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(71) Applicant: **HUBER+SUHNER AG** [CH/CH]; Degersheimerstrasse 14, 9100 Herisau (CH).

(72) Inventors: **TRAUSCHEIN, Liebmer**; Rebberg 172, 8240 Thayingen (CH). **KOFFEL, Philipp**; Rosenbergstrasse 17, 8200 Schaffhausen (CH). **TIBOLLA, Dominik**; Riederen 31, 9402 Mörschwil (CH).

(74) Agent: **RENTSCH PARTNER AG**; Bellerivestrasse 203, Postfach, 8034 Zürich (CH).

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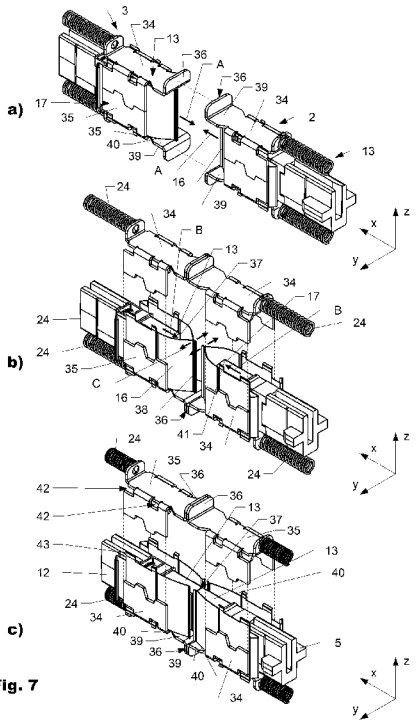


Fig. 7

(57) Abstract: The invention is directed to a connector assembly (1) comprising a first connector part (2) which is interconnectable to a second connector part (3). The first con- nector part (2) comprises a ferrule (13) which is encompassed by a shutter frame (17) and a thereto attached shutter (16). The shutter (16) is arranged movable with respect to the ferrule (13) in a first direction (x) between a closed position, in which the shutter (16) encompasses a connection face (37) of the ferrule (13), and an open position, in which the connection face (37) is set free from the shutter (16). The shutter frame (17) and/or the shutter (16) comprises at least one locat- ing surface (36) which during mating interacts with the second connector part (3) such that the shutter (16) is displaced relative to the ferrule (13) from the closed to the open position.

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CONNECTOR ASSEMBLY COMPRISING A SHUTTER

FIELD OF THE INVENTION

The present invention relates to a connector assembly comprising a shutter to prevent pollution, especially during interconnection of a first and a second connector part.

BACKGROUND OF THE INVENTION

US2014219624A was first published in 2014 in the name of Xyratex Tech Ltd. and is directed to an optical connector for coupling with a complementary optical connector and for supporting an optical component. The connector comprises a cover moveable between a first and second position. The cover may also comprise a moveable shield and biasing components. Furthermore an optical connector assembly comprising covers that sequentially open is provided.

US2013315539A was first published in 2013 in the name of Japan Aviation Electron. It provides an optical connector whose miniaturization is easier than conventional. The optical connector comprises a housing holding an optical member, a slider slidably held by the housing, a shutter provided to the slider adapted to be

opened and closed to expose and isolate the optical member. Furthermore coil springs are foreseen to push the slider in a direction away from the housing. The slider-side coil springs are disposed in a width direction of the shutter. The shutter is closed when the slider is moved by an elastic force of the slider-side coil springs away from the housing. The shutter is opened when the slider is moved against the elastic force of the slider-side coil springs in a direction approaching the housing.

JP2010224021A was first published in 2010 in the name of Mitsubishi Cable Ind. Ltd. A connector with a shutter plate is provided which prevents dust entering inside the connector. The backward motion of an outer case is restricted by abutting a leaf spring member to an abutting spring when the optical connector plug is not connected to a counterpart plug. A slider part is moved backward and the shutter plate fixed on the slider part is pulled up to release the abutting of the leaf spring. When the optical connector plug is connected to the counterpart plug, the outer case and the slider part are moved backward to project a ferrule toward the counterpart plug.

US2008247709A was first published in 2008 in the name of Honda Tsushin Kogyo Co. Ltd. It describes an optical connector which comprises a shading member. The shading member includes a shutter housing enclosing a plug frame slidably on an outside thereof and inserted into an engagement opening of a connector receptacle to be engaged when the shading member-equipped optical connector is connected. A shutter is supported by the shutter housing at a front part of the housing. It closes so as to shade the optical fibers at a position in front of the ferrule.

An elastic member is disposed between the plug frame and the shutter housing that urges said shutter housing forward.

US6039585A was first published in 1998 in the name of Reynolds Ind. Inc. It is directed to a connector assembly to join two contacts that have a seal assembly comprised of replaceable and inexpensive components. The connector assembly has a female housing that automatically seals a contact when the connector assembly is not assembled. A male housing includes a rigid projection and a longitudinal passageway sized to mount a first contact therein. The seal assembly includes a resilient sleeve and the spring. During a connection process, a projection on the male housing portion forces the spring to release its engagement with the resilient sleeve so that the sleeve can deform and open into its normal position.

US5708745A was first published in 1996 in the name of Fujitsu Ltd. It is directed to a device for preventing laser beam leakage. When an external connector has been removed from an optical transmission apparatus, a pair of movable shield plates are constantly urged in respective directions for closing a receiving opening of the apparatus to bring joining portions of the movable shield plates into close contact with each other, thereby preventing dust from entering the inside of the apparatus and the laser beam from being leaked.

The connector assemblies comprising a shutter as known from the prior art have a complex design, are difficult to operate and normally require a male and a female part which makes it even more complex. It is an object of the invention to provide

a less complex connector assembly comprising a shutter which is easy and reliable to operate and which allows to arrange several connector assemblies in a dense manner and to prevent negative pollution of them.

