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(54) **SWITCHGEAR AND A HIGH-VOLTAGE SWITCH ASSEMBLY THEREFOR**

(57) This invention concerns a switch assembly 48, 50 for a high-voltage joint 46 for a wind turbine 10. The switch assembly 48, 50 comprises a first connector 54 associated with a live cable and a second connector 56 associated with a de-energised cable. The first and second connectors 54, 56 comprise respective primary contact surfaces 58 configured to be brought together to form an interface establishing an electrical connection. The switch assembly 48, 50 further comprises an electrical conductor 60 comprising a secondary contact surface 62. The electrical conductor 60 is attached to one connector of the first or second connectors 54, 56 and is configured such that at least part of the secondary contact surface 62 extends axially by a distance beyond the primary contact surface 58 of the one connector of the first or second connectors 54, 56 so as to establish an electrical connection between the first and second connectors 54, 56 before the interface is formed.

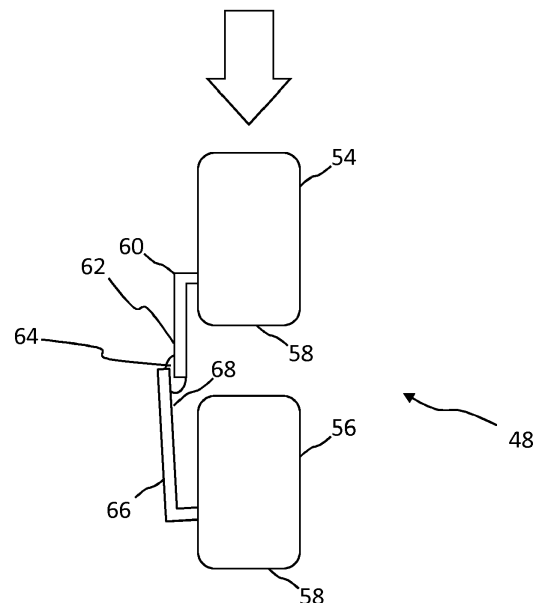


FIG. 5

Description

FIELD OF THE INVENTION

[0001] This invention generally concerns switchgear for a wind turbine. In particular, it relates to a high-voltage switch assembly for the switchgear.

BACKGROUND

[0002] When servicing and/ or correcting a fault condition within a wind turbine that forms part of a wind power plant, it is often necessary to disconnect the wind turbine from a collector grid of the wind power plant while at least some of the other wind turbines of the wind power plant remain operational. Once the servicing has been completed, the wind turbine is then reconnected to the collector grid. Reconnecting the wind turbine to the collector grid can mean connecting live and de-energised parts of the collector grid. However, electric discharges, due to the large difference in electric potential between the live and de-energised parts of the collector grid, can damage connectors of the collector grid.

[0003] It is against this background that the invention has been devised.

STATEMENTS OF INVENTION

[0004] According to a first aspect of the invention, there is provided a switch assembly for a high-voltage joint for a wind turbine, the switch assembly comprising: a first connector associated with a live cable; and, a second connector associated with a de-energised cable, wherein the first and second connectors comprise respective primary contact surfaces configured to be brought together to form an interface establishing an electrical connection between the first and second connectors, the switch assembly further comprising: an electrical conductor comprising a secondary contact surface, wherein the electrical conductor is attached to one connector of the first or second connectors and is configured such that at least part of the secondary contact surface extends axially by a distance beyond the primary contact surface of the one connector of the first or second connectors so as to establish an electrical connection between the first and second connectors before the interface is formed. Preferably, the switch assembly further comprises a second electrical conductor comprising a secondary contact surface, wherein the second electrical conductor is attached to the other connector of the first or second connectors, and wherein the secondary contact surfaces of the first and second electrical conductors are configured to interconnect to establish an electrical connection between the first and second connectors before the interface is formed.

[0005] Preferably, at least part of the secondary contact surface of the second electrical conductor extends axially by a distance beyond the primary contact surface

of the other connector of the first or second connectors, and wherein an end of one electrical conductor of the first or second electrical conductors is arranged to pass over an end of the other electrical conductor of the first or second electrical conductors to form an interconnection between the secondary contact surfaces of the first and second electrical conductors before the interface is formed.

[0006] Alternatively, the secondary contact surface of the second electrical conductor extends radially from the other connector of the first or second connectors. Preferably, the second electrical conductor comprises an open bore configured to receive the first electrical conductor before the interface is formed.

[0007] Preferably, the first electrical conductor is moveable between a first position, in which the distance between the secondary contact surface of the first electrical conductor and the primary contact surface of the one connector of the first or second connectors is a maximum distance, and a second position, in which the distance is less than the maximum distance, the first and second electrical conductors being arranged such that the second electrical conductor urges the first electrical conductor from the first position when the first and second electrical conductors interconnect to the second position when the interface is formed.

[0008] Preferably, the first electrical conductor comprises a biasing means configured to bias the first electrical conductor in the first position.

[0009] Preferably, the secondary contact surface of the first electrical conductor comprises a circular contact surface concentrically arranged with the first connector, the circular contact surface being configured to abut the secondary contact surface of the second electrical conductor to interconnect the first and second electrical conductors.

[0010] Preferably, the second electrical conductor comprises a flange. More preferably, the flange is offset axially from the primary contact surface of the other connector of the first or second connectors.

[0011] Preferably, the first electrical conductor is a sacrificial component arranged to fail after the interface has been formed less than ten times.

[0012] Preferably, the second electrical conductor is a sacrifice component arranged to fail after the interface has been formed less than ten times.

[0013] Preferably, the live cable comprises a cable coming into the wind turbine and the de-energised cable comprises a cable going out of the wind turbine for connecting the wind turbine to another wind turbine in a wind power plant.

[0014] According to a second aspect of the invention, there is provided switchgear for a wind turbine, the switchgear comprising a switch assembly according to the first aspect of the invention.

