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GB 2049977A
GB 1551273
GB 1481334
GB 1440806
GB 1425264
EP 15309A
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(71) Applicant
Hewlett Packard Company,
1501 Page Mill Road, Palo Alto, California 94304,
United States of America
(72) Inventors
Donald L. Lubin,
John Uebbing,
Donald A. Shipley,
Rickson Sun

(54) Housing for Interfacing a Semiconductor Device With a Fiber Optic Cable

(57) A housing (2) to interface a semiconductor device (16) with a fiber optic cable (6) allows the cable to be simply snapped in and out of the housing. Once snapped in, the cable is automatically axially aligned with the semiconductor device and held firmly in place for minimal loss of light transmission between cable and device. In some preferred embodiments, the housing is configured to allow the electrical leads (20) of the semiconductor device to be connected directly to elements external to the housing, and even to attach the housing itself to the external element.

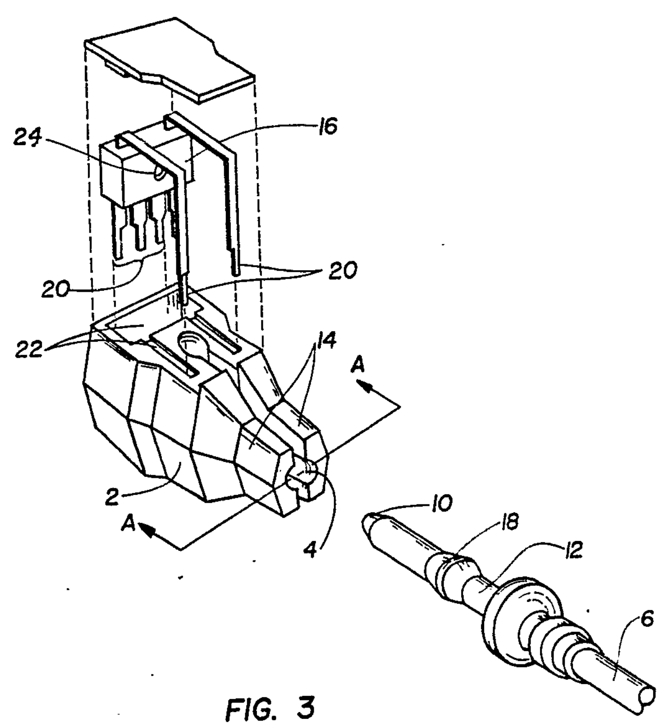

FIG. 3

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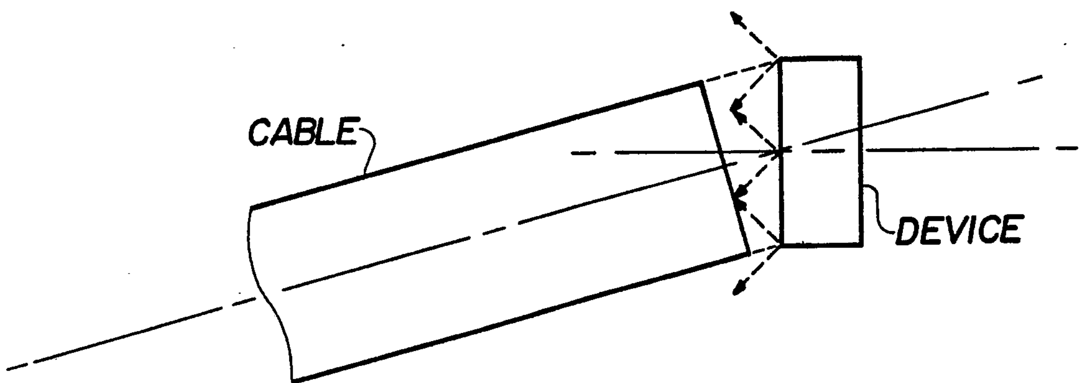