SUMMARY OF THE INVENTION

In a preferred variation, a connector assembly according to the invention comprises a first connector part, which is interconnectable to a second connector part. The first connector part comprises at least one ferrule, which is encompassed directly or indirectly by a shutter frame and a thereto attached shutter which together form part of a shutter assembly. If appropriate, the ferrule can be held by a housing, which holds the shutter frame. In a preferred variation the shutter is arranged moveable with respect to the housing holding the ferrule. The ferrule can be arranged in the housing rigid or in a floating manner. If appropriate the shutter frame can be arranged at a certain distance with respect to the ferrule. It can be held by the housing which encompasses the ferrule.

The shutter assembly, comprising the shutter frame and at least one resilient sheet, is arranged movable with respect to the ferrule in a first direction between a closed position, in which the at least one resilient sheet of the shutter encompasses and protects a connection face of the ferrule from outside influences, and an open position, in which the connection face is set free from the at least one resilient sheet of the shutter. In the open position the connection face of the ferrule is ready for connection with a corresponding connection face of the second connector part.

The first direction corresponds normally to the mating direction of the first and the second connector parts.

In a simple design, the shutter frame and/or the shutter comprises at least one locating surface, which during mating interacts with the second connector part and/or an external support, such that the shutter assembly is displaced relative to the ferrule from a closed to an open position. The ferrule normally terminates at least one optical fiber. Depending on the field of application other type of connectors can be protected by the shutter arrangement as described herein.

In a variation, the shutter assembly comprises at least one resilient sheet, which is attached directly or indirectly to the shutter frame. The at least one resilient sheet extends in the closed position in a curved manner in front of a connection face of the ferrule. When displaced in a reward direction with respect to the ferrule, the ferrule presses on the inside of the at least one resilient sheet and thereby deforms it in a resilient manner in an outward direction such that the connection face of the ferrule becomes apparent. In an open position the at least one resilient sheet and the ferrule can be designed such that the resilient sheet rest on an outside wall of the ferrule without exerting force in the first direction (force neutral). In a preferred variation, the shutter assembly comprises two resilient sheets attached to the shutter frame, which encompasses the ferrule. The resilient sheets are arrange opposite to each other in a pointed arch like manner around the front of the ferrule which carries the connection face. During opening of the shutter the ferrule and/or a

thereto adjacent part acts as a wedge forcing from the inside the at least one resilient sheet away. When the resilient sheet has a curved design with a variable inclination, the force necessary to open the shutter can be adjusted. In a preferred variation the inclination becomes less against the rear end of the resilient sheet, i.e. the area where the resilient sheet is attached to the shutter frame. If appropriate at least one resilient sheet can be replaced by a hinged flap rotating around a hinge with respect to the shutter frame. The hinge is preferably arranged along a rear edge of the flap. The flap can be moved between a closed and an open position similar to the resilient sheet as described hereinafter. If appropriate the flap can be spring loaded to assure proper alignment at least in the closed position.

The resilient sheet of the shutter is preferably made from thin resilient sheet metal, such as spring steel or the like. Good results can be achieved when the sheet metal has a thickness in the range of 0.05 mm to 0.2 mm. Depending on the size of the connector and its purpose of application, other dimensions may be appropriate. Alternatively or in addition, the resilient sheet can be made from a plastic material. Good results can be achieved by a symmetric balanced setup wherein the shutter comprises two resilient sheets which are arranged opposite to each other and which in a closed position interact with each other along a sealing edge. The resilient sheets are arranged in a prestressed manner, such that the firmly press against each other and thereby protect the ferrule arranged between them from unwanted outside influences. To assure that the shutter can be closed again, the shutter frame and/or the shutter can be arranged displaceable with respect to the ferrule in the first direction against the force of a spring. The shutter frame may comprises at least

one rim extending along a side edge of shutter. The rim is arranged preferably close to the shutter leaving only a small gap, which does not significantly change during operation of the shutter. In a preferred variation, the rim merges into a locating surface, which is used to operate the shutter via the shutter frame as described hereinafter in more detail. The number of different parts can be reduced when the shutter frame comprises an upper and a lower part which have a symmetric design. The second connector part may also comprise a shutter and a shutter frame similar to the first connector part. To operate the shutter during interconnection at least one of the connectors parts may comprise an inner housing to which a ferrule is interconnected and which during mating with the second connector part is arranged translatable in the first direction with respect to the outer housing.

The shutter assembly as described herein offers the advantage, that the optical ferrules and interfaces can be protected effectively against contamination (e.g. dust particles etc.), furthermore laser radiation can be prevented as the ferrules are never exposed to the outside. Furthermore physical damage of optical interfaces can be effectively prevented. The shutter system as described herein can be used or added independently to connectors and ferrules etc. as modular element. A further advantage can be seen in the fact that the shutter design minimizes airflow during connection / disconnection and does not expand (i.e. increase of volume) the inner volume of the protected area. In addition the shutter function helps to avoid dust transport from outside to the inside area of the connector assembly during opening and closing (connection / disconnection). The shutter assembly can be designed as self-closing mechanism of shutter (i.e., shutter is always closed if disconnected).

A further advantage is that the shutter can be designed with low connection force which does not interfere with the overall connection / disconnection force of the assembly. If appropriate the shutter can be designed such that it offers shielding against electromagnetic fields (i.e., through conductive and antistatic shutter assembly, grounding). Alternatively or in addition the shutter and/or the shutter frame when made from and/or coated by conductive material can be used for transmission of electrical signals and/or power transmission and/or signals for control and indication, etc. Furthermore, the conductive parts can be electrostatically charged to obtain a dust repellant effect. As mentioned above, the shutters in a connection assembly can be designed symmetrical, such that no male / female configuration is necessary. In addition the shutter design supports high packing density and the shutter design is robust and cost efficient as it relies only on few parts. If appropriate a sealing means can be arranged in the area of the locating surface, which during interaction of the first and the second connector parts seals the ferrules foreseen to interact of the first and the second connector part with respect to the environment. Preferably the sealing means engages before the shutter releases the ferrule which it encompasses.