[0015] According to a third aspect of the invention, there is provided a wind turbine comprising switchgear according to the second aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other aspects of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a wind turbine;

Figure 2 is a schematic view of an array of foundations and respective transition pieces, for carrying the wind turbine of Figure 1;

Figure 3 is a schematic view of a switchgear device for use in the transition pieces of Figure 2, comprising a switch assembly in accordance with the invention;

Figures 4a and 4b show a first embodiment of the switch assembly of Figure 3;

Figure 5 shows a second embodiment of the switch assembly of Figure 3;

Figure 6 shows a third embodiment of the switch assembly of Figure 3; and,

Figures 7a and 7b show a fourth embodiment of the switch assembly of Figure 3.

[0017] In the drawings, like features are denoted by like reference signs.

SPECIFIC DESCRIPTION

[0018] The following description refers to the accompanying drawings that show, by way of illustration, specific details and embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilised and structural, logical, and electrical changes may be made without departing from the scope of the invention as defined in the appended claims. Moreover, references in the following description to "upper", "lower" or any other terms having an implied orientation are not intended to be limiting and refer only to the orientation of the features as shown in the accompanying drawings.

[0019] Figure 1 shows an offshore wind turbine, generally designated as 10, of the kind that may be used with embodiments of the invention. In this example, the wind turbine 10 is a three-bladed upwind horizontal-axis wind turbine, which is the most common type of wind turbine in use. The wind turbine 10 comprises a tower 12 supporting a nacelle 14, to which a rotor 16 is mounted. The rotor 16 comprises a plurality of rotor blades 18 extending radially from a central hub 20. In this example, the rotor 16 comprises three rotor blades 18, although only two are visible. However, it will be apparent to the skilled reader that other configurations are possible. The rotor 16 is

operatively coupled to a power generation system, represented schematically by box 22, housed inside the nacelle 14. The power generation system 22 comprises a generator, arranged to be driven by the rotor 16 to produce electrical power, and a power converter system, which converts the electrical power outputted from the generator into a form suitable for delivery to an electrical grid (not shown). In addition to the power generation system 22, the nacelle 14 and the tower 12 house miscellaneous components required for converting wind energy into electrical energy, along with various other components needed to operate, control, and optimise the performance of the wind turbine 10. It should be noted that the wind turbine 10 of Figure 1 is referred to by way of example only, and that it would be possible to implement embodiments of the invention into many different types of wind turbines and their associated systems.

[0020] The wind turbine 10 is located on an offshore foundation 24, which includes a platform 26 that is supported on a plurality of pillars 28 that are piled into the seabed. A transition piece 30 is provided on the platform 26, positioned below and arranged to carry the wind turbine 10.

[0021] A coupling transformer 32, which acts to suitably couple the power generation system 22 to a grid transmission or distribution line (not shown), is located inside the transition piece 30 and is operatively connected to the power generation system 22 via a set of cables 34 that extend inside the tower 12. A switchgear device 34, comprising a circuit breaker panel for isolating the electrical equipment inside the wind turbine 10 in the event of a fault condition, is also located in the transition piece 30, and is connected to the coupling transformer 32 via a set of cables or a busbar 36.

[0022] In addition to the circuit breaker panel, the switchgear device 34 comprises a high-voltage joint associated with an incoming cable 38 and an outgoing cable 40.

[0023] Although the wind turbine 10 has been described individually up to this point, it would typically form part of a wind power plant comprising a plurality of wind turbines that are electrically connected together via respective incoming and outgoing cables 38, 40 to form a collector grid.

[0024] Figure 2 shows an array of foundations 24a-24c and respective transition pieces 30a-30c. In this example, three foundations 24a-24c are shown, but there would normally be many more than this for a typical wind power plant. The transition pieces 30a-30c, containing respective switchgear devices 34a-34c, are installed prior to the installation of the wind turbines 10. This arrangement allows the incoming and outgoing cables 38a-38c; 40a-40c, to be connected and tested prior to installing the wind turbines 10. The incoming cable 38a, associated with the first foundation 24a, and the outgoing cable 40c, associated with the third foundation 24c, connect the cables 38a-38c; 40a-40c to a substation 44, which is arranged to supply electrical power to the grid distribution

or transmission line (not shown). The substation 44 includes its own switchgear (not shown), allowing the substation 44 to be connected to or disconnected from the collector grid as required.

[0025] With reference to Figure 3, as noted above, the switchgear device 34 comprises a high-voltage joint, generally designated by 46, comprising a pair of switch assemblies 48, 50, together with the circuit breaker panel, generally designation by 52. The switch assemblies 48, 50 are associated respectively with the incoming cable 38 and the outgoing cable 40, and are connected to each other and the circuit breaker panel by a busbar 51. In addition to facilitating the testing of the incoming and outgoing cables 38a-38c; 40a-40c prior to the installation of the wind turbines 10, the switch assemblies 48, 50 enable a wind turbine to be de-energised by disconnecting it from the collector grid, for example when service operations on the wind turbine are undertaken, and/ or in the event of faults. In some cases, this means re-energising the wind turbine by connecting a live cable, such as incoming cable 38, to the high-voltage joint 46 or, in other cases, connecting a de-energised cable, such as outgoing cable 40, to the high-voltage joint 46 that has been energised by a live cable. In both instances, however, the difference in the electric potential between the live cable and the de-energised cable creates numerous electric discharges or sparks extending between contacts surfaces associated with the live and de-energised cables as the contact surfaces are brought together to establish an electrical connection across the switch assemblies 48, 50. These electric discharges can damage the contact surfaces, leading to a poor electrical connection across the switch assemblies 48, 50. Conventionally, this problem is addressed by coating the contact surfaces in a reinforcing alloy so as to minimise any damage associated with the electric discharge. However, modifying the contact surfaces in this way is expensive.

