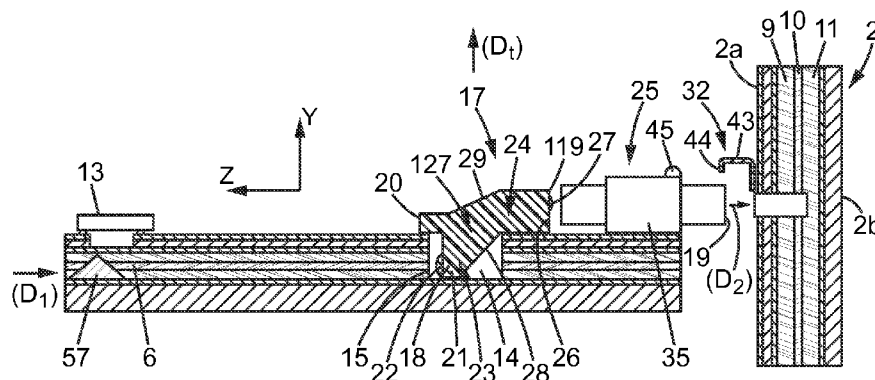




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(54) **Title:** OPTICAL COUPLING SYSTEM**FIG. 4**

(57) **Abstract:** An optical communication system comprises : _ a daughter optical circuit board (3) having an embedded optical layer (6), - a mother optical circuit board (2), having an embedded optical layer (10), - an optical coupling system having :. a first optical interface (18) optically coupled to a first optical interface of the daughter circuit board, and, a second optical interface (19) optically coupled to a first optical interface of the mother circuit board. The optical coupling system comprises an optical coupling device (17), formed as an integral part of translucent material comprising light beam forming structures (22;27), fixed to the daughter board.

OPTICAL COUPLING SYSTEM

FIELD OF THE INVENTION

The invention relates to optical coupling systems.

5 BACKGROUND OF THE INVENTION

Most communication systems involve a number of system-cards. Such cards are usually manufactured as so called printed circuit boards (PCBs). Usually, system-cards which are called daughter boards are assembled together on a rigid system-card called backplane, or mother board.

The daughter boards usually extend parallel with each other and are interconnected together via the backplane, which extends perpendicular to them. There are several practical advantages to such a configuration: Easy insertion, removal, and replacement of the daughter-boards, for instance.

Because of the ever increasing requirements in data rates, due for example to the Internet, using electrical communications between the daughter-boards through the backplane becomes insufficient. It has become difficult to guarantee good signal integrity over the electrical lines traced within the backplane and/or connectors.

To respond to this bandwidth demand, high speed systems are developed based on optical layers (optical fibres or planar waveguides) incorporated in replacement of the electrically-conducting metal. Indeed, light does not suffer from the same limitations as electricity. Then, backplanes and daughter boards comprise at least one optical layer parallel to their respective average plane.

30 Such backplanes and daughter boards need to be connected.

It is known, for example from US 7,561,763, to place an optical connector at the edge of the daughter board, to interconnect the embedded layers of the two circuit boards.

However, this system is rather complex, and the optical coupling at the daughter board might not be satisfactory.

There is therefore a need to provide an alternative
5 way of providing an optical connection between embedded layers of two boards.

SUMMARY OF THE INVENTION

According to the invention, it is provided an optical communication system which comprises a daughter and a
10 mother optical circuit boards and an optical coupling system.

The daughter optical circuit board has a top face, and an embedded optical layer extending sensibly parallel to the top face, and having a first optical interface.

15 The mother optical circuit board has a top face, and an embedded optical layer extending sensibly parallel to the top face.

The mother optical circuit board has a first optical interface.

20 The optical coupling system has a first optical interface defining a plurality of parallel first optical paths. This interface is optically coupled to said first optical interface of the daughter circuit board. It further has a second optical interface defining a plurality of
25 parallel second optical paths. The interface is optically coupled to said first optical interface of the mother circuit board. An optical channel is defined between the first and second optical interfaces so that each first optical path corresponds to a corresponding second optical
30 path.

The optical coupling system comprises an optical coupling device, formed as an integral part of translucent material comprising at least one light beam forming structure, fixed to the daughter board.

With these features, an easy connection is possible, furthermore with good optical characteristics.

According to another aspect, it is provided an optical coupling system has a first optical interface defining a plurality of parallel first optical directions or paths. This first interface is optically coupled to a first optical interface of a first circuit board. The optical coupling system further comprises a second optical interface defining a plurality of parallel second optical directions or paths.

This second interface faces and is optically coupled to a second optical interface of a second optical circuit board.

An optical channel is defined between the first and second optical interfaces so that each first optical path corresponds to a corresponding second optical path. A reflective arrangement comprises at least one mirror adapted to direct light between one of said first and second optical paths to a transmission direction not parallel to the first optical path.

The first optical path is parallel to and orientated like the corresponding second optical path and offset therefrom with respect to a transverse direction normal to the first optical path.

With these features, the optical path provided by the coupling system is sensibly S-shaped. The connection between the two boards is made much easier. Indeed, the method of US 7,561,763 required a cut-out to be performed in the edge of the daughter-board, so as to have the front of the connector sensibly flush with the edge of the card outside the region for optical connection, as schematically shown on Fig. 13. Thus, this technique suffers from some drawbacks, in particular because large portions of the daughter board have to be removed so as to insert the optical connector. Such surfaces could have been used for

other purposes. Further the connector has to be adapted to the specific thickness of the daughter board.

Although the invention is introduced with reference to connection of two optical boards, it is believed to find an application in other kinds of connection systems.

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

BRIEF DESCRIPTION OF THE DRAWINGS

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

On the drawings:

- Fig. 1 is a perspective view of an optical system according to a first embodiment,
- Fig. 2 is a partial exploded view showing the assembly of a connector to a daughter board according to the first embodiment,
- Fig. 3 is a sectional view along line III-III of Fig. 2 of the system of Fig. 2,
- Fig. 4 is a sectional view along line IV-IV of Fig. 1 of the system of Fig. 1,
- Fig. 5 is a partial sectional view, along line IV-IV of Fig. 1 of the mother board,
- Fig. 6 is a partial sectional view of an optical coupling system according to a second embodiment,
- Figs. 7, 8 and 9 are cross sectional views corresponding to Fig. 4, according to a third, fourth, and fifth embodiment of the invention respectively,
- Fig. 10 is a side sectional view of a sixth embodiment,
- Fig. 11 is a top view of the embodiment of Fig. 10,
- Fig. 12 is a schematic view of a seventh embodiment,

- Fig. 13 is a schematic top view of a system according to the prior art.

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

5 DETAILED DESCRIPTION

Fig. 13 is a schematic top view of a system according to the prior art. A cut-out 104 is performed in the daughter board 103, to receive a connector 125, the front edge of which is flush (or almost flush) with the front
10 edge of the daughter board, for connection to the mother board 102. Here the daughter board 103 is in the plane of the paper sheet and the mother board 102 is perpendicular to the daughter board 103 and to this plane.

Fig. 1 shows, in perspective, an optical system 1,
15 according to a first embodiment of the invention. This optical system comprises a mother board 2 extending sensibly parallel to an X-Y plane. The remaining Z direction corresponds to the thickness of the mother board 2. One or more daughter boards 3 can be assembled to the
20 mother board 2. Only one daughter board 3 is shown on Fig. 1. However, a plurality of such could be provided in parallel, for example stacked above one another along the direction Y. The daughter board 3 extends perpendicular to the mother board 2, and is connected to a top face 2a of
25 the mother board.