It is to be understood that both the foregoing general description and the following detailed description present embodiments, and are intended to provide an overview or framework for understanding the nature and character of the disclosure. The accompanying drawings are included to provide a further understanding, and

are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments, and together with the description serve to explain the principles and operation of the concepts disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

The herein described invention will be more fully understood from the detailed description given herein below and the accompanying drawings which should not be considered limiting to the invention described in the appended claims. The drawings are showing:

Fig. 1 A first embodiment of a connector assembly in a perspective manner from above and right;

Fig. 2 The connector assembly according to Figure 1 in a perspective manner from above and left;

Fig. 3 The connector assembly according Figure 1 in a top view in unmated position;

Fig. 4 A section view along section line DD according to Figure 3;

Fig. 5 An arrangement of ferrules in an isolated manner;

Fig. 6 A second embodiment of a connector assembly in a perspective manner from above and right;

Fig. 7 Figure 7a through Figure 7c a method of interconnecting ferrules.

DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail to certain embodiments, examples of which are illustrated in the accompanying drawings, in which some, but not all features are shown. Indeed, embodiments disclosed herein may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Whenever possible, like reference numbers will be used to refer to like components or parts.

Figure 1 shows a connector assembly 1 in a perspective view from above and right in an uncoupled manner. **Figure 2** show the connector assembly 1 in a perspective view from above and left. **Figure 3** shows the connector assembly 1 in a top view. **Figure 4** shows the connector assembly 1 in a section view along section line DD of **Figure 3**. **Figure 5** shows 2x2 ferrules 13 normally arranged inside and forming part of a variation of the connector assembly 1. **Figure 6** shows a second embodiment of a connector assembly 1. **Figure 7** schematically shows in three steps (a)

through (c) how ferrules 13 of a first and a second connector part 2, 3 are interconnected to each other.

The connector assemblies 1 shown in **Figures 1** through **4** and **Figure 6** comprise a first connector part 2 and a second connector part 3 suitable to be interconnected (mated) to the first connector part 2 in a first direction x (mating direction). In the shown variations, the first and the second connector part 2, 3 are part of a board-to-board connector assembly 1 foreseen to interconnect a first board 21 and a second board 22 (see e.g. **Figure 1**). The first and the second board 21, 22 are arranged at an angle of 90° with respect to each other. Other angles or parallel arrangements are possible. While the second board 22 and the thereon arranged second connector part 3 are arranged in a fixed manner, the first board 21 and thereon arranged first connector part 2 are arranged moveable for mating with the second connector part 3. An advantage of the connector assembly is that several connector assemblies 1 can be arranged next to each other due to compact design of shutter. This causes no difficulty due to the effective reduction of the forces necessary for mating the first and the second connector parts 1. As visible in **Figure 2,** the housing 12 of the second connector part 3 comprises a connection tube 27, which is foreseen to introduce or extract air or an inert gas, etc. into the connector assembly or extract it from there. In the housing at least one filter 28, e.g. made from a porous material or pollution retracting material, can be arranged in at least one of the housings 4, 5, 12 which prevents unwanted pollution from entering into the sensitive inner area of the connector assembly 1. In the shown variation both connector parts 2, 3 each comprise a filter 28. The optical fibers 14 pierce through

the filter 28 which is here made from foamed plastic. In the shown variation, the outer housing 4 of the first connector part 2 comprises on the outside a circumferential seal 29 which in the engaged position seals the outer housing 4 of the first connector part 2 with respect to the housing 12 of the second connector part 3. The first connector part 2 comprises an outer housing 4 and an inner housing 5, which at least during mating with the second connector part 3 is arranged translatable in the first direction with respect to the outer housing 4. A gear mechanism 6 which is best visible in **Figure 4** interconnects the first and the second connector part 2, 3 and influences the relative movement between the inner and the outer housing 4, 5 of the first connector part 2 in relation to the relative movement between the first connector part 2 and the second connector part 3 during mating.

As visible in **Figure 4** and **Figure 6** the first gear 7 is a gear wheel arranged rotatable about a gear axis 8 and the second gear 9 is a gear rod. The gear wheel 7 is arranged at the inner housing 5 of the first connector part 2 and the second gear 9 is arranged on the inside of a housing 12 of the second connector part 3. The outer housing 4 of the first connector part 2 is, at least during mating of the first and the second connector parts 2, 3, mechanically interconnected to the first gear 7. In the shown embodiment this is achieved by a lever 10 which interacts with a nose 20. The gear mechanism 6 can be, as here shown, loaded by a spring 11 which executes a reset force onto the gear mechanism 6. Thereby it is achieved that the gear mechanism 6 is in a defined position ready for mating with the second connector part 3.

The first connector part 2 is an optical connector and comprises a first pair of ferrules 13 on the inside arranged by a distance spaced apart from each other. Depending on the field of application other number of ferrules 13 are possible. If appropriate the connector can comprise alternatively or in addition electrical connecting means on the inside. The ferrules 13 are foreseen to encompass (terminate) at least one optical fiber 14. The ferrules 13, respectively the optical fibers encompassed therein extend in the mated position the first direction (x-direction). The ferrules 13 are each arranged displaceable with respect to the inner housing 5 in the first direction x against the force of a thereto related spring 15.

As visible in **Figure 5** and **Figure 7** which shows the Ferrules 13 of the first and the second connector part 2, 3 in an isolated manner. The ferrules 13 are protected by a shutter assembly as described hereinafter in more detail. The path of interconnection of the connector parts 2, 3 is schematically indicated by dotted lines. In **Figure 5** the ferrules 13 of the second connector part 3 are arranged at position of 90° with respect to mating. In **Figure 7**, they are arranged in a line. Some parts are shown in a cut manner, such that the inside becomes better apparent. In **Figure 5** the two shutters 16 at the front are shown in an open (with respect to x-direction retracted position) such that the ferrules 13 arranged on the inside become visible.