FIG. 1A

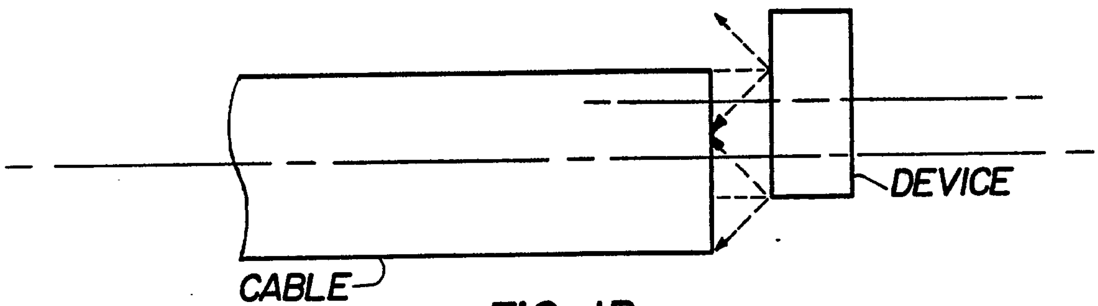

FIG. 1B

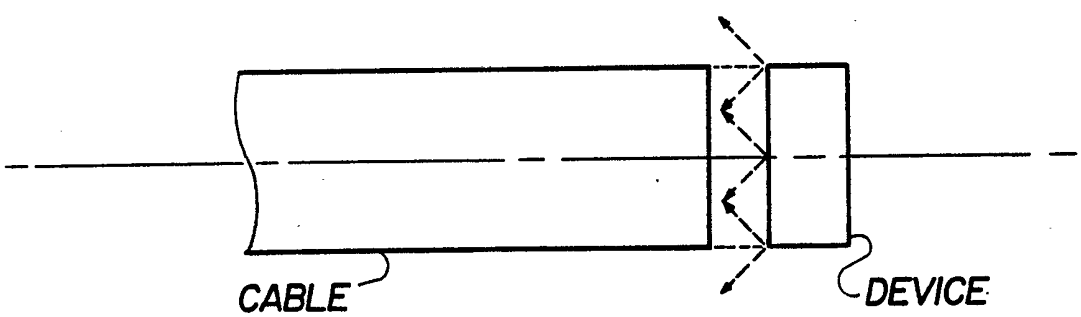

FIG. 1C

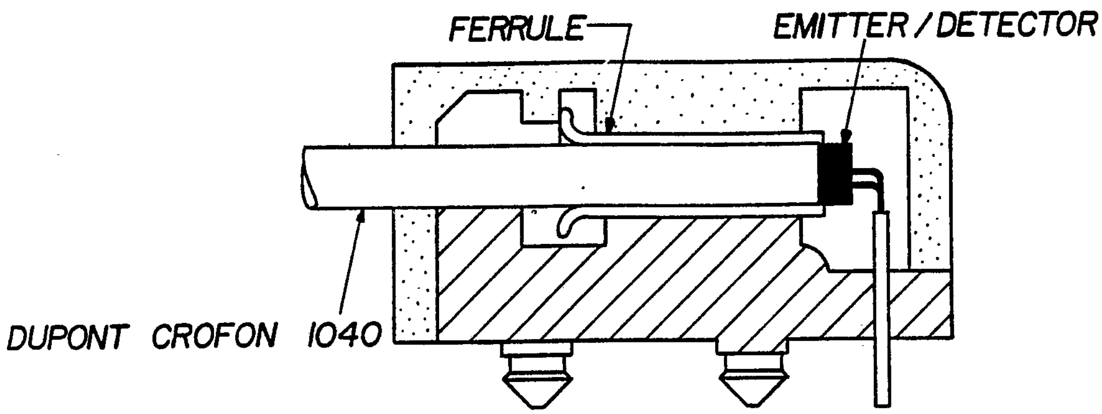

FIG. 2A (PRIOR ART)