In the present example, both the mother board 2 and the daughter board 3 are optical circuit boards. Each of them comprises at least one optical layer 4, 5, which extends internally, embedded into the circuit board. Each
30 of these optical layers comprises an optical waveguide. As visible on Fig. 2 for the daughter board, the optical waveguide comprises an optical core layer 6 adapted to transmit light, and embedded between a bottom cladding layer 7 and a top cladding layer 8. The terms "top" and
35 "bottom" are given for the daughter board 3 in relation

with the orientation of the axis Y. However, this is purely illustrative.

The optical core layer and cladding layers are manufactured in any suitable way, with suitable layers of glass or plastic. This description of the daughter board 3 also applies to the mother board 2. As shown on Fig. 4, the mother board 2 comprises a top face 2a facing toward the daughter board 3, a top cladding layer 9, an optical core layer 10, a bottom cladding layer 11 and a bottom face 2b superposed along the axis Z.

Back to Fig. 2, the daughter board 3 has a front edge 12 which faces the top face 2a of the mother board 2.

In particular, the front edge 12 extends continuously parallel to the X-Y plane, along the whole width and thickness of the daughter board, without any cut-out or the like.

As can be seen on Fig. 1, and will be explained in more details later, the top face 3a of the daughter board also carries a set of opto-electronic components 13 such as light-emitting and/or light-receiving opto-electronic components which convert light to/from electricity. These components are for example disposed along one row extending parallel to the direction X, and facing toward the optical layer 5 of the daughter board.

As shown on Fig. 2, the top face 3a of the daughter board 3 has a cut-out 14 formed therein, at least through the optical core layer 6, so as to define an optical interface 15 of the daughter board 3. The optical interface 15 comprises a plurality of light-transmitting regions 16 (three of them shown on Fig. 2), each optically associated with a respective opto-electronic component 13 through the optical layer 5. The optical interface 15 is interfaced with an optical coupling device 17 (not shown on Fig.2) which will be described in more details below in relation to Figs. 3 and 4. Light leaving the daughter board at a

light-transmitting region defines a first direction or first light path. Here, all the first light paths are parallel to one another and they are even coplanar.

According to the first embodiment, as shown on Figs. 3 and 4, an optical coupling device 17 is provided as an integral moulded part made of translucent plastic. It has a first optical interface 18 and another second optical interface 119 which are optically coupled to one another.

An optical channel extends between these two interfaces.

The coupling device 17 comprises positioning feet 20 which cooperate with complementary positioning marks 63 (see Fig. 2) formed in the daughter board 3 to define a precise positioning of the optical coupling device with respect to the daughter board 3. The marks 63 are for example provided on a reference layer of the board 3, internal to the board 3 (rather than the shown top surface 3a) and accessible through the cut-out 14. The optical coupling device 17 is fixed in this precise position, by any suitable way. Once fixed to the daughter board 3, the optical coupling device 17 has its first optical interface 18 optically coupled to the optical interface 15 of the daughter board 3. The first optical interface 18 of the optical coupling device 17 comprises a plurality of first optical transmission regions 21, which are each optically coupled with a respective light transmission region 16 of the daughter board (see Fig. 2). If necessary, the first optical interface comprises, in each light transmission region 16, a first light beam forming structure, such as a suitable lens 22 or the like.

According to this first embodiment, the optical coupling device 17 comprises a first portion 23 and a second portion 24. The first portion extends sensibly in the cut-out 14. The second portion 24 extends outside of

the cut-out 14. It projects over the plane of the top face 3a of the daughter board 3.

A second optical interface 119 of the optical coupling device 17 is optically coupled to a first optical connector 5 25 which will be described later in more details.

It comprises a plurality of second light transmission regions 26 which are each optically associated to a corresponding first light transmission region 21 of the first optical interface 18. Each second light transmission region 26 comprises a second light beam forming structure, such as a suitable lens 27, so as to improve the optical coupling between the optical coupling device 17 and the first optical connector 25. In the present example, the first and second optical interfaces 18, 119 of the optical coupling device 17 extend parallel to one another. In other words, light transmitted along a first light path D1 between the daughter board 3 and the optical coupling device 17 at the first optical interface 18 extends in a plane parallel to light transmitted along a second direction D2 at the second optical interface 119. In the present example, both extend parallel to the X-Z plane.

Further, light is shifted up between the first and second interfaces. In other words, these two planes are offset with respect to one another along Y direction. Whereas light extends in the daughter board 3 at the first interface, it extends out of the daughter board, over its top face 3a at the second interface 119.

The optical coupling device comprises a reflective arrangement 127 to provide this offsetting. In particular, the optical coupling device 17 may be provided with a first mirror 28, which extends along the X direction and forms a 45° angle with the Z direction in order to deflect the light propagated in a plane parallel to the X-Z plane to light propagated along a transmission direction Dt not parallel with the X-Z plane, and in the present example

parallel to an X-Y plane. The reflective arrangement 127 further comprises the second mirror 29 extending parallel to the first mirror 28, so as to reflect light transmitted in the X-Y plane back into a plane parallel to the X-Z
5 plane. Hence, the first mirror 28 is formed in the first portion 23 of the optical coupling device, and the second mirror 29 in the second portion 24 thereof.

The system further comprises an optical connector assembly 30, as shown on Fig. 1. The optical connector
10 assembly comprises the first optical connector 25 attached to the daughter board 3, and a complementary second optical connector 32 attached to the mother board 2.

As shown on Fig. 2, the first optical connector 25 is placed over (on top of) and attached on the top face 3a of
15 the daughter board 3. In other words, the top face 3a of the daughter board has retention features 33, and the first optical connector 25 has complementary retention features 34 which are adapted to engage the retention features 33 of the daughter board to fix the optical connector 25 to the
20 daughter board 3. For example, the complementary retention features 34 are press-fit studs which are shaped to be introduced into precisely defined holes or recesses 33 formed in the top face 3a of the daughter board, in order to maintain the first optical connector 25 on the daughter
25 board 3. For example, the optical connector 25 comprises a housing 35. This housing has a bottom face 35b facing the top face 3a of the daughter board, and the retention features 34 project downward from this bottom face 35b.

As shown on Fig. 3, the connector 25 is also fixed in
30 precise alignment with the coupling device 17, by using pins 64 cooperating with alignment channels 62 of the face of the coupling device carrying its second optical interface.

The first optical connector 25 comprises a first
35 optical interface 36 and a second optical interface 37. In

particular, the second optical interface 37 extends, with respect to the Z direction, beyond the front edge 12 of the daughter board 3. The first optical interface 36 comprises a plurality of first light transmission regions 38 which are each optically coupled to a respective second light transmission region 26 of the second interface of the optical coupling device 17. The second optical interface 37 comprises a plurality of second light transmission regions 39 which are each optically associated with a respective first light transmission region 38 of the first optical interface 36.

For example, the first optical connector 25 comprises or holds a plurality of optical fibres 40, each having a first end and an opposite second end forming, respectively, the first and the second light transmission regions 38, 39 mentioned above. The fibres are for example assembled as a flexible cable thereby allowing independent movement of the two ends along the Z direction. In the present example, the cable extends substantially flat, parallel to the X-Z plane. It does not need to be bent much, since the two interfaces of the optical connector are substantially parallel to one another. On the first end, the fibres are assembled together in precisely defined relative locations in a mechanical transfer ferrule 41 housed in the housing 35. At the second end, the fibres are similarly assembled together in precisely defined relative locations in another mechanical transfer ferrule 42 received in the housing 35. In between, they define an optical path.