Good results and a simple but yet space saving design is achieved by the shown shutter 16 which is arranged at a shutter frame 17. As among others visible in **Figure 7a** through **Figure 7c** and described in more detail hereinafter, the shutter 16

and the shutter frame 17 are arranged displaceable with respect to the ferrule 13 against the force of a spring 24. In the shown variation the shutter 16 comprises two resilient sheets 16 which extend in a closed position in front of the ferrule 13 enclosing the ferrule 13.

In **Figure 7a** through **Figure 7c** several steps of interconnecting a first and a second ferrule 13 along the first direction (x-direction) are schematically shown. Each of the ferrules 13 is encompassed by a shutter frame 17 to which a first and a second shutter 16 is arranged. The shutter frame 17 comprises in the shown embodiment an upper frame part 34 and a lower frame part 35 which are made from sheet metal and from a viewer's point of view are assembled in z-direction (schematically indicated by dotted lines). Compared to the shutter 16, the shutter frame 17 in the shown embodiment is designed more rigid and thereby less deformable. This can be achieved in that the material of the sheet metal is thicker than the sheet metal used for the shutter.

The shutter frames 17 and the thereto attached shutters 16 are arranged displaceable relative to the ferrule 13 such that while moving the shutter frames 17 and the shutters 16 in a rearward direction with respect to the front face (connection face 37) of the ferrules 13. The shutters 16 are moved apart from a closed (**Figure 7a**) to an open position (**Figure 7c**) in a lateral direction in that the ferrule 13 presses by an edge 41 against the inside of the curved shutter 16. This process is schematically shown in **Figure 7a** through **Figure 7c**.

In **Figure 7a** the ferrules 13 and the shutter frames 17 with the shutters 16 surrounding the ferrules 13 are displaced against each other as indicated by opposite arrows A until at least one locating surface 36 arranged at each shutter frame 17 interacts with an opposite locating surface 36 of an opposite shutter frame 17. When the contact between the shutter frames 17 via the locating surfaces 36 is established, the ferrules 13 are moved further against each other as schematically indicated in **Figure 7b** by arrows B. As a result thereof the shutters 16 which are preferably made from an elastically deformable material, such as thin sheet metal, e.g. spring steel, are forced apart in a lateral direction as indicated by arrows C such that dedicated front faces 37 of the ferrules 13 can mate with each other as schematically indicated by **Figure 7c**. In the shown variation the shutters are deformed in a resilient manner when forces apart. Alternatively or in addition the shutters 16 can be arranged in a hinged manner and if necessary spring loaded.

The connector assembly 1 according to a variation of the invention comprises a first connector part 2, which is interconnectable to a second connector part 3. The first connector part 2 comprises a ferrule 13 which is encompassed by a shutter frame 17 and at least one thereto attached shutter 16 which is arranged movable with respect to the ferrule 13 in a first direction x between a closed position, in which the at least one shutter 16 encompasses a connection face 37 of the ferrule 13, and an open position, in which the connection face 37 is set free from the at least one shutter 16. The shutter frame 17 and/or the at least one shutter 16 may comprise at least one locating surface 36 which during mating interacts with the second

connector part 3, e.g. in that the second connector part comprises a locating surface similar to the locating surface of the first connector part. Thereby the at least one shutter 16 is displaced relative to the ferrule 13 in the first direction from the closed to the open position. Superimposed to the movement in the first direction the shutter 16, due to interaction with the ferrule 13, swivels sideways thereby releasing the connection face 37. Good results can be achieved when the shutter 16 comprises at least one resilient sheet 16, which is attached to the shutter frame 17. In the closed position as shown in **Figure 7a** the resilient sheet 16 extends in front of the connection face 37 of the ferrule 13 and thereby protects the sensitive areas from negative outside influences. A continuous course of the forces necessary to connect the first and the second connector parts can be achieved when the resilient sheet 16 extends in a continuously curved manner in front of the connection face. As shown in the present variation the shutter 16 may comprise two resilient sheets 16 which in a closed position interact with each other along a sealing edge 38 in a prestressed manner. The shutter frame 17 and/or the shutter 16 can be arranged displaceable with respect to the ferrule 9 in the first direction x against the force of a spring 24, which supports reclosing of the shutter assembly (shutter frame 17 and shutter 16). The shutter frame 17 may comprise at least one rim 39 extending parallel along a side edge 40 of the shutter 16. In that during operation only a small gap exists between the side edge 40 and the rim 39 such that entry of dust from the outside can be prevented effectively. At the end the rim 39 merges into locating surface 36. As schematically shown in **Figure 7c** the locating surface 36 is during interconnection foreseen to interact directly or indirectly with the second connector

part 3, i.e. in the shown variation having a symmetric setup, a second location surface 36. Thereby the shutter frame 17 and the thereto interconnected shutter 16 are pushed in a rearward direction with respect to the ferrule 13 thereby releasing the connection face 37. An advantage is that the interaction between two opposite shutter frames 17 in the described manner can effectively prevent of dust from the outside as the direct interaction can work as a seal.

The shutter frame 17 comprises an upper and a lower part 34, 35 which have a symmetric setup. The upper and the lower part 34, 35 comprise at least one opening 42 which is foreseen to cooperate with at least one snap finger 43 arranged at the resilient sheet of the shutter 16. Thereby the shutter frame 17 and the resilient sheets 16 of the shutter 16 can be easily assembled by snap fit.

