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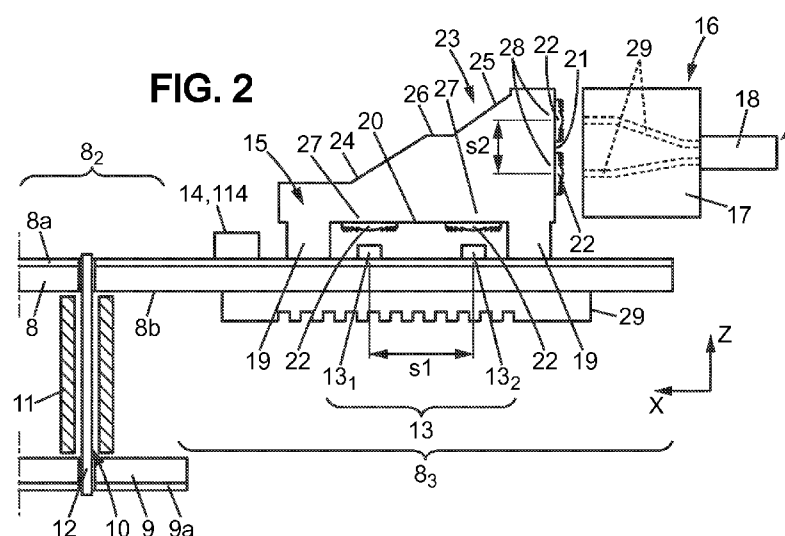
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(54) Title: OPTOELECTRONIC CONNECTOR



(57) Abstract: An optoelectronic connector comprises: a housing, - a printed circuit board (83) mounted in the housing, and carrying: optoelectronic components (13) arranged along a plurality of lines and a plurality of columns, an optical coupling device (15), having a first optical interface (20) optically coupled to the optoelectronic components, and a second optical interface (21) to exchange light with a mating optical cable (3). The first optical interface comprises a plurality of light-transmission regions, arranged along a plurality of rows and a plurality of columns, each associated to a respective optoelectronic component.

OPTOELECTRONIC CONNECTOR.

FIELD OF THE INVENTION

The invention relates to optoelectronic connectors.

5

BACKGROUND OF THE INVENTION

Because of the ever increasing requirements in data rates in communication systems, due for example to the Internet Electrical communications between electronic circuit boards becomes insufficient. Indeed, it becomes difficult to guarantee good signal integrity when transferring information through electrical lines between the boards.

To respond to this bandwidth demand, high-speed systems use light to transfer information, in replacement of the electrically-conducting metal. Indeed, light does not suffer from the same limitations as electricity.

Light enables to improve the transfer of information between two points. However, the circuit boards which handle such information still use, at least partially, electricity-carried information. Optoelectronic components are known to be components which transform light from/to electricity. The LASER is an example of a light-emitting optoelectronic component. A photo-detector or photo-diode is an example of a light-receiving optoelectronic component.

It is known to provide such optoelectronic components on boards. Such boards would therefore exhibit one or a plurality of optical interfaces. However, when a board is produced, the number of its interfaces which will be used in service is not necessarily known in advance, and is most often greater than the number of interfaces actually used, so as to enable the user to later upgrade his system. Therefore, board interfaces often remain idle for a long time. When it comes to optical interfaces, a

very efficient sealing of an idle optical interface is necessary so as to protect from any ingress of dust, if one wants to use the interface at some time. Further, these systems are costly since the expensive optoelectronic components which are provided at the idle interfaces are unused.

Active optical cables are used to connect electrical devices to optical devices. Such cables comprise an optical fibre ending in a housing which houses such optoelectronic components, which are themselves electrically connected to a board. Using such active optical cables enables to provide a board with electrical interfaces, and to provide the optoelectronic components in the cable. The overall cost of the system is lowered, since only the required amount of cables is used, and the idle interfaces do not comprise any expensive component. Further, the optoelectronic components provided in a cable housing can more easily be protected from any ingress of material.

Such optical cables are highly technological objects, since they must integrate in a very small space such critical components, and must ensure that both the electrical coupling to the electrical device and the optical coupling to the optical device are satisfactory.

An aim of the invention is to simplify the conception of such objects.

