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(71) Applicant: **DOSEVUE NV** [BE/BE]; Bioville Campus,
Agoralaan A bis, 3590 Diepenbeek (BE).

(72) Inventors: **D'AGOSTINO, Emiliano**; Bioville Campus,
Agoralaan A bis, 3590 Diepenbeek (BE). **PLESU, Adrian**;
Bioville Campus, Agoralaan A bis, 3590 Diepenbeek (BE).

(74) Agent: **BRANTSANDPATENTS BVBA**; Pauline Van
Pottelsberghelaan 24, 9051 Ghent (BE).

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(54) Title: CONNECTING DEVICE FOR FIBER OPTICS

(57) Abstract: The current invention concerns a hermaphroditic device (1) for connecting axially aligned elements, suitable for connecting fiber optics, comprising a body (3), a axially aligned protruding external screw threaded cylinder (2) at one axial end and a sunken axially aligned annular cavity (4) at the other axial end.

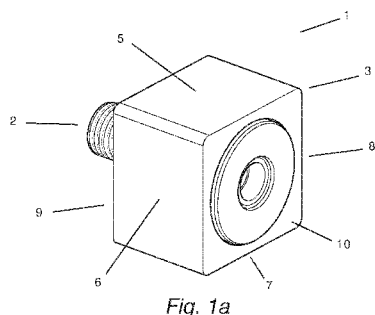


Fig. 1a

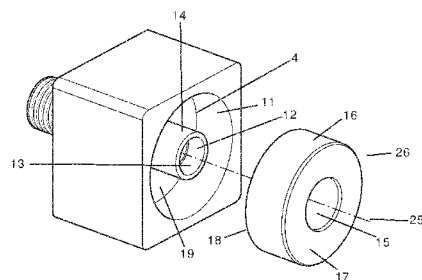


Fig. 1b

CONNECTING DEVICE FOR FIBER OPTICS

TECHNICAL FIELD

- 5 The present invention relates to a device for connecting axially aligned elements and, in particular provides a hermaphroditic device for connecting axially aligned elements, suitable for connecting fiber optics.

BACKGROUND

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Cable connections are commonly seen in the industry for the purpose of power and information transmission. In the last century, optical fibers, which are used as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, are greatly developed and widely used in industry. They allow transmission over longer distances and at higher bandwidths (data rates) than electrical cables. Fibers are also used for illumination and imaging, and are often wrapped in bundles so they may be used to carry light into, or images out of confined spaces, as in the case of a fiberscope. Specially designed fibers are also used for a variety of other applications, some of them being fiber optic sensors and fiber lasers.

20

For instance, radiation dosimetry deals with methods for quantitative determination of energy deposited in a given medium directly or indirectly by ionizing radiations. Optical fibers offer a solution for in vivo radiotherapy dosimetry with many advantages over currently employed clinical dosimetry systems. An optical fiber radiation dosimeter is a photonic system based on optical fiber technology, whereby radiation introduces a modification or modulation in some of the characteristics of the optical signal. The optical fibers can be directly affected by the radiation, in which case it is called an intrinsic sensor, or it can be used for the sole purpose of transmitting the optical signal, and is known as an extrinsic sensor.

30

As widely used as optical fibers, an optical fiber connector is naturally desired. The mechanism of an optical fiber connector assembly precisely interconnects two optical fiber end surfaces that need to be connected, so that photon energy output by a transmit optical fiber can be coupled to a receive optical fiber to an utmost extent.

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The first widely used connector in the data world, at least in North America, was the Snap and Twist (ST). Nowadays, one of the widely used optical fiber connector or connecting meanings is a subminiature assembly (or SMA), designed by Amphenol in CT (computed tomography) as a variation of their coaxial electrical connect. A couple of disadvantages could, however, still be drawn: it is not friendly to terminate in the field; if connectors are not polished within the long side of the length tolerance, one could crash another connector (damage the glass and the polish) or worse, a device like an LED, laser or detector; the polishing process itself is markedly different from those of standard communications connectors, and therefore requires some different procedures, tools and films, in order to produce acceptable assemblies.

A first challenge for a connector is the reliability. EP 3214471 discloses an optical fiber connector with one end fastened to the flat drop cable and a thread connection with hook grooves at the other end.

Moreover, though great attention has been drawn on minimizing the effort on assembling the connector onsite, it often still requires certain operation. There are many instances where it would be desirable to be able to magnetically connect both electrical conductors and optical waveguides in a coaxial cable. As disclosed in CA 2320684, using an O-ring sleeve to magnetically connect two coaxial cable greatly improves the operational ease.

Furthermore, the positioning of a connector is often neglected, as it normally lies with (or in between) the cables without a specific fixed manner. As such it might cause unnecessary movements of cables since it is normally heavier than a cable in terms of weight per unit.

Current gap for designing a device for connecting axially aligned elements is that it should i) offer a reliable connection; ii) minimize the effort to assemble cables in the connector; iii) offer a secured solution to fix the connector as not weltering the cables and further mulling the operation environment.

US 8 834 037 discloses a hermaphroditic connector assembly for fiber optic cables. Such connector is not suited for use during therapy, in particular radiotherapy. Furthermore, such connector is not suited for one-hand plug in of an optic fibre.

US 2001 0 007 641, EP 1 586 921, US 2016 0 310 234 and CN 205 691 817 disclose connectors, which may be used in connecting fibre optic cables. However, none of these connectors are suited for use during therapy, in particular radiotherapy.