When interconnecting a first and a second connector part 2, 3 of a connector assembly 1 the first connector part 2 is aligned a second connector part 3 with respect to the first direction x. Then the first and the second connector part 2, 3 are displaced relative to each other until the locating surface 36 which is interconnected to the shutter 16 interacts with a corresponding part 36 of the second connector part 3 (**Figure 7b**). Then by continuous movement, the shutter 16 is displaced relative to the ferrule 13 from the closed position to the open position (**Figure 7c**). As a result, the shutter frame 17 is moved along the ferrule 13 in the first direction x the elastic sheets 16 of the shutter 16 are deformed in an outward direction due to interaction with an edge 41 of the ferrule 13.

LIST OF DESIGNATIONS

A	Arrows
B	Arrows
C	Arrows
1	Connector assembly
2	First connector part
3	Second connector part
4	Outer housing (first connector part)
5	Inner housing (first connector part)
6	Gear mechanism
7	First gear
8	Gear axis
9	Second gear
10	Lever
11	Spring (gear mechanism)
12	Housing (second connector part)
13	Ferrule
14	Optical fiber
15	Spring (Ferrule)
16	Shutter / Resilient sheet (shutter)
17	Shutter frame
18	Socket (first connector part)
19	Spring (between socket and outer housing of first connector part)
20	Nose (at the outer housing of the first connector part)
21	First board
22	Second board
23	Guiding means (first board)
24	Spring (shutter)
25	First guiding means
26	Second guiding means
27	Connection tube
28	Filter
29	Seal
30	Protrusion (Socket)
31	Rear wall
32	Tooth (outer housing)
33	Lug (socket)
34	Upper frame part (shutter frame)
35	Lower frame part (shutter frame)
36	Locating surface

37 Connection face (ferrule)

38 Sealing edge (shutter)

39 Rim (shutter frame)

40 Side edge (shutter)

41 Edge (ferrule)

42 Opening (shutter frame)

43 Snap finger (shutter)

PATENT CLAIMS

1. Connector assembly (1) comprising

a. a first connector part (2) which is interconnectable to a second connector part (3), said first connector part (2) comprising

b. a ferrule (13) which is encompassed by a shutter frame (17) and at least one thereto attached shutter (16) which is arranged movable with respect to the ferrule (13) in a first direction (x) between

i. a closed position in which the at least one shutter (16) encompasses a connection face (37) of the ferrule (13) and

ii. an open position in which the connection face (37) is set free from the at least one shutter (16), and wherein

c. the shutter frame (17) and/or the at least one shutter (16) comprises at least one locating surface (36) which during mating interacts with the second connector part (3) such that the at least one shutter (16) is displaced relative to the ferrule (13) from the closed to the open position.

2. The connector assembly (1) according to claim 1, **wherein** the ferrule (13) encompasses at least one optical fiber (14).

3. The connector assembly (1) according to one of the preceding claims, **wherein** the shutter (16) comprises at least one resilient sheet (16), which is attached to the shutter frame (17) and which extends in the closed position in front of the connection face (37) of the ferrule (13).

4. The connector assembly (1) according to claim 3, **wherein** the resilient sheet (16) extends in a continuously curved manner in front of the connection face (37).

5. The connector assembly (1) according to claim 3 or claim 4, **wherein** the shutter (16) comprises two resilient sheets (16) which in a closed position interact with each other along a sealing edge (38) in a prestressed manner.

6. The connector assembly (1) according to one of the preceding claims, **wherein** the shutter frame (17) and/or the shutter (16) are arranged displaceable with respect to the ferrule (9) in the first direction (x) against the force of a spring (24).

7. The connector assembly (1) according to one of the preceding claims, **wherein** the shutter frame (17) comprises at least one rim (39) extending along a side edge (40) of the shutter (16).

8. The connector assembly (1) according to claim 7, **wherein** the rim (39) merges into a locating surface (36).

9. The connector assembly (1) according to one of the preceding claims, **wherein** the shutter frame (17) comprises an upper and a lower part (34, 35) which have a symmetric setup.

10. The connector assembly (1) according to one of the preceding claims, **wherein** the second connector part (3) comprises a shutter (16) and a shutter frame (17) similar to the first connector part (2).

11. The connector assembly (1) according to one of the preceding claims, **wherein** at least one of the connectors parts (2, 3) comprises an inner housing (5) to which a ferrule (13) is interconnected and which during mating with the second connector part (3) is arranged translatable in the first direction (x) with respect to the outer housing (4).

12. The connector assembly (1) according to one of the preceding claims, **wherein** shutter (16) and/or the shutter frame (17) are made from and/or coated by electrical conductive material.

13. The connector assembly (1) according to claim 12, **wherein** the parts made from and/or coated by electrical conductive material are used for transmission of a signal and/or electrical power.

14. The connector assembly (1) according to one of the preceding claims, **wherein** a sealing means is arranged in the area of the locating surface (36)

of at least one connector part (2, 3), which during interaction of a first and a second connector part (2, 3) seals the ferrules (13) with respect to the environment.

15. The connector assembly (1) according to claim 14, **wherein** the shutter (16) releases the connection face (37) after the sealing means engages between the first and the second connector part (2, 3).

16. First connector part (2) suitable to be used in a connector assembly according to one of the preceding claims.

17. Second connector part (3) suitable to be used in a connector assembly according to one of the preceding claims.

18. Method for interconnecting a first and a second connector part (2, 3) of a connector assembly (1) comprising the following method steps:

a. providing a first connector part (2) with a ferrule (13) which is encompassed by a shutter frame (17) and at least one thereto attached shutter (16) which is arranged movable with respect to the ferrule (13) in a first direction (x) between a closed position in which the at least one shutter (16) encompasses a connection face (37) of the ferrule (13) and an open position in which the connection face (37) is set free from the at least one shutter (16);

b. aligning the first connector part (2) to a second connector part (3) with respect to the first direction (x);

c. displacing the first and the second connector part (2, 3) toward each other until a locating surface (36) interconnected to the shutter (16) interacts with a corresponding part (36) of the second connector part (3), such that the at least one shutter (16) is displaced relative to the ferrule (13) from the closed to the open position.