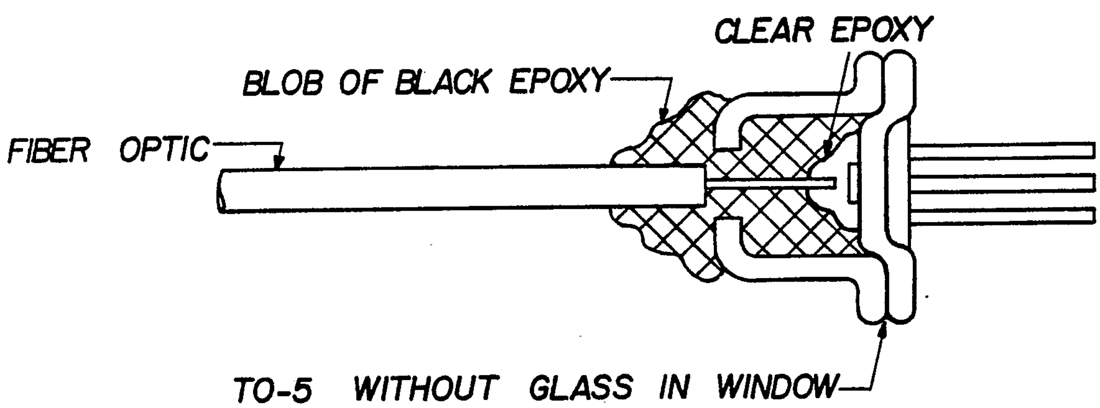

FIG. 2B (PRIOR ART)

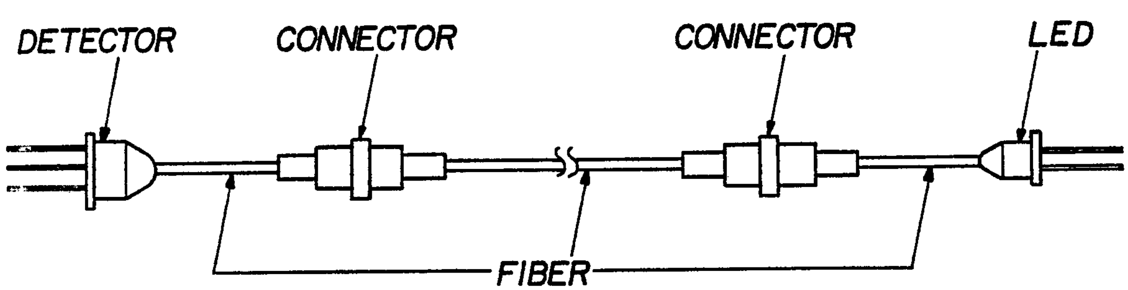

FIG. 2C (PRIOR ART)

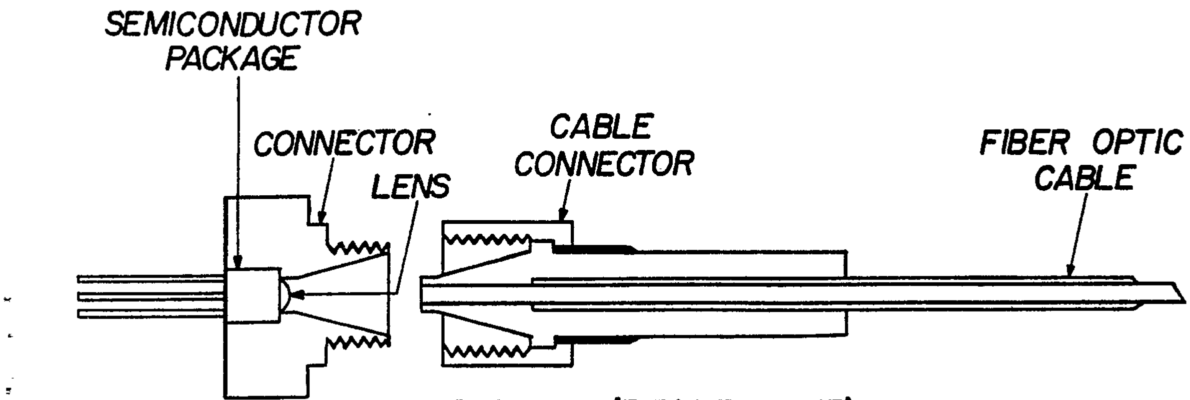

FIG. 2D (PRIOR ART)