5 SUMMARY OF THE INVENTION

In a first aspect, the invention provides a hermaphroditic device for connecting axially aligned elements, suitable for connecting fiber optics, in a subject in need thereof, the device comprising:

- 10 - a body;
- a axially aligned protruding external screw threaded cylinder at one axial end;
- a sunken axially aligned annular cavity at the other axial end.

15 The inventors have thus realized a device which is suitable for connecting two fiber optics, wherein one end is connected with screw thread and the other end is pluggable, which improves the operation effectivity in use. Furthermore, said device is suitable to be fastened onto a fixed position using magnetic force.

20 In a second aspect, the present invention provides a kit for assembling a monitoring system for the matter of in-vivo dosimeter in radiotherapy, in a subject in need thereof, the kit comprising:

- a monitoring device for receiving and analysing the radiation data from the end tips of fiber optics;
- 25 - a plurality of said connecting devices;
- a plurality of in-vivo dosimeters applied in a subject;
- a plurality of pre-protected optical extensions linking the said monitoring device and said connecting device;
- a plurality of fiber optics linking the said connecting device sand said
- 30 dosimeter.

In a third aspect, the present invention provides an assembly according to claim 14.

In a fourth aspect, the present invention pertains to a use according to claim 15.

DESCRIPTION OF FIGURES

Fig. 1A shows schematically a perspective view of the device when all components are assembled. **Fig. 1B** shows schematically a perspective view of the device when the ring cylindered sleeve is separated from the body along the axially centerline.

Fig. 2A shows schematically a perspective view of the device of Fig. 1A from a topical view of the pluggable port end. **Fig. 2B** shows schematically a perspective view of the device of Fig. 1A from a topical view of the front. **Fig. 2C** shows schematically a perspective view of the device of Fig. 1A from a topical view of the protruding end.

Fig. 3 shows schematically a perspective view of the device of Fig. 1A from a cross-section view marked in Fig. 2A (A-A).

Fig. 4A shows schematically a perspective view of the device of Fig. 1A and two ends (or fiber collectors) need to be connected. **Fig. 4B** shows schematically a perspective view of said device and ends in connected state.

DETAILED DESCRIPTION OF THE INVENTION

The present invention concerns a connecting device suitable for fiber optics in radiotherapy.

Unless otherwise defined, all terms used in disclosing the invention, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.

Device for connecting axially aligned elements

In a first aspect, the invention provides a hermaphroditic device for connecting axially aligned elements, suitable for connecting fiber optics, in a subject in need thereof, the device comprising:

- a body;
- a axially aligned protruding external screw threaded cylinder at one axial end;
- a sunken axially aligned annular cavity at the other axial end.

The inventors have thus realized a device which is suitable for connecting two fiber optics, wherein one end is connected with screw thread and the other end is pluggable, which improves the operation effectivity in use. Furthermore, said device is suitable to be fastened onto a fixed position using magnetic force.

5

In a preferred embodiment (Fig. 1A), the present invention provides a connector (1) according to the first aspects of the invention, comprising a body (3), a axially aligned protruding cylinder (2) at one axial end, a sunken axially aligned annular cavity (4) at the other axial end.

10

In a preferred embodiment, the body (3) is a cubic shape and the outer surface (10) that is orthogonal to the centerline (25) is a square. Four outer surface (5, 6, 7, 8) of the body (3) are flat and magnetized. As shown in Fig. 1B, the sunken cavity (4) further comprises a ring cylindered sleeve (26) and a paired thin wall sleeve (12) that matches the inner surface (15) of said ring cylindered sleeve (26). When assembled (Fig. 1A, Fig. 3), the inner flat surface (19) of said cavity (4) directly contacts the outer flat surface (18) of said ring sleeve (26). The same applies to the inner ring surface (11) of said cavity (4) and outer ring surface (16) of said ring sleeve (26). The same also applies to the outer surface (14) of said thin wall sleeve (12) and the inner surface (15) of said ring cylindered sleeve (26). It requires all mentioned surfaces in said cavity (4) and said ring cylindered sleeve (26) to be smooth. The sunken annular cavity (4) is, in a subject of matters, to serve as a pluggable port using magnetic force. Thus the inner surface (13) of said thin wall sleeve (12) is magnetized, by the fact that a magnet is glued in the annular cavity (not shown in Fig. 1B).

25

In a preferred embodiment, the body (3) is solid integrated with a axially aligned protruding cylinder (2), which comprises a SMA-905 screw thread (27) on the outer surface (Fig. 2B). Said protruding cylinder (2) comprises a cylindrical hollow (20) inside that also requires a smooth surface (21). Said inner surface (21) of said cylindrical hollow (20) is of different diameters to the inner surface (13) of said thin wall sleeve (12). Said inner surfaces (21 and 13) are connected using a trapezoidal table, making the connector (1) is hollow along the centreline (25) from one end to the other. Thus it leaves the space for two fiber optics to be connected inside the connector (1).

35

In a preferred embodiment, the edges (24) of said body (3) and the edges (23) of said ring cylindered sleeve (26) are rounded to be hand-touch friendly and further benefiting the operation process when in use.

5 In a preferred embodiment, the axially aligned protruding cylinder (2) is connected with a paired inner-screw-threaded fiber optic collector (29), as shown in Fig. 4a. The inner screw thread is coupling with the outer screw thread on the surface of said protruding cylinder (2). As further shown in Fig. 4a, the sunken annular cavity (4) is connected with a paired pluggable fiber optic collector (28). When in use, the
10 outer surface of said collector (28) is fastened onto the inner surface (13) of the thin wall sleeve (12) by magnetic force.

The phrase "hermaphroditic" used in this invention only refers to the fact that said connector (1) contains a axially aligned protruding end (2) and a cavity end (4). It
15 however, does not imply that the protruding end (2) could match the cavity end (4) nor using the same coupling at both ends (i.e. protruding end (2) of a connector (1) cannot be inserted to the cavity end (4) of another same connector). In present invention, said two ends (2 and 4) need to couple with different fiber optic collectors (28 and 29), as shown in Fig. 4.

20

One practical application of present invention in a preferred embodiment is in radiotherapy. Typically a monitoring device is positioned outside the sterile surgery room, an optical extension (e.g. 10m) is linking the monitoring device and the near
25 of surgery table. As fiber cables are pricy, especially a long one such as an optical extension. A pre-protection is usually applied to said optical extension, such as plastic coating. The optical extension is usually fixed to avoid disturbance during the radiotherapy. On the other hand, in order to apply the dosimeter in possibly anywhere of a subject, the fiber optic (typically 1m) linked to the dosimeter needs to be flexible and easy to apply on a subject. Thus said fiber extension and fiber
30 optic are connected by a connector (1). Typically, the proximal end of fiber extension is integrated in an inner-screw-threaded fiber optic collector (29), and said collector (29) is screwed with said protruding end (2) of said connector (1). Once screwed, the surgeon/nurse can easily fasten said connector (1) on a metaling bed. The proximal end of fiber optic linked to the dosimeter is integrated in a pluggable fiber
35 optic collector (28). The surgeon/nurse can easily plug said collector (28) in the connector (1) with one hand. As the plugging is using magnetic force, it

automatically ensures the collector (28) in correct position and securely connected during the treatment.

Kit for assembling a monitoring system for the matter of in-vivo dosimeter in radiotherapy

In a second aspect, the present invention provides a kit for assembling a monitoring system for the matter of in-vivo dosimeter in radiotherapy, in a subject in need thereof, the kit comprising:

- 10 - a monitoring device for receiving and analysing the radiation data from the end tips of fiber optics;
- a plurality of said connecting devices;
- a plurality of in-vivo dosimeters applied in a subject;
- a plurality of optical extensions linking the said monitoring device and
15 said connecting device;
- a plurality of fiber optics linking the said connecting device sand said dosimeters.

A basic working scope of said kit is disclosed in previous paragraphs, in case of a
20 single channel does monitoring in radiotherapy. When multiple monitoring channels are needed during a radiotherapy, a plurality of a connector (1) according to the first aspects of the invention are needed. In a preferred embodiment, a monitoring device can host up to 4 channels, which requires 4 sets of an optical extension (integrated with a collector), a connector (1), a fiber optic (integrated with a
25 collector) and a dosimeter. The surface (5, 6, 7, 8) of said connector (1) is magnetized, thus the connectors could be fastened to each other and onto the metaling bed. An alternative is to build a housing that can host a plurality of said connector (1), wherein said housing is fastened onto a metaling bed. Such that a plurality of optical cables are organized in order and will not cause a mess, and the
30 collected dose information are easy to categorize.

In cases that more than 4 channels need to be applied during a radiotherapy, a monitoring device with more channels could be applied. Alternatively, a plurality of
35 current monitoring device could be applied, with a careful calibration between different monitoring devices. The fiber cables and connectors could be applied same as above.

Preferably, said kit is configured for using a device according to the first aspect of the invention.

Using the preferred embodiments disclosed in this document to summarize the advantages of current invention in first aspect – the connector and in second aspect – the kit (the monitoring system), it is that, in a radiotherapy, i) a monitoring system offers a reliable connection for data obtaining; ii) the fiber optics is organized in order and not disturb the surgery operation; iii) the optical extension stays fixed and is not forced to reach the desired location; iv) the connector keeps the optical extension fixed to the near of surgery table, and the connector can be fastened in any suitable location on the metaling surgery bed; v) the plug-in operation of the fiber optic linking the dosimeter is a single hand movement; vi) the fiber optic linking the dosimeter is flexible and adaptable for anywhere in a subject; vii) the fiber optic linking the dosimeter is replaceable in case of need; viii) it is possible to apply multiple channels without interfering the operation environment or adding extra work for the surgeon/nurse.

In a third aspect, the present invention provides an assembly for the matter of in-vivo dosimeter in radiotherapy, preferably in a subject in need thereof, the assembly comprising a monitoring device for receiving and analysing radiation data from an end tip of a fiber optic, a connecting device according to a first aspect of the invention, a dosimeter, a pre-protected optical extension linking said monitoring device and said connecting device and a fiber optic linking the connecting device and said dosimeter.

In a fourth aspect, the present invention pertains to a use of the hermaphroditic device according to a first aspect of the invention, a plurality of device according to a first aspect of the invention, the kit according to a second aspect of the invention or the assembly according to a third aspect of the invention, for radiotherapy, preferably for in vivo dosimetry during radiotherapy.

Both the protruding external screw and the annular cavity are axially aligned. Upon connecting a fibre optic to both the external screw and the cavity, both fibre optics will be aligned with respect to each other. As a consequence, a centre optical waveguide of a first of these fibres will be optically connected to a centre optical waveguide of a second of these fibres. Such configuration thus allows proper alignment of both fibres and consequently also a proper optical signal transmission.

According to a preferred embodiment, the sunken axially aligned annular cavity comprises a ring cylindered sleeve forming a pluggable port. Said cavity comprising an inner ring surface. Said ring cylindered sleeve comprising an outer ring surface. When assembled, the inner ring surface of said cavity preferably contacts the outer
5 ring surface of said ring cylindered sleeve. Such configuration allows for a proper alignment of two fibre optics. Furthermore, such configuration allows for a tight fit between a fibre optic and the annular cavity via the cylindered sleeve.

According to a preferred embodiment, the cavity comprises a ring cylindered sleeve
10 and a paired thin wall sleeve that matches the inner surface of said ring cylindered sleeve. When assembled, the inner ring surface of said ring cylindered sleeve preferably contacts the outer flat surface of said thin wall sleeve. Such configuration allows for a further improved alignment of two fibre optics. Furthermore, such configuration allows for a further improved fit between a fibre optic and the annular
15 cavity. Preferably, the thin wall sleeve is an integrated thin wall sleeve matched with the inner surface of said ring cylindered sleeve.

Preferably, the thin wall sleeve is magnetic or magnetized. Such configuration allows fastening an outer surface of an end of a collector comprising a ferromagnetic
20 material to the inner surface of the thin wall sleeve by magnetic force. Furthermore, such configuration allows for an easy one-hand plug in of the collector. Furthermore, such configuration allows for a highly reproducible connection between the cavity and the collector. Preferably, at least a part of the annular cavity is magnetic and at least a part of the thin wall sleeve substantially comprises or consists of a
25 ferromagnetic material. Such thin wall sleeve will thus be magnetized by the magnetic part in the annular cavity and will consequently allow for a magnetic plug-in of a collector. Preferably, said thin wall sleeve is an integrated thin wall sleeve matched with the inner surface of said ring cylindered sleeve.

Preferably, an annular part of the cavity is magnetic. More preferably, the inner
30 surface of the pluggable port end of the device is magnetic. Such configurations allow for an even magnetisation of the thin wall sleeve. Consequently, the reproducibility of the connection between an optic fibre and the cavity is even further improved.

35 Preferably, an outer sidewall portion of the ring cylindered sleeve comprises a non-magnetic or non-ferromagnetic material. When the ring cylindered sleeve is plugged

in, the outer sidewall portion of said sleeve is provided along an outer surface of the device. Such configuration further improves easy one-hand plug in of the collector as a ferromagnetic end of the collector will interact with the thin walled sleeve instead of the outer sidewall portion of the ring cylindered sleeve and/or any other
5 nearby magnetic or magnetized portion of the device.

According to a preferred embodiment, the protruding end is solid integrated with the body of the device. Such configuration prevents excessive stress on the protruding end. The protruding end of the device might be subjected to frequent
10 jerking motions due to for example a moving patient or apparatus during therapy. Such jerking motion may misalign a not solid integrated protruding end of the device. As a consequence, signal transition between two optic fibres might be hampered. In order to prevent such misalignment, the protruding end should thus be solid integrated with the device body as a jerking movement will consequently
15 move the entire device instead of the protruding end.

According to a preferred embodiment, the cross section orthogonal to the axial centreline of the body is a square. According to a preferred embodiment, the body is of a cubic shape. Such configurations allow easy stacking of a plurality of devices
20 in a kit or during storage. Furthermore, such configurations allow for an easy grouping of a plurality of devices during treatment. Grouping devices during treatment improves organisation and overview for an operator during therapy. Preferably, the axially aligned protruding external screw threaded cylinder and the sunken axially aligned annular cavity are provide at opposite plane surfaces of a
25 cubic shaped body.

Preferably, an outer surface of the body is magnetic. Preferably, said outer surface corresponds with a plane surface of a cubic shaped body. Preferably, said outer surface corresponds with a plane surface of a cubic shaped body not provided with
30 the protruding cylinder or the annular cavity. Such configurations allow for a magnetic grouping of a plurality of devices. Furthermore, such configurations allow magnetic connection of the device to a ferromagnetic bed.

Preferably, two or more outer plane surfaces of a cubic shaped body are magnetic.
35 More preferably, three or more outer plane surfaces of a cubic shaped body are magnetic. More preferably, four or more outer plane surfaces of a cubic shaped body are magnetic. Preferably, said magnetic outer surfaces correspond with a plane

surface of a cubic shaped body not provided with the protruding cylinder or the annular cavity. Most preferably, the entire outer surface of said body is magnetic. Above configurations allow both a magnetic grouping and a magnetic connection to a ferromagnetic bed. In particular, above configurations allow for an easy parallel
5 configuration of the axes of a plurality of devices. Consequently, such configurations further improve organisation and overview for an operator.

According to a preferred embodiment, at least two opposite outer surfaces of the body of the device comprise opposite magnetic poles. The orientation of these
10 opposite poles allows for a structured grouping of a plurality of devices. Preferably, at least two opposite magnetic outer plane surfaces of a cubic shaped body of the device comprise opposite magnetic poles. Such configuration is suited for structured grouping of a plurality of devices. In particular, such configuration is suited for an easy parallel grouping of a plurality of devices such that the axes of the plurality of
15 devices are provided in a parallel configuration. Consequently, such configuration further improves organisation and overview for an operator during therapy.