SUMMARY OF THE INVENTION

To this aim, an optoelectronic connector comprises a housing defining an electrical interface and a printed circuit board (PCB) mounted in the housing. The PCB carries a plurality of optoelectronic components. These are arranged along a plurality of lines and a plurality of columns. Each optoelectronic component is adapted to emit or detect light along a respective light direction. They are in electrical communication with the electrical

interface.

The PCB further carries at least one electronic control component, adapted to control the optoelectronic components.

5 The PCB further carries an optical coupling device. The optical coupling device has a first optical interface optically coupled to the optoelectronic components. It further has a second optical interface associated to the first optical interface, and adapted to exchange light with
10 a mating optical cable.

The first optical interface comprises a plurality of light-transmission regions, arranged along a plurality of rows and a plurality of columns. Each light-transmission region is associated to a respective opto-
15 electronic component.

With these features, a simplified device is provided, which comprises a reduced number of components.

In some embodiments, one might also use one or more of the features as defined in dependent claims.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Other characteristics and advantages of the invention will readily appear from the following description of four of its embodiments, provided as a non-limitative example, and of the accompanying drawings.

25 On the drawings:

- Fig. 1 is a perspective view of an optoelectronic connector,
- Fig. 2 is a partial side view inside the connector of Fig. 1 according to a first embodiment,
- 30 - Fig. 3 is a partial top view of a circuit board used in the first embodiment, and
- Fig. 4 is a schematic partial perspective view inside the connector of Fig. 1,
- Fig. 5 is a view similar to Fig. 2 of a second
35 embodiment,

- Fig. 6 is a view similar to Fig. 2 of a third embodiment,

- Fig. 7 is a view similar to Fig. 2 of a fourth embodiment, and

5 - Fig. 8 is partial perspective view of an electrical connector complementary to the optical cable according to the above embodiments.

On the different Figures, the same reference signs designate like or similar elements.

10 DETAILED DESCRIPTION

Fig. 1 schematically shows an optoelectronic connector 1. Such a connector comprises an electrical interface 2 for electrical connection to a not-shown complementary mating electrical/electronic device. Such an
15 optoelectronic connector 1 further comprises an optical interface 3 for connection to a not-shown complementary mating optical device. The connector 1 comprises a housing 4 which is provided with the electrical interface on a first face 4a and with the optical interface on an opposite
20 second face 4b, although this is illustrative only. The housing 4 comprises for example a portion made of an electrically insulating material in which the electrical interface 2 is formed. For example, the electrical interface 2 comprises two parallel protrusions 5a, 5b
25 extending along the width Y of the connector and spaced apart from one another along the height Z of the connector. The two protrusions are for example identical and symmetrical with respect to an X-Y plane. Thus, only one of the protrusions will be described in detail below. The
30 protrusion 5a comprises a top face 6 which extends parallel to the X-Y plane. A plurality of electrical tracks 7a, ..., 7i are borne by the top face 6. For example, the protrusion 5a comprises twelve differential pairs of tracks, i.e. 24 such tracks. At the electrical interface,
35 these tracks extend parallel to one another along the

direction X, toward the inside of the connector 1. For example, such tracks are electrical tracks provided on a top surface 8a of a printed circuit board 8 (see Fig. 4).

5 A similar description also applies to the protrusion 5b, for which the tracks are numbered from $7i+1$ to $7n$. For example, $n = 2*i$. Such tracks are provided on the bottom surface 9a of a second printed circuit board 9 (see Fig. 4).

10 Alternatively, the electrical interface is provided as slots rather than protrusions.

As can be seen on Fig. 4, the printed circuit boards 8 and 9 inside the connector differ from one another. The second printed circuit board 9 has a first portion 9_1 corresponding to the electrical interface which 15 has been described above. The second printed circuit board further comprises a second portion 9_2 which extends beyond the first portion 9_1 along the X direction. This portion is a connection portion to the first circuit board, as will be described in more details below.

20 The first circuit board 8 also comprises a first portion 8_1 corresponding to the electrical interface, and as second portion 8_2 , which is an electrical connection portion to the second printed circuit board 9. The first printed circuit board 8 further comprises a third portion 25 8_3 which extends beyond the first and second portions 8_1 , 8_2 along the direction X, and comprises an optical engine, or optical sub-assembly (not shown on Fig. 4), and will be described in more details below in relation to Fig. 2. The second printed circuit board does not comprise any such 30 third portion comprising an optical engine.

In the second portion 8_2 , the first printed circuit board 8 carries on the left-hand side, the i electrical tracks originating from the first protrusion 5a. On the right hand side, it carries n electrical tracks. Of those, 35 i are continuous from the i electrical tracks originating

from the first protrusion 5a, and the other $n-i$ tracks are electrically connected to the $n-i$ tracks carried by the second printed circuit board 9 by way of a suitable electrical connector 10. Such an electrical connector is adapted to electrically connect together electrical tracks from two different printed circuit boards. In particular, such an electrical connector 10 comprises a dielectric housing 11 which receives electrical pins 12, which extend from a first end 12a to a second end 12b. The first end 12a is an electrical contact with a track of the second electrical circuit board. The second end 12b is in electrical contact with an electrical track $7_{n+1}, \dots, 7_{2n-i}$ of the first printed circuit board 8.

In the present case, the electrical contact of the pins 12 to the tracks $7_{n+1}, \dots, 7_{2n-1}$ of the first printed circuit board 8 will be done through its substrate. This also applies to the electrical contact of the pins 12 to the tracks $7_{i+1}, \dots, 7_n$ of the second printed circuit board. Thus, in the third portion 8_3 of the first printed circuit board, n (in the present example, 48) electrical tracks extend, i of them being directly electrically connected to the first protrusion 5a, and $n-i$ of them being electrically connected to the second protrusion 5b through the electrical connector 10.

Fig. 2 shows the optical engine carried in the third portion 8_3 of the first printed circuit board. The first face 8_a of the printed circuit board 8, carries a number of components. This printed circuit board carries active optoelectronic devices 13, such as a row of light-emitting optoelectronic devices 13_1 . This row, in the present example extends along the direction Y, so that only one such device is visible on Fig. 2. Please refer to the top view of Fig. 3 to see the whole row. Examples of such light-emitting optoelectronic devices include vertical-cavity surface emitting lasers (VCSELs). The printed

circuit board 8 further comprises electronic control devices 14, such as electronic devices which control the VCSELs 13₁. The electronic control devices are electronically connected to the VCSELs 13₁ by electrical
5 tracks provided on the first face 8_a.

The printed circuit board 8 further carries other optoelectronic devices such as light-detecting devices 13₂. Such devices are for example suitable photo-diodes or photo- detectors. They are, for example, arranged along a
10 row disposed along the direction Y, so that only one of them is visible on Fig. 2. See the top view of Fig. 3 to understand that this row is spaced from the row of light-emitting components along the direction X. For example, they are situated at the same level as the lasers 13₁ along
15 the direction Y, or they are shifted laterally with respect thereto. Such photo-diodes 13₂ are also electrically connected to suitable electronic control devices 114 in any suitable way.

The printed circuit board 8 further carries an
20 optical coupling device 15 which is adapted to optically couple light emitted from/directed to the optoelectronic components 13₁, 13₂ to/from a mating optical component 16. Such an optical component 16 comprises for example a mechanical-transfer ferrule 17 which receives optical
25 fibres 29 in precisely defined relative locations. Right of the ferrule, the optical fibres are arranged together as a cable 18 forming the optical interface 3 of the connector 1.

The optical coupling device 15 is for example a
30 unitary integrally moulded part. It comprises positioning feet 19 which are used to precisely define the location of the coupling device 15 with respect to the optoelectronic components 13, both in the X-Y plane and their height with respect to them along the axis Z.

35 The optical coupling device 15 comprises a first

optical interface 20 optically coupled to the optoelectronic components 13. The optical coupling device further comprises a second interface 21 optically coupled to the ends of the optical fibres held in the ferrule 17.

5 Each optical interface 20 and 21 comprises optical transmission regions 27, 28, respectively, arranged in rows and columns, and each associated to a corresponding optoelectronic component 13 or fibre. Hence, each interface of the optical coupling device comprises light-

10 transmission regions arranged along a plurality of rows and a plurality of columns. In particular, each transmission region comprises a lens 22 or other suitable light-beam forming device, to enhance the optical coupling between the optical coupling device 15 and the respective mating

15 optical component.