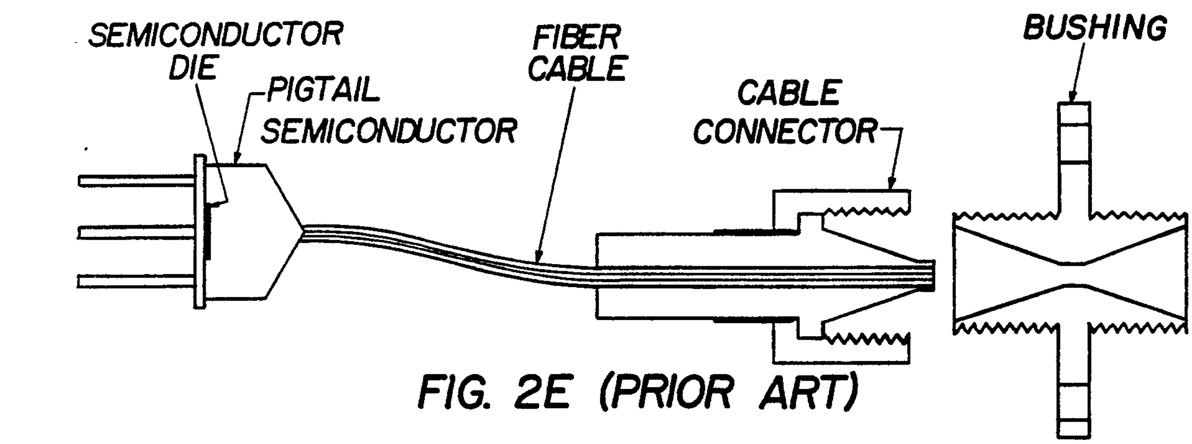

FIG. 2E (PRIOR ART)

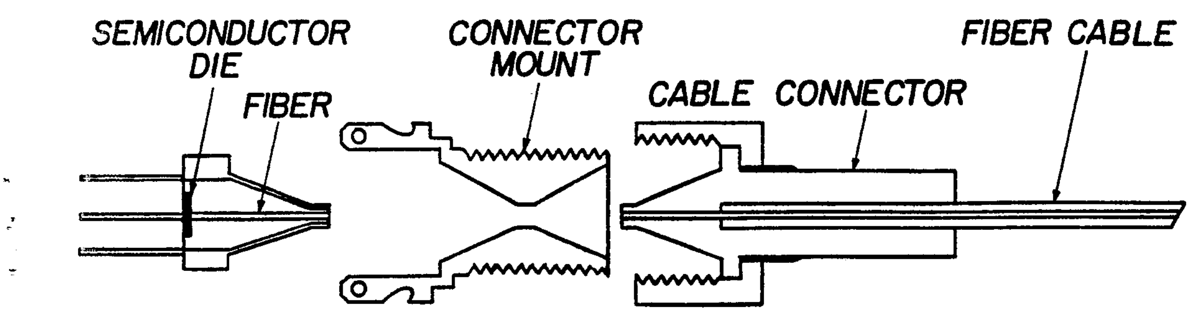

FIG. 2F (PRIOR ART)