As shown on Fig. 4, the first and second optical connectors 25 and 32 further comprise fixation devices to mechanically retain the first 25 and second 32 optical connectors to one another. For example, the mechanical fixation system of the two optical connectors comprises a flexible lance 43 carried by the mother board 2 and having a stop 44. During connection of the daughter board 3 to the

mother board 2, the lance 43 is deflected until the stop 44 snaps back into locking engagement with a lug 45 carried by the housing 35. Variants of this fixation mechanism may be used in other embodiments.

5 The first optical connector 25 is optically coupled to the daughter board 3. The first optical connector 25 and the optical coupling device 17 together define an optical coupling system. The first optical interface 18 of this optical coupling system is optically coupled to a
10 complementary optical interface of the daughter board. The second optical interface 19 of this optical coupling system is formed by the second optical interface 37 of the connector 25. It is optically coupled to the complementary optical interface of the complementary optical connector 32
15 provided on the mother board. The second optical interface 19 has light-transmitting regions, each one of which corresponding to a respective light-transmitting region of the first optical interface 18. Light leaving the optical coupling system from a light-transmitting region of the
20 second interface 19 extends along a second direction or second light path. Here, the second light path for a light-transmitting region of the second interface extends parallel to the first light path for a corresponding light transmitting region of the first interface. Further, the
25 first and second light paths are shifted (offset) with respect to a transverse direction normal to these first or second light paths. The first and second light paths are said to be oriented in the same way, meaning that, when light enters the optical coupling system propagating from
30 left to right on Fig. 4, it will leave the optical coupling system propagating from left to right on this same figure.

As shown on Fig. 5, the second optical connector 32 is precisely placed with respect to a cut-out 46 formed in the mother board 2, and which receives an optical coupling
35 device 47. Such an optical coupling device 47 is, for

instance, an integrally formed moulded plastic part comprising a first optical interface 48 optically coupled with the second optical interface 19 of the optical 30 coupling system, and a second optical interface 49
5 optically coupled with the optical waveguide of the mother board. Light is guided along an optical path between these two interfaces. A mirror 50 is used to deflect light between the first 48 and second 49 optical interfaces of the optical coupling device 47. The mother board 2 has an
10 optical interface 54 which has light-transmission regions 53. Each of the first and second optical interfaces 48, 49 comprises a plurality of light transmission regions respectively 51, and 52, optically associated to one another, and to a respective light transmission region,
15 respectively, of the second optical interface 19 and of the mother board 2. Lenses 55, 56 may also be provided in the optical coupling device 47, as explained above.

Back to Fig. 4, the system which has just been described operates as follows. In the present example, the
20 opto-electronic component 13 is a LASER emitting a light signal along the Y direction, toward the optical core layer 6 of the daughter board 3. A mirror mount 57 reflects this emitted signal into the optical core layer 6 until it reaches the optical interface 15. Then, light is
25 transmitted into the optical coupling device 17, to be shifted out of the daughter board. In particular, it is reflected on the first mirror 28, then on the second mirror 29 toward the second optical interface 119 of the optical coupling device. It exits the optical coupling device at
30 this interface, and enters the first material transfer ferrule 41 of the first optical connector 25 at their coupled interfaces 119, 36. Light propagates in the optical connector 25 in the optical fibres 40 until it reaches the second optical interface 37 of the first connector (second
35 optical interface 19 of the coupling system). Then, it

exits and enters the optical coupling device 47 shown on Fig. 5. It is then propagated in this optical coupling device, from the first optical interface 48 to the second one 49, by reflection on the mirror 50, then exits the optical coupling device 47 at this second interface, to enter the optical core layer 10 of the mother board 2, in which it can be propagated to its final destination.

When, the opto-electronic component 13 is a light detection device, light can be transmitted along the same path, as described above, in the opposite direction.

Fig. 6 shows a second embodiment of the invention.

According to this second embodiment, the first portion 23 of the optical coupling device 17 is removed. The first mirror 28 is replaced by a mirror mount 58 provided in the daughter board 3. Only the top layer 59 of the daughter board 3 is cut-out. Light is enabled to exit from the daughter board 3. The assembly of the coupling device 117, of the mirror 58, and of the optical connector 25 forms an optical coupling system which replaces the optical coupling system 17, 25 of the first embodiment. The coupling device 117 extends sensibly totally over the top face of the daughter board and has its two interfaces normal to one another. The lenses 122, which replace the lenses 22 of the first embodiment, and couple the light signal between the optical coupling device 117 and the optical waveguide of the daughter board 3, are now provided on a bottom face 60 of the optical coupling device 117, over the intersection of the optical core layer 6 and the reflective facet 61 of the mirror mount 58.

Fig. 7 shows a third embodiment of the invention.

This embodiment corresponds to the embodiment of Fig. 4, with the difference that the optical coupling device 17 is held within the housing 35 of the connector. Hence, the connector forms the whole optical coupling system.

Fig. 8 shows a fourth embodiment of the invention.

Compared with the embodiment of Fig. 4, it differs in that it is not necessary to provide the ferrules 41, 42 and the linking optical ribbon between the two. On the contrary, the optical coupling system consists of an optical connector 25 which comprises a housing 35 which holds the optical coupling device 17. The second optical interface 19 of the optical coupling system is then that 119 of the optical coupling device 17.

The embodiments described in relation to Figs. 7 and 8 could also, in alternative embodiments, be applied to the embodiment of Fig. 6, i.e. with a mirror mount 58 provided directly in the daughter board.

Fig. 9 shows a fifth embodiment of the invention.

Compared to the embodiment of Fig. 4, the optical coupling device 17 comprises only the first bottom portion 23 of the first embodiment. Hence, the two interfaces of the optical coupling device 17 now extend orthogonal to one another.

The optical coupling system may comprise any means to drive light from the second interface of the optical coupling device 17 to the second optical interface of the whole optical coupling system. These means will not necessarily imply the use of a mirror. For example, as shown, an optical fiber ribbon or cable 65 may be bent between two mechanical transfer ferrules 41, 42 which are disposed at right angles to one another. If necessary, the whole optical coupling system is held in a housing 35 of a connector 25, as shown on Fig. 9.

Fig. 10 now shows a sixth embodiment of the invention. One difference of this embodiment compared to any of the above embodiments is the use of two parallel optical core layers 6a, 6b, offset with respect to one another along the direction Y, instead of the sole optical core layer 6 of Fig. 1. However, the above embodiments could also be

implemented with a plurality of parallel optical core layers of the daughter board 3.

Another difference between the embodiments of Fig. 10 with the above embodiments is that the optical interfaces of the optical coupling system are no longer offset with respect to the direction Y. Instead the first optical interface 18 and the second optical interface 19 of the optical coupling system are aligned with one another. The optical path between two associated transmission regions of respective interfaces is straight.

The optical coupling system comprises a connector housing 35 which receives an optical coupling device 17. In the present embodiment, the cut-out 14 is formed in the edge 12 of the daughter board 3.

The optical coupling device 17 does not have any reflective part. Indeed, light is transmitted straight inside the optical coupling device 17 between the first optical interface 18 and the second optical interface 19, without any deflection. Therefore, losses associated with reflections of the light signal can be avoided.