In the present example, the second optical interface 21 extends in the Y-Z plane, i.e. is normal to the first optical interface 20, which extends in the X-Y plane. The optical coupling device 15 thus further

20 comprises a reflective arrangement 23 defining an optical path between each transmission region of the first interface 20 with a respective transmission region of the second optical interface 21. For example, the reflective arrangement 23 comprises a mirror portion 24, oriented at

25 45° with respect to the X axis, and extending along the Y direction, and reflecting light emitted from the lasers 13_1 toward a respective fibre of the ferrule 17. Another mirror portion 25 may be used to reflect the light from a fibre held by the ferrule 17 toward a photodiode 13_2 . For

30 example, the mirror portion 25 has the same orientation as the first mirror portion 24. Further, the two mirror portions 24 and 25 are offset with respect to one another by an intermediate portion 26, extending between the two mirror portions 24 and 25 in the optical coupling device,

35 and with an angle different from 45° with respect to the X

or the Z direction. In the present case, where it is wished to have a broader spacing s_1 between the two rows of optoelectronic components, compared to the spacing s_2 between the two rows of fibres held by the ferrule 17, the intermediate portion 26 has a small angle, for example zero degree, with respect to the X axis. Hence, light propagating from the LASERs 13₁ is offset with respect to light propagated to the photodiodes 13₂ within the coupling device 15. Efficient thermal handling of the optical engine can thus be achieved, thanks to the spacing between the components 13₁ and 13₂ while not increasing too much the size of the ferrule, nor of the whole connector.

The ferrule 17 is held in any suitable way in the housing 1, so as to define a precise optical coupling between the second interface 21 of the optical coupling device and the fibres of the ferrule.

Assuming that the distribution of the light-emitting and light-receiving optoelectronic components is predetermined, and for example corresponds to a standard, it is possible to manufacture in series optical coupling devices 15 which are specifically tailored for this application. In particular, each optical path inside the optical coupling device 15 can be optimized. For example, the lenses 22 will not be manufactured in the same way, regarding whether the path is a detection path or an emission path, because the light-beam-forming requirements would differ. In such a case, it would be possible to manufacture in series only one component which would be suitable for all applications. A heat sink 29 can be provided below the printed circuit 8, to perform thermal regulation of the system. Since, there is only one printed circuit board which has to be submitted to thermal regulation, the characteristics of the system as a whole are improved.

The system has an electrical interface which is

compatible with other systems, which also have two printed circuit boards 8, 9, but have one optical engine provided per circuit board. Thus, it is possible to plug the present active cable to a complementary older socket.

5 Fig. 5 schematically shows a second embodiment of the invention. Compared with the first embodiment, the second embodiment differs in that the second printed circuit board extends throughout the housing 4 and that the electrical connector 10 between the two printed circuit
10 boards 8, 9 is provided directly below the optoelectronic components 13₁, 13₂.

 Fig. 6 schematically shows a third embodiment. Compared to the second embodiment, it mainly differs in that the optical connector 10 is provided on the back end
15 4b side of the housing 4.

 According to a fourth embodiment, as shown on Fig. 7, the control components 14, 114 is provided in the first portion 8₁ of the first printed circuit board 8. If necessary, these components are located elsewhere.

20 Another difference between the embodiments of Figs. 5, 6 and 7 with respect to the embodiment of Fig. 1 is that the reflective arrangement 23 of the optical coupling device comprises a single continuous mirror, rather than the two offset mirror portions 24, 25 of the first
25 embodiment. Using one configuration or the other depends on the room available in the connector housing 4, and of the spacing of the optoelectronic components.

 Fig. 8 now schematically shows an example of a complementary electrical mating connector 101, which has an
30 electrical interface adapted to cooperate with the electrical interface of the optoelectronic active cable already described. For example, this connector 101 is attached to a not-shown printed circuit board of an electronic device. Its electrical interface 102 for
35 example comprises two slots 103_a, 103_b which are shaped to

receive the protrusions 5_a , 5_b , respectively, of the cable housing. These slots thus comprise electrical tracks which will be in electrical communication with the tracks 7_1-7_n of the housing.

