(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 886 133 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.09.2021 Bulletin 2021/39

(51) Int Cl.:
H01H 33/666 *(2006.01)*

(21) Application number: **20200515.3**

(22) Date of filing: **07.10.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **24.03.2020 IN 202031012780**

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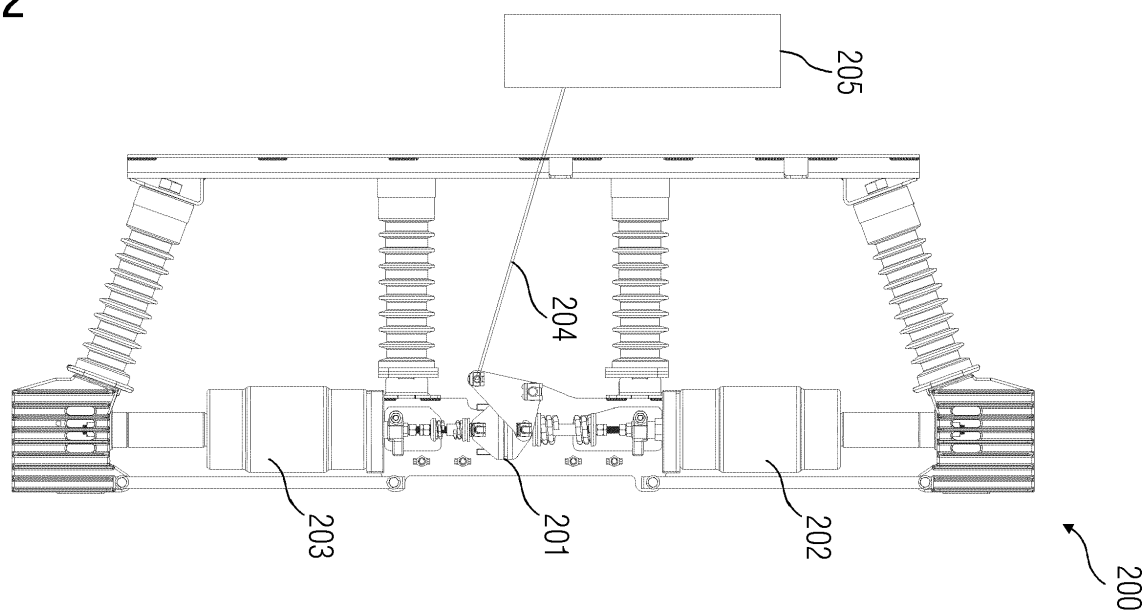
(54) **INTERLINK ARRANGEMENT FOR A SWITCHING DEVICE**

(57) A pole assembly (200) of a switching device (106) and a method of operating the switching device (106) are provided. The pole assembly (200) including a first interrupter unit (202) providing a path for current flow therethrough in a closed state and interrupting the current flow in an open state, a second interrupter unit (203) operably connected to the first interrupter unit (202) allowing the current flow through the first interrupter unit (202) in an open state and grounding the switching device (106) in a closed state, and an interlink arrangement (201) operably connected to a moveable member (202A) of the first interrupter unit (202) and a moveable member (203A) of the second interrupter unit (203) for setting stroke of the second interrupter unit (203) independent of the stroke of the first interrupter unit (202) .

FIG 2



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Description

[0001] The present disclosure relates to switching devices such as circuit breakers. More particularly, the present disclosure relates to a physical interlink between a circuit breaker and a grounding switch.

[0002] Like Circuit breakers, grounding or earthing transformers are an important component of any power network. More particularly, grounding transformers are essential for renewable power generator plants, for example, in large multi-turbine wind farms where the substation transformer frequently provides a sole earthing source for distribution system. A grounding transformer placed on a wind turbine string provides a ground path in an event when the string becomes isolated from the system ground provided by the substation transformer. A ground fault on a collector cable causes the substation circuit breaker to open and the wind turbine string becomes isolated from the system ground source. The wind turbines do not always detect this fault or the fact that the string is isolated and ungrounded. As a result, the generators continue to energize the collector cable, and the voltages between the un-faulted cables and the ground rise far above the normal voltage magnitude. This results in a staggering increase in operational costs.