[0026] Figure 4a is a schematic illustration of an embodiment of one of the switch assemblies 48, 50 in accordance with the invention. The switch assembly, generally designated by 48, comprises a first connector 54 and a second connector 56. One of the connectors 54, 56 is associated with a live cable, while the other connector is associated with a de-energised cable. The connectors 54, 56, each comprise a primary contact surface 58 for forming an interface to establish an electrical connection between the connectors 54, 56. The primary contact surfaces 58 are shown here, and in the other embodiments of the switch assemblies 48, 50, as being located at the ends of the connectors 54, 56. However, the primary contact surfaces 58 could also be located on sides of the connectors 54, 56, such as when one connector 54, 56 is configured to be received in a bore of the other connector 54, 56. In this case, the interface, establishing an electrical connection between the connectors 54, 56, is formed between an internal side of the connector 54, 56 defining the bore and an external side of the connector 54, 56 received within the bore. The

switch assembly 48 further comprises a receiver (not shown), including respective sockets for the connectors 54, 56 to hold the connectors 54, 56 in position when the interface is formed. One of the connectors, in this instance the first connector 54, comprises an electrical conductor 60 having a secondary contact surface 62. In this embodiment, the electrical conductor 60 comprises an appendage attached to the side of the first connector 54 and extending axially beyond the primary contact surface 58 such that at least part of the secondary contact surface 62 also extends axially beyond the primary contact surface 58, between the connectors 54, 56.

[0027] With reference to Figure 4b, at least one of the connectors 54, 56, in this embodiment the first connector 54, is moveable relative to the other connector 54, 56 to bring the primary contact surfaces 58 together to form the interface. As the connectors 54, 56 are brought together and before the primary contact surfaces 58 form the interface, the electrical conductor 60 moves close enough to the side of the second connector 56 to establish an electrical connection with the second connector 56. Accordingly, any electric discharges, indicated by 64, resulting from the difference in the electric potential between the connectors 54, 56, are guided between the second connector 56 and the electrical conductor 60 via the secondary contact surface 62. That is, the electrical conductor 60 functions to reduce the difference in the electric potential between the connectors 54, 56 before the interface is formed, and in doing so avoids the generation of electric discharges between the primary contact surfaces 58.

[0028] Figure 5 is a schematic illustration of a second embodiment of one of the switch assemblies 48, 50 in accordance with the invention. This embodiment is similar to the previous embodiment save for the fact that both connectors 54, 56 comprise respective electrical conductors 60, 66. This embodiment shows the first connector 54 including the first electrical conductor 60 and the second connector 56 including a second electrical conductor 66, in the form of an appendage attached to the side of the second connector 56. In this embodiment, the secondary contact surface 62 of the first electrical conductor 60 is located on an outer radial surface of the first electrical conductor 60, and a secondary contact surface 68 of the second electrical conductor 66 is located on an inner radial surface of the second electrical conductor 66. In both instances, at least part of the secondary contact surfaces 62, 68 extend axially beyond the respective primary contact surface 58 of the first and second connectors 54, 56.

[0029] As the connectors 54, 56 are brought together and before the primary contact surfaces 58 form the interface, the first and second electrical conductors 60, 66 are arranged to move close enough together to establish an electrical connection. Accordingly, any electric discharges 64 resulting from the difference in the electric potential between the connectors 54, 56, are guided between the first and second electrical conductors 60, 66

via the secondary contact surfaces 62, 68, thereby reducing the difference in the electric potential between the connectors 54, 56 before the interface is formed to avoid electric discharges between the primary contact surfaces 58. In this embodiment, the first and second electrical conductors 60, 66 are radially offset with respect to each other such that the secondary contact surface 68 of the second electrical conductor 66 passes over the outer radial surface of the first electrical conductor 60 to establish an interconnection between the conductors 60, 66 as the connectors 54, 56 are brought together. However, it will be apparent to the skilled reader that the secondary contact surface 62 of the first electrical conductor 60 could be located on an inner radial surface of the first electrical conductor 60, and the secondary contact surface 68 of the second electrical conductor 66 could be located on an outer radial surface of the second electrical conductor 66. In which case, the first and second electrical conductors 60, 66 are arranged such that the secondary contact surface 62 of the first electrical conductor 60 slides over the outer radial surface of the second electrical conductor 66 to establish an electrical connection between the secondary contact surfaces 62, 68 before the interface between the primary contact surfaces 58 is formed.

[0030] Figure 6 is a schematic illustration of a third embodiment of one of the switch assemblies 48, 50 in accordance with the invention. In this embodiment, the secondary contact surface 68 of the second electrical conductor 66 does not extend axially beyond the primary contact surface 58 of the second connector 56, but instead extends radially from the side of the second connector 56. The secondary contact surface 68 comprises an aperture 70, which forms part of an open bore 72 within the second electrical conductor 66. The open bore 72 is axially aligned with the first electrical conductor 60, which in this embodiment comprises an appendage attached to the side of the first connector 54. The first electrical conductor 60 extends axially such that at least part of the secondary contact surface 62, defined by the outer surface of the first electrical conductor 60, extends beyond the primary contact surface 58 of the first connector 54. As the connectors 54, 56 are brought together and before the primary contact surfaces 58 form the interface, the first and second electrical conductors 60, 66 are arranged to move close enough together to establish an electrical connection such that any electric discharges 64 resulting from the difference in the electric potential between the connectors 54, 56 are guided between the first and second electrical conductors 60, 66 via the secondary contact surfaces 62, 68. At this point, the distal end of the first electrical conductor 60 may be located slightly above the aperture 70 (according to the orientation of the switch assembly 48 shown in Figure 6) or within the open bore 72. Further movement of the first connector 54 towards the second connector 56 causes the distal end of the first electrical conductor 60 to pass through the open bore 72 to enable the formation of the interface between the primary contact surfaces 58. In this embod-

iment, the second electrical conductor 66 forms part of an upper surface of a flange 74 extending outwardly from the side of the second connector 56. The flange 74 is longitudinally offset from the primary contact surface 58 of the second connector 56, ensuring that any electric discharges 64 between the first and second electrical conductors 60, 66 are generated away from the primary contact surface 58 of the second connector 56.

[0031] Figure 7a is a schematic illustration of a fourth embodiment of one of the switch assemblies 48, 50 in accordance with the invention. In this embodiment, the first electrical conductor 60 is moveable between a first position and a second position. The first electrical conductor 60 comprises a flange 76 secured to the side of the first connector 54. The flange 76 comprises at least two open bores 78, through which respective arms 80 are slidably received. The arms 80 extend axially a distance beyond the primary contact surface 58 of the first connector 54 and are arranged to carry the secondary contact surface 62 at their distal ends. In this embodiment, the secondary contact surface 62 is circular, forming part of the lower surface of a ring 82, but other configurations of the secondary contact surface 62 will be apparent to the skilled reader. Each arm 80 comprises a first collar 84, located above the upper surface of the flange 76. The first collars 84 are arranged to abut the upper surface of the flange 76 to limit downward movement of the arms 80, defining a maximum distance between the secondary contact surface 62 and the primary contact surface 58 of the first connector 54, which defines the first position of the first electrical conductor 60. As in the previous embodiment, the secondary contact surface 68 of the second electrical conductor 66 is defined by the upper surface of the flange 74, radially extending from the outer surface of the second connector 56.