Fig. 11 shows a top view of the daughter board 3 of the embodiment of Fig. 10 before insertion of the optical coupling system. The cut-out 14 in fact comprises a first region 14a closest to the edge 12 of the mother board 3 and a second region 14b which has a bottom which is stepped with respect to the bottom of the region 14a, as can be seen in particular on Fig. 10. The bottom of the region 14b can be a Y-reference layer, the height of which, along direction Y, is precisely known with respect to the optical core layer(s) 6a, 6b of the daughter board. Hence, positioning feet of the optical coupling device 17 can rest on this layer so as to precisely define the height of the optical coupling device 17 with respect to the optical core layers 6a, 6b. The orientation of the optical coupling device 17 in the X-Z plane with respect to the mother board

3 can be precisely defined by using fiducial marks 63 to which the optical coupling device 17 can be aligned in the X-Z plane.

5 The optical coupling device 17 will thus be placed with its positioning feet resting on so-called "stand-off zones" 128 of the board 3. Fixation areas 129 can be provided on the top surface 3a of the daughter board so as to fix the optical coupling device 17 to the daughter board 3 in this precise position.

10 Fixation patterns 130 can be provided in the daughter board 3 to provide for the fixation of the housing 35 to the board 3. For example, these patterns 130 are holes formed to receive press fit studs of the housing 35. In the present embodiment, some of these holes are provided in 15 the bottom surface of the first region 14a of the cut-out, whereas other holes are provided behind the coupling device in the top surface 3a.

An optical communication system is now provided in relation to Fig. 12. As mentioned above, the mother board 2 20 can receive a plurality of similar (or different) optical daughter boards 3. In this way, daughter boards 3 of a given system may communicate with one another using light through the mother board 2.

One particular feature of the embodiment of Fig. 12 is 25 that one or more of the daughter board 3 may comprise an additional optical interface 115 other than the one which is to be interfaced with the mother board 2, and which is according to any of the above embodiments. In particular, the supplemental interface 115 may also be of any above-described types, when applicable. This supplemental optical 30 interface 115 is adapted to be optically coupled to another optical system 1' of the type similar to the optical coupling system 1 which has been described above. Such coupling may be performed through an optical cable 131. In 35 such way, the optical system 1 may communicate, using

17

light, through one of its daughter board 3, with another optical system 1', in particular a daughter board thereof.

In the present case, the mirror mount 57 of the first embodiment, which is shown on Fig. 4 is replaced by a
5 mirror mount 157 which direct light from some of the opto-electronic components 13 toward the mother board 2, as before, and some other of these components to the supplementary interface 115.

10

CLAIMS

1. An optical communication system comprising:
- a daughter optical circuit board (3) having:
 - 5 . a top face (3a),
 - . an embedded optical layer (6) extending sensibly parallel to the top face, and having a first optical interface (15),
 - a mother optical circuit board (2), having:
 - 10 . a top face (2a),
 - . an embedded optical layer (10) extending sensibly parallel to the top face,
 - wherein the mother optical circuit board has a first optical interface (51),
 - 15 - an optical coupling system having :
 - . a first optical interface (18) defining a plurality of parallel first optical paths (D1), and optically coupled to said first optical interface (15) of the daughter circuit board (3), and
 - 20 . a second optical interface (19) defining a plurality of parallel second optical paths (D2) and optically coupled to said first optical interface (51) of the mother circuit board (2),
 - . an optical channel being defined between the
 - 25 first and second optical interfaces (18, 19) so that each first optical path corresponds to a corresponding second optical path,
 - wherein the optical coupling system comprises an optical coupling device (17), formed as an integral part of translucent material comprising at least one light beam
 - 30 forming structure (22;27), fixed to the daughter board.
2. Optical communication system according to claim 1, wherein the optical coupling system comprises a reflective arrangement (127) comprising at least one mirror
- 35 adapted to direct light between one of said first and

second optical paths to a transmission direction not parallel to the first optical path,

wherein the first optical path is parallel to and orientated like the corresponding second optical path and offset therefrom with respect to a transverse direction normal to the first optical path.

3. Optical communication system according to claim 2, wherein the optical coupling system is formed so that a transmitted light plane at the second optical interface is parallel to a transmitted light plane at the first optical interface, and offset with respect to that plane.

4. Optical communication system according to claims 2 or 3 wherein the optical coupling system comprises at least two successive reflection surfaces (28,29 ;61,29) between the first and second optical paths.

5. Optical communication system according to claim 1, wherein transmitted light planes at the first and second optical interface of the optical coupling system are common.

6. Optical communication system according to claim 5, wherein light extends straight between the first and second optical interfaces of the optical coupling system.

7. Optical communication system according to any of claims 1 to 6, wherein the mother optical circuit board (2) comprises an optical coupling device (47) having a second optical interface (52), optically coupled to the optical layer of the mother optical circuit board, and a first optical interface (51) optically coupled to the second optical interface (19) of the optical coupling system, an optical channel being defined between the first and second optical interfaces (51, 52).

8. Optical communication system according to any of claims 1 to 7, wherein the top face (2a) of the mother optical circuit board is normal to the top face (3a) of the daughter optical circuit board.

9. Optical communication system according to any of claims 1 to 8, wherein the daughter optical circuit (3) has an edge face (12) which faces the top face (2a) of the mother optical circuit.

5 10. Optical communication system according to any of claims 1-9 wherein the optical coupling system comprises a connector (25) comprising a housing (35), receiving at least part of the optical coupling system.

10 11. Optical communication system according to claim 10 wherein the housing (35) is placed on and attached to the top of the top face (3a) of the daughter optical circuit (3).

15 12. Optical communication system according to claim 11, wherein the top face (3a) of the daughter optical circuit board (3) has positioning marks (63) adapted to position the coupling system (17), and retention features (33) adapted to position the connector (25), with respect to the daughter optical circuit board (3), and wherein the coupling system has positioning devices (62) adapted to
20 cooperate with alignment devices (64) of the connector to align the coupling system to the connector.

25 13. Optical communication system according to claim 11 or 12, wherein feet project from a bottom face of the housing (35) and are configured to cooperate with recesses (33) of the daughter board (2).

14. Optical communication system according to any of claims 1-9, wherein the optical coupling system consists only of said optical coupling device (17).

30 15. Optical communication system according to any of claims 1-13, wherein the optical coupling system further comprises at least one of a flexible optical cable, a mirror mount adapted to be fixed to the daughter optical circuit board.

16. An optical coupling system having:

- a first optical interface (18) defining a plurality of parallel first optical paths (D1), and adapted to be optically coupled to a first optical interface (15) of a first optical circuit board, and

5 - a second optical interface (19) adapted to face a complementary optical interface of a second optical circuit board, said second optical interface (19) defining a plurality of parallel second optical paths (D2) and is adapted to be optically coupled to the complementary
10 optical interface of the second optical circuit board, an optical channel being defined between the first and second optical interfaces so that each first optical path corresponds to a corresponding second optical path,

wherein the system comprises a reflective arrangement
15 (127) comprising at least one mirror adapted to direct light between said first and second optical paths (D1 ; D2) to a transmission direction (Dt) not parallel to the first optical path,

wherein the first optical path (D1) is parallel to and
20 orientated like the corresponding second optical direction (D2) and offset therefrom with respect to a transverse direction normal to the first optical path (D1).