[0003] FIG 1A illustrates a wind power generation system 100, according to the state of the art. The wind power generation system 100 has a string of wind turbines WTG1-WTGX each of which are connected to a medium voltage circuit breaker 101 and a grounding transformer 102, via respective line transformers 103A-103X. This wind power generation system 100 is then connected to a step-up transformer 104 to step up the voltage suitable for power transmission over the transmission system 105. FIG 1B illustrates a wind power generation system 100 comprising a switching device 106 having a combined functionality of circuit breaking and ground switching, according to the state of the art. FIG 1B discloses an embodiment of the wind power generation system 100 shown in FIG 1A. In this embodiment, the circuit breaker 101 and the grounding transformer 102 are integrated into a single switching device 106. The switching device 106 performs the switching and grounding through a combined medium voltage circuit breaker and a grounding vacuum switch thereby, eliminating the grounding transformer 102. However, for performing defined functions of the circuit breaker and the grounding switch it is required that a switching stroke of both circuit breaker and ground switch must set independent of one another. The switching stroke refers to a gap between a fixed contact and a moving contact of the switching device such as a vacuum interrupter when it is in an open condition. This stroke is a function of the time delay required for conducting the switching operation. For example, greater the time delay larger is the stroke. Thus, if the stroke requirements are different for the circuit breaker and the grounding switch then a mutual exclusion among their physical design is required. Typically, a drive connection rod of the switching device is used for stroke adjustment however, this does not allow for independent stroke adjustment.

[0004] Accordingly, it is an object of the present invention, to provide a switching device having a first interrupter unit, that is, a circuit breaker, providing a path for current flow therethrough in a closed state and interrupting the current flow in an open state, and a second interrupter unit operably connected to the first interrupter unit allowing the current flow through the first interrupter unit in an open state and grounding the switching device in a closed state, that is, acting as a grounding switch, that addresses the aforementioned problems of independent stroke adjustment while ensuring ease of assembly and mechanical design without increase in costs associated therewith.

[0005] The switching device disclosed herein is, for example, a medium voltage switchgear having an operational rating of up to 38 kilo Volts and up to 40 kilo Amperes and comprises at least one pole assembly, per phase, in an operable connection with a drive unit via a drive connection rod.

[0006] According to an embodiment of the present disclosure, the switching device, that is, a circuit breaker is employed in renewable power generation stations, such as a wind power generation station and is a three phase switching device having one pole assembly per phase. The pole assembly includes post insulators supporting two vacuum interrupters connected to one another representing a circuit breaker and a grounding switch respectively. The drive connection rod is used to set a stroke of the circuit breaker. The stroke refers to a gap between a fixed contact and a moving contact of a vacuum interrupter with the circuit breaker in an open condition.

[0007] The switching device achieves the aforementioned object in that, the pole assembly includes an interlink arrangement therein operably connected to a moveable member of the first interrupter unit and a moveable member of the second interrupter unit of the pole assembly, and comprises at least one stroke adjusting member for setting a stroke of the second vacuum interrupter without affecting a stroke of the first vacuum interrupter.

[0008] The interlink arrangement of the pole assembly sets a stroke of the vacuum interrupter representing the grounding switch independent of the stroke of the circuit breaker. Advantageously, the stroke adjusting member varies a distance of the moveable member of the second interrupter unit with respect to the moveable member of the first interrupter unit thereby, achieving independent stroke setting and/or adjustment.

[0009] The stroke adjusting member is disposed between connectors that are in operable connection with at least one of the moveable members of the interrupter units. Advantageously, the stroke adjusting member adjusts the stroke during an open condition of the respective interrupter unit. For example, the stroke adjusting member adjusts a stroke of the grounding switch interrupter unit when the circuit breaker interrupter unit is in a closed condition and the grounding switch interrupter unit is in an open condition.

[0010] According to one embodiment of the present disclosure, the stroke adjusting member comprises one or more spacer plates removably arranged between the connectors. As used herein, spacer platers refer to sheet metal elements having a thickness of about 1 mm. According to this embodiment, the spacer plates are stacked on top of one another. A quantity of the spacer plates is determined based on an adjustment required to be made to the stroke of the grounding switch, for example, post stroke setting via the drive connection rod. According to another embodiment, the quantity of the spacer plates is determined based on ageing of the contacts which may have led to stroke adjustment requirements. Advantageously, the spacer plates are removably stacked for ease of stroke adjustment. According to another embodiment, there is a single spacer plate configured of an overall thickness required for stroke adjustment.

[0011] Advantageously, each of the spacer plates is having a generally U-shape defining a space therewithin allowing for movement of the moveable member(s) therethrough. According to this embodiment, the connectors are links configured to sandwich the spacer plates therebetween via one or more fasteners. For example, the links are configured as concave members biased against the spacer plates. According to this embodiment, the connectors are in a physical connection with the moveable members of the interrupter units respectively.