[0032] With reference to Figure 7b, as the connectors 54, 56 are brought together and before the primary contact surfaces 58 form the interface, the first and second electrical conductors 60, 66 are arranged to move close enough together to establish an electrical connection. At this point or shortly thereafter, the secondary contact surfaces 62, 68 abut or interconnect as shown in Figure 7b. Further movement of the first connector 54 with respect to the second connector 56 causes the second electrical conductor 66 to urge or drive the first electrical conductor 60 from its first position until the interface between the primary contact surfaces 58 is formed. At this point, the first electrical conductor 60 is in its second position, where the distance between the secondary contact surface 62 and the primary contact surface 58 of the first connector 54 is less than the maximum distance.

[0033] As shown in Figures 7a and 7b, each arm 80 may also include an optional a second collar 86 located below the lower surface of the flange 76. The upper surface of the second collar 86 is used to hold a biasing means 88, in the form of a helical spring, positioned between the second collar 86 the lower surface of the flange 76, in order to urge the first electrical conductor 60 into

its first position when the connectors 54, 56 disconnect.

[0034] It will be apparent by those skilled in the art that the invention has been described by way of example only, and that a variety of alternative approaches may be adopted without departing from the scope of the invention as defined by the appended claims. For example, the first and second electrical conductors 60, 66 have been shown in the figures attached to the first and second connectors 54, 56 respectively. This was done to aid in the description of the various embodiments of the invention, but the skilled reader will appreciate that first and second electrical conductors 60, 66 can just as easily be attached to the second and first connectors 56, 54 respectively. Moreover, the embodiments of the invention described herein show the first connector 54 being moveable with respect to the second connector 56. However, the skilled reader will understand that both connectors 54, 56 could be moveable, or the second connector 56 could be moveable with respect to the first connector 54, in order to form the interface between the primary contact surfaces 58. It would be understood that although the first and second electrical conductors 60, 66 have been described as sacrificial components, protecting the primary contact surfaces 58 from damaging electric discharges, this does not mean that the conductors 60, 66 are limited to one-time use, and that they could be arranged to fail only after the interface has been formed several times.

Claims

1. A switch assembly (48, 50) for a high-voltage joint (46) for a wind turbine (10), the switch assembly (48, 50) comprising:

a first connector (54) associated with a live cable; and,
a second connector (56) associated with a de-energised cable, wherein the first and second connectors (54, 56) comprise respective primary contact surfaces (58) configured to be brought together to form an interface establishing an electrical connection between the first and second connectors (54, 56), the switch assembly (48, 50) further comprising:
an electrical conductor (60) comprising a secondary contact surface (62), wherein the electrical conductor (60) is attached to one connector of the first or second connectors (54, 56) and is configured such that at least part of the secondary contact surface (62) extends axially by a distance beyond the primary contact surface (58) of the one connector of the first or second connectors (54, 56) so as to establish an electrical connection between the first and second connectors (54, 56) before the interface is formed.

2. A switch assembly (48, 50) according to claim 1, further comprising a second electrical conductor (66) comprising a secondary contact surface (68), wherein the second electrical conductor (66) is attached to the other connector of the first or second connectors (54, 56), and wherein the secondary contact surfaces (62, 68) of the first and second electrical conductors (60, 66) are configured to interconnect to establish an electrical connection between the first and second connectors (54, 56) before the interface is formed.
3. A switch assembly (48, 50) according to claim 2, wherein at least part of the secondary contact surface (68) of the second electrical conductor (66) extends axially by a distance beyond the primary contact surface (58) of the other connector of the first or second connectors (54, 56), and wherein an end of one electrical conductor of the first or second electrical conductors (60, 66) is arranged to pass over an end of the other electrical conductor of the first or second electrical conductors (60, 66) to form an interconnection between the secondary contact surfaces (62, 68) of the first and second electrical conductors (60, 66) before the interface is formed.
4. A switch assembly (48, 50) according to claim 2, wherein the secondary contact surface (68) of the second electrical conductor (66) extends radially from the other connector of the first or second connectors (54, 56).
5. A switch assembly (48, 50) according to claim 4, wherein the second electrical conductor (66) comprises an open bore (72) configured to receive the first electrical conductor (60) before the interface is formed.
6. A switch assembly (48, 50) according to claim 4, wherein the first electrical conductor (60) is moveable between a first position, in which the distance between the secondary contact surface (62) of the first electrical conductor (60) and the primary contact surface (58) of the one connector of the first or second connectors (54, 56) is a maximum distance, and a second position, in which the distance is less than the maximum distance, the first and second electrical conductors (60, 66) being arranged such that the second electrical conductor (66) urges the first electrical conductor (60) from the first position when the first and second electrical conductors (60, 66) interconnect to the second position when the interface is formed.
7. A switch assembly (48, 50) according to claim 6, wherein the first electrical conductor (60) comprises a biasing means (88) configured to bias the first electrical conductor (60) in the first position.

8. A switch assembly (48, 50) according to claim 6 or 7, wherein the secondary contact surface (62) of the first electrical conductor (60) comprises a circular contact surface concentrically arranged with the first connector (54), the circular contact surface being configured to abut the secondary contact surface (68) of the second electrical conductor (66) to interconnect the first and second electrical conductors (60, 66).

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9. A switch assembly (48, 50) according to any one of claims 4 to 8, wherein the second electrical conductor (66) comprises a flange (74).

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10. A switch assembly (48, 50) according to claim 9, wherein the flange (74) is offset axially from the primary contact surface (58) of the other connector of the first or second connectors (54, 56).

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11. A switch assembly (48, 50) according to any preceding claim, wherein the first electrical conductor (60) is a sacrificial component arranged to fail after the interface has been formed less than ten times.

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12. A switch assembly (48, 50) according to claim 11 when dependent on any one of claims 2 to 10, wherein the second electrical conductor (66) is a sacrifice component arranged to fail after the interface has been formed less than ten times.

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13. A switch assembly (48, 50) according to any preceding claim, wherein the live cable comprises a cable (38) coming into the wind turbine (10) and the de-energised cable comprises a cable (40) going out of the wind turbine (10) for connecting the wind turbine (10) to another wind turbine in a wind power plant.

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14. Switchgear (43) for a wind turbine (10), the switchgear (10) comprising a switch assembly (48, 50) according to any preceding claim.

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15. A wind turbine (10) comprising switchgear (34) according to claim 14.

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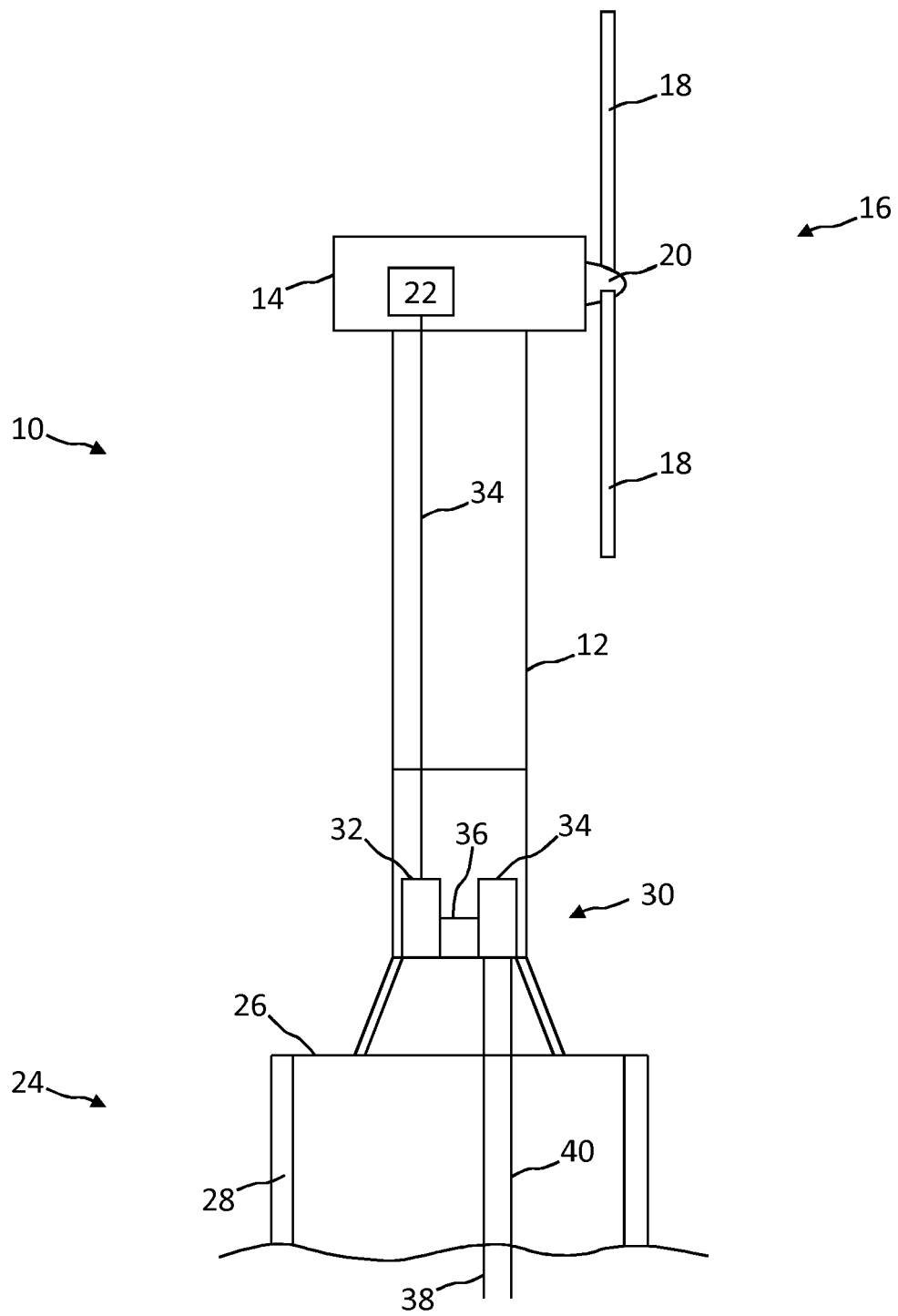