17. Daughter optical circuit board comprising:

- a top face,
25 - an embedded optical layer extending sensibly parallel to the top face, and having a first optical interface to be optically coupled to a mother optical circuit board, and a second optical interface to be optically coupled to a remote optical system,

30 - a set of opto-electronic components,
 - a reflective arrangement adapted to transmit light between some of the opto-electronic components and the first optical interface and between some other of the opto-electronic components and the second optical
35 interface.

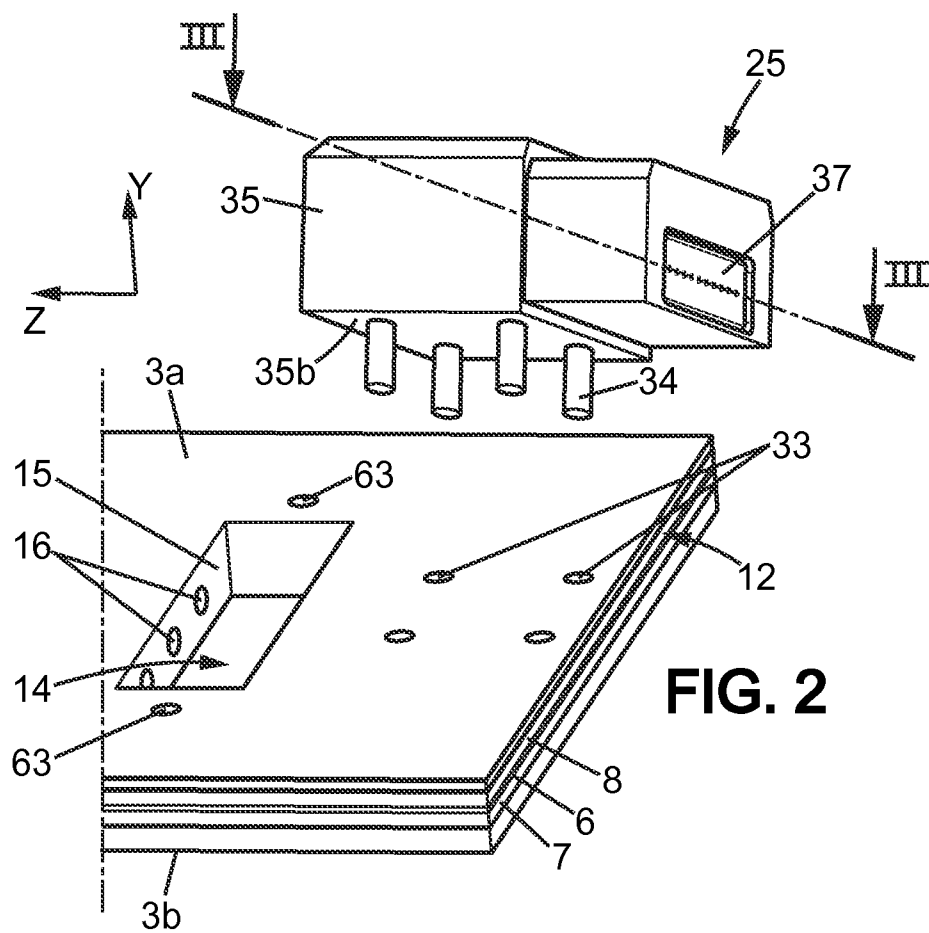
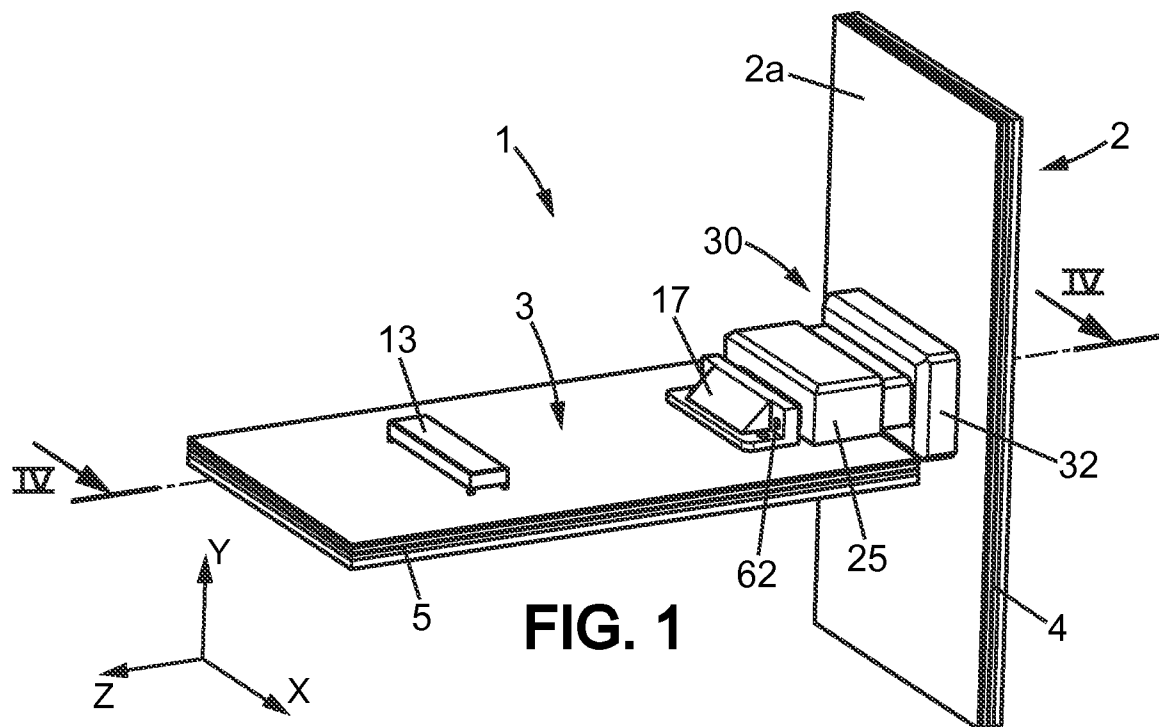