[0012] According to another embodiment of the present disclosure, the stroke adjusting member is configured to have multiple extrusions each having a predefined radius. According to this embodiment, the stroke adjusting member is configured as a generally elliptical shaped disc having multiple holes therewithin which is rotatably disposed against the connectors for selectively aligning one of the extrusions, that is, holes with the connectors. Advantageously, the stroke adjusting member is pivotable about its central axis. Advantageously, the radii of the holes provide for a varied adjustment of the stroke such that larger is the radius of an extrusion from its centroidal axis, bigger is the stroke being set. According to this embodiment, the connectors are configured as elongate members sandwiching therewithin the stroke adjusting member, and connected to both the moveable members of the interrupter units. Advantageously, the connectors, the stroke adjusting member and the moveable member of the grounding switch are positioned in parallel to one another and connected with one or more fasteners allowing the stroke adjusting member to rotate about its central axis. According to this embodiment, the connectors are configured with a slit which when aligned with a hole of a required radius allows the fastener such as a pin, to pass therethrough thereby allowing the moveable member connected thereto to move up and down axially resulting in stroke adjustment.

[0013] Also disclosed herein is a method for operating aforementioned switching device having a pole assembly as described above with two vacuum interrupters representing a circuit breaker and a grounding switch operably connected to one another. The method includes displacing a drive connection rod by operating a drive unit connected thereto, of the switching device, configuring a stroke adjusting member of an interlink arrangement of the pole assembly for varying a physical distance of a moveable member of an interrupter unit with respect to a moveable member of another interrupter unit, when the interrupter unit is in an open state. According to one embodiment, configuring the stroke adjusting member of the interlink arrangement comprises selectively removing and adding spacer plates between connectors of the interlink arrangement, based on a stroke to be maintained for the grounding switch. According to another embodiment, configuring the stroke adjusting member of the interlink arrangement comprises selectively rotating the stroke adjusting member with respect to connectors of the interlink arrangement for aligning the connectors with one of the multiple extrusions configured on the stroke adjusting member. The extrusion to be aligned is selected based on a stroke to be maintained for the grounding switch.

[0014] The above mentioned and other features of the invention will now be addressed with reference to the accompanying drawings of the present invention. The illustrated embodiments are intended to illustrate, but not limit the invention.

[0015] The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1A	illustrates a wind power generation system according to the state of the art.
FIG 1B	illustrates a wind power generation system comprising a switching device having a combined functionality of circuit breaking and ground switching, according to the state of the art.
FIG 2	illustrates a pole assembly for one of the phases of the switching device shown in FIG 1B, according to an embodiment of the present disclosure.
FIGS 3A-3B	illustrate different views of an interlink arrangement of the pole assembly shown in FIG 2, according to one embodiment of the present disclosure.
FIG 4	illustrates a stroke adjusting member of the interlink arrangement shown in FIGS 3A-3B.

FIGS 5A-5B illustrate different views of an interlink arrangement of the pole assembly shown in FIG 2, according to another embodiment of the present disclosure.

FIG 6 illustrates a stroke adjusting member of the interlink arrangement shown in FIGS 5A-5B.

FIG 7 illustrates a process flowchart showing a method for setting strokes for a switching device shown in FIG 1B having a circuit breaker and a grounding switch integrated therewithin.

[0016] Various embodiments are described with reference to the drawings, wherein like reference numerals are used to refer like elements throughout. In the following description, for the purpose of explanation, numerous specific details are set forth in order to provide thorough understanding of one or more embodiments. It may be evident that such embodiments may be practiced without these specific details.

[0017] FIG 2 illustrates a pole assembly 200 for one of the phases of the switching device 106 shown in FIG 1B, according to an embodiment of the present disclosure. The pole assembly 200 comprises a vacuum interrupter 202 operably connected to another vacuum interrupter 203 via an interlink arrangement 201. The vacuum interrupter 202 represents the circuit breaker 101 shown in FIG 1A and the vacuum interrupter 203 represents the grounding switch 102 shown in FIG 1A. The pole assembly 200 thus includes an integration of the circuit breaker and the grounding switch into a single switching device 106 shown in FIG 1B. The interlink arrangement 201 is operably connected to a drive connection rod 204 which is in turn connected to a drive unit 205 of a switching device 106. The interlink arrangement 201 allows for an adjustment of a stroke of the vacuum interrupter 203, that is, the grounding switch without affecting the stroke of the vacuum interrupter 202, that is, the circuit breaker.

[0018] FIGS 3A-3B illustrate different views of an interlink arrangement 201 of the pole assembly 200 shown in FIG 2, according to one embodiment of the present disclosure. FIG 3A shows an elevation view of the interlink arrangement 201. FIG 3B shows a perspective view of the interlink arrangement 201. The interlink arrangement 201 comprises a stroke adjusting member 201C operably connected to moveable stems 202A and 203A of the vacuum interrupters 202 and 203 respectively. As shown in FIGS 3A and 3B the stroke adjusting member 201C is sandwiched between connectors 201A and 201B. The connector 201A is operably connected to the movable stem 202A of the vacuum interrupter 202. The connector 201B is operably connected to the movable stem 203A of the vacuum interrupter 203. The connectors 201A and 201B are connected to one another via fasteners 201D to sandwich the stroke adjusting member 201C therebetween.

[0019] FIG 4 illustrates a stroke adjusting member 201C of the interlink arrangement 201 shown in FIGS 3A-3B. The stroke adjusting member 201C is configured of at least one spacer plate 201C' which is a metallic plate of a generally U-shape defining a space 201C" centrally therewithin. The generally U-shaped configuration of the spacer plate 201C' allows axial movement of the moveable stems 202A and 203A. Moreover, the generally U-shaped configuration allows ease of removal and insertion of the spacer plate 201C' from and between the connectors 201A and 201B. Multiple such spacer plates 201C' are stacked on top of one another by loosening fasteners 201D thereby, achieving adjustment in the stroke of the vacuum interrupter 203 representing the grounding switch. The stroke of the vacuum interrupter 202 representing the circuit breaker can be adjusted via the drive connection rod 204 connected to the drive unit 205 shown in FIG 2 thereby, achieving independent stroke adjustment of the vacuum interrupters 202 and 203.

[0020] FIGS 5A-5B illustrate different views of an interlink arrangement 201 of the pole assembly 200 shown in FIG 2, according to another embodiment of the present disclosure. FIG 5A shows an elevation view of the interlink arrangement 201. FIG 5B shows a perspective view of the interlink arrangement 201. The interlink arrangement 201 comprises two stroke adjusting members 201C each of which are sandwiched between a pair of connectors 201A and 201B which in turn are operably connected to moveable members 202A and 203A of the vacuum interrupters 202 and 203. The interlink arrangement 201 comprises fasteners 201D allowing operable connection between the stroke adjusting members 201C, the connectors 201A and 201B and the moveable members 202A and 203A.

[0021] FIG 6 illustrates a stroke adjusting member 201C of the interlink arrangement 201 shown in FIGS 5A-5B. The stroke adjusting member 201C is configured as a generally elliptical shaped plate adjustably connected to the moveable members 202A and 203A via the connectors 201A and 201B with help of one or more fasteners 201D shown in FIGS 5A and 5B. The stroke adjusting member 201C is configured to have multiple extrusions 201E punched therethrough. The stroke adjusting member 201C is configured to have a semi-circular slot 201 centrally punched in the spacer 201E, and a plurality of holes 201H surrounding the semi-circular slot 201F. Each of the extrusions 201E are of varying radii. For example, the radii go on increasing from an extrusion 201Ea to 201Ed such that when the stroke adjusting member 201C is rotated with respect to the connectors 201A and 201B, along the semi-circular slot 201F and the fastener 201D is adjusted to fit through one of the extrusions 201Ea, 201Eb, 201Ec, or 201Ed, the stroke of the grounding switch, that is, the vacuum interrupter 203 goes on increasing in correspondence with the radius of the respective extrusion 201Ea, 201Eb, 201Ec, or 201Ed. The stroke of the vacuum interrupter 202 representing the circuit breaker can be adjusted via the drive connection rod 204 connected to the drive unit 205 shown in FIG 2 thereby, achieving independent stroke adjustment of the vacuum interrupters 202 and 203.

[0022] FIG 7 illustrates a process flowchart 700 showing a method for operating aforementioned switching device 106 having a pole assembly 200 as described above with two vacuum interrupters 202 and 203 representing a circuit breaker and a grounding switch operably connected to one another via an interlink arrangement 201. At step 701, the method displaces a drive connection rod 204 by operating a drive unit 205 connected thereto, of the switching device 106. