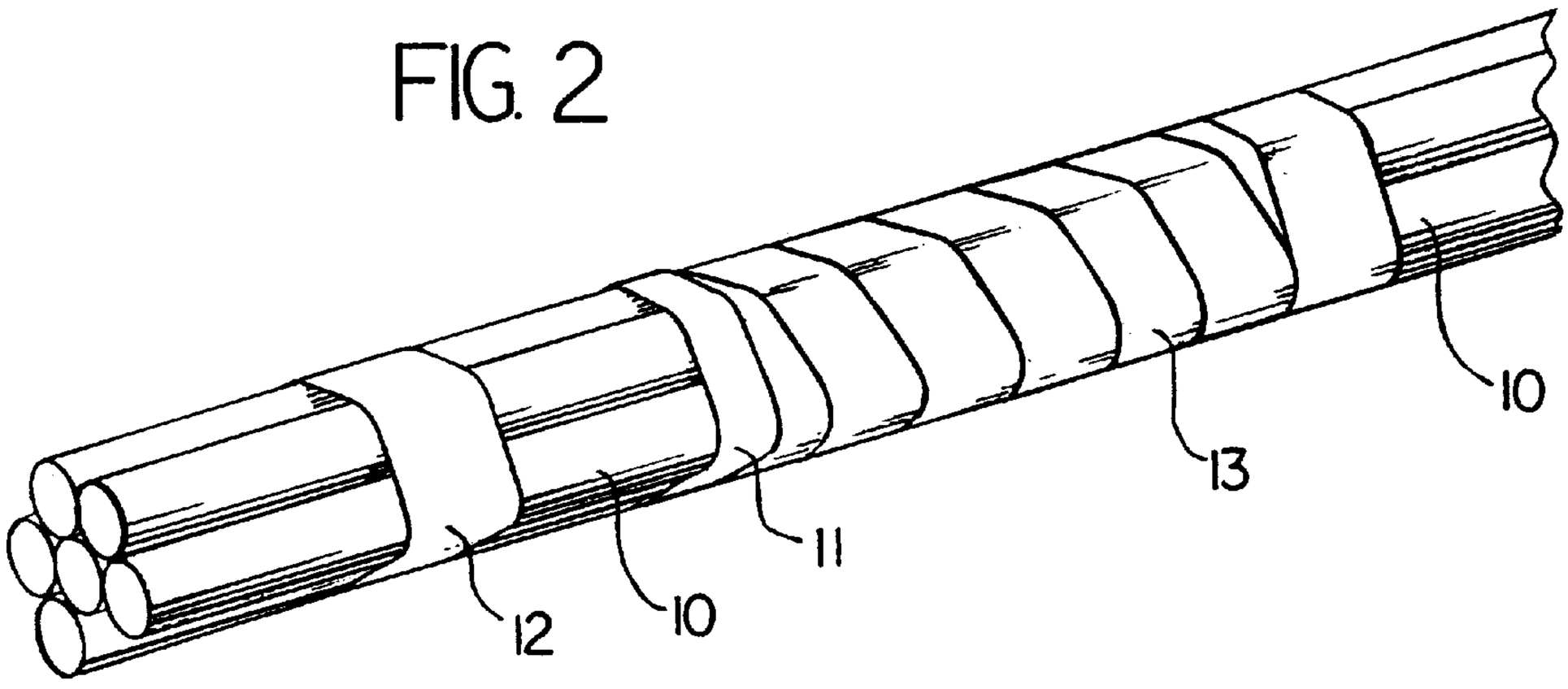



FIG. 2



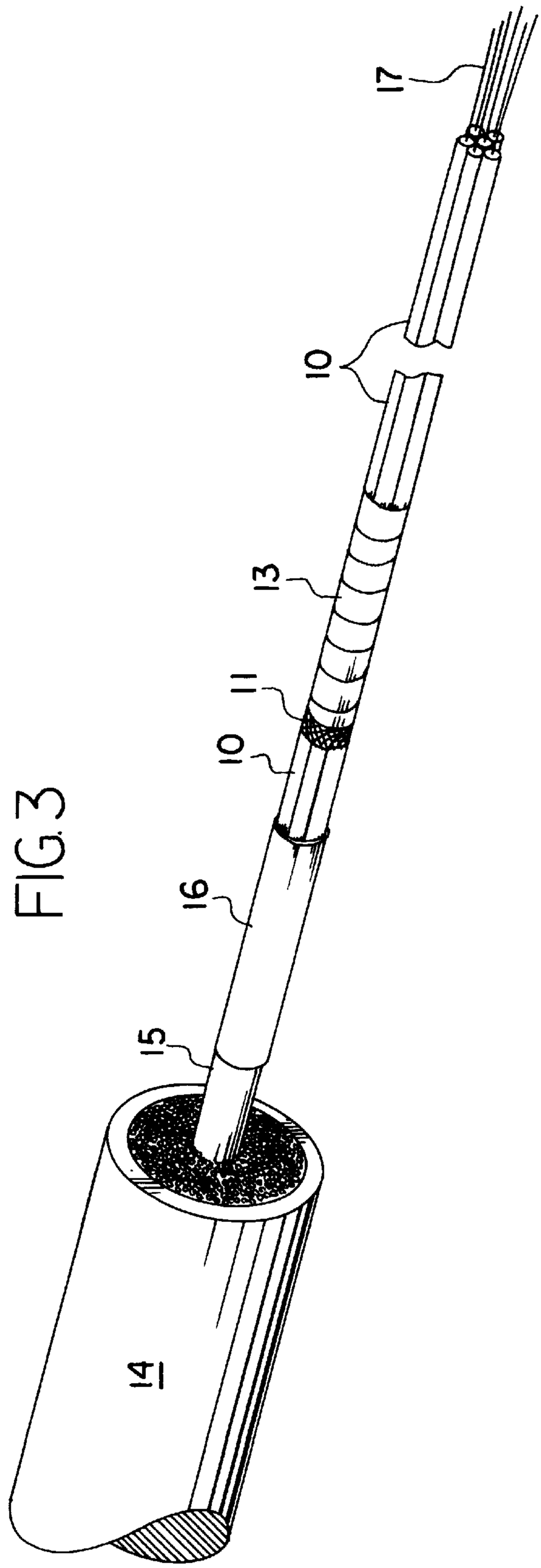