19. Method according to claim 18, **wherein** the shutter frame (17) is moved along the ferrule (13) in the first direction (x) and an elastic sheet (16) of the shutter (16) is deformed due to interaction with an edge (41).

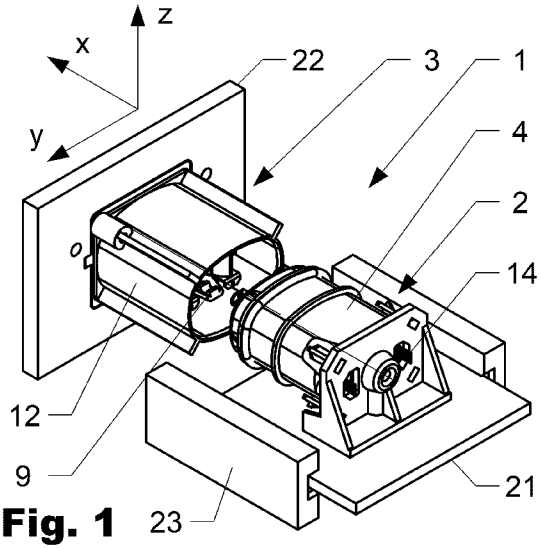


Fig. 1

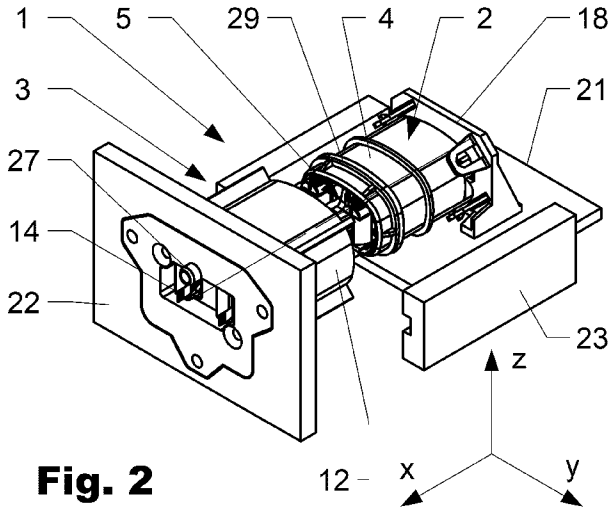


Fig. 2

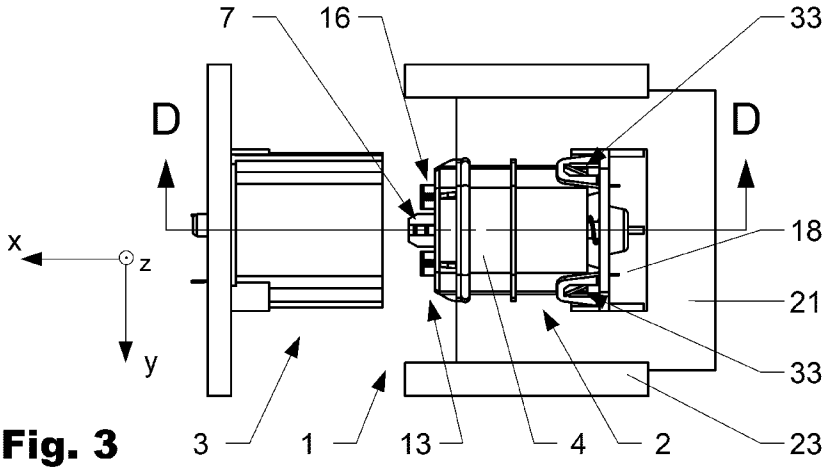


Fig. 3

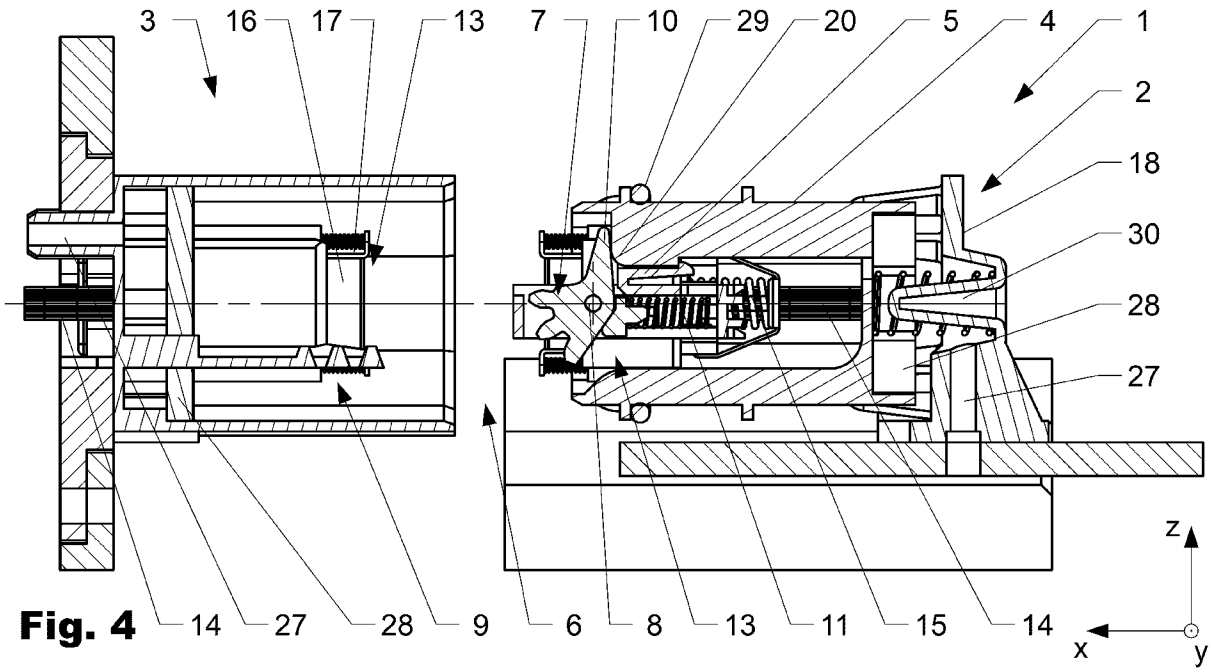


Fig. 4

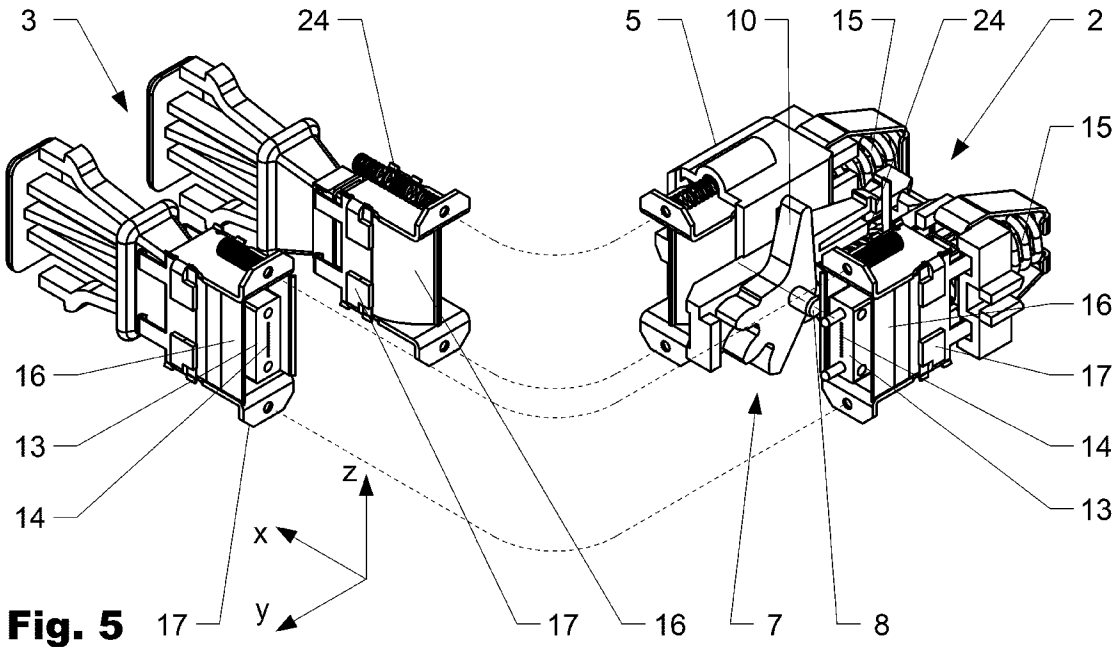

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Fig. 5

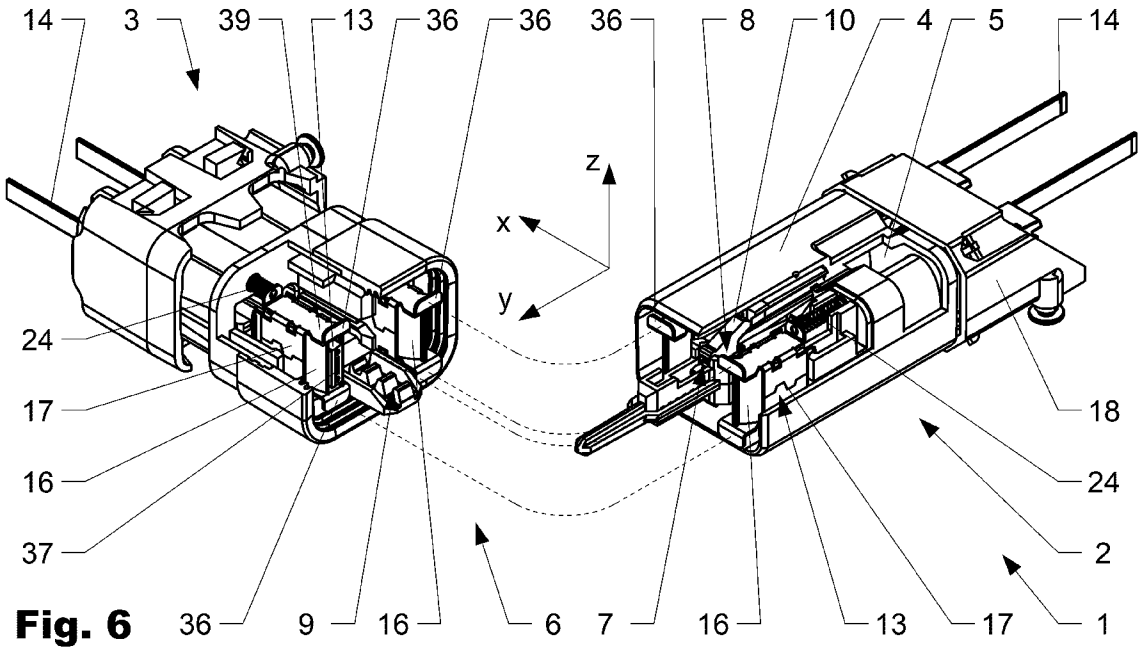

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Fig. 6

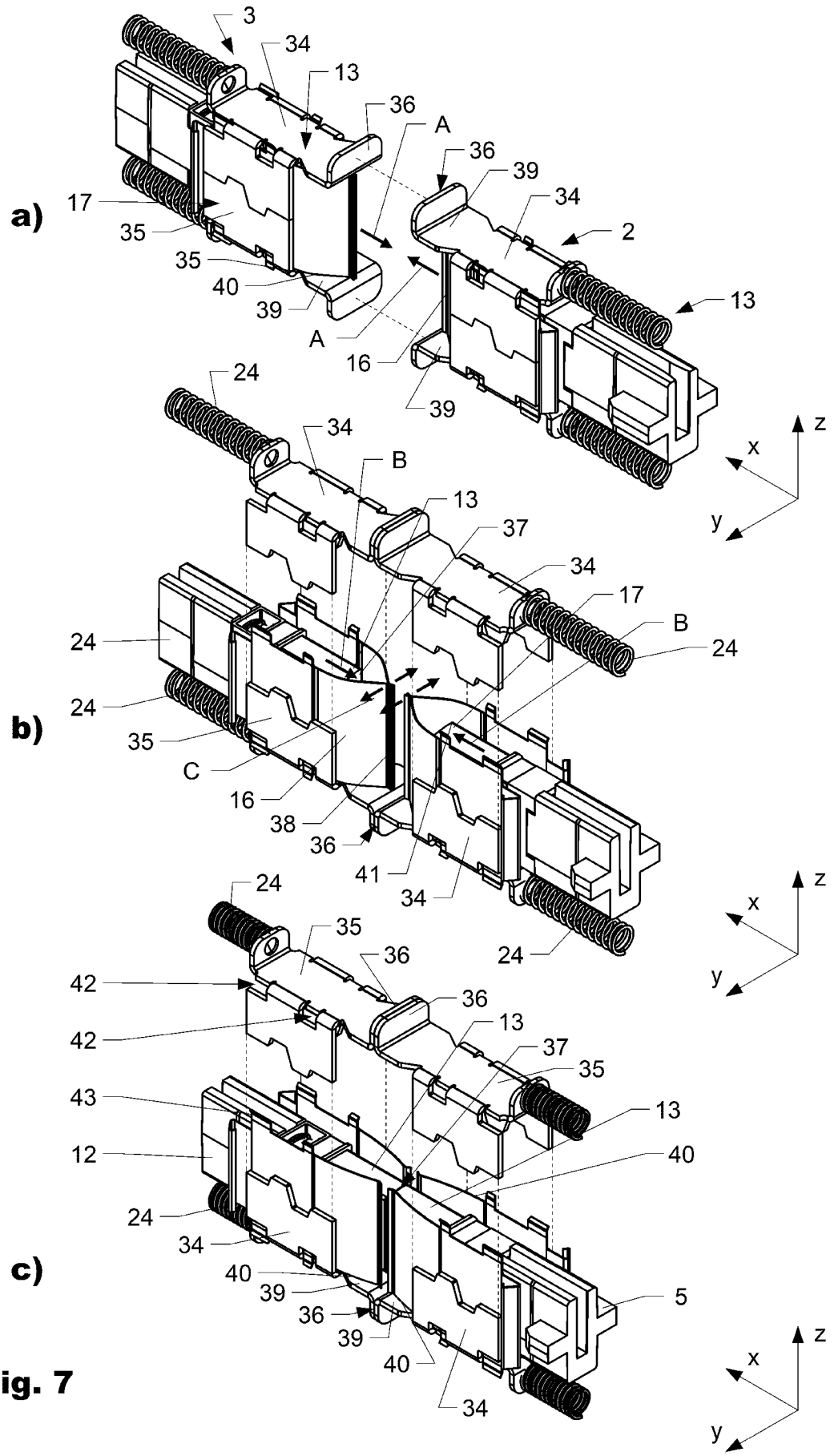

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Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/068831

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

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

B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/052472 A1 (ROTH RICHARD F [US] ET AL) 18 March 2004 (2004-03-18) paragraphs [0082] - [0090]; figures 7a-7f -----	1-3, 6-12, 16-18