FIG. 1

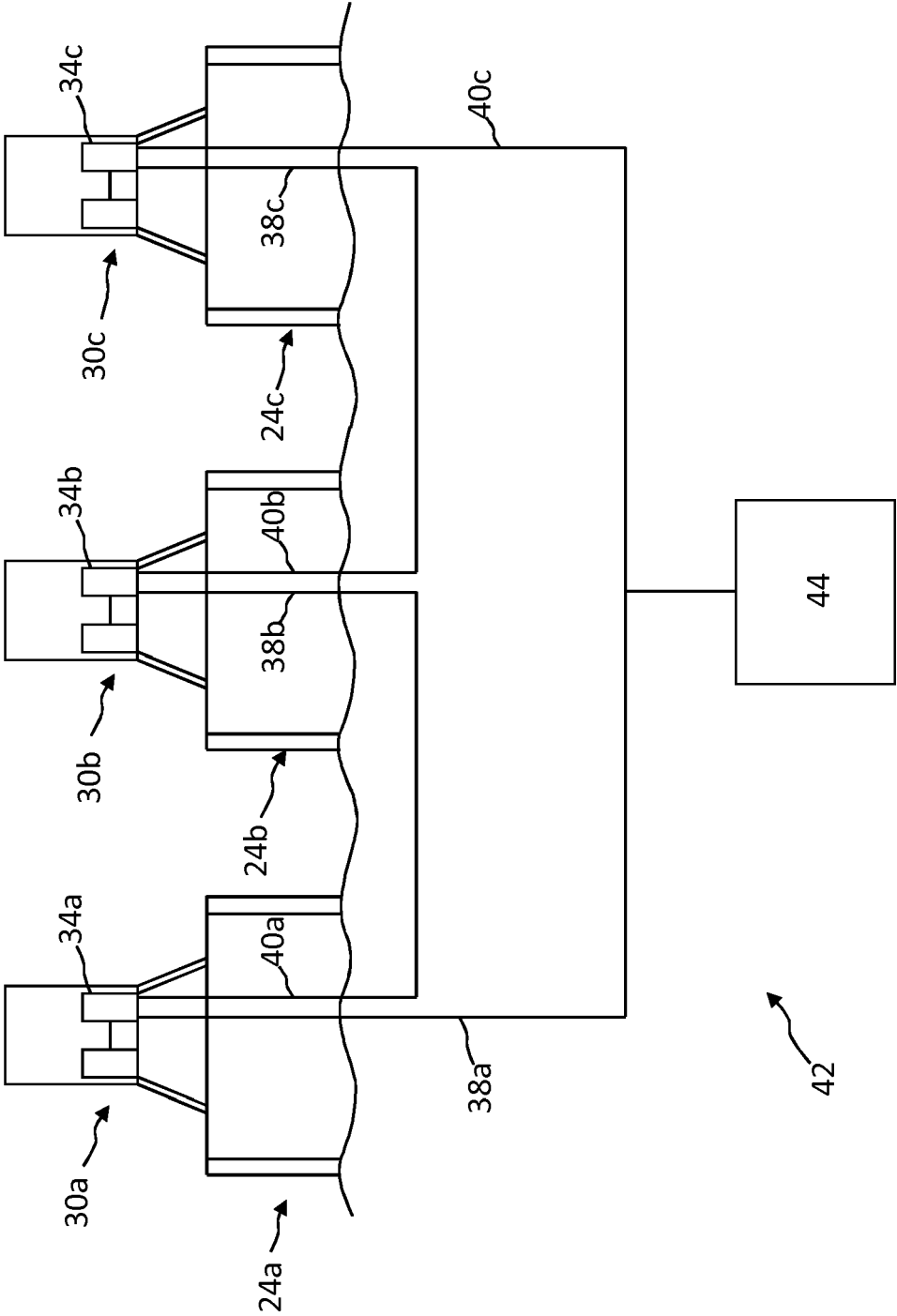


FIG. 2

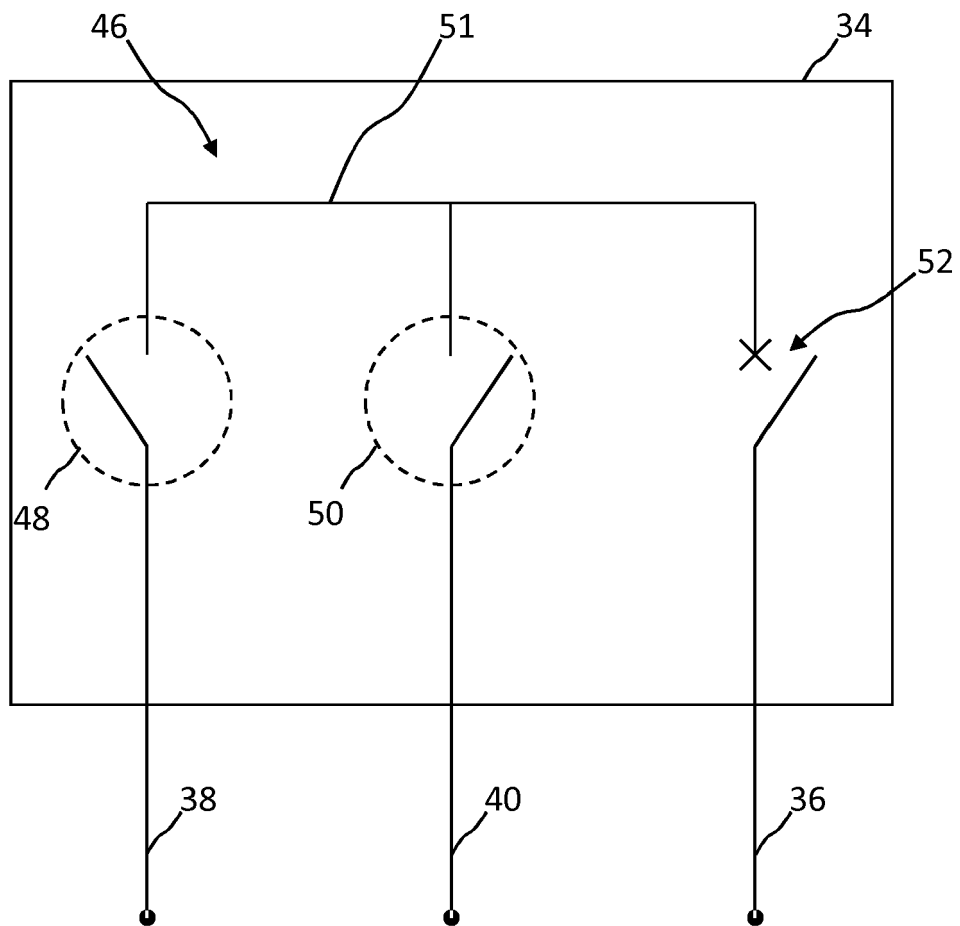


FIG. 3

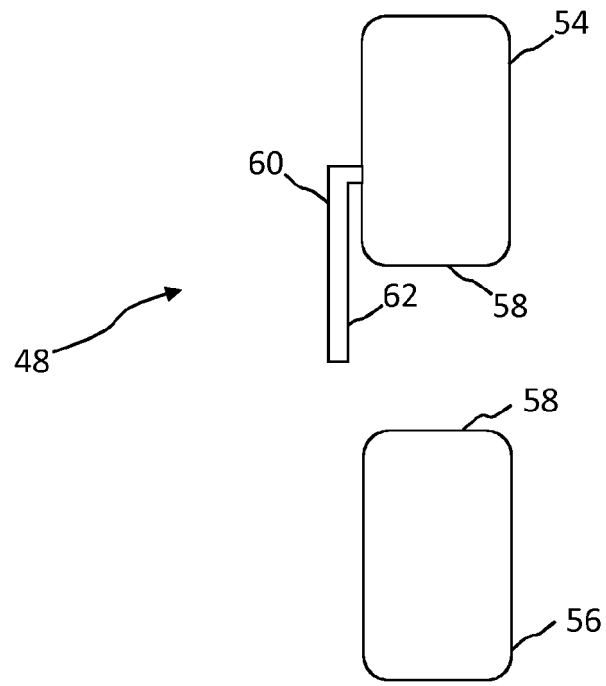


FIG. 4a

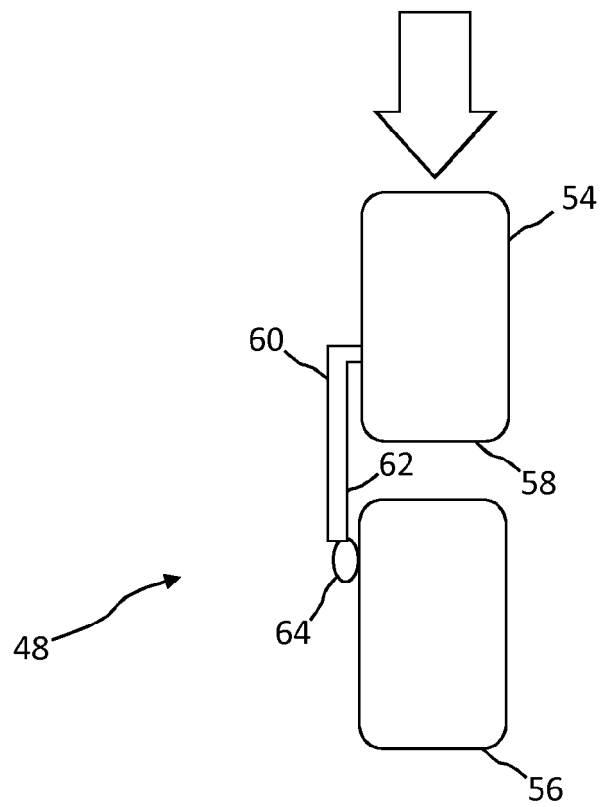


FIG. 4b

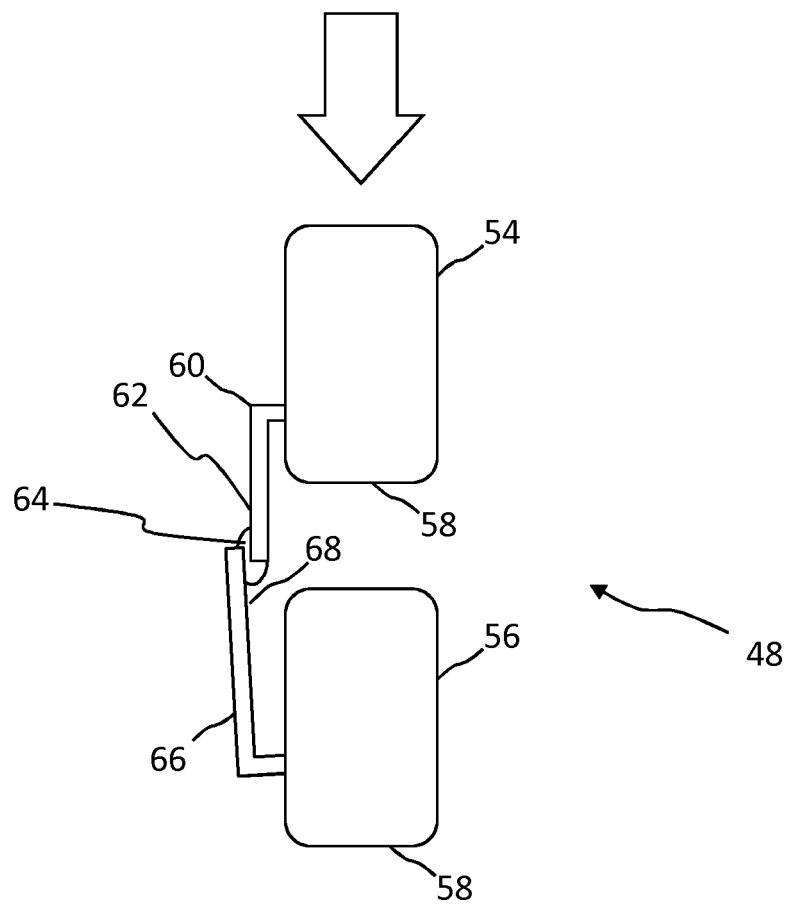


FIG. 5

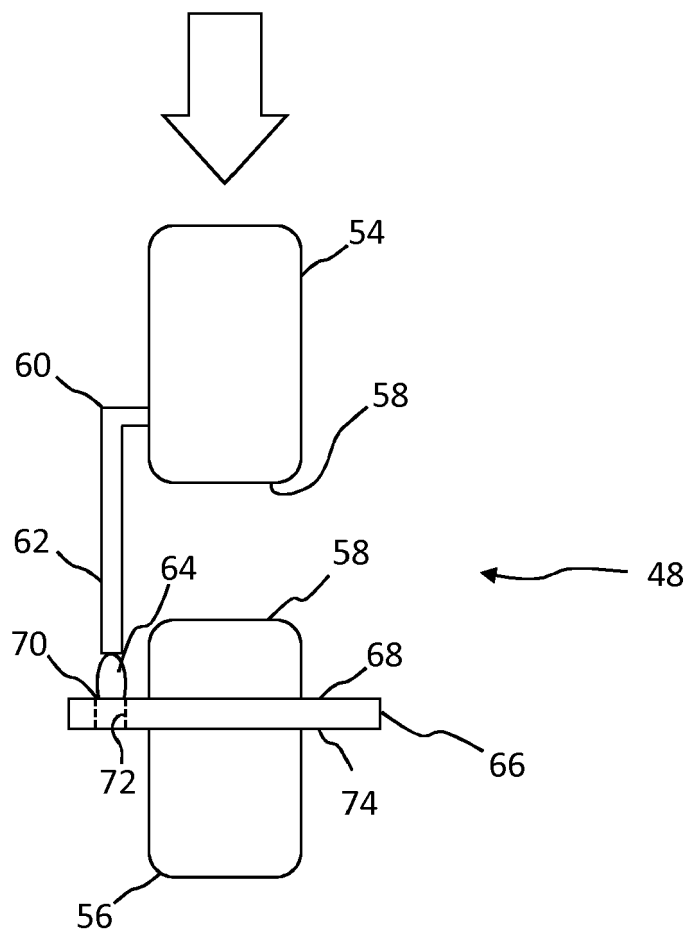
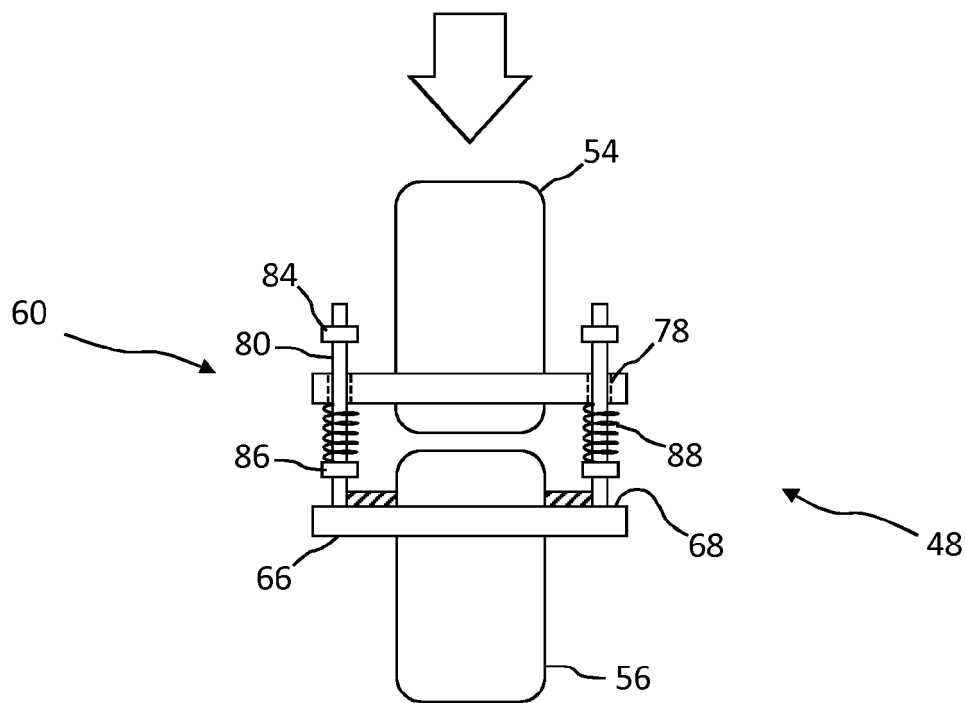
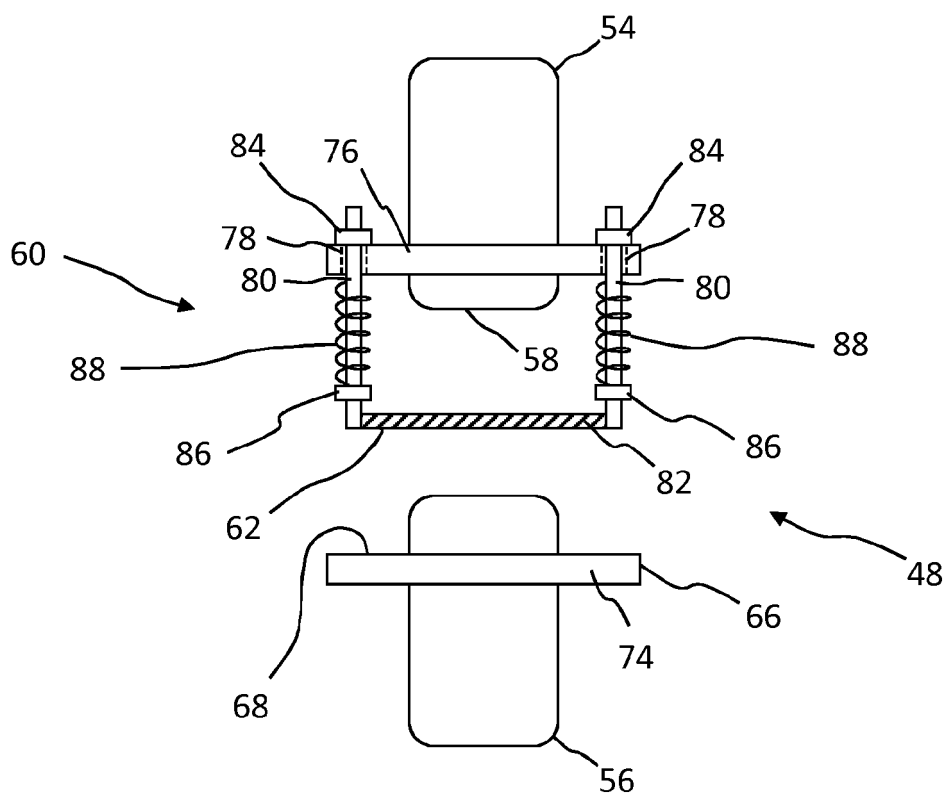


FIG. 6





EUROPEAN SEARCH REPORT

Application Number
EP 18 19 7810

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 052 576 A (SMITH ROBERT KIRKLAND) 4 October 1977 (1977-10-04)	1-12,14	INV. H01H33/12
Y	* column 8, line 53 - column 10, line 29 * * column 14, line 47 - column 16, line 24 * * figures 3,4,14 *	13,15	
X	US 2014/353279 A1 (KOSTOVIC JADRAN [CH]) 4 December 2014 (2014-12-04) * paragraphs [0013], [0014], [0017] - [0021] * * figures 1a,1b *	1,2,4,5,11,12	
Y	US 2015/152850 A1 (NIELSEN JESPER [DK]) 4 June 2015 (2015-06-04) * paragraphs [0002] - [0004], [0036] - [0039] * * figures 1-3 *	13,15	TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 March 2019	Examiner Ledoux, Serge
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 19 7810

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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