The inventors furthermore note that all of the above constructional details aid a one-handed plug-in of a collector in the cavity of the body of the device. Such one-
20 handed plug-in substantially improves use during therapy. In the case of for example radiotherapy such as brachytherapy, an assembly for in-vivo dosimeter during said radiotherapy should be formed by an operator. A first half of this assembly is formed by the operator by screwing a first collector connected to a monitoring device to the external screw on the body of the device. This first half of
25 the assembly should be formed prior to therapy. Ideally, multiple of these first-half assemblies are formed prior to therapy. A second half of this assembly should be formed by the operator when a patient is present. Therefore, it is a huge benefit if said operator has free hand, which he/she can use for other activities such as applying dosimeters to the body of the patient. A one-handed plug-in of a second
30 collector in the cavity of the body of a device by an operator in order to complete each assembly, thus substantially improves use of the device during therapy.

The one-handed plug-in is facilitated at an overview-level and a device-level. In order to facilitate the one-handed-plug-in at an overview-level, the first-halves of
35 the assemblies should be organized and grouped in a fixed position by the operator. In order to be fixed and structurally grouped, each of the device bodies has a specific magnetic configuration, is cubic-shaped, etc. When overview is maintained over the

different first-half assemblies, an operator does not repeatedly needs to check which second collector should be connected to which device in order to complete each assembly. As a consequence, a one-handed plug-in of the second connectors to the devices is substantially facilitated. The one-handed plug-in is improved at a device-level by facilitating entrance of a tip end of a second collector in a cavity of the body of a device. This entrance is for example facilitated by magnetically coupling the tip end and the cavity. This magnetic coupling is further improved by providing the ring cylindered sleeve in the cavity as discussed hereabove.

It has to be noted that the preferred embodiment nevertheless is used to disclosed the present invention, it however, never restricts the scope of the invention, including but not restrict to: the using situations, the shape and material of the connecting device, the collectors paired with the connecting device, etc.

EXAMPLE

A preferred embodiment of the present invention is presented below. It is however clear that other embodiments can easily be contemplated within the scope of the invention. The presentation below should thus not be construed restrictive, but it should be realized that the skilled person will easily apply modifications to the presented example without reappraisal of the appended claims.

EXAMPLE 1

During Intra Operative Radiation Therapy (IORT) it is important to be able to perform real-time dosimetry in order to assess the dose really delivered to the patient and/or the remaining dose absorbed by the stopper after the treatment. Due to the particular conditions of this type of treatment, i.e. such treatment requires to be in sterile conditions in a surgery room. In most instances, during such therapy, multiple processes are under operation, which leaves no special care available for the use of devices. Thus, for the sake of stable data transfer and operation efficiency, it is fundamental to be able to manipulate the radiation detectors in a secured and easy manner.

In current system, the monitoring device is often put outside the surgery room. A rather long optical extension is linking the monitoring device to the near of surgery table. Surgeons and/or nurses will first need to connect a typically 1m long fiber

sensor to the optical extension, and second apply the fiber sensor to the patient. This connecting system i) ensures the flexibility of applying the 1m fiber sensor to the patient as the treatment requires; ii) protects the long optical extension from being damaged during the treatment due to the rather busy operation process. In currently commercially available connector systems (e.g. ST connectors), it is necessary to connect the fiber sensor (1m) to the optical extension, using both ends acting on a bayonet-like connection system (e.g. SMA). Furthermore, it is also necessary to tape the connector to the surgery table in order to avoid that the fiber sensor would move, once in the patient.

In a preferred embodiment, a kit of optical fiber based detectors comprising a monitoring device, a typically 10m long optical extension, an outer screwed fiber collector, and terminated by a magnetic connector. The connector has a magnetic outer surface, which allows it to be fastened to a metaling surgery table.

When ready for the irradiation, the surgeon/nurse, plugs the typically 1m long radiation sensor (in-vivo dosimeter) on the available end of the connecting device and applies the other end of the 1m long radiation sensor to the patient.

The connector end of the 1m long fiber is plugged in the magnetic connector. The strength of the local magnetic field in the connector will automatically make sure that the fiber sensor is brought in the right position, and secure the connection stable in order to follow radiation in real-time.

This simple operation can be executed with one hand and, as a result of the design of the magnetic connector, an extremely reproducible coupling is obtained. Moreover, the connector itself is fastened in a metaling surgery bed by magnetic force, leaves the cables around the surgery bed orderly.

In situations that more sensors need to be applied to a patient, it is also possible to have a plurality of above said kit. Current monitoring device is able to host maximum four fiber optics which requires up to four connectors to be fastened on the metaling bed. It is first possible to position the four connectors in a housing box fastened/integrated in the metaling bed, collecting all the connectors in one position and not disturbing the surgery table. Secondly, in a more preferred embodiment, the surfaces of the connector are all magnetized, which allows them to be fastened not only to the metaling bed but also to other connectors using magnetic force. It has to be noted that above situation also applies to two and three connectors. When

more than four fiber sensors are needed in a therapy, adding more said monitoring device and said kit would serve the purpose, when the synchronization between monitoring devices is being attentively taken care of.

