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(54) Title: BUSBAR CONNECTION

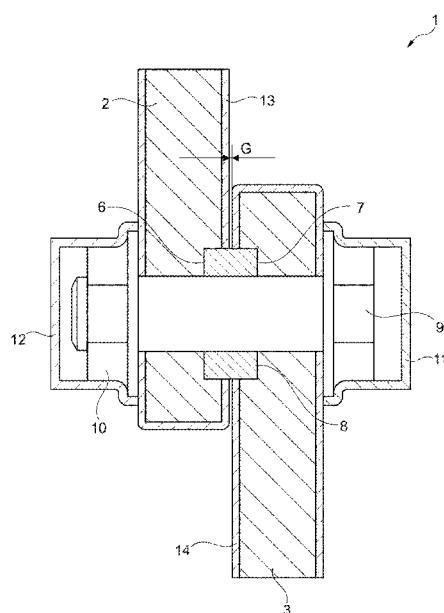


Fig. 2

(57) Abstract: The invention relates to a busbar connection comprising: - a first and second busbar ends with a longitudinal direction and with a through hole arranged in each busbar end; - mounting means, in particular, a bolt and nut, extending through all the through holes of the busbar ends to clamp the busbar ends together; wherein each busbar end comprises a contact surface arranged around the respective through hole and directed towards the contact surface on the adjacent busbar end wherein an electrically insulating layer is arranged on the outer surface of each busbar end, which electrically insulating layer extends up to the contact surface, wherein at least one of the contact surfaces is stepped relative to the surrounding outer surface of the busbar end and in the axial direction of the through hole, in order to be in electrical contact with the contact surface of the adjacent busbar end.

Busbar connection

The invention relates to a busbar connection comprising:

- 5 - a first and second busbar ends with a longitudinal direction and with a through hole arranged in each busbar end;
- mounting means, in particular, a bolt and nut, extending through all the through holes of the busbar ends to clamp the busbar ends together;

10 wherein each busbar end comprises a contact surface arranged around the respective through hole and directed towards the contact surface on the adjacent busbar end,

 wherein an electrically insulating layer is arranged on the outer surface of each busbar end, which electrically
15 insulating layer extends up to the contact surface.

 Such a busbar connection is generally known and has typically busbar ends with a rectangular cross-section bolted together. Such busbar connections are used in for example switchgear housings to connect busbars of adjacent switchgear
20 housings or for connecting switchgear to the busbars. These busbars are typically insulated such that the switchgear housing can be opened for maintenance without direct danger to the maintenance personnel.

 However, at the busbar connection, the contact
25 surfaces are uncovered to provide electrical contact surfaces. Due to tolerances, still some parts near the contact surfaces will not be covered with insulation material and leave some parts of the busbar ends not insulated when connected to each other.

30 These non-insulated parts cause a risk when maintaining parts near these non-insulated parts. When for example a wire gets loose or some tool falls, it could get into contact or too close to the non-insulated parts causing

violent sparks, damaging the parts and causing possible bodily harm to maintenance personnel.

This risk is typically overcome by using shrink sleeved solutions or plastic arc free cap solutions (plastic
5 box like structures), which are complicated to assemble, expensive and prone to human error.

Prevention of an arc-flash is a far better measure than limiting the effects. Therefore, there is a need to reduce the bare copper area and have a cost-effective, easy to
10 assemble and a completely arc free design, to ensure complete safety during maintenance and service.

The object of the invention is therefore to reduce the above-mentioned disadvantages of the prior art.

This object of the invention is achieved with a
15 busbar connection according to the preamble, which is characterized in that at least one of the contact surfaces is stepped relative to the surrounding outer surface of the busbar end and in the axial direction of the through hole, in order to be in electrical contact with the contact surface of
20 the adjacent busbar end.

By providing a stepped contact surface, the contact surface will no longer be in the same plane as the outer surface of the busbar end. As a result, the size of the contact surfaces is no longer defined by the size of the
25 busbar ends. So, the contact surface dimensions can be designed such that any bare copper areas resulting from the tolerance of the insulation layer are covered by the adjacent busbar ends.

The stepped contact surface also allows for to
30 compensate for the thickness of the insulation layer, while the contact surfaces of both busbars end need to be bare.

In a preferred embodiment of the busbar connection according to the invention, the contact surface of the first

busbar end is stepped outwardly relative to the surrounding outer surface.