FIG. 3

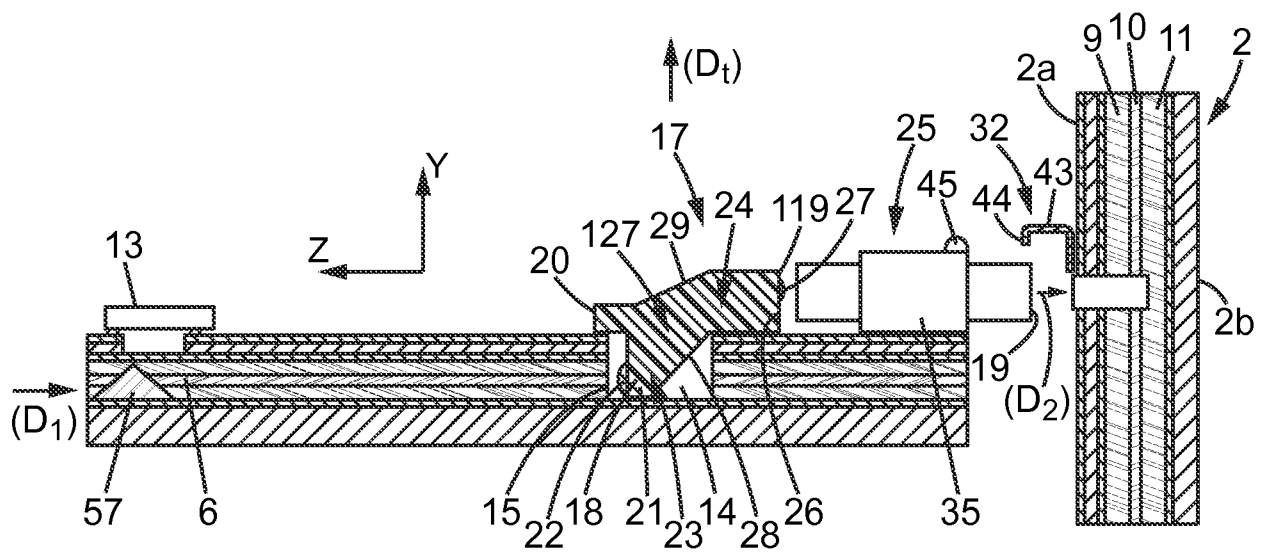
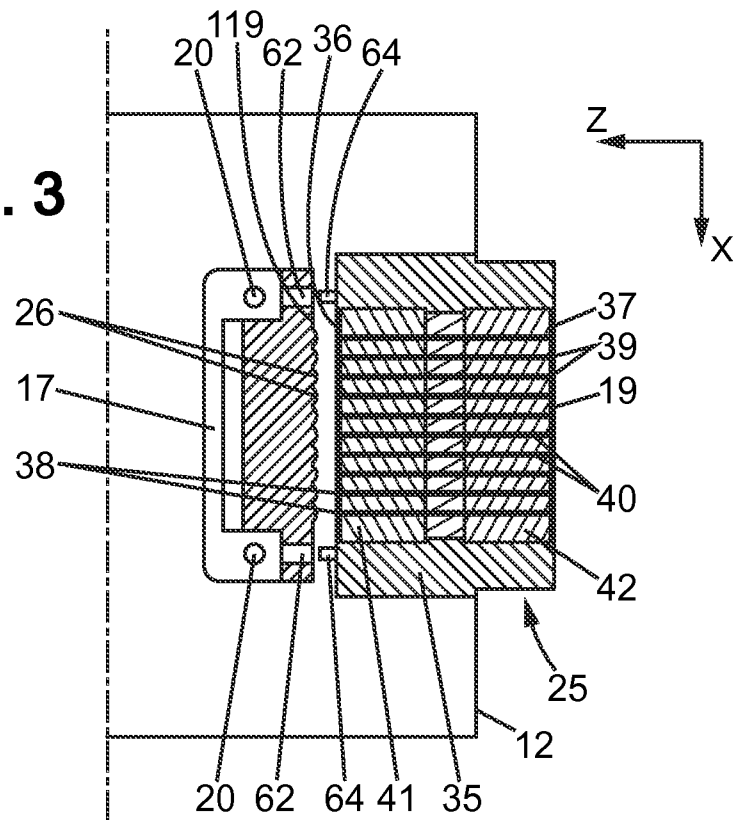


FIG. 4

FIG. 5

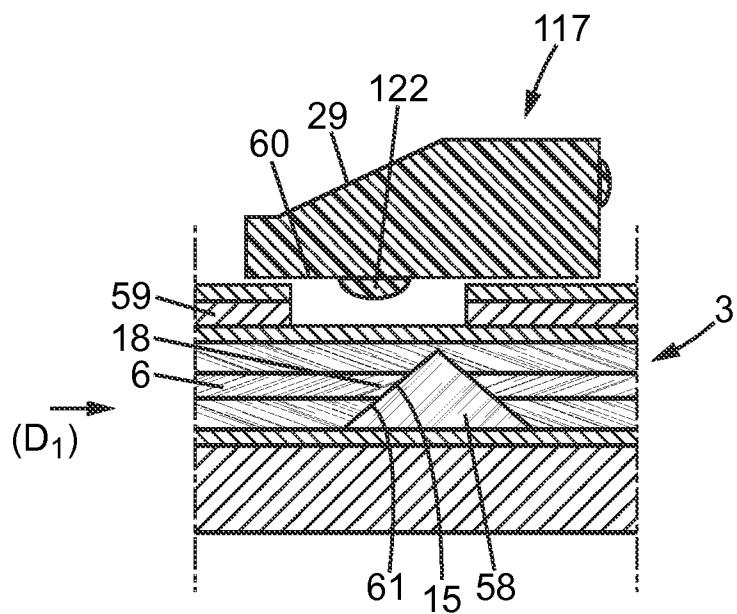
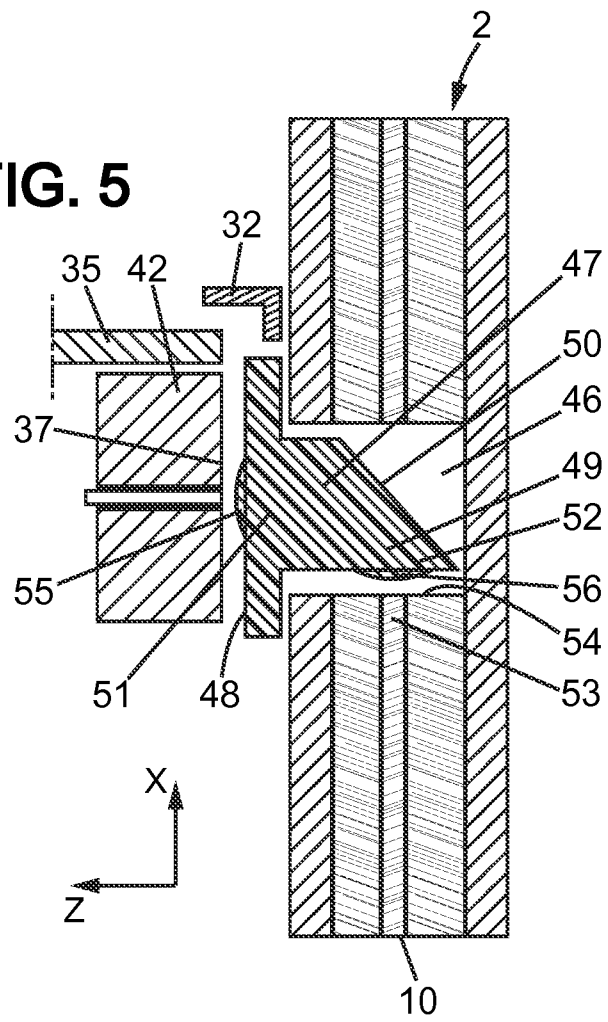


