



(51) International Patent Classification:
G02B 6/42 (2006.01) *G02B 6/44* (2006.01)

(21) International Application Number:
PCT/US2016/049710

(22) International Filing Date:
31 August 2016 (31.08.2016)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: CCS TECHNOLOGY, INC. [US/US]; 103
Foulk Road Suite 278-T, Wilmington, Delaware 19803
(US).

(72) Inventors: KUBIAK, Tomasz Mateusz; Harcerska 4m 38,
91-710 Lodz (PL). TOSIK, Grzegorz; ul Pienki 5B, 98-113
Buczek (PL).

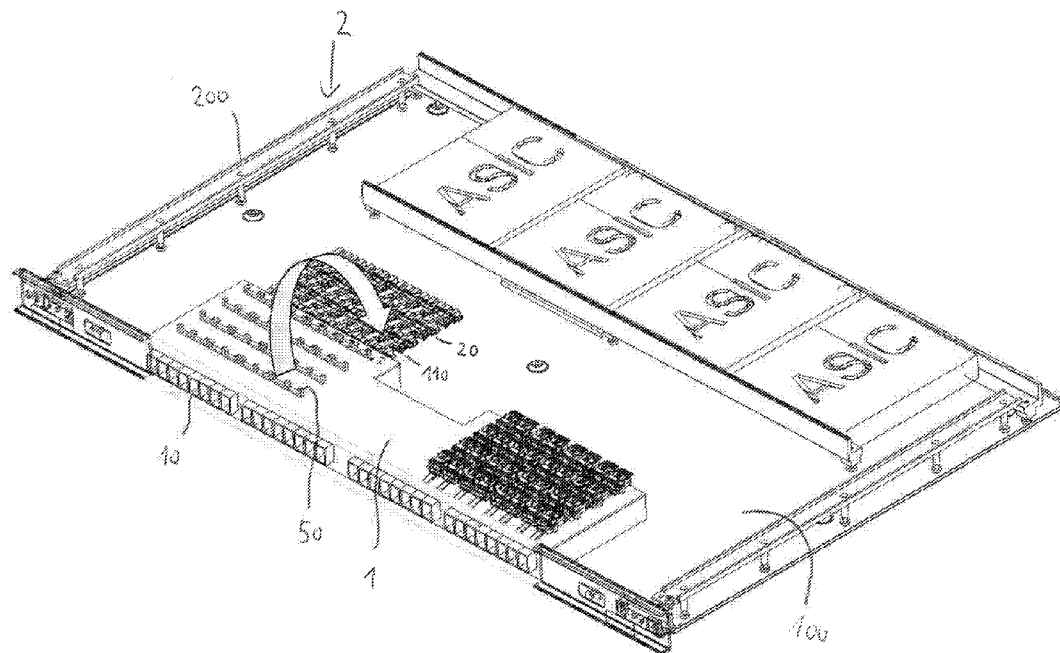
(74) Agent: RAMETTA, Brad Christopher; Corning Optical
Communications LLC, Intellectual Property Department
SP-TI-03-1, Corning, New York 14831 (US).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ,
EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR,
HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA,
LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN,
MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE,
PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE,
SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ,
UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

(54) Title: MID-BOARD OPTICAL MODULE

FIG 8



(57) Abstract: A mid-board optical module (1) comprises a plurality of optical adapters (10) to respectively receive an optical connector, a plurality of optical engines (20), a plurality of optical fibers (30) and a casing (40). A respective one of the optical adapters (10) is arranged in a respective one of first openings (41) of the casing (40). A respective one of the optical engines (20) terminates a respective one of the optical fibers (30) that is guided through a respective one of the second openings (42) of the casing (40). The mid-board optical module (1) may be installed in an opto-electronic assembly (2) without any process with the cabling. The optical engines may be secured in securing elements (50) of the module (1) during transportation and connected to connectors of the opto-electronic assembly after mounting the module (1) in the opto-electronic assembly (2).

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

MID-BOARD OPTICAL MODULE

5 Technical Field

Aspects of the present disclosure relate generally to optical modules, such as mid-board optical modules that allow to embed optical transceiver technologies inside computer and
10 communication systems.

Background

Mid-board optics (MBO), also known as on-board optics (OBO),
15 is a solution that becomes more and more a bridge between pluggable and silicon-photonics platforms for future data centers. The mid-board optics technology allows to mount interchangeable optical modules comprising for example, an optical transmitter, receiver or transceiver, to a printed
20 circuit board assembly (PCBA), such as a line card, a switch fabric card, etc.. The printed circuit board assembly comprises an electronic (printed circuit) board along with all the typical components, such as resistors, capacitors, etc. soldered in place.

25

It is predicted that MBO will be introduced into switches in the near future, estimated in two to four years, and in Silicon Photonics (SiP) platforms in approximately 10 to 15 years. MBO is designed to move the I/O connection from a
30 system's faceplate onto its printed circuit board - allowing systems to achieve ultra-high bandwidth density. The internal I/O connection helps free up faceplate space, enabling more connections and hence overall higher system density.

It is desirable to provide a mid-board optical module that allows embedding high-speed optical transceiver technologies onto a traditional printed circuit board of an opto-
5 electronic assembly, such as a switch and/or a silicon-photonics platform, in an easy way. Another aim is to provide an opto-electronic assembly that allows embedding of high-speed optical transceiver technologies onto a traditional electronic board in an easy way.

10

Summary

An embodiment of a mid-board optical module that allows embedding of high-speed optical transceiver technologies onto
15 an electronic board, such as a traditional printed circuit board, of an opto-electronic module is specified in claim 1.

The mid-board optical module comprises a plurality of optical adapters to respectively receive an optical connector, a
20 plurality of optical engines, a plurality of optical fibers, and a casing comprising a plurality of first and second openings. A respective one of the optical adapters is arranged in a respective one of the first openings of the casing. A respective one of the optical fibers is guided
25 through a respective one of the second openings of the casing so that a respective first section of each of the optical fibers is housed in the casing and a respective subsequent second section of each of the optical fibers is arranged outside the casing. A respective one of the optical engines
30 terminates the second section of a respective one of the optical fibers.

According to a further embodiment, the mid-board optical module comprises at least one cable routing device being arranged in the casing and embodied for guiding and managing the optical fibers in the casing. The at least one cable
5 routing device may be arranged on a fiber management tray inside the casing of the module. The at least one cable routing device allows all cable management to be done inside the module.

10 According to a further embodiment, the mid-board optical module comprises a plurality of securing elements to secure/fix the plurality of optical engines at the casing to manage the optical engines. The securing elements may be mounted/arranged at an upper and/or lower outer surface of
15 the casing, for example a lid of the casing or a bottom side of the casing. The securing elements may be provided with snapping features to secure the optical engines at the casing. The provision of securing elements for securing the optical engines on an outer surface of the casing allows easy
20 transportation and management of the mid-board optical module before being assembled onto an electronic board of an opto-electronic assembly.

An opto-electronic assembly that allows embedding of high-
25 speed optical transceiver technologies onto an electronic board of the opto-electronic assembly in an easy way is specified in claim 14.

The opto-electronic assembly comprises one of the embodiments
30 of the mid-board optical module as described above, an electronic board to perform a signal processing, and a case for housing the mid-board optical module and the electronic board. The case comprises a front panel having at least one

opening. The mid-board optical module is arranged in the case of the opto-electronic assembly such that the optical adapters of the mid-board optical module are arranged in the at least one opening of the front panel of the case.

5

The optical adapters may be mounted at a front surface/panel of the casing of the mid-board optical module. Since the adapters' mounting plate is the front surface/panel of the mid-board optical module, the opto-electronic assembly may just be provided with a case having a front panel with one big cut-out/opening in which the optical adapters are arranged when the mid-board optical module is mounted on the electronic board of the opto-electronic assembly.

10

15 The optical fibers respectively comprise a first section being housed in the casing of the mid-board module and a second section protruding out of the second openings of the mid-board optical module. The respective first section of the optical fibers is connected to a respective optical adapter/connector being arranged at the front surface/panel of the mid-board optical module. The respective second section of the optical fibers is connected to a respective one of the optical engines. The optical engines are configured to be plugged into respective connectors/slots arranged on the (printed circuit) electronic board of the opto-electronic assembly.

20

25

The mid-board optical module offers a ready-to-install solution that does not require any additional actions other than installing the mid-board optical module into the case of the opto-electronic assembly, and connecting the desired optical engines to the appropriate connectors arranged on the electronic board of the opto-electronic assembly.

30

Additional features and advantages are set forth in the Detailed Description that follows, and in part will be readily apparent to those skilled in the art from the description or recognized by practicing the embodiments as described in the written description and claims hereof, as well as the appended drawings. It is to be understood that both the foregoing general description and the following Detailed Description are merely exemplary, and are intended to provide an overview or framework to understand the nature and character of the claims.

Brief Description of the Drawings

The accompanying Figures are included to provide a further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiments, and together with the Detailed Description serve to explain principles and operations of the various embodiments. As such, the disclosure will become more fully understood from the following Detailed Description, taken in conjunction with the accompanying Figures, in which:

Figure 1 shows a perspective view of an embodiment of a mid-board optical module with a first portion of optical engines mounted to securing elements and a second portion of optical engines being removed from the securing elements;

Figure 2 shows a cross-sectional view of an embodiment of a mid-board optical module with a portion of optical engines to be mounted to securing elements;

Figure 3 shows an embodiment of an upper surface/lid of a mid-board optical module with securing elements arranged thereon.

5 Figure 4 shows an embodiment of a casing of a mid-board optical module with fiber routing devices to manage the arrangement of the optical fibers inside the casing.

Figure 5 shows an embodiment of a casing of a mid-board
10 optical module with optical adapters being mounted in openings of the casing.

Figure 6 shows an opto-electronic assembly with a mid-board optical module to be mounted on an electronic board of the
15 opto-electronic assembly.

Figure 7 shows an embodiment of an opto-electronic assembly with a mid-board optical module being inserted in openings of a front panel of a case of the opto-electronic assembly.

20

Figure 8 shows an opto-electronic assembly with a portion of optical engines of a mid-board optical module being mounted to connectors of the electronic board of the opto-electronic assembly.

25

Detailed Description

Figure 1 shows an embodiment of a mid-board optical module 1 in a perspective view, and Figure 2 shows a cross-sectional
30 view of the embodiment of the mid-board optical module 1. The module 1 comprises a plurality of optical connectors/adapters 10 to respectively receive an external optical connector, not shown in Figure 1. The mid-board optical module 1 further

comprises a plurality of optical engines 20. The optical engines 20 may respectively be configured to convert an optical signal into an electrical signal and/or to convert an electrical signal into an optical signal. The mid-board

5 optical module 1 comprises a plurality of optical fibers 30, wherein a first section 31 of each of the optical fibers 30 is housed in a casing 40 of the module 1 and a respective subsequent second section 32 of each of the optical fibers 30 is arranged outside the casing 40.

10

The casing 40 comprises a plurality of first openings 41. A respective one of the optical adapters 10 is arranged in a respective one of the first openings 41 of the casing 40. The casing 40 further comprises a plurality of second openings

15 42. A respective one of the optical fibers 30 is guided through a respective one of the second openings 42 of the module so that the respective first section 31 of each of the optical fibers 30 is housed in the casing 40 and the respective second section 32 of each of the optical fibers 30 is arranged outside the casing 40. The second section 32 of a
20 respective one of the optical fibers 30 is terminated by one of the optical engines 20.

A respective one of the optical engines 20 may comprise an
25 opto-electronic receiver 21 to receive an optical signal transferred through the respective one of the optical fibers 30 that is terminated by the respective one of the optical engines 20. The optical receiver 21 is configured to convert the optical signal into an electrical signal. According to a
30 possible embodiment, the opto-electronic receiver 21 may be configured as a vertical cavity surface emitting laser.

A respective one of the optical engines 20 may further comprise an opto-electronic transmitter 22 being configured to convert an electrical signal into an optical signal and to couple the optical signal in the respective one of the
5 optical fibers 30 that is terminated by the respective one of the optical engines 20. The opto-electronic transmitter 22 may be configured as a photodiode.

According to another embodiment, the optical engines 20 may
10 respectively comprise an optical transceiver 23 being configured to convert an optical signal that is transferred to the optical fiber being terminated by the optical engine in an electrical signal, and to convert an electrical signal into an optical signal. The optical signal is coupled into
15 the optical fiber being terminated by the optical engine 20.

The casing 40 comprises an upper outer surface 43, a lower outer surface/bottom surface 44, a front surface/panel 45, a back surface/panel 46 and lateral surfaces 47. The first
20 openings 41 are provided in the front surface/panel 45 and the second openings 42 are provided in the back surface/panel 46 of the casing 40.

Figure 3 shows a perspective view of the upper surface 43 of
25 the casing 40. The upper surface 43 may be configured as a lid of the casing 40. As shown in Figures 1 and 3, the mid-board optical module comprises a plurality of securing elements 50 to secure/fix the plurality of optical engines 20 at the casing 40. The securing elements 50 may be mounted at
30 the upper outer surface 43 of the casing 40 and/or at the lower outer surface 44 of the casing 40. According to a possible embodiment of the mid-board optical module 1, each of the securing elements 50 may comprise a respective slot

being configured for inserting a respective one of the optical engines 20. The shape and form of each of the securing elements 50 is dependent on the shape of the optical engines 20 to be secured at the casing 40.

5

As shown in Figures 1 and 3, the securing elements 50 may be arranged in an array in which the securing elements 50 are arranged in several columns C1, ..., C8 and rows R1, R2, R3, R4 on the upper and/or lower surface 43, 44 of the casing 40.

10 Figures 1 and 3 show an embodiment of the mid-board optical module, wherein the securing elements 50 are arranged in two arrays being spaced apart from each other, wherein each of the arrays comprises four rows R1, ..., R4 and eight columns C1, ..., C8. However, the arrangement of the securing elements
15 shown in the Figures is only illustrated as an example and not limited to two arrays of respectively four rows and eight columns.

An upper/first row R1 of the securing elements 50 is arranged
20 near a first rim 48 of the upper and/or lower surface 43, 44 of the casing 40, wherein the first rim 48 borders the front surface/panel 45 of the casing 40. A second/lower row R4 of the securing elements 50 is arranged near a second rim 49 of the upper and/or lower surface/panel 43, 44 of the casing 40.
25 The rim 49 borders the back surface/panel 46 of the casing 40. The remaining securing elements 50 are arranged in rows R2, R3 between the upper row R1 and the lower row R4 of the securing elements.

30 As best illustrated in Figure 2, a certain number of the second sections 32 of optical fibers 30 is led through each of the second openings 42 outside of the casing 40. The number of the second sections 32 of the optical fibers 30 is

equal to the number of rows of the securing elements arranged on the top or bottom surface 43, 44 of the casing. In the exemplified embodiment of the mid-board optical module of Figures 1 and 2, each array of the securing elements 50
5 arranged on the upper surface 43 on the left and right hand side comprises four rows R1, R2, R3 and R4. Accordingly, four optical fibers 30a, 30b, 30c and 30d are led through each of the openings 42. Each end section 32 of the optical fibers 30a, 30b, 30c and 30d is terminated by a respective optical
10 engine 20a, 20b, 20c and 20d.

As illustrated in Figure 2, the second sections 32 of the optical fibers 30a, 30b, 30c and 30d led through each of the openings 42 have a different length. The second section 32 of
15 a first optical fiber 30a has a first length that is longer than the length of the second section 32 of the other optical fibers 30b, 30c and 30d. The second section 32 of the optical fiber 30d is shorter than the respective length of the second sections 32 of the other optical fibers 30a, 30b and 30c.

20

As illustrated in Figure 1, a respective one of the columns C1, ..., C8 of the securing elements 50 is assigned to a respective one of the openings 42. The respective length of the second section 32 of the optical fibers 30a, 30b, 30c and
25 30d is adapted to secure each one of the optical engines 20a, 20b, 20c and 20d to a respective one of the securing elements being arranged in a column that is assigned to the respective one of the openings 42 out of the which the optical fibers 30a, 30b, 30c and 30d are guided.

30

As illustrated in Figure 2, the length of the second section 32 of the optical fiber 30a is adapted to secure the optical engine 20a in the securing element 50a being arranged in the

first row R1 and the first column C1 of the array of the securing elements. The second section 32 of the optical fiber 30b has a length being adapted to secure the optical engine 20b to the securing element 50b being arranged in the row R2 and the column C1. The second section 32 of the optical fiber 30c has a length being adapted to secure the optical engine 20c to the securing element 50c being arranged in the row R3 and the column C1 of the array of the securing elements 50. The second section 32 of the optical fiber 30d has a length being adapted to secure the optical engine 20d to the securing element 50d being arranged in the row R4 and the column C1 of the array of the securing elements. **(Remark to inventors: I recommend to provide an amended Figure 2 in which the securing elements/slots 50a, ..., 50d are shown without the optical engines so that it is clear from Figure 2 that the optical engines 20a, ..., 20d have to be installed in the respective empty slots 50a, ..., 50d).**

Figure 4 shows a portion of the casing 40 comprising the lower surface 44, the front surface/panel 45, the back surface/panel 46 and the lateral surfaces 47. As illustrated in Figure 2, the first openings 41 are provided in the front surface/panel 43 and the second openings 42 are provided in the back surface/panel 44 of the casing 40.

To ensure EMI protection at high data rate, it is necessary to avoid any large openings, such as MTP or prism connectors having big dimensions. According to the embodiment of the mid-board optical module 1, the openings 41 are adapted for receiving an optical connector/adapter, for example an MXC receptacle. The openings 41 are not bigger than the cross-section of an optical connector/adapter 10 to be received in the openings 41. Furthermore, the openings 42 are not bigger

than an outer diameter of an optical fiber that is led through the opening 42. As illustrated in Figure 4, the openings 42 are configured as small slits having a width of about 250 μm , i.e. a typical outer diameter of an optical fiber. The casing with the small openings 41 and 42 allows EMI protection at high frequency, especially at frequencies higher than 5 GHz. In order to improve the EMI protection, the material of the housing comprises electrically conductive components.

10

According to the embodiment of the mid-board optical module 1 shown in Figure 4, the module comprises at least one fiber routing device 60 being embodied for guiding the optical fibers 30 in the casing 40. The at least one fiber routing device 60 may be arranged on an inner surface I44 of the casing 40. According to the embodiment of the mid-board optical module 1 shown in Figure 4, the casing includes tube-shaped structures, for example elements with small gaps there between, that are arranged on the inner surface I44 of the casing 40 in the shape of a tube to manage the arrangement of the optical fibers inside the casing. The fiber routing devices 60 inside the casing 40 provide compact fiber management for high density interconnects and very tight tolerances on ribbon lengths between front panel and optical engines, as required by PCB design.

25

Figure 5 shows another embodiment of the casing 40 of the mid-board optical module, wherein the optical connectors/adapters 10 are inserted in the openings 41 of the front surface/panel 43 of the casing 40. For simplification purposes, the fiber routing devices 60 are not shown in the casing 40. The optical connectors/adapters 10 may respectively be embodied as MXC receptacles.

30

Figures 6 to 8 show the mounting of the mid-board optical module 1 in a case 200 of an opto-electronic assembly 2. The opto-electronic assembly 2 comprises an electronic board 100, for example a printed circuit board, to perform a signal processing of optical signals that are converted by the optical engines 20 into electrical signals. The case 200 is configured for housing the mid-board optical module 1 and the electronic board 100.

The case 200 comprises a front panel 210 having at least one opening 211. As shown in Figures 6 to 8, the mid-board optical module 1 is arranged in the case 200 of the opto-electronic assembly 2 such that the optical adapters/connectors 10 of the mid-board optical module 1 are arranged in the at least one opening 211 of the front panel 210. According to the exemplified embodiment of the opto-electronic assembly 2, the case 200 comprises four openings 211. After being mounted to the electronic board 100, the four segments of the optical connectors/adapters 10 are arranged in the four openings 211 of the case 200.

The arrows shown in Figures 6 and 7 indicate the movement direction for inserting the mid-board optical module 1 in the case 200 to mount the mid-board optical module on the electronic board 100. The arrow shown in Figure 6 indicate the movement trail of the module 1. The arrow shown in Figure 7 indicates the direction of the last movement of the module 1 needed to secure the mid-board optical module 1 into the target opto-electronic assembly 2.

During transportation of the mid-board optical module 1 and mounting of the mid-board optical module 1 to the electronic

board 100 of the opto-electronic assembly 2, the optical engines 20 are secured in the securing elements 50 on the upper surface 41 of the casing 40 to prevent any damage of the optical engines 20 and to provide protection of the optical engines during transportation and installation of the module 1 in the case 200 of the opto-electronic assembly 2. The electronic board 100 comprises connectors 110 to couple the optical engines 20 to the electronic board 100. The arrow shown in Figure 8 demonstrates the movement trail of the optical engines 20 to electrically connect the optical engines to the connectors 110 on the electronic board 100.