CLAIMS

1. An optoelectronic connector comprising:
 - a housing (4) defining an electrical interface,
 - 5 - a printed circuit board (8₃) mounted in the housing, and carrying:
 - . a plurality of optoelectronic components (13) arranged along a plurality of lines and a plurality of columns, each adapted to emit or detect light along a
 - 10 respective light direction, the optoelectronic components being in electrical communication with the electrical interface,
 - . an optical coupling device (15), having a first optical interface (20) optically coupled to the
 - 15 optoelectronic components, and a second optical interface (21) associated to the first optical interface, and adapted to exchange light with a mating optical cable (3),
 - wherein the first optical interface comprises a plurality of light-transmission regions, arranged along a
 - 20 plurality of rows and a plurality of columns, each associated to a respective optoelectronic component.
2. Optoelectronic connector according to claim 1, comprising a first set of a plurality of light-emitting optoelectronic components (13₁), and a second set of light-
- 25 receiving optoelectronic components (13₂).
3. Optoelectronic connector according to claim 2, wherein the components (13₁) of the first set are aligned along a first row, and wherein the components (13₂) of the second set are aligned along a second row parallel to the
- 30 first row.
4. Optoelectronic connector according to any of claims 1 to 3, wherein said electrical interface comprising a first printed circuit board (8₃) and a second printed circuit board (9₁), different from the first printed
- 35 circuit board,

wherein the first printed circuit board (8₃) further carries electrical tracks (7₁, ..., 7_i, 7_{n+1}, ..., 7_{2n-1}) electrically coupled to the optoelectronic components, a part (7_{n+1}, ..., 7_{2n-1}) of said electrical tracks being
5 electrically connected to the second circuit board (9) through an electrical connector (10).

5. Optoelectronic connector according to claim 4, wherein a first part (7₁, ..., 7_i) of the electrical tracks are continuous all along the first printed circuit board
10 (8₃).

6. Optoelectronic connector according to claim 5, wherein the printed circuit board comprises a first region forming at least a part of the electrical interface, a third region carrying said optoelectronic components, a
15 second region intermediate between the first and third regions, and wherein a first part of the tracks run from the first to the third region, while a second part of the tracks run only from the second to the third region.

7. An optoelectronic connector comprising:
20 - a housing (4)
- a printed circuit board (8) mounted in the housing, and having a first region (8₁) forming part of an electrical interface of the connector, a second region (8₂) and a third region (8₃) carrying:

25 . a first set of a plurality of light-emitting optoelectronic components (13₁),

. a second set of light-receiving optoelectronic components (13₂),

. an optical coupling device (15), having a
30 first optical interface (20) optically coupled to the optoelectronic components, and a second optical interface (21) associated to the first optical interface, and adapted to exchange light with a mating optical cable (3),

. electrical tracks (7₁, ..., 7_i, 7_{n+1}, ..., 7_{2n-1})
35 electrically coupled to the optoelectronic components,

wherein a first part ($7_1, \dots, 7_i$) of said electrical tracks, run from the first to the third region, wherein a second part of said tracks run only from the second to the third region,

5 - an electrical connector (10) adapted to electrically connect the second part ($7_{n+1}, \dots, 7_{2n-i}$) of said electrical tracks to a second electrical circuit board (9), also forming part of the electrical interface of the connector.

10 8. Optoelectronic connector according to any of claims 1 to 7, wherein the first optical interface of the optical coupling device has a first spacing, wherein the second optical interface of the optical coupling device has a second spacing, different from the first spacing, and
15 wherein the optical coupling device is adapted to offset light beams propagated between said first and second interfaces.

 9. An optoelectronic system comprising an optoelectronic connector according to any of claims 1 to 8,
20 and an optical cable (3) having an end formed by a mechanical-transfer ferrule (17), wherein the mechanical-transfer ferrule is optically coupled to the second optical interface (21) of the optical coupling device.