FIG. 6

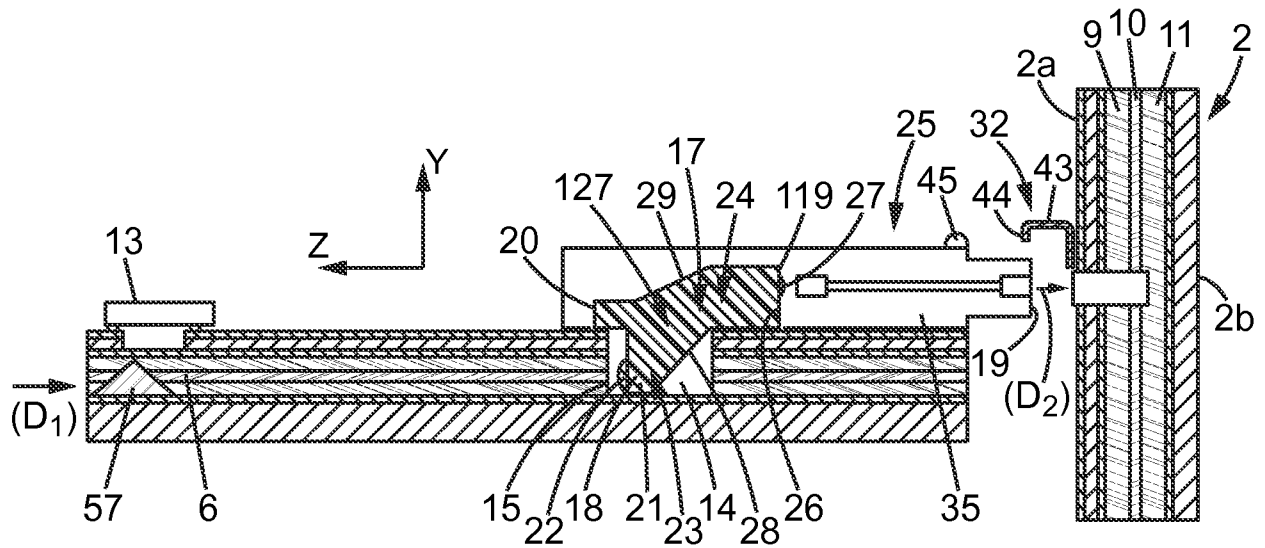


FIG. 7

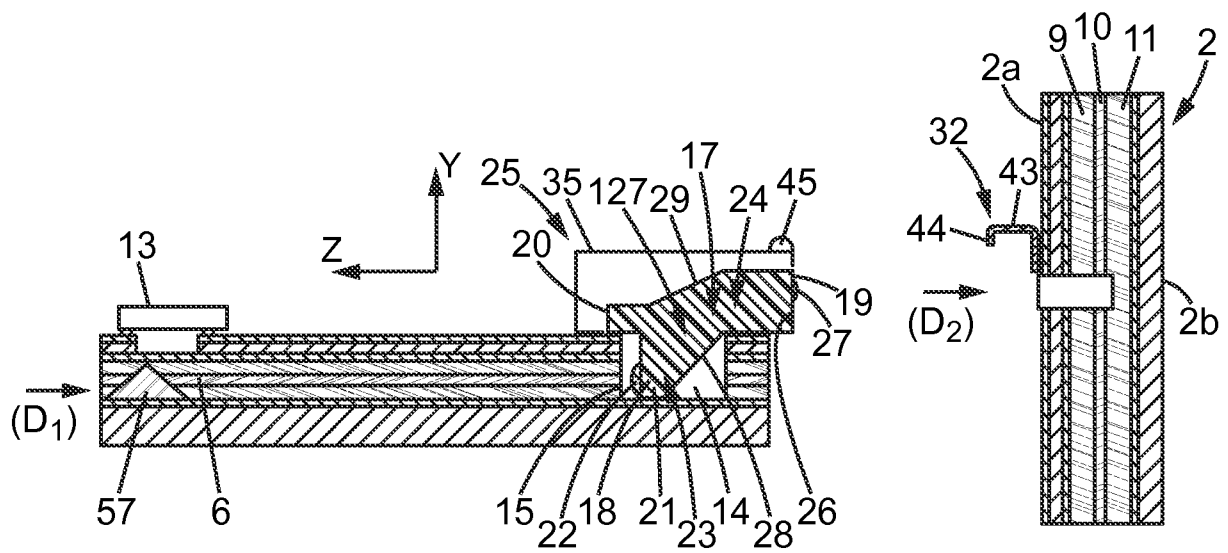


FIG. 8

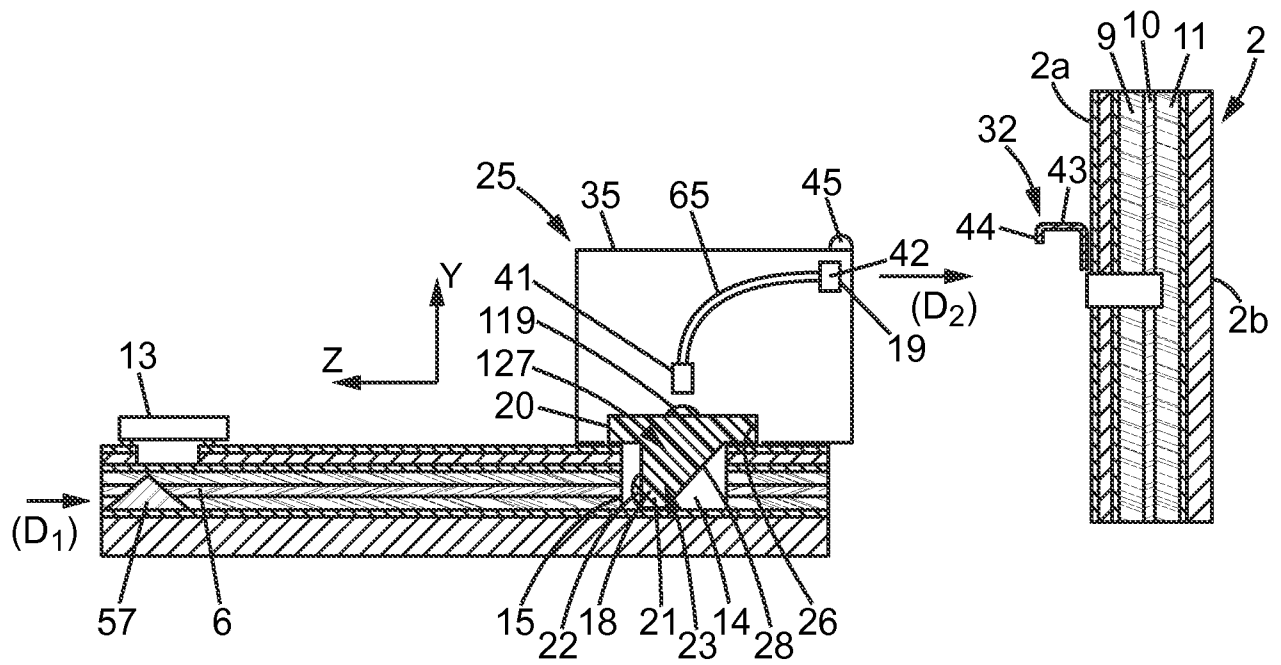


FIG. 9

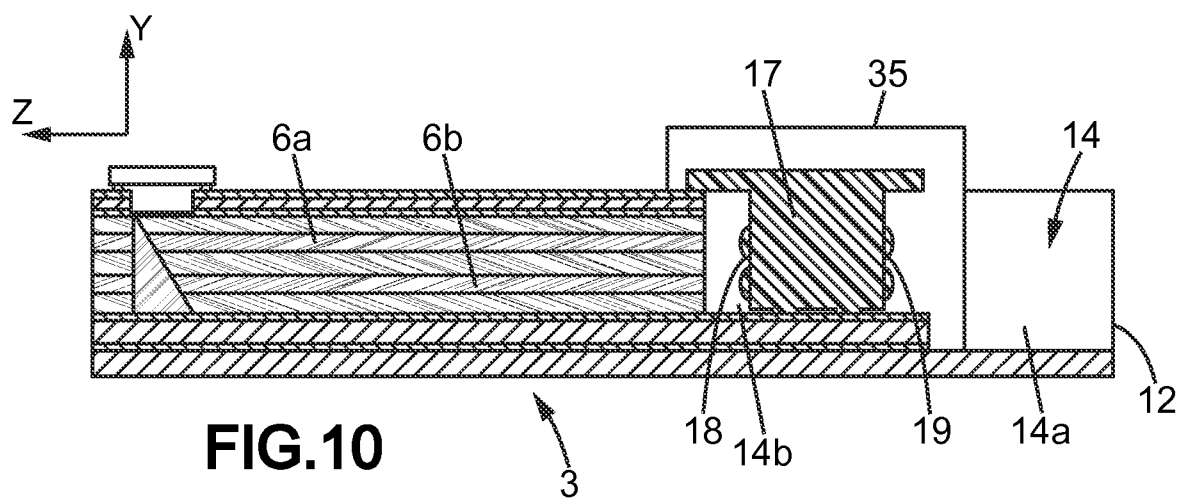
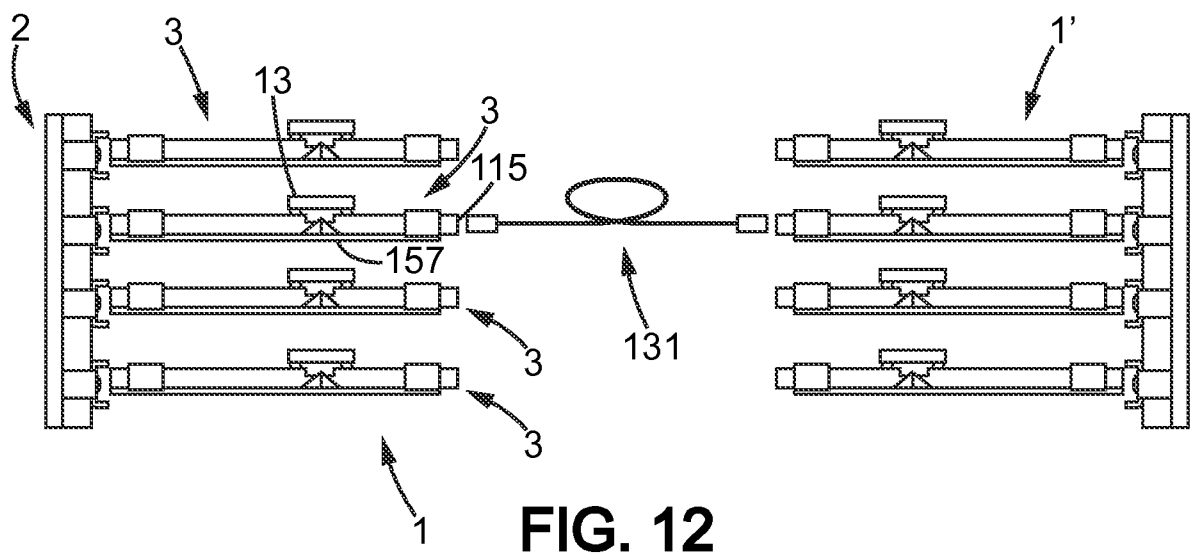
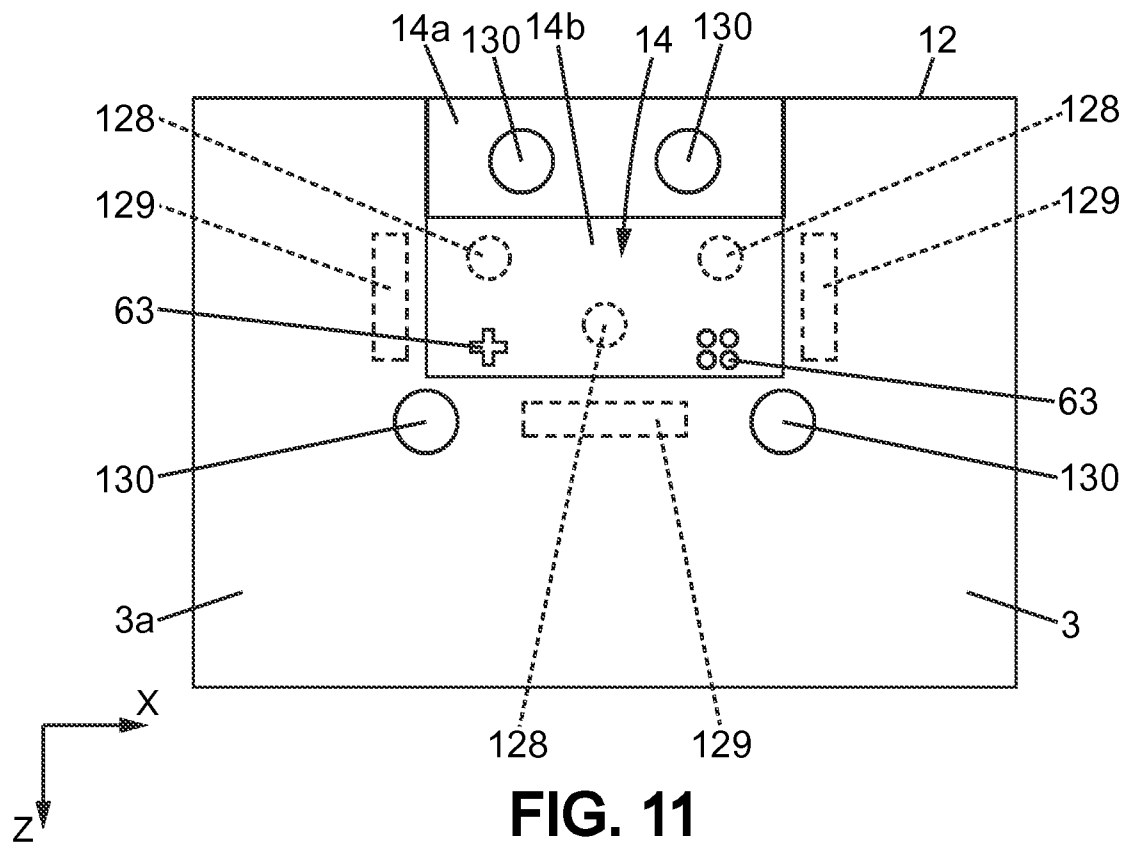


FIG.10



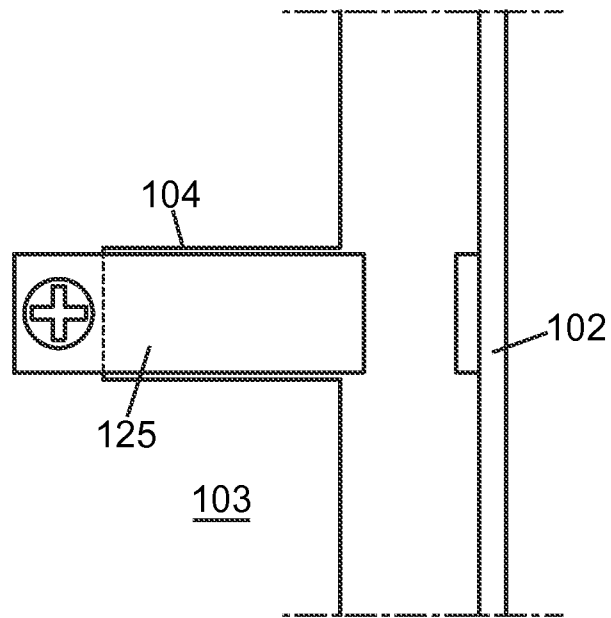


FIG. 13
(PRIOR ART)