CLAIMS

1. A hermaphroditic device for connecting axially aligned elements, suitable for connecting fiber optics, comprising a body, a axially aligned protruding
5 external screw threaded cylinder at one axial end and a sunken axially aligned annular cavity at the other axial end.
2. A device according to claim 1 wherein the sunken axially aligned annular cavity comprises a ring cylindered sleeve forming a pluggable port.
3. A device according to claim 1 or 2, wherein at least one surface of said device
10 is magnetic, preferably wherein at least one outer surface of the body is flat and/or magnetic.
4. A device according to any of the previous claims 1-3, wherein said protruding end is solid integrated with said body.
5. A device according to any of the previous claims 2-4, wherein said body
15 comprises an integrated thin wall sleeve matched with the inner surface of said ring cylindered sleeve.
6. A device according to any of the previous claims 1-5, wherein the cross section orthogonal to the axial centreline of said body is a square.
7. A device according to, to any of the previous claims 1-6, wherein said body
20 is of a cubic shape.
8. A device according to, to any of the previous claims 1-7 wherein said body comprises an inner and outer surface and wherein the outer surface of said body is magnetic.
9. A device according to claim 8, wherein the opposite two outer surfaces are
25 with opposite magnetic poles.
10. A device according to any of the previous claims 1-9, wherein the inner surface of the pluggable port end is magnetic.
11. A device according to any of the previous claims 1-10, whereby two fiber optics are interconnected and whereby one fiber optic is connected with a
30 monitoring device for radiation data analysing and the other fiber optic is connected with an in-vivo dosimeter.
12. A plurality of device according to any of the previous claims 1-11 which are magnetically grouped.
13. A kit for assembling a monitoring system for the matter of in-vivo dosimeter
35 in radiotherapy, comprising: a monitoring device for receiving and analysing the radiation data from the end tips of fiber optics, a plurality of said connecting devices according to any of the claims 1-11, a plurality of in-vivo

dosimeters applied in a subject, a plurality of pre-protected optical extensions linking said monitoring device and said connecting device, a plurality of fiber optics linking the said connecting device and said dosimeter.

14. An assembly for the matter of in-vivo dosimeter in radiotherapy, comprising:
- 5 a monitoring device for receiving and analysing radiation data from an end tip of a fiber optic, a connecting device according to any of the claims 1-11, a dosimeter, a pre-protected optical extension linking said monitoring device and said connecting device and a fiber optic linking the connecting device and said dosimeter.
- 10 15. Use of the hermaphroditic device according to any of preceding claims 1-11, the plurality of device according to preceding claim 12, the kit according to preceding claim 13 or the assembly according to preceding claim 14, for radiotherapy, preferably for in vivo dosimetry during radiotherapy.