The conception of the mid-board optical module 1 is to provide a supplier with a mid-board optical module that, after receiving the shipment, is ready to be installed in an appropriate opto-electronic assembly without any process with the cabling. The front surface/panel 45 has only to be mounted in the front plate of the case 200 of the opto-electronic assembly 2 with the optical connectors/adapters 10 being ready to be connected to outside cables. The outside cables may be terminated with connectors that may be inserted in the optical connectors/adapters 10.

The top or bottom surface 43, 44 of the mid-board optical module 1 is equipped with securing elements 50 whose shape is dependent on the optical engines 20 that are to be mounted to the electronic board 100. The fitting is easy enough that the optical engines can be removed from the securing elements 50 by hand, and secure enough to be shipped without special protection other than standard. After mounting the mid-board optical module 1 in the target opto-electronic assembly 2, the optical engines 20 can be unplugged from the securing elements 50 of the module 1 and secured in target

slots/connectors 110 on the electronic board 100 of the opto-electronic assembly 2. The fiber management by means of fiber routing devices inside the casing of the mid-board optical module ensures exact length between module and transceivers
5 arranged on the electronic board 100. All cable management is done inside the casing of the mid-board optical module.

The opto-electronic module 1 solves the problem of shipping readymade components to the target manufacturer site, the
10 client side assembly or client side warehouse management and enables to set up warranty sealing easily, and gives control of the equipment. The mid-board optical module 1 enables an easy assembly on an electronic board of an opto-electronic assembly as well as easy transportation and management during
15 assembly.

The optical engines 20 are protected during transportation by being fixed in the securing elements 50 at the casing of the mid-board optical module. Due to the placement of the optical
20 engines 20 in the same pattern on the securing elements 50, the risk of wrong mounting on the electronic board 100 is very low.

Full control over the quality of a product is obtained, as
25 the final module assembly may be done in-plant. The casing 200 of the opto-electronic assembly may be manufactured by a simplified machining process, because the optical connectors/adapters 10 are included in the mid-board optical module so that a few, or only one, large cut-out/opening is
30 needed on the front panel of the case of an opto-electronic assembly for inserting the optical connectors/adapters 10.

List of Reference Signs

	1	mid-board optical module
	2	opto-electronic assembly
5	10	optical connector/adapter
	20	optical engine
	30	optical fiber
	40	casing
	50	securing elements
10	60	fiber routing device
	100	electronic board
	200	case

Claims

1. A mid-board optical module, comprising:
 - a plurality of optical adapters (10) to respectively
 - 5 receive an optical connector,
 - a plurality of optical engines (20),
 - a plurality of optical fibers (30),
 - a casing (40) comprising a plurality of first and second openings (41, 42),
 - 10 - wherein a respective one of the optical adapters (10) is arranged in a respective one of the first openings (41) of the casing (40),
 - wherein a respective one of the optical fibers (30) is guided through a respective one of the second openings (42)
 - 15 of the casing (40) so that a respective first section (31) of each of the optical fibers (30) is housed in the casing (40) and a respective subsequent second section (32) of each of the optical fibers (30) is arranged outside the casing (40),
 - wherein a respective one of the optical engines (20)
 - 20 terminates the second section (32) of a respective one of the optical fibers (30).
2. The mid-board optical module as claimed in claim 1, comprising:
 - 25 a plurality of securing elements (50) to secure the plurality of optical engines (20) at the casing (40).
3. The mid-board optical module as claimed in claim 2,
 - wherein the casing (40) comprises an upper and lower outer
 - 30 surface (43, 44), a front surface (45), a back surface (46) and lateral surfaces (47),

- wherein the plurality of the securing elements (50) is mounted at the upper and/or lower outer surface (43, 44) of the casing (40),
- wherein the first openings (41) are provided in the front surface (43) and the second openings (42) are provided in the back surface (44) of the casing (40).

4. The mid-board optical module as claimed in claim 2 or 3, wherein each of the securing elements (50) is embodied as a respective slot being configured for inserting a respective one of the optical engines (20).

5. The mid-board optical module as claimed in claim 1, comprising:
at least one fiber routing device (60) being arranged inside the casing and embodied for guiding the optical fibers (30) in the casing (40).

6. The mid-board optical module as claimed in claim 1, wherein the casing (40) is configured to provide electromagnetic interference protection of the first sections (31) of the optical fibers.

7. The mid-board optical module as claimed in claim 1, wherein the optical adapters (10) are respectively embodied as an MXC receptacle.

8. The mid-board optical module as claimed in claim 1, - wherein a respective one of the optical engines (20) comprises an opto-electronic receiver (21) to receive an optical signal transferred through the respective one of the optical fibers (30) that is terminated by the respective one of the optical engines (20), wherein the optical receiver

(21) is configured to convert the optical signal in an electrical signal,

- wherein a respective one of the optical engines (20) comprises an opto-electronic transmitter (22) being

5 configured to convert an electrical signal in an optical signal and to couple the optical signal in the respective one of the optical fibers (30) that is terminated by the respective one of the optical engines (20).

10 9. The mid-board optical module as claimed in claim 8,

- wherein the opto-electronic receiver (21) is configured as a vertical cavity surface emitting laser,

- wherein the opto-electronic transmitter (22) is configured as a photodiode.

15

10. The mid-board optical module as claimed in claim 1,

- wherein the securing elements (50) are arranged in several columns (C1, ..., C8) and rows (R1, ..., R4) on the upper and/or lower surface (43, 44) of the casing (40),

20 - wherein a first row (R1) of the securing elements (50) is arranged near a first rim (48) of the upper and/or lower surface (43, 44) of the casing (40) bordering the front surface (45) of the casing (40),

- wherein a second row (R4) of the securing elements (50) is
25 arranged near a second rim (49) of the upper and/or lower surface (43, 44) of the casing (40) bordering the back surface (46) of the casing (40).

11. The mid-board optical module as claimed in claim 10,

30 wherein the optical fibers (30) are arranged so that a number of the optical fibers (30) is led through each of the second openings (42), the number of the optical fibers (30) being

equal to the number of rows (R1, ..., R4) of the securing elements.

12. The mid-board optical module as claimed in claim 1,
5 wherein the second sections (32) of the optical fibers (30) that are led through a respective one of the second openings (42) of the casing (40) have a different length.

13. The mid-board optical module as claimed in claim 10,
10 - wherein a respective one of the columns (C1, ..., C8) of the securing elements (50) is assigned to a respective one of the second openings (42),
- wherein the second section (32) of a first one of the optical fibers (30a) that is led through the respective one
15 of the second openings (42) and arranged outside of the casing (40) has a first length being adapted to secure a first one of the optical engines (20a) terminating the second section (32) of the first one of the optical fibers (30a) to a first one of the securing elements (50a) being arranged in
20 the first row (R1) and the respective one of the columns (C1) of the securing elements,
- wherein the second section (32) of a second one of the optical fibers (30d) that is led through the respective one of the second openings (42) of the casing and arranged
25 outside of the casing has a second length being adapted to secure a second one of the optical engines (20d) terminating the second section (32) of the second one of the optical fibers (30d) to a second one of the securing elements (50d) being arranged in the second row (R4) and the respective one
30 of the columns (C1) of the securing elements,
- wherein the first length of the second section (32) of the first one of the optical fibers (30a) is longer than the

length of the second section (32) of the second one of the optical fibers (30d).