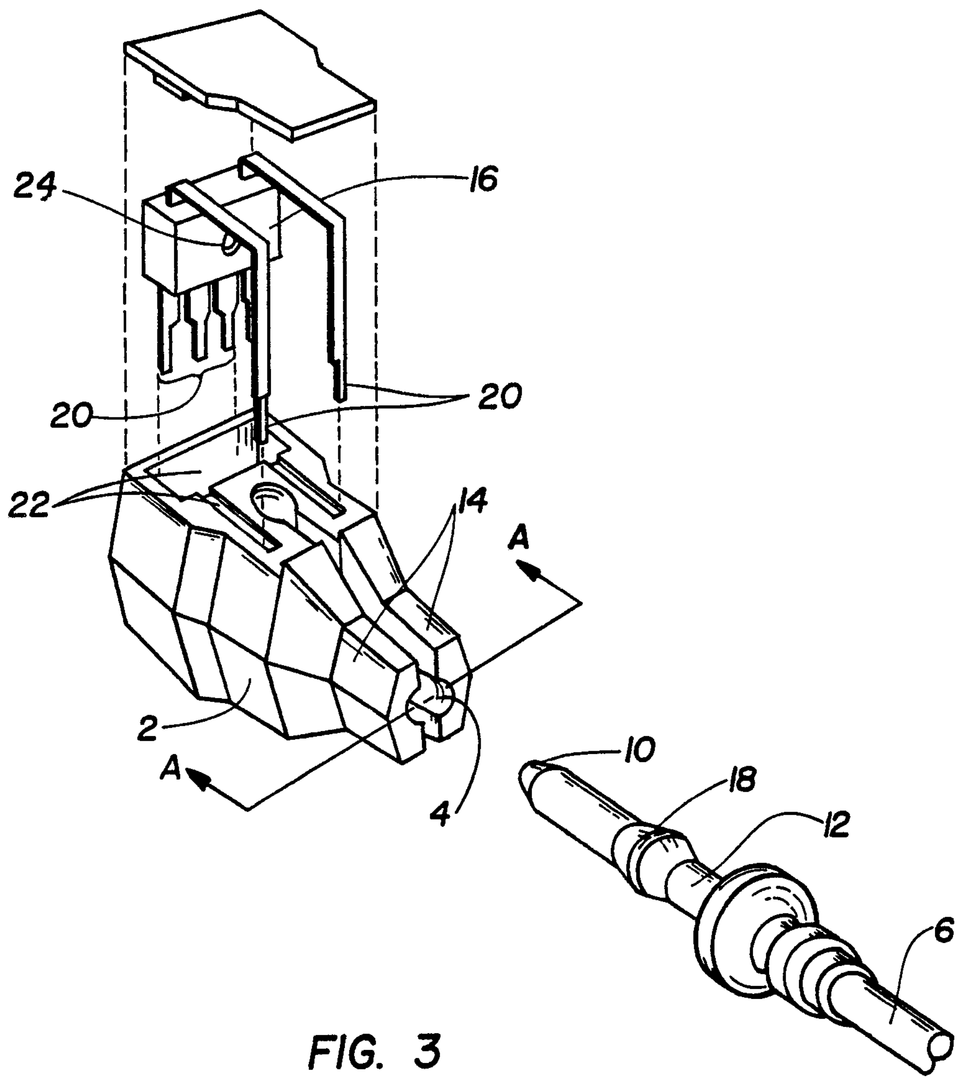

FIG. 3

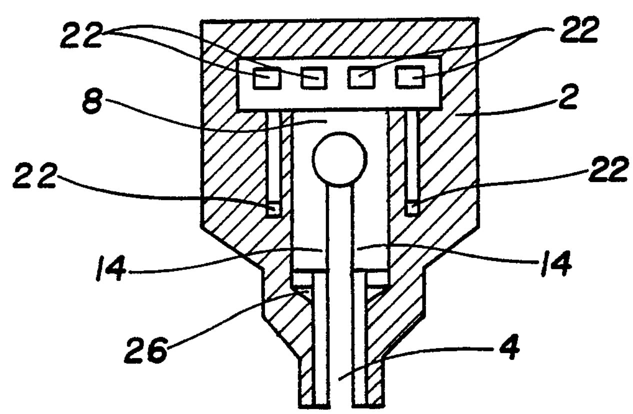

FIG. 4

SPECIFICATION

Housing for Interfacing a Semiconductor Device With a Fiber Optic Cable

This invention is concerned with improvements in or relating to apparatus for interfacing a semiconductor device with a fiber optic cable.

Interfacing a highly precise fiber optic cable to a semiconductor device requires special attention in order to minimize any loss of light being transmitted between the semiconductor device and the fiber optic cable. For example, if there is an angular misalignment between the cable and device as shown in Figure 1A, there is a loss of transmitted light. Losses in transmission can also occur when the fiber optic cable is axially misaligned with the semiconductor device as shown in Figure 1B. Additionally, there are Fresnel losses due to reflection when light flux passes from one material to another, when the materials have different indices of refraction. Thus, when light is transmitted from the semiconductor device to the fiber optic cable, it might pass through epoxy on the device and through air before entering the fiber cable. In an exemplary case where the semiconductor device is taken as gallium arsenide phosphide (GaAsP), the Fresnel loss may be calculated by:

$$T=\frac{4}{2+n_2/n_1+n_1/n_2} \qquad (1)$$

where T represents the transmissivity between two media with indices of refraction n_1 and n_2. The index of refraction for GaAsP is 3.6; for clear epoxy, n is 1.5; and for a fiber optic cable, n is 1.5. The loss in transmission, according to Equation (1), can thus reach approximately 1.2 dB for this typical case.