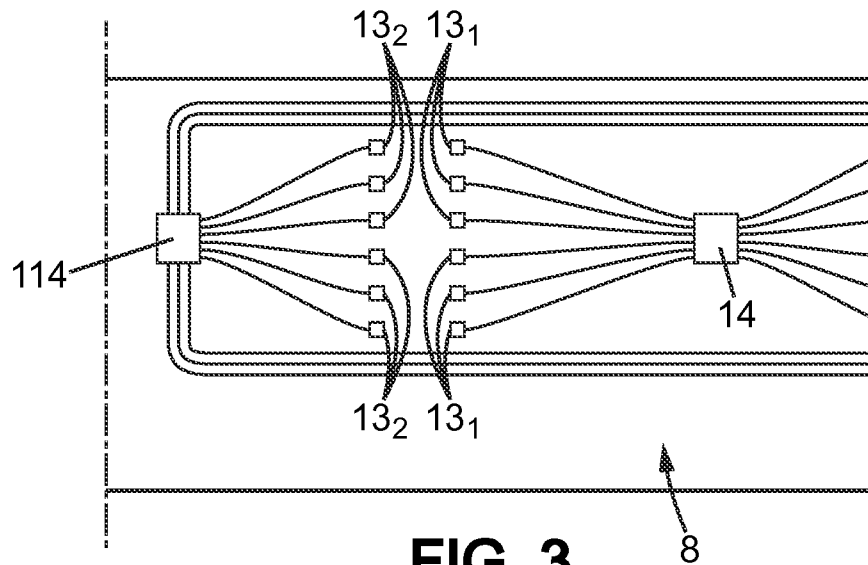


FIG. 3

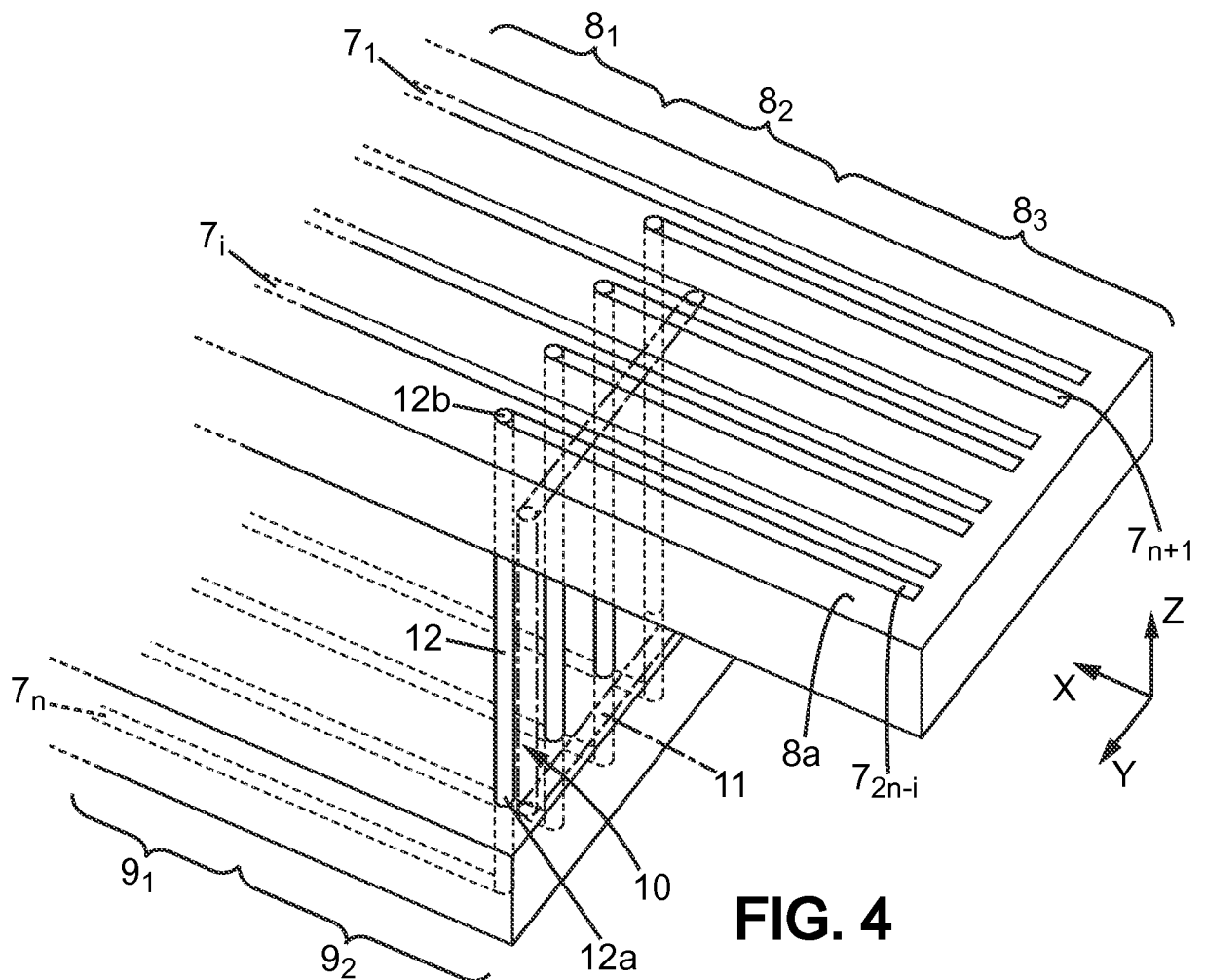
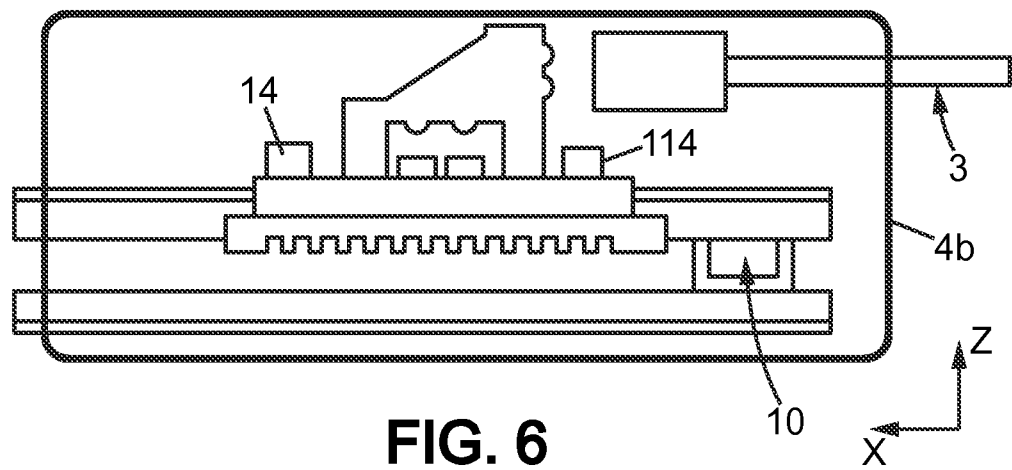
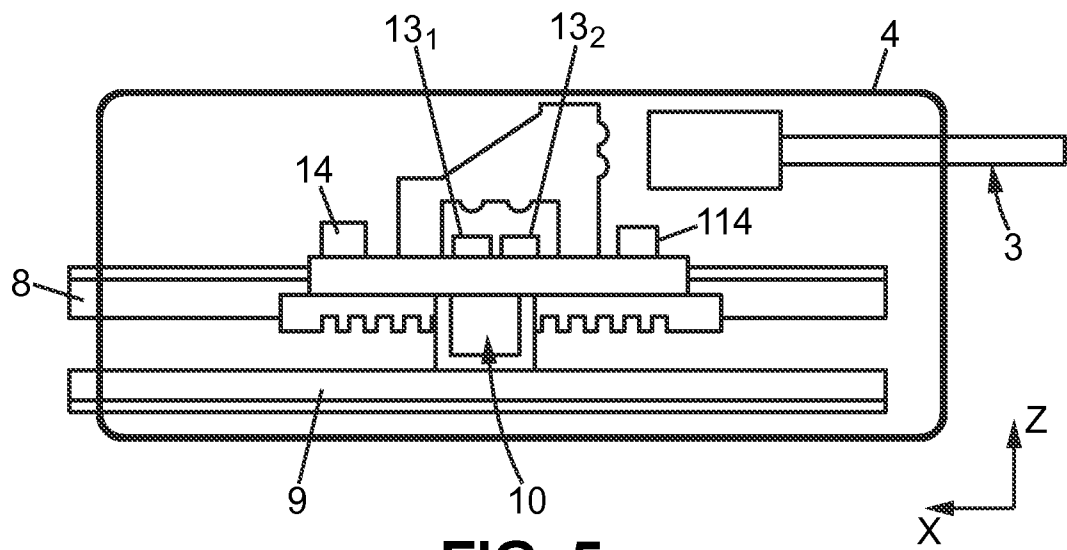
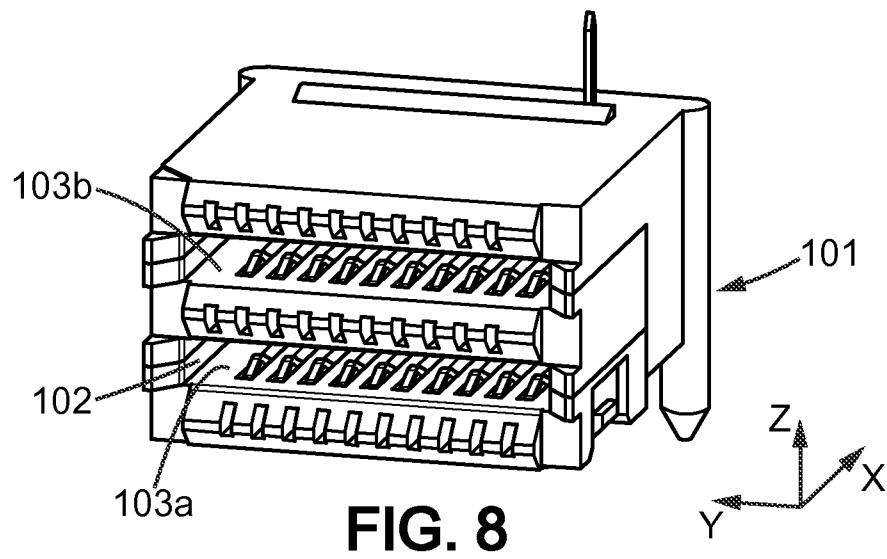
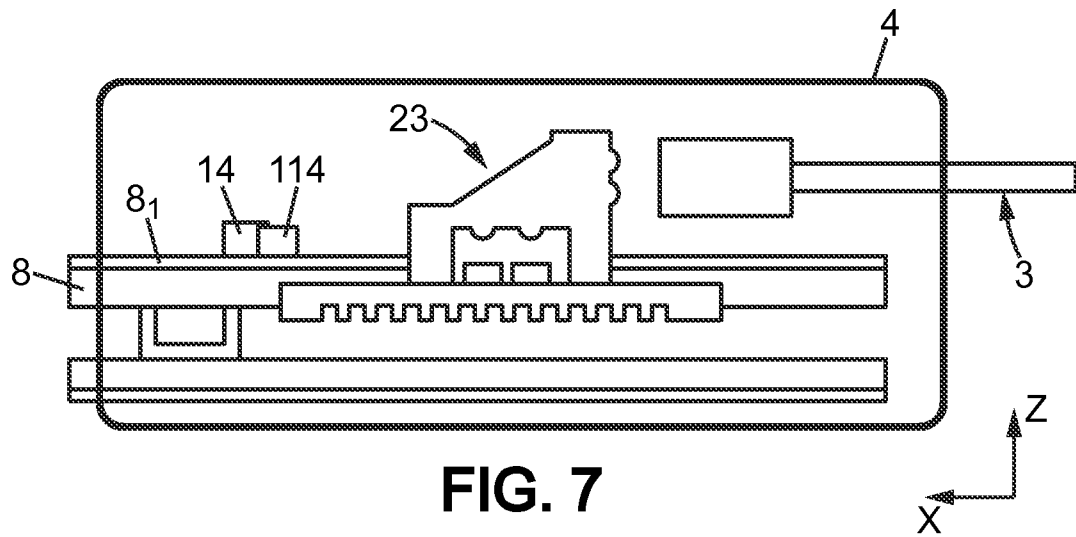


FIG. 4





INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/002579

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/42
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 practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 6 364 542 B1 (DEANE PETER [US] ET AL) 2 April 2002 (2002-04-02) abstract; figures 1,2,5 column 3 - column 5 -----	1-9
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A	US 2003/156327 A1 (TERAKAWA YUKARI [JP] ET AL) 21 August 2003 (2003-08-21) abstract; figures 4-18 ----- -/-	1-9

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2010/002579

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2010/002579

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