FIGURES

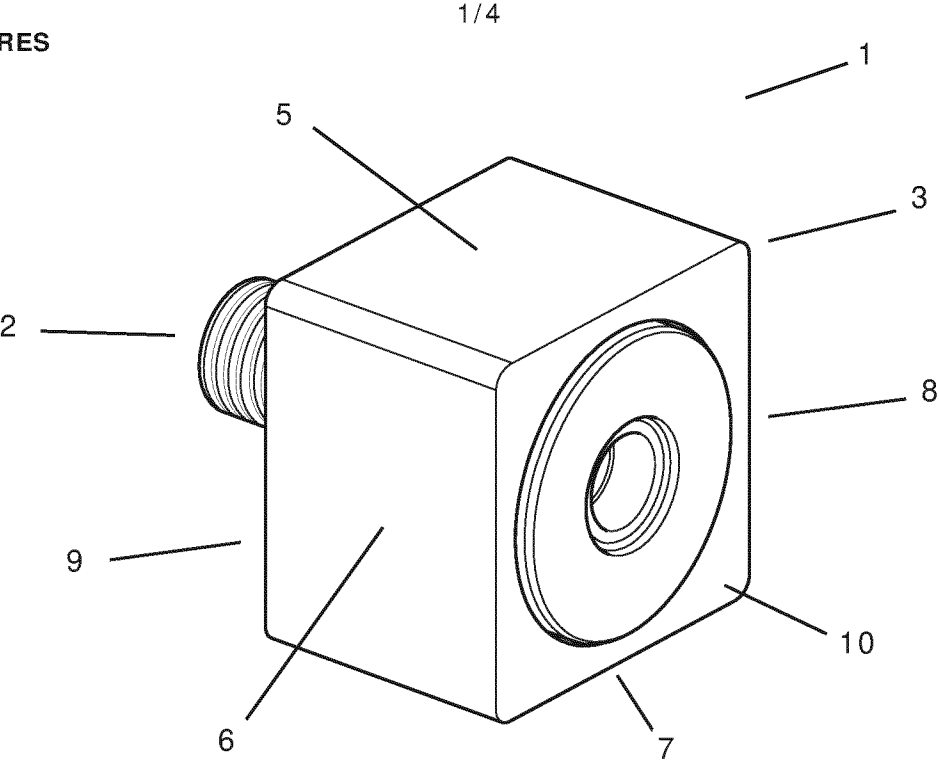


Fig. 1a

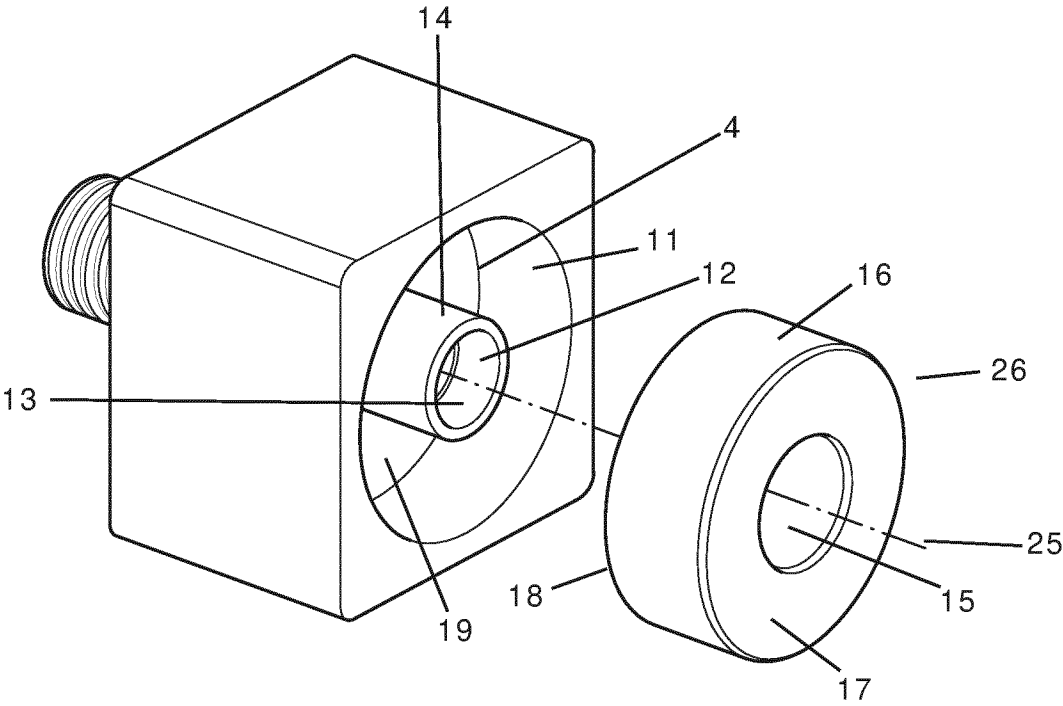
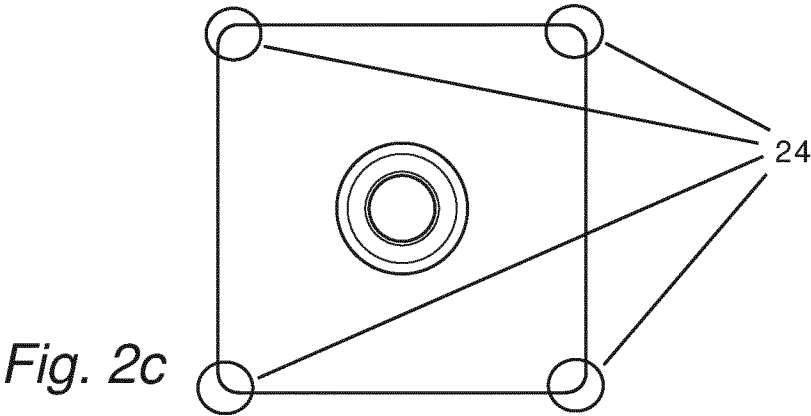
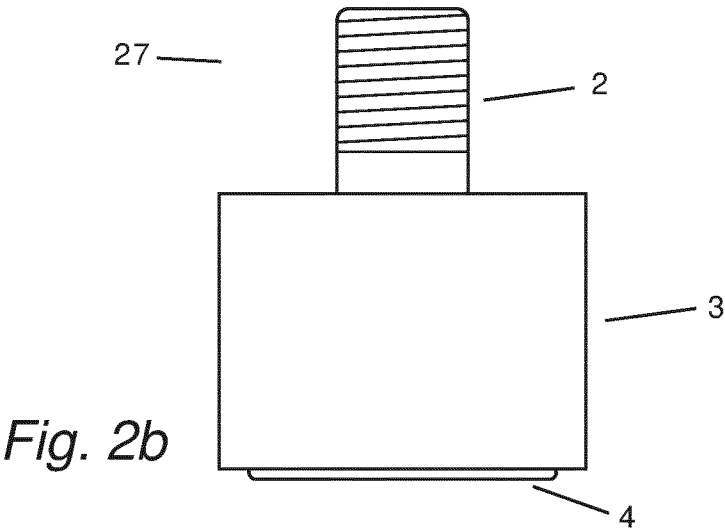
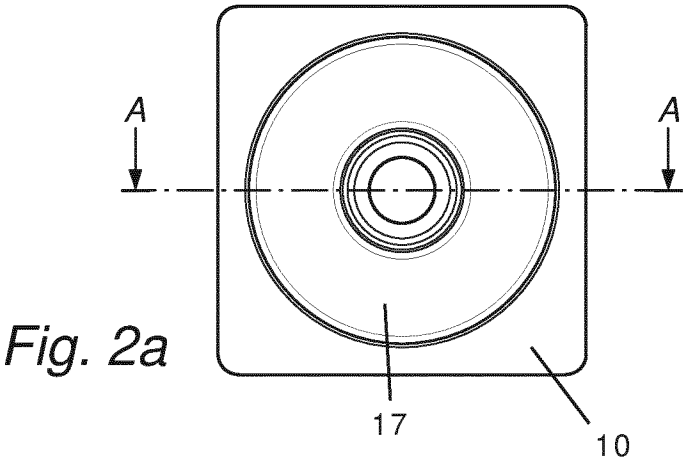