FIG.3

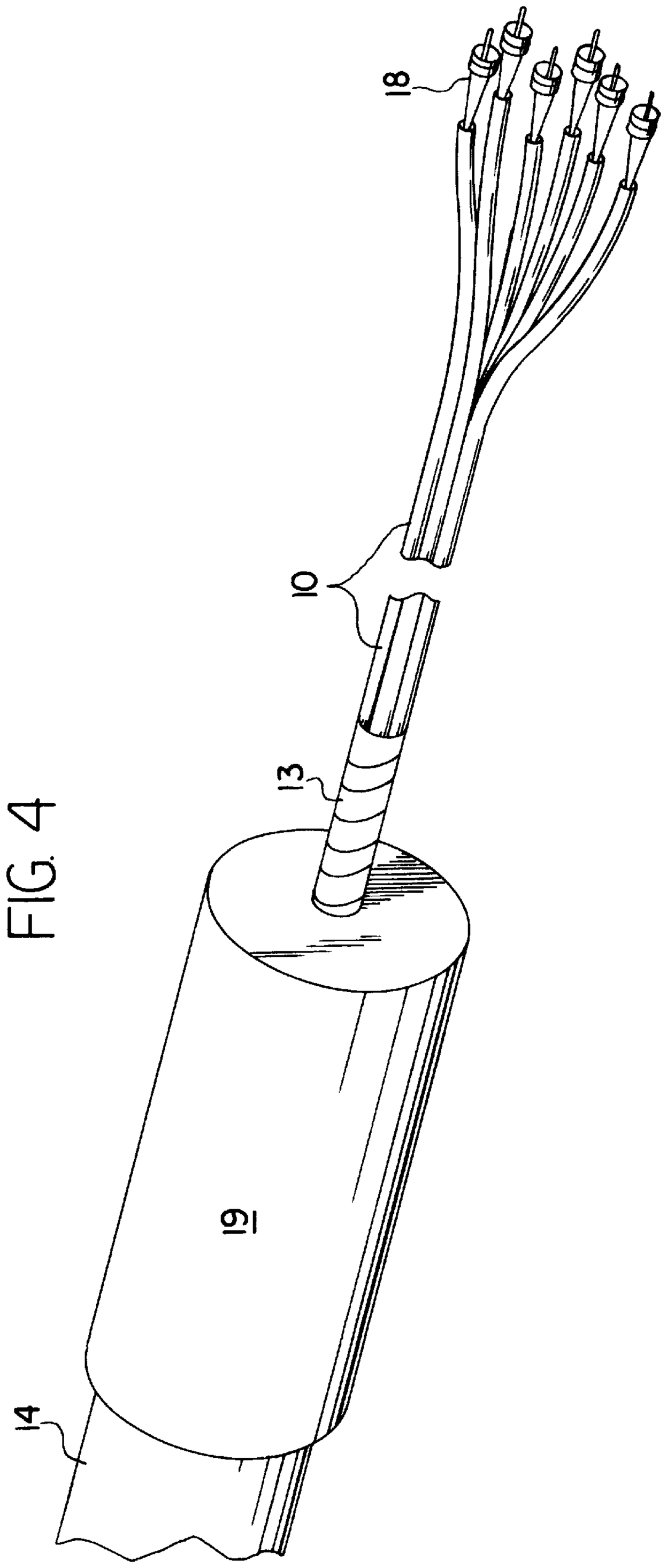