X	US 2014/334779 A1 (MEGASON GEORGE D [US] ET AL) 13 November 2014 (2014-11-13) paragraphs [0015] - [0032]; figures 1a-2b -----	1-3, 5-11, 16-18
X	US 2015/055928 A1 (YOSHIZAKI TSUYOSHI [JP]) 26 February 2015 (2015-02-26) paragraphs [0028] - [0032]; figures 1a-6b ----- -/--	1-4,6-9, 11-13, 16-19

[X] Further documents are listed in the continuation of Box C.

[X] 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	Date of mailing of the international search report
29 October 2018	07/11/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ciarrocca, Marco

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2018/068831

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 17(partially)
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/068831

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/284655 A1 (NAKANO TOSHIAKI [JP] ET AL) 11 November 2010 (2010-11-11) paragraphs [0040] - [0050]; figures 2b,10a-10c,13a-14b	1-8, 11-19
E	WO 2018/130338 A1 (HUBER & SUHNER AG [CH]) 19 July 2018 (2018-07-19) page 12, line 20 - page 13, line 4; figures 5,6 page 14, line 16 - page 15, line 16	1-11, 14-19

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/068831

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004052472 A1	18-03-2004	NONE	
US 2014334779 A1	13-11-2014	CN 104067154 A	24-09-2014
		TW 201337366 A	16-09-2013
		US 2014334779 A1	13-11-2014
		WO 2013126068 A1	29-08-2013
US 2015055928 A1	26-02-2015	CN 104422991 A	18-03-2015
		EP 2840424 A1	25-02-2015
		JP 5988047 B2	07-09-2016
		JP 2015040988 A	02-03-2015
		TW 201508364 A	01-03-2015
		US 2015055928 A1	26-02-2015
US 2010284655 A1	11-11-2010	JP 4304213 B2	29-07-2009
		JP 2008175943 A	31-07-2008
		US 2010284655 A1	11-11-2010
WO 2018130338 A1	19-07-2018	NONE	

Continuation of Box II.2

Claims Nos.: 17(partially)

Claim 17 is defined uniquely in terms of a separate non-standard entity, i.e. the first connector part of claims 1-16. Thus it is unclear which features it should comprise. As a consequence the search has been limited to that necessary to assess novelty of claim 17 and does not cover the full theoretical literal scope of claim 17.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.2), should the problems which led to the Article 17(2) declaration be overcome.