With the contact surface of the first busbar end being stepped outwardly, the contact surface will protrude
5 above the outer surface of the busbar end. This allows for the contact surface to be positioned at such a height, that a small gap can be present between the busbar ends, but that the width of this gap is small enough to prevent any foreign parts to enter the gap, contacting the bare surface and causing
10 arcing.

In a further embodiment of the busbar connection according to the invention, the contact surface of the second busbar end is stepped inwardly relative to the surrounding outer surface.

15 With the contact surface of the second busbar end stepped inwardly, a cavity is provided in the second busbar, into which cavity the protrusion formed by the contact surface of the first busbar end can extend. This will further reduce access to bare surface parts of the busbar ends in the mounted
20 state of the busbar connection. It also provides a shape defined positioning of the busbar ends relative to each other, which facilitates mounting of the busbar connection.

A next preferred embodiment of the busbar connection according to the invention further comprising an electrically
25 conducting spacer ring arranged between the contact surfaces of the first and second busbar ends, wherein at least the contact surface of the first busbar is stepped inwardly relative to the surrounding outer surface.

An inwardly stepped contact surface is more easily
30 provided on a busbar end. With the additional spacer ring, an electrical connection can be achieved similar to the embodiment with the outwardly stepped contact surface. The spacer ring will be kept in position by the cavity provided by

the inwardly stepped contact surface.

In a further preferred embodiment of the busbar connection according to the invention, the contact surface of the second busbar end is stepped inwardly relative to the surrounding outer surface.

Having the contact surfaces of both busbar ends inwardly stepped, which is more easily manufactured, the spacer ring will still provide the required electrical contact between the contact surfaces, while all bare parts of the busbar ends and spacer ring are enveloped by the insulated parts of the busbar ends, such that no arcing can occur.

In yet another embodiment of the busbar connection according to the invention, the axis of each through hole is perpendicular to the longitudinal direction of the respective busbar end.

Preferably, the contact surfaces are annular and concentrically arranged around the through hole of the respective busbar end. Although other shapes, such as triangular, square and the like, are possible for the contact surfaces, an annular contact surface allows for the busbar ends to be rotated relative to each other around the axis of the through holes. This facilitates mounting of the busbar connection and allows for taking up any deviations in dimensions.

In yet another preferred embodiment of the busbar connection according to the invention, the main dimension of the contact surfaces is smaller than the width of both the busbar ends. This allows for the bare parts of the busbar ends to be fully covered by the opposite busbar end.

Preferably, the at least one stepped contact surface spaces the busbar ends apart, wherein the gap between the busbar ends is less than 1 mm. This ensures that the gap is too small for a wire of 1 mm diameter or more to contact the

live parts.

These and other features of the invention will be elucidated in conjunction with the accompanying drawings.

Figures 1A, 1B and 1C show the first embodiment in an exploded view, a cross-sectional view, and a side view.

Figure 2 shows an enlarged and more detailed cross-sectional view of the first embodiment according to figure 1.

Figures 3 - 5 show cross-sectional views of a second, third and fourth embodiment of the invention.

Figure 1A shows an exploded view of the first embodiment of a busbar connection 1 according to the invention. The busbar connection 1 has a first busbar end 2 and a second busbar end 3. Each busbar end 2, 3 is provided with a through hole 4, 5 respectively (see also figure 1B).

Around the respective through holes 4, 5 an inwardly stepped contact area 6, 7 is provided. A spacer ring 8 is positioned into the cavities formed by the inwardly stepped contact area's 6, 7 to provide electrical contact between the two busbar ends 2, 3.

A bolt 9 is mounted through the through holes 4, 5 and clamps with the nut 10 the first busbar end 2, the second busbar end 3 and the spacer ring 8 together.

Insulating caps 11, 12 are arranged over the bolt 9 and nut 10 respectively to ensure that no bare part is accessible.

Figure 1C shows the busbar ends 2, 3 and space ring 8 in a side view. Clearly, the gap G between the first busbar end 2 and the second busbar 3 is kept so small, that no foreign parts, like an ignition wire, can get into contact with the spacer ring 8 or the contact surfaces 6, 7. Preferably, this gap G is less than 1 mm.

Figure 2 shows an enlarged cross-sectional view of the busbar connection 1. The outer surface of both busbars

ends 2, 3 are provided with an insulating coating 13, 14, which insulates the busbar ends 2, 3. The insulating caps 11, 12 furthermore insulate the mounting means 9, 10, while the thickness of the spacer ring 8 is designed such that the gap G is kept minimal and no foreign parts can get into contact with the electrically conducting parts or surfaces of the busbar connection 1.

Figure 3 shows a cross-sectional view of a second embodiment of a busbar connection 20 according to the invention. The connection 20 has a first busbar end 21 and a second busbar end 22. The first busbar end 21 has an inwardly stepped contact surface 23, while the second busbar end 22 has a contact surface 24 which is provided flush with the outer surface of the second busbar end 22.

A spacer ring 25 is arranged between the contact surfaces 23, 24 to ensure electrical contact between the first busbar end 21 and the second busbar end 22, as well as a minimal gap G.

Figure 4 shows a cross-sectional view of a third embodiment of a busbar connection 30 of a first busbar end 31 and a second busbar end 32. The first busbar end 31 is provided with an outwardly stepped contact surface 33, while the second busbar end 32 is provided with an inwardly stepped contact surface 34.

The protrusion formed by the contact surface 33 extends into the cavity formed by the contact surface 34, such that the relative position of both busbars ends 31, 32 is defined and mounting of the busbar connection 30 is facilitated.

Figure 5 shows a fourth embodiment 40 of a busbar connection according to the invention. The busbar connection 40 has a first busbar end 41 and a second busbar end 42. The first busbar end 41 is punched, such that an outwardly stepped

contact surface 43 is provided. This contact surface 43 is in contact with a contact surface 44 which is provided flush with the outer surface of the second busbar end 42 to provide an electrical connection between the busbar ends 41, 42.

5 Due to the outwardly stepped contact surface 43 a small gap G is provided allowing space for the insulating coating, while still keeping the gap G to minimal to avoid contact of foreign objects with the contact surfaces 43, 44.

Claims

1. Busbar connection (1; 20; 30; 40) comprising:

- a first (2; 21; 31; 41) and second busbar (3; 22; 32; 42) ends with a longitudinal direction and with a through hole (4, 5) arranged in each busbar end;

- mounting means, in particular a bolt (9) and nut (10), extending through all the through holes (4, 5) of the busbar ends (2, 3; 21, 22; 31, 32; 41, 42) to clamp the busbar ends (2, 3; 21, 22; 31, 32; 41, 42) together;

wherein each busbar end (2, 3; 21, 22; 31, 32; 41, 42) comprises a contact surface (6, 7; 23, 24; 33, 34; 43, 44) arranged around the respective through hole (4, 5) and directed towards the contact surface (6, 7; 23, 24; 33, 34; 43, 44) on the adjacent busbar end (2, 3; 21, 22; 31, 32; 41, 42),

wherein an electrically insulating layer (13, 14) is arranged on the outer surface of each busbar end (2, 3; 21, 22; 31, 32; 41, 42), which electrically insulating layer (13, 14) extends up to the contact surfaces (6, 7; 23, 24; 33, 34; 43, 44),

characterized in that

at least one of the contact surfaces (6, 7; 23; 33, 34; 43) is stepped relative to the surrounding outer surface of the busbar end (2, 3; 21; 31, 32; 41) and in the axial direction of the through hole (4, 5), in order to be in electrical contact with the contact surface (6, 7; 24; 33, 34; 44) of the adjacent busbar end (2, 3; 22; 31, 32; 42).

2. Busbar connection (30; 40) according to claim 1, wherein the contact surface (33; 43) of the first busbar end (31; 41) is stepped outwardly relative to the surrounding outer surface.

3. Busbar connection (30) according to claim 2,

wherein the contact surface (34) of the second busbar end (32) is stepped inwardly relative to the surrounding outer surface.

4. Busbar connection (1; 20) according claim 1, further comprising an electrically conducting spacer ring (8; 25) arranged between the contact surfaces (6, 7; 23, 24) of the first (2; 21) and second (3; 22) busbar ends, wherein at least the contact surface (6; 23) of the first busbar (2; 21) is stepped inwardly relative to the surrounding outer surface.

5. Busbar connection (1) according to claim 4, wherein the contact surface (7) of the second busbar end (3) is stepped inwardly relative to the surrounding outer surface.

6. Busbar connection (1; 20; 30; 40) according to any of the preceding claims, wherein the axis of each through hole (4, 5) is perpendicular to the longitudinal direction of the respective busbar end (2, 3; 21, 22; 31, 32; 41, 42).

7. Busbar connection (1; 20; 30; 40) according to any of the preceding claims, wherein the contact surfaces (6, 7; 23, 24; 33, 34; 43, 44) are annular and concentrically arranged around the through hole (4, 5) of the respective busbar end (2, 3; 21, 22; 31, 32; 41, 42).

8. Busbar connection (1; 20; 30; 40) according to any of the preceding claims, wherein the main dimension of the contact surfaces (6, 7; 23, 24; 33, 34; 43, 44) is smaller than the width of both the busbar ends (2, 3; 21, 22; 31, 32; 41, 42).

9. Busbar connection (10; 20; 30; 40) according to any of the preceding claims, wherein the at least one stepped contact surface (6, 7; 23; 33, 34; 43) spaces the busbar ends (2, 3; 21, 22; 31, 32; 41, 42) apart, wherein the gap (G) between the busbar ends (2, 3; 21, 22; 31, 32; 41, 42) is less than 1 mm.

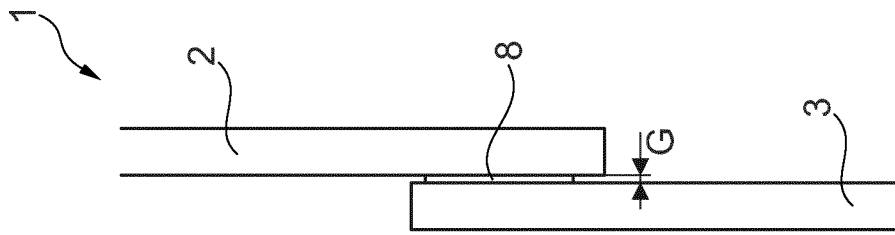


Fig. 1C

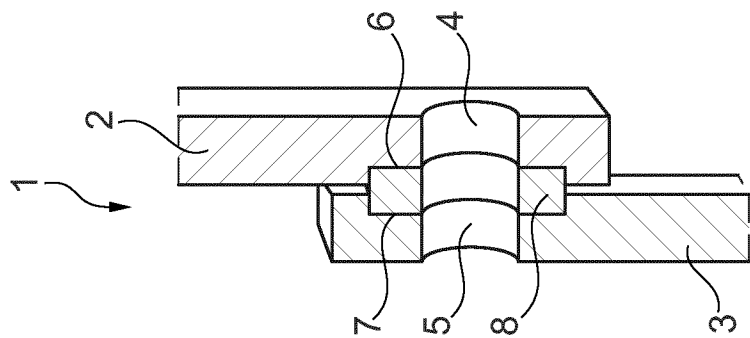


Fig. 1B

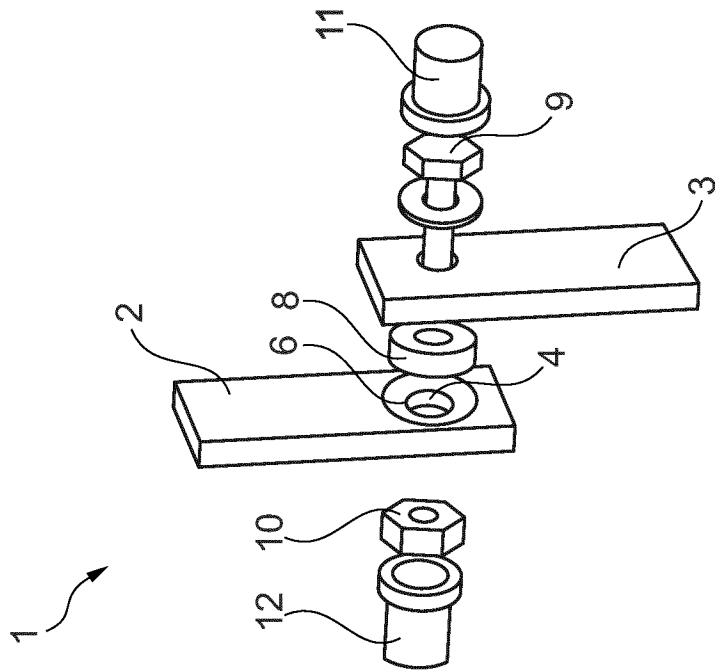


Fig. 1A

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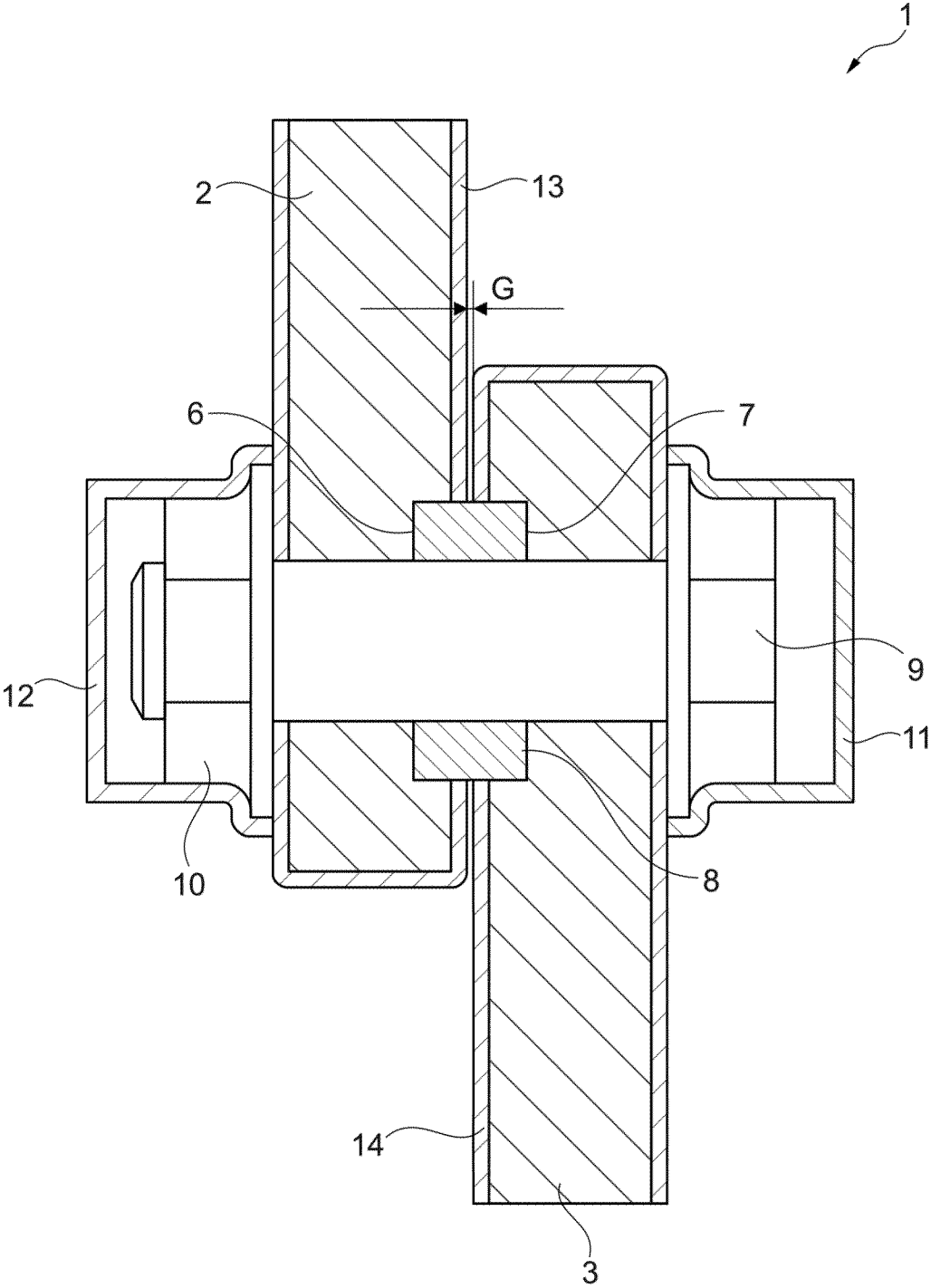


Fig. 2

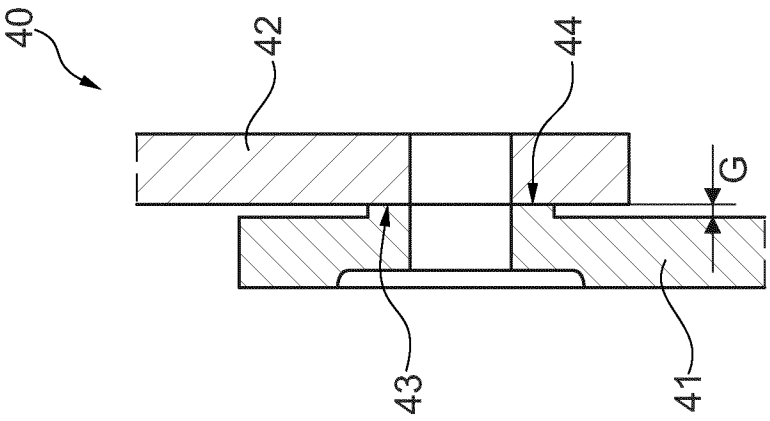


Fig. 5

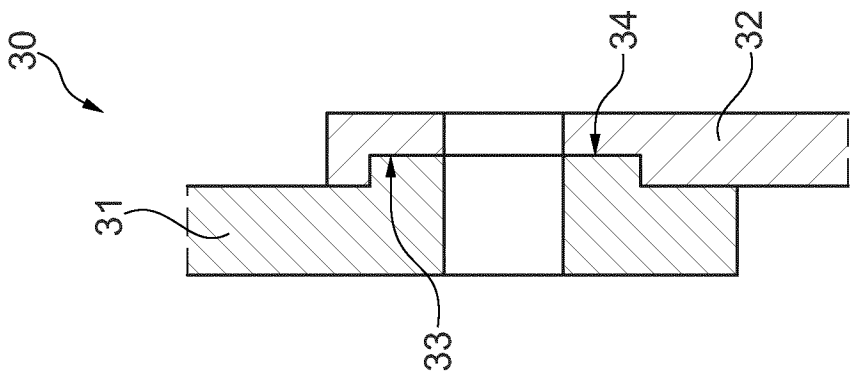


Fig. 4

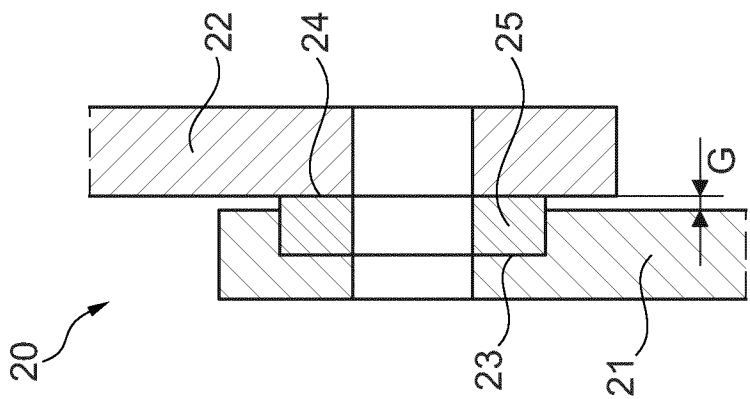


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/051400

A. CLASSIFICATION OF SUBJECT MATTER INV. H01R25/14 H01R25/16 H02B1/21 H02G5/00 H01R4/34 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) H01R H02G H02B 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 <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>US 5 828 008 A (LOCKWOOD MARK D [US] ET AL) 27 October 1998 (1998-10-27) page 5, line 26 - page 6, line 5; figures 3,4 -----</td> <td>1-9</td> </tr> <tr> <td>Y</td> <td>US 4 361 724 A (OLASHAW WILLIAM F) 30 November 1982 (1982-11-30) column 7, line 19 - line 34; figure 17 -----</td> <td>6</td> </tr> <tr> <td>Y</td> <td>EP 1 014 494 A1 (ZURECON AG [CH]) 28 June 2000 (2000-06-28) paragraphs [0011] - [0012]; figures 1-5 -----</td> <td>1,2,9</td> </tr> <tr> <td>Y</td> <td>US 3 002 173 A (KILGANNON ALLEN ROBERT) 26 September 1961 (1961-09-26) column 3, line 33 - line 43; figures 1-4 ----- -/--</td> <td>2,7</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	US 5 828 008 A (LOCKWOOD MARK D [US] ET AL) 27 October 1998 (1998-10-27) page 5, line 26 - page 6, line 5; figures 3,4 -----	1-9	Y	US 4 361 724 A (OLASHAW WILLIAM F) 30 November 1982 (1982-11-30) column 7, line 19 - line 34; figure 17 -----	6	Y	EP 1 014 494 A1 (ZURECON AG [CH]) 28 June 2000 (2000-06-28) paragraphs [0011] - [0012]; figures 1-5 -----	1,2,9	Y	US 3 002 173 A (KILGANNON ALLEN ROBERT) 26 September 1961 (1961-09-26) column 3, line 33 - line 43; figures 1-4 ----- -/--	2,7
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																	
* Special categories of cited documents : <table> <tr> <td> "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 </td> <td> "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 </td> </tr> </table>			"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													
"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																
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17 April 2019		26/04/2019															
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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2019/051400

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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