FIG. 4

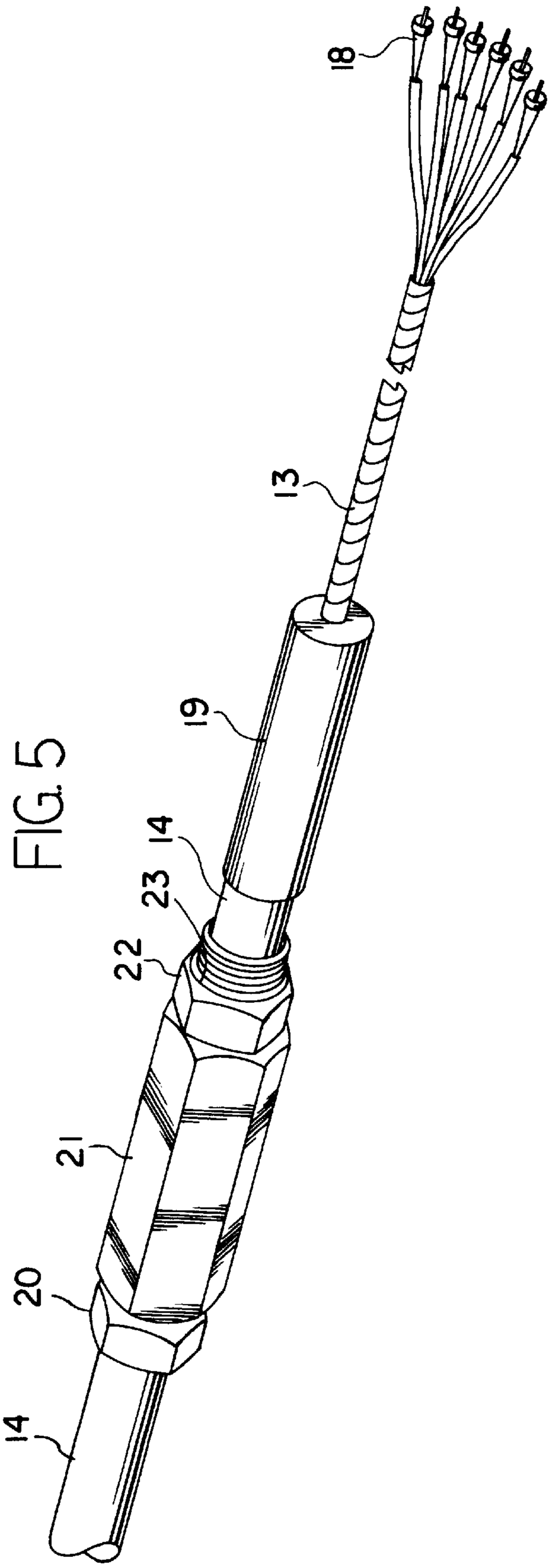



FIG. 5

FIG. 6