Fig. 1b



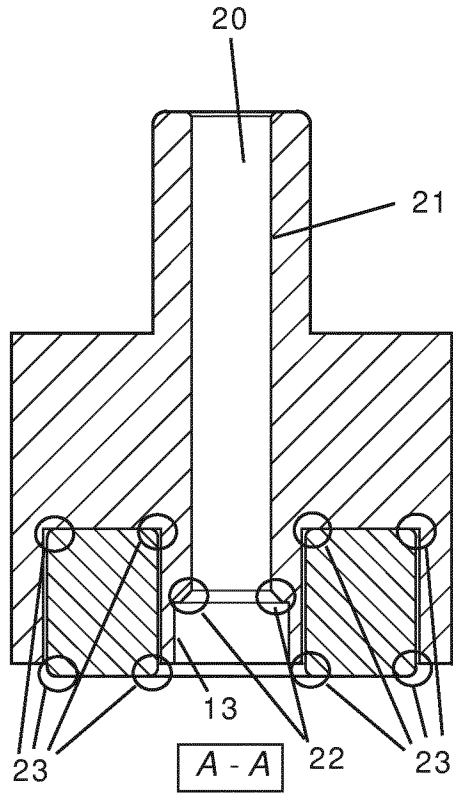


Fig. 3

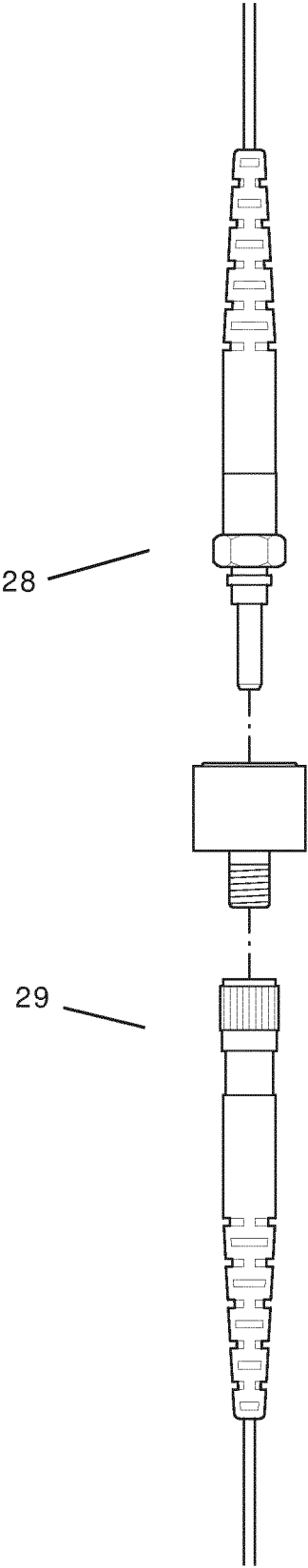


Fig. 4a

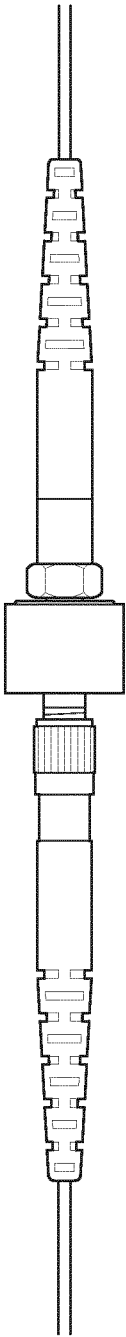


Fig. 4b

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2020/061518

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/38
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8 834 037 B2 (WOUTERS VINCENT A [US]; OPTICAL CABLE CORP [US]) 16 September 2014 (2014-09-16) the whole document	1,3,4,8, 9,12
A		2,5-7, 10,11, 13-15
X	----- US 2001/007641 A1 (JOVANOVIĆ STEVAN B [US] ET AL) 12 July 2001 (2001-07-12) paragraph [0055] - paragraph [0056]; figures 4,5	1
X	----- EP 1 586 921 A1 (CANARE ELECTRIC CO LTD [JP]) 19 October 2005 (2005-10-19) paragraph [0015]; figures 8A-C ----- -/-	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

15 June 2020

Date of mailing of the international search report

01/07/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Andreassen, Jon

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/061518

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016/310234 A1 (RITTER AUSTIN RASMUSSEN [US]) 27 October 2016 (2016-10-27) paragraph [0102] - paragraph [0103]; figure 27 -----	1-15
A	CN 205 691 817 U (ROSENBERGER COMMUNICATION TECH CO LTD) 16 November 2016 (2016-11-16) page 3; figures 14,15 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/061518

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 8834037	B2	16-09-2014	NONE
US 2001007641	A1	12-07-2001	AT 424552 T 15-03-2009
		EP 1019694 A1	19-07-2000
		ES 2321350 T3	04-06-2009
		JP 2001516048 A	25-09-2001
		US 6190616 B1	20-02-2001
		US 2001007641 A1	12-07-2001
		WO 9913312 A1	18-03-1999
EP 1586921	A1	19-10-2005	EP 1586921 A1 19-10-2005
		JP 2005301151 A	27-10-2005
		US 2005232552 A1	20-10-2005
US 2016310234	A1	27-10-2016	US 2016310234 A1 27-10-2016
		US 2018235586 A1	23-08-2018
CN 205691817	U	16-11-2016	NONE