In addition to the Fresnel losses when the light transmission passes through different media, the amount of axial separation of the cable from the semiconductor device itself (shown in Figure 1C) contributes some loss.

To overcome these problems, several approaches have been advanced in the prior art:

The fiber optic cable is made an integral part of the semiconductor device, as illustrated in Figure 2A. This semiconductor cable combination, generally referred to as a "pig-tail" construction, is dropped into a housing and clamped in place within the housing. This method assures proper alignment and minimal Fresnel losses. The main disadvantage with this approach, as with all "pig-tail" constructions, is the fragility inherent when a delicate cable protrudes from an equally delicate semiconductor device. This necessitates special handling and greatly inhibits the flexibility in mechanical designs.

Another prior art device of the pig-tail type is shown in Figures 2B and 2C. Basically, a fiber optic cable is made to abut a semiconductor device and the combination is epoxied to form an integral unit. In this way, Fresnel losses are minimized. However, losses from mechanical misalignment can nevertheless occur during the epoxying process unless stringent control in assuring proper alignment is enforced.

Yet another prior art device uses a similar pig-tail type of construction with its semiconductor device interfacing with a cable. But it has the further disadvantage of requiring the user to prepare the cable for use by inserting it into its kit for a 3-step polishing process and a 2-step connecting procedure.

Another method typically adopted in the prior art to overcome transmission loss problems is the use of a screw-type mechanical connector to interface, or mate, the cable with the semiconductor device. Typical connectors are shown in Figures 2D, 2E, and 2F. This approach has its own disadvantages. Because the cable must be screwed into a connector, cable connection is difficult, especially if the area in which the semiconductor device to be mated with the cable is limited. Further, because the cable can be partially separated from the connector itself by an excessive tractive axial force, the partial separation and the resultant loss in light transmission would be difficult to ascertain immediately. In other words, the resultant degradation may exist for a long period before this cause is found and corrected.

The present invention provides apparatus for interfacing a semiconductor device with a fiber optic cable, the apparatus comprising an orifice for insertion of a fiber optic cable therein; and retaining means adjacent to said orifice for exerting a spring-like force on said fiber optic cable to axially align and detachably lock said cable into said housing in a position such that it can be interfaced with the semiconductor device.

In apparatus as set forth in the last preceding paragraph it is preferred that said retaining means is configured to mate with a fiber optic cable terminating in a sleeving having a ridge.

In apparatus as set forth in either one of the last two immediately preceding paragraphs, it is preferred that said housing has a semiconductor device affixed therewithin, said semiconductor device comprising an opening for receiving said fiber optic cable.

In apparatus as set forth in the last preceding paragraph, it is preferred that said semiconductor device further comprises a lens within said opening for focussing light passing between said fiber optic cable and semiconductor device.

An apparatus as set forth in the last preceding paragraph may further comprise a plurality of leads protruding from said semiconductor device and extending from said housing means to provide attachment leads for said housing means.

Many of the problems involved with interfacing a semiconductor device with a fiber optic cable are eliminated by a device in accordance with the preferred embodiment of the present invention. In particular, a housing is provided to axially align a fiber optic cable with a semiconductor device with minimal separation. In accordance with the preferred embodiment of the invention, a fiber optic cable inserted into the housing is locked in by a spring-like force. Thus, the cable can be simply inserted or detached by application of a predetermined force. Once locked into place in the housing, the cable is self-aligned to minimize misalignment losses. Since no screw-type mechanical connectors are involved, there is no need to provide space for insertion and manipulation of a screwing tool; the size of the device may therefore be minimized. Also by not having a pig-tail construction, special handling requirements are eliminated. Furthermore, the danger of damage from either the fragility of a pig-tail construction or the rigidity of a connector construction is eliminated.

There now follows a detailed description, which is to be read with reference to the accompanying drawings, of prior art constructions and of apparatus according to the inventions; it is to be clearly understood that the illustrated apparatus has been selected for description to illustrate the invention by way of example and not by way of limitation.

In the accompanying drawings:—

Figures 1A, 1B and 1C show the transmission of light when a fiber optic cable and a semiconductive device are improperly aligned (A and B) or exclusively separated (C);

Figures 2A, 2B, 2C, 2D, 2E and 2F show various interfacing schemes in the prior art;

Figure 3 shows the preferred embodiment in accordance with the present invention; and

Figure 4 shows the A—A cross-section view of the embodiment of Figure 3.

Referring to Figures 3 and 4, a housing 2, typically molded from some resin-like acetal material, contains a semiconductor device 16 and has an orifice 4 adapted to accept a fiber optic cable 6 inserted therein. The semiconductor device 16 is fabricated with a conical depression or opening 24 to further receive the fiber optic cable 6. The housing orifice 4 is constructed so that when the cable 6 is inserted, the cable 6 is automatically axially aligned. This is accomplished by having an opening 8 adapted to allow the conical depression 24 on the semiconductor device 16 to receive a corresponding conical part 10 on the fiber optic cable. This conical part 10 may be in a protective sleeving 12 attached to the end of the cable. The cable 6 is locked in place by means of a mating section 14 adjacent the orifice 4, which exerts a spring-like force against the cable 6 either directly or on the protective sleeving 12 of the cable. The mating section 14 also forces the fiber optic cable 6 to abut the semiconductor 16 for a more precise alignment even when the semiconductor device 16 is not rigidly fixed in relation to the housing 2. For example, if a ridge 18 is included on the protective sleeving 12, the spring-like force radially exerted on the cable sleeving can be translated into an axial force by a corresponding housing ridge 26 to aid in abutting the cable directly against the semiconductor device 16. Locking the cable solely with the spring-like force also allows the cable to be detached and removed simply. This prevents damage to the cable 6 and the semiconductor device 16, should an excessive tractive force be exerted on the connected fiber optic cable 6. When this happens, the cable 6 merely disengages from the housing 2.

In the preferred embodiment, the housing 2, because of its small size, which is typically only slightly larger than the semiconductor device it houses, can be firmly attached to electrical components, e.g. printed circuit boards, using electrical leads 20 of the semiconductor device 16 itself. Cavities 22 to effect this attachment are fabricated in the housing so that when the semiconductor device is inserted into the housing, the device leads protrude from the cavities. The leads, when fixed to an external surface, firmly fix the housing to that surface. This combination of a locked cable with a firmly attached housing holding a semiconductor device effects the mating of cable and device with substantially all the advantages of a pig-tail or connector type of construction but displaying none of its disadvantages.

To maximize the effectiveness of the housing in accordance with the invention, the semiconductor device 16 may also include a lens fabricated onto the device itself within the conical depression, or opening 24. When such a lens is present, most of the transmitted light can be effectively focussed from the semiconductor device 16 onto the fiber optic cable 6, or vice versa.

Claims

1. Apparatus for interfacing a semiconductor device with a fiber optic cable, the apparatus comprising:

an orifice for insertion of a fiber optic cable therein; and

retaining means adjacent to said orifice for exerting a spring-like force on said fiber optic cable to axially align and detachably lock said cable into said housing in a position such that it is can be interfaced with the semiconductor device.

2. Apparatus according to claim 1 wherein said retaining means is configured to mate with a fiber optic cable terminating in a sleeving having a ridge.

3. Apparatus according to either one of claims 1 and 2 wherein said housing has a semiconductor device affixed therewithin, said semiconductor device comprising an opening for receiving said fiber optic cable.

4. Apparatus according to claim 3 wherein said semiconductor device further comprises a lens within said opening for focussing light passing between said fiber optic cable and semiconductor device.

5. Apparatus according to claim 4 and further comprising a plurality of leads protruding from said semiconductor device and extending from said housing means to provide attachment leads for said housing means.

6. Apparatus for interfacing a semiconductor device with a fiber optic cable, substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

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