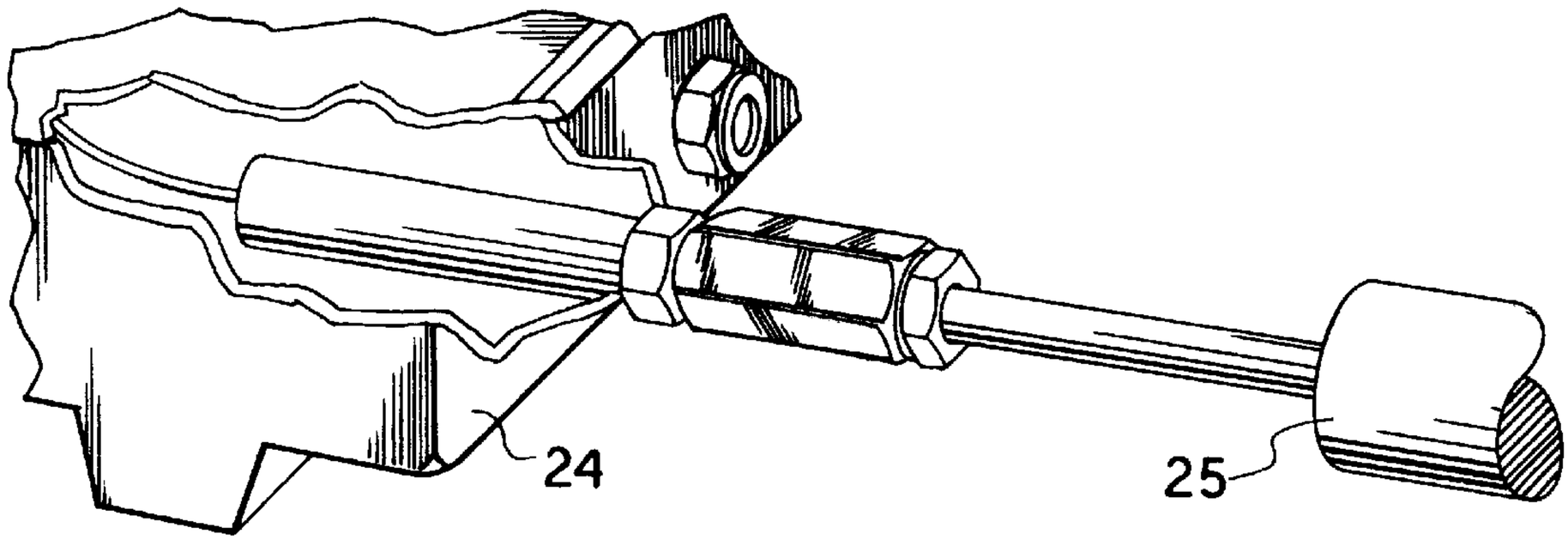
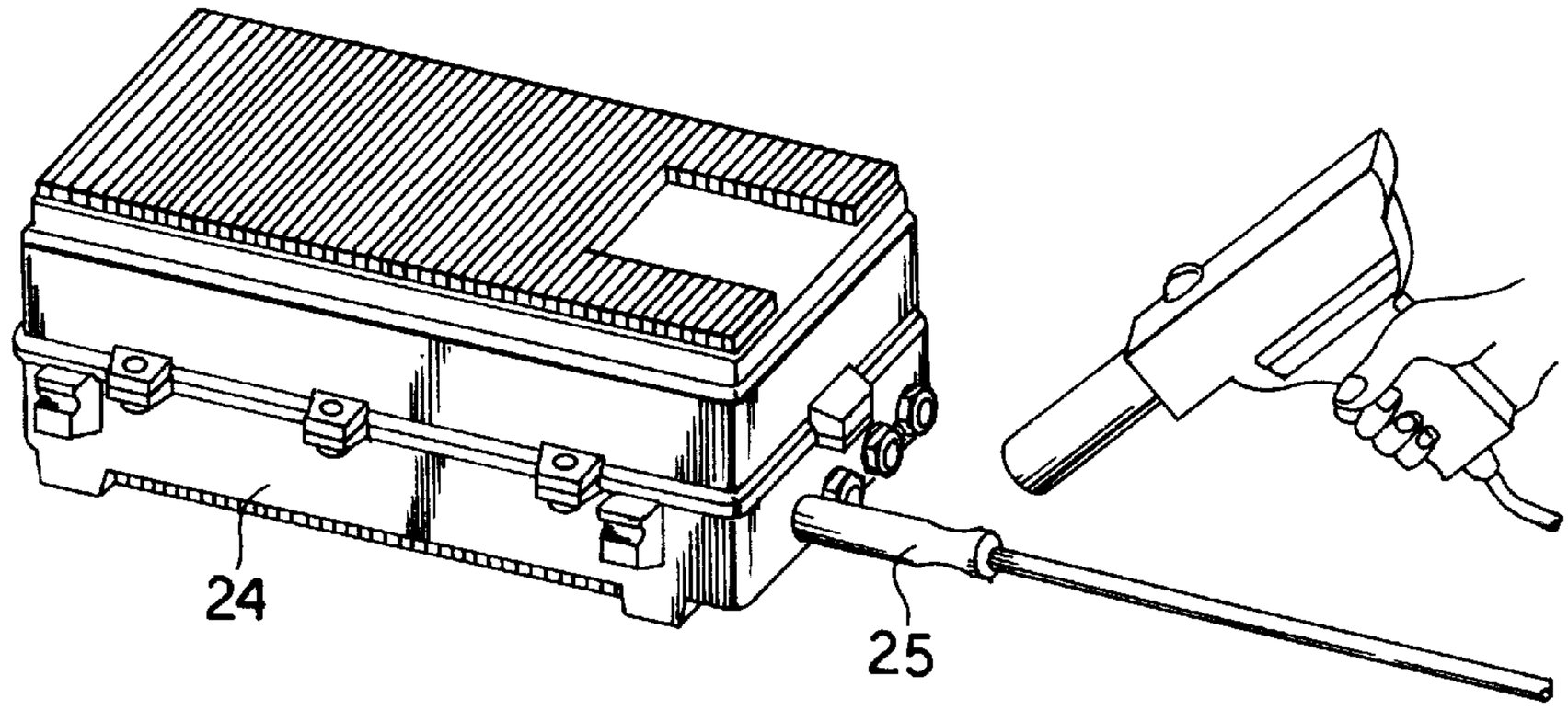



FIG. 7



# CABLE ASSEMBLY FOR USE WITH OPTO-ELECTRONIC EQUIPMENT ENCLOSURES

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

## BACKGROUND OF THE INVENTION

The field of the invention is optical cable assembles.

Background of the Invention. There are several disadvantages associated with the current practices for installation, termination, and environmental sealing of fiber optic cables placed into cable television system electronic equipment enclosures. A prior art practice is to strip back the end of a fiber optic cable and feed the exposed coated optical fibers into the fiber optic entry point of an electronic closure. A threaded connector on the cable is screwed into the entry port. The connector, after tightening, grips the fiber optic cable jacket for strain relief. The exposed fibers are then fusion spliced inside the enclosure. No additional protection is provided for the fibers, no mechanism is provided to control core pistoning into the enclosure, and no mechanism is provided to block the migration of water from entering the electronic enclosure if the cable sheath is damaged behind the strain relief connector. The current method is also labor intensive and costly to the cable television company.

## SUMMARY OF THE INVENTION

The invention solves the foregoing problems by pre-connectorizing the optical fiber terminal ends, protecting the exposed optical fibers with flexible tubing, and sealing the assembly by providing a plug around the end of the cutback cable jacket through which moisture might otherwise enter. A jacketed cable includes a plurality of light waveguides. The plurality of light waveguides includes a proximal span included within the jacketed cable, a distal end to which an optical coupler is affixed, and a mediate span therebetween. A plurality of flexible tubes is provided, each flexible tube surrounding a mediate span of one of the said light waveguides. A water impervious plug encases a portion of the mediate span of the plurality of light waveguides, the plug extending onto and over a portion of the cable jacket. The optical couplers and the plug are placed in an opto-electronic equipment enclosure. A prior art threaded connector mounts the cable to the entry port of the closure and is surrounded by a watertight seal. The equipment closure may be an aerial closure which is part of a cable television system.

## BRIEF DESCRIPTION OF THE DRAWINGS

The preferred embodiment is described with the aid of the drawings, in which:

FIGS. **1** and **2** are perspective views of portions of a plurality of bundled flexible tubes;

FIG. **3** is a perspective view of the assembly prior to formation of the sealed plug;

FIG. **4** is a perspective view of the assembly including the sealed plug and the attached optical couplers;

FIG. **5** is a perspective view of the assembly including the threaded metallic strain relief connector;

FIG. **6** is a perspective view of the assembly as inserted into an electronic closure; and

FIG. **7** is a perspective view of a heat shrinkable tubing applied over the assembly as it enters the outside of the enclosure.



## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An array of flexible tubes **10** are bundled as shown in FIG. **1** by two strips **11, 12** of heat shrinkable material which are preferably ¼ inch wide. Tubes **10** are preferably made of a lightweight, low friction, highly flexible plastic such as Teflon® plastic. Strips **11, 12** are placed 3/16th of an inch apart. Strip **12** is located around ¼ inch from one end of tubes **10**.

After strips **11, 12** have cooled, spiral wrap material **13** is placed over the bundle of tubes **10**, with one edge over strip **11** and the remainder proceeding in the direction opposite strip **12**.

A light waveguide cable is then prepared as shown in FIG. **3**. After one end of cable jacket **14** has been cut back, a buffer tube **15** including light waveguides **17** extends a short distance. Each fight waveguide **17** is threaded through a flexible tube **10**, with an optical coupler **18** being placed on the distal end of each fight waveguide **17**. As shown in FIG. **4**, tubes **10** extend to meet the rear of couplers **18**. A protective boot on each coupler **18** may cover the end of a tube **10**. After one end of tubes **10** have been placed inside buffer tube **15**, an adhesive fined piece of heat shrinkable material **16** is placed over the junction of buffer tube **15** and flexible tubes **10**. Heat is then applied to produce the configuration of FIG. **3**.

The assembly of FIG. **3** is then placed in a mold such that the end of cable jacket **14** lies at one end of the mold and spiral wrap material **13** and tubes **10** extend from the other end of the mold. After O-rings are placed at the ends of the mold, an epoxy is injected into the mold to produce a cylindrical water imperious plug **19**, which has a constant outer diameter of slightly less than ⅝ inch. Aramid fibers or other strength members extending slightly from the edge of cable jacket **14** into the mold provide strain relief for the cable assembly. After molding, the assembly has the appearance as shown in FIG. **4**.

FIG. **5** depicts the threaded metal connector used to anchor the cable assembly to the optical entry port of an opto-electronic closure. Connector components include back nut **20**, main body **21**, and entry nut **22** having external threads **23** thereon, all of which are inserted over cable jacket **14** prior to molding plug **19** if desired. O-rings are provided for each nut **20, 22**.

The assembly is shown in FIG. **6** as inserted through the optical entry port of an opto-electronic aerial closure **24**, which is part of a cable television network system. Both plug **19** and couplers **18** are inserted into closure **24** through the optical entry port, which has a standard diameter of ⅝ inch. The plug outer diameter must be smaller than the inner diameter of the optical entry port. Plug **19** is pulled snugly against the edge of enclosure **24**, and entry nut **22** is screwed into the inner threaded entry port of the enclosure. Main body **21** and rear nut **20** are then tightened against entry nut **22**. A further piece of heat shrinkable tubing **25**, having previously been placed over the edge of cable jacket **14**, is then moved forward over the metallic connector and heated as shown in FIG. **7** to provide a sealed junction of the assembly with closure **24**. In this manner, light waveguides **17** are protected throughout their length, including proximal spans included within cable jacket **14**, their distal ends to which couplers **18** are attached, and the mediate span of each optical fiber **17** located therebetween.

What is claimed is:

**1**. A cable assembly for use with opto-electronic equipment enclosures, comprising:

a plurality of light waveguides, each light waveguide including a proximal span in which the light waveguide is loosely held within a tube within a cable having an outer jacket, a distal end to which an optical coupler is affixed, and a mediate span not enclosed by the outer cable jacket therebetween;

a plurality of flexible tubes, each said flexible tube surrounding a mediate span of one of the said light waveguides; **[**and,**]**

a water-impervious plug of constant outer diameter encasing a portion of the mediate span of the plurality of light waveguides and flexible tubes, the plug extending to and over a portion of the cable jacket*; and*

*an opto-electronic equipment enclosure having an optical entry port of constant inner diameter greater than the plug outer diameter, the enclosure containing the optical couplers and the plug, and sealed means for attaching the cable to the enclosure*.

**[2**. A cable assembly as recited in claim **1** further comprising an opto-electronic equipment closure having an optical entry port of constant inner diameter greater than the plug outer diameter, the closure containing the optical couplers and the plug, and sealed means for attaching the cable to the closure.**]**

**3**. A cable assembly as recited in claim **[2]** *1* wherein the **[**closure**]** *enclosure* is an aerial **[**closure**]** *enclosure* which is part of a cable television system.

**4**. A cable assembly as recited in claim **[2]** *1* wherein the plug outer diameter is less than five-eights of an inch.

*5. A cable assembly as recited in claim 1 further comprising:*

*a rigid tube assembly surrounding both the proximal span of the plurality of light waveguides and the cable with the outer jacket, said rigid tube assembly having a first end proximate to the distal ends of the light waveguides and a second end proximate to the proximal ends of the light waveguides.*

*6. A cable assembly as recited in claim 5, wherein the first end of the rigid tube assembly and the optical entry port each threadably engage one another.*

*7. A cable assembly as recited in claim 6, wherein the rigid tube assembly is externally threaded at the first end to be receivably engaged by the optical entry port.*

*8. A cable assembly as recited in claim 5, wherein the rigid tube assembly comprises:*

*a first nut;*

*a second nut; and*

*a rigid tube between the first and second nuts.*



*9. A cable assembly as recited in claim 5 further comprising:*

*a heat shrinkable tube over the rigid tube assembly.*

*10. A cable assembly comprising:*

*a plurality of light waveguides, each light waveguide including a proximal span in which the light waveguide is loosely held within a tube within a cable having an outer jacket, a distal end, and a mediate span not enclosed by the outer cable jacket therebetween;*

*a plurality of flexible tubes, each said flexible tube surrounding a mediate span of one of the said light waveguides;*

*a water-impervious plug encasing a portion of the mediate span of the plurality of light waveguides and flexible tubes, the plug extending to and over a portion of the cable; and*

*an opto-electronic equipment enclosure, wherein the opto-electronic equipment enclosure comprises an optical entry port through which the plug and the distal ends of the plurality of light waveguides is inserted into the opto-electronic equipment enclosure.*

*11. A cable assembly as recited in claim 10 further comprising:*

*a rigid tube assembly surrounding both the proximal span of the plurality of light waveguides and the cable with the outer jacket, said rigid tube assembly having a first end proximate to the distal ends of the light waveguides and a second end proximate to the proximal ends of the light waveguides.*

*12. A cable assembly as recited in claim 11, wherein the first end of the rigid tube assembly and the optical entry port each threadably engage one another.*

*13. A cable assembly as recited in claim 12, wherein the rigid tube assembly is externally threaded at the first end to be receivably engaged by the optical entry port.*

*14. A cable assembly as recited in claim 11, wherein the rigid tube assembly comprises:*

*a first nut;*

*a second nut; and*

*a rigid tube between the first and second nuts.*

*15. A cable assembly as recited in claim 11 further comprising:*

*a heat shrinkable tube over the rigid tube assembly.*

*16. A cable assembly as recited in claim 10, wherein the distal end of each of the optical waveguides includes an optical coupler.*

*17. A cable assembly as recited in claim 10, wherein the plug and optical entry port have constant diameters with the outer diameter of the plug being less than the inner diameter of the optical entry port.*

* * * * *