14. An opto-electronic assembly, comprising:

- 5 - the mid-board optical module (1) as claimed in any of the claims 1 to 13,
- an electronic board (100) to perform a signal processing,
- a case (200) for housing the mid-board optical module (1) and the electronic board (100),
- 10 - wherein the case (200) comprises a front panel (210) having at least one opening (211),
- wherein the mid-board optical module (1) is arranged in the case (200) of the opto-electronic assembly (2) such that the optical adapters (10) of the mid-board optical module (1) are
- 15 arranged in the at least one opening (211) of the front panel (210) of the case (200).

15. The opto-electronic assembly as claimed in claim 14,

- wherein the electronic board (100) comprises at least one
- 20 connector (110),
- wherein at least one of the optical engines (20) of the mid-board optical module (1) is inserted in the at least one connector (110) of the electronic board (100).

FIG 2

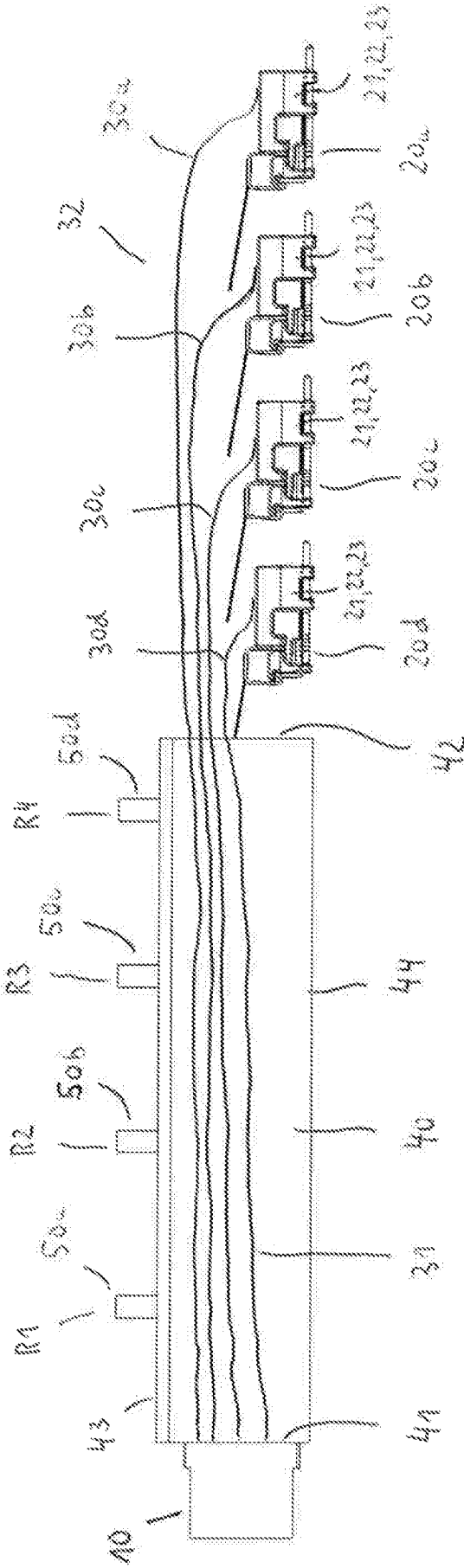


FIG 3

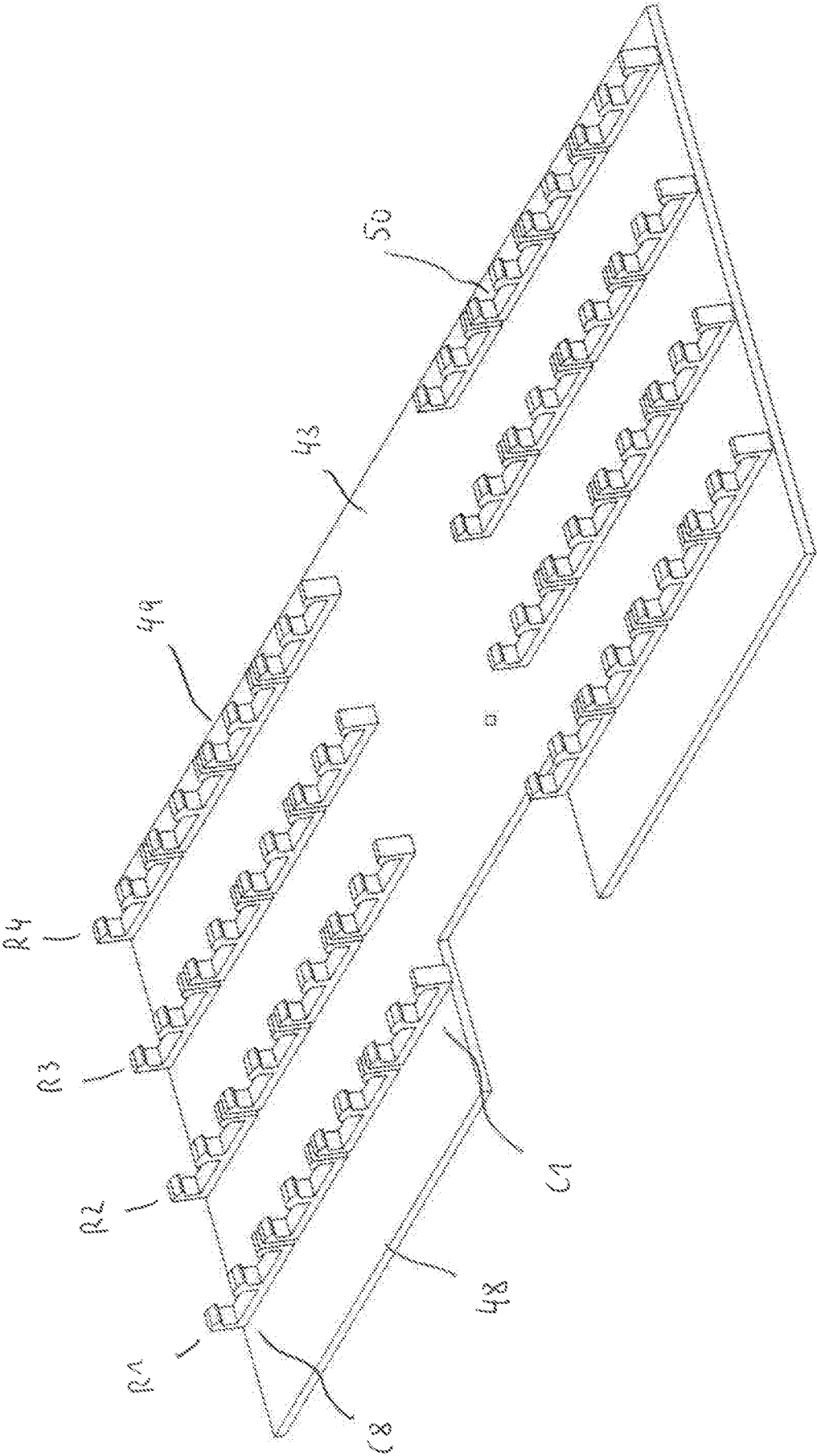


FIG 4

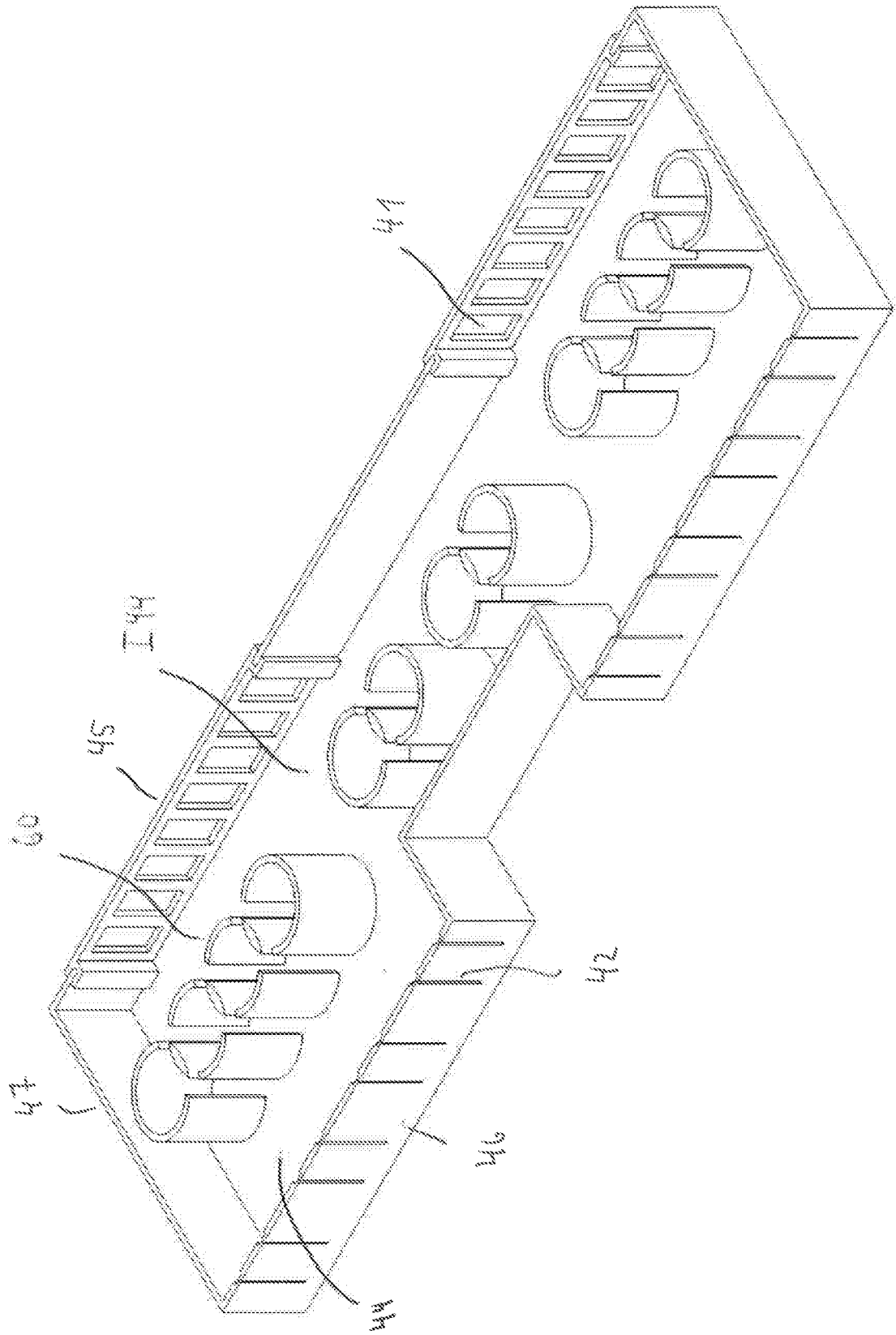


FIG 5

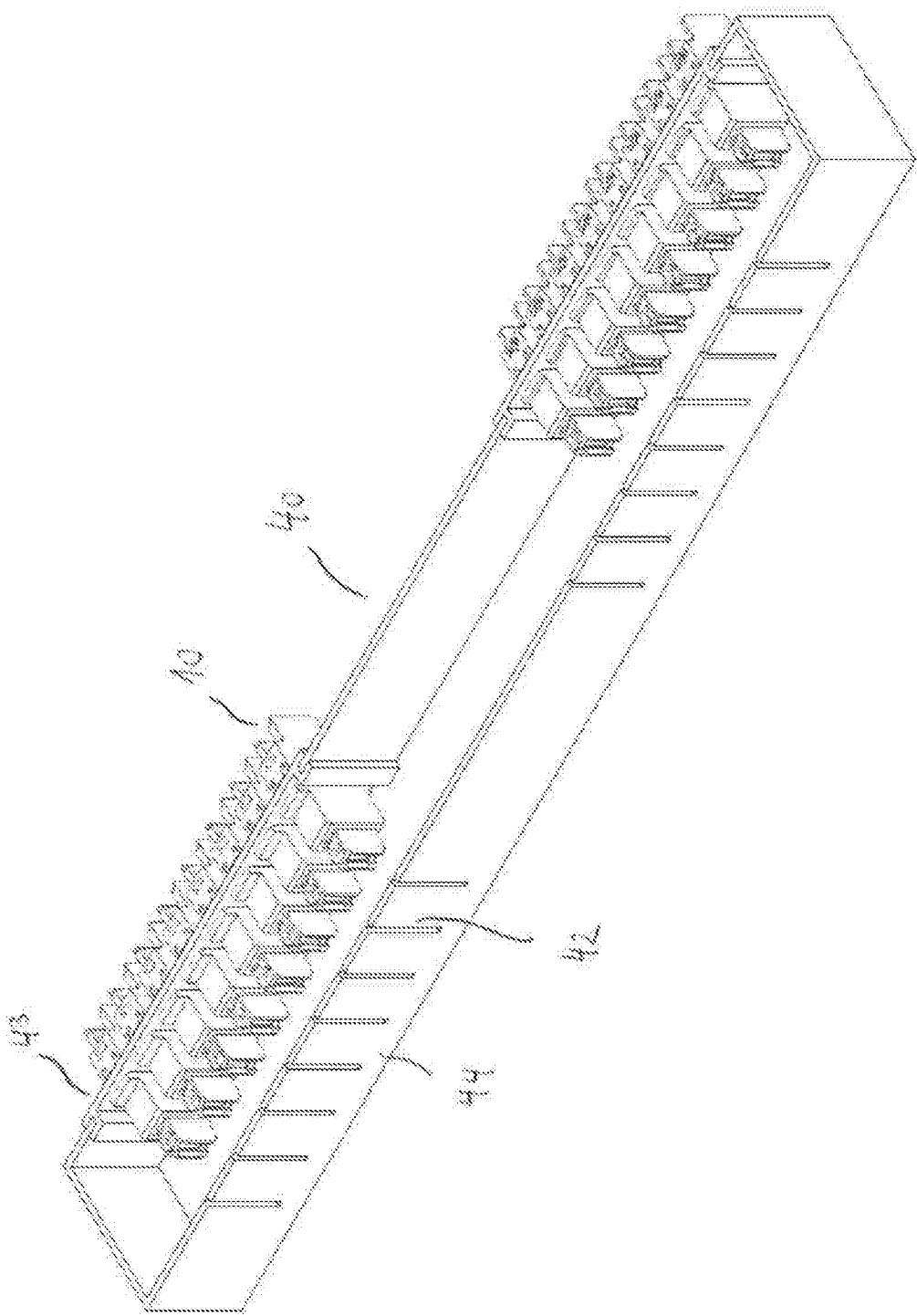
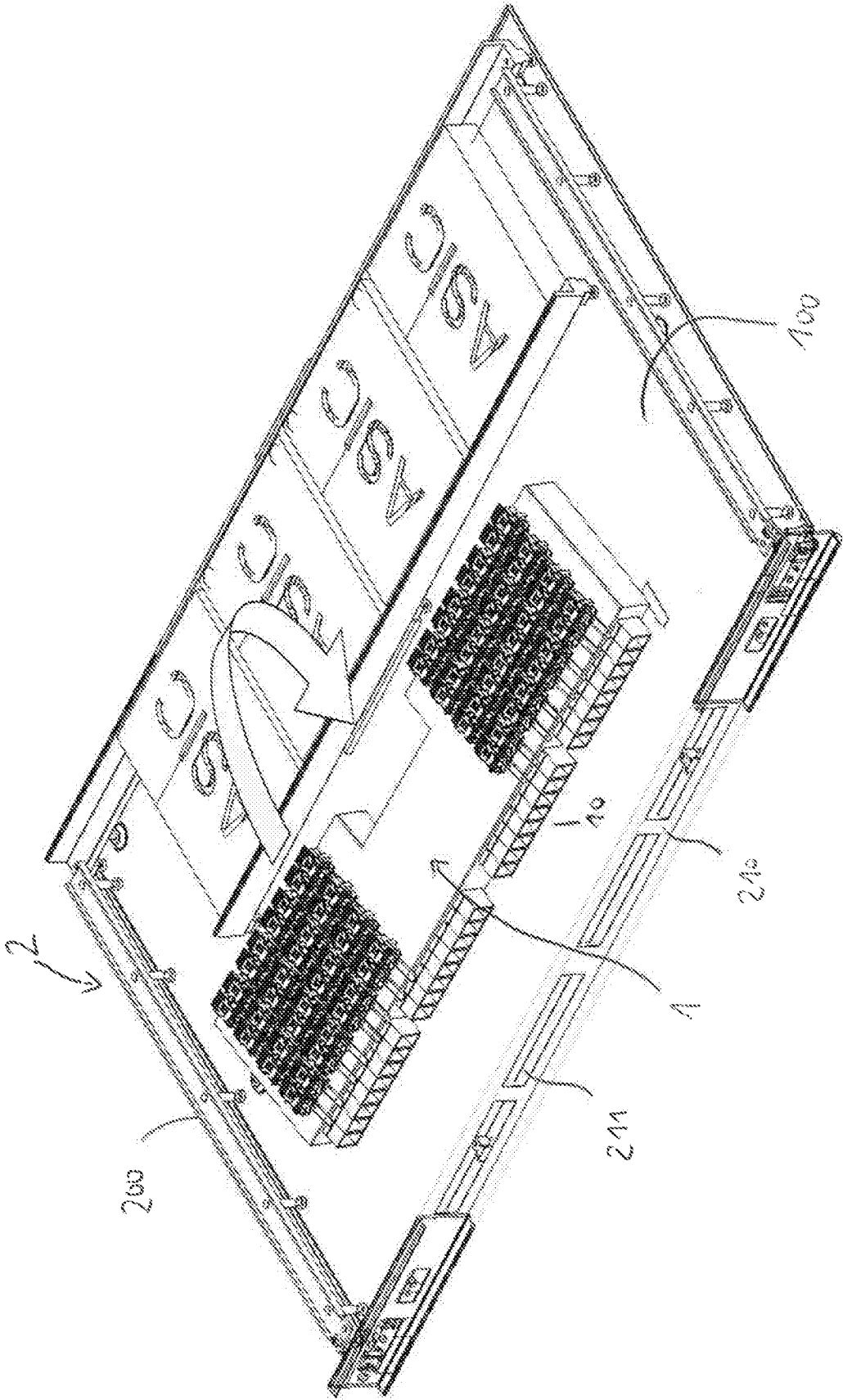
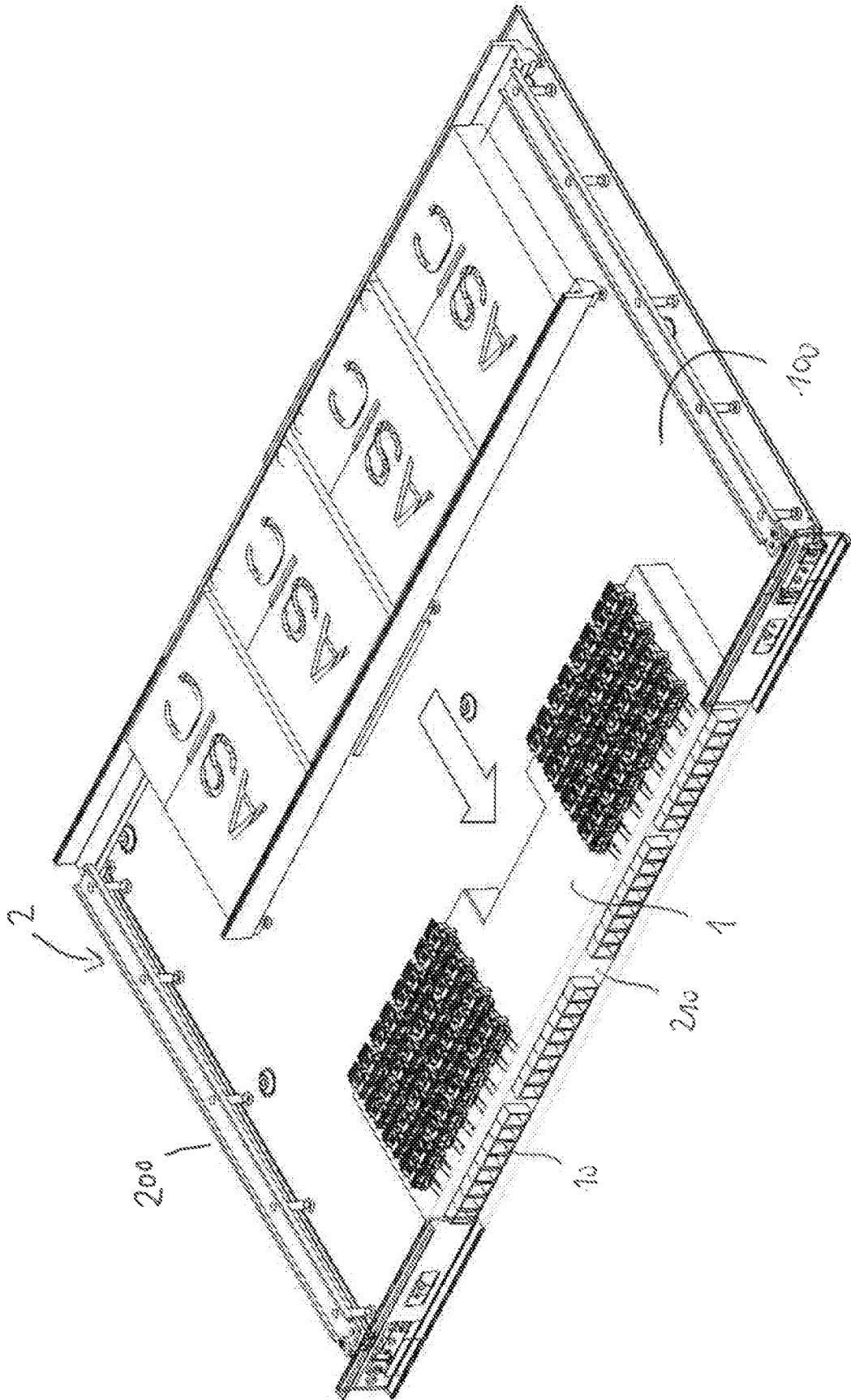
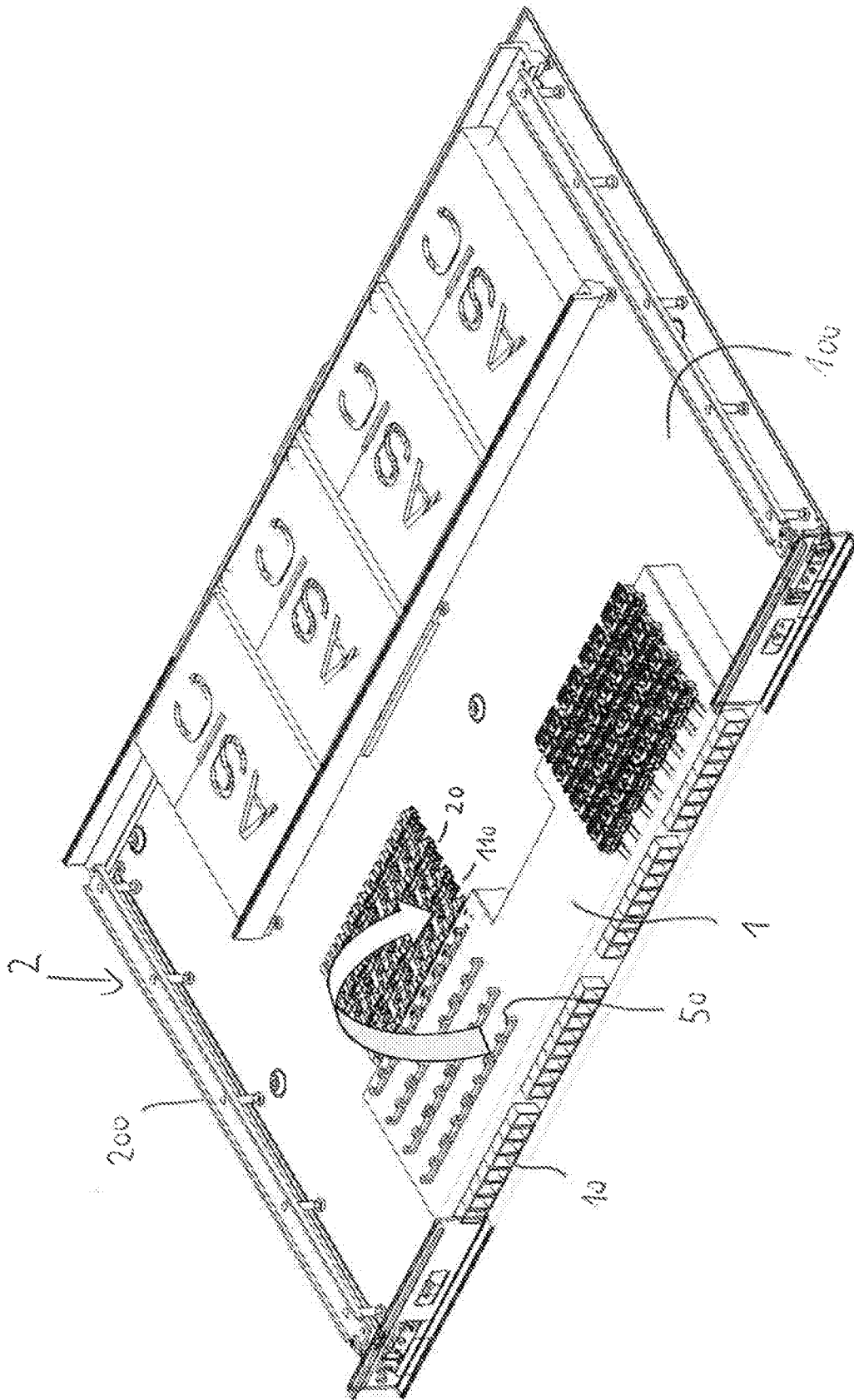


FIG 6



7GF





INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/049710

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/42 G02B6/44
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)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/010600 A1 (KIM DAEHWAN DANIEL [US] ET AL) 8 January 2009 (2009-01-08) figures 1, 2 paragraphs [0034], [0035], [0037], [0042], [0044], [0048] -----	1-15
X	US 2004/057039 A1 (MATSUURA HIROYUKI [JP] ET AL) 25 March 2004 (2004-03-25) figures 1, 2, 4, 5, 9 paragraphs [0097], [0098] -----	1-15
X	US 2002/131122 A1 (ANDERL WILLIAM JAMES [US] ET AL) 19 September 2002 (2002-09-19) figures 4-6 paragraphs [0035], [0038] -----	1-15
A	US 2015/180578 A1 (LEIGH KEVIN B [US] ET AL) 25 June 2015 (2015-06-25) figures 1, 2 -----	1-15

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

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 May 2017

Date of mailing of the international search report

22/05/2017

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

Zakynthinos, P

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/049710

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009010600 A1	08-01-2009	NONE	
US 2004057039 A1	25-03-2004	CN 1529810 A JP 4115387 B2 US 2004057039 A1 WO 03004986 A1	15-09-2004 09-07-2008 25-03-2004 16-01-2003
US 2002131122 A1	19-09-2002	US 2002131122 A1 US 2006098924 A1 US 2008062640 A1 US 2009087188 A1	19-09-2002 11-05-2006 13-03-2008 02-04-2009
US 2015180578 A1	25-06-2015	US 2015180578 A1 WO 2013165344 A1	25-06-2015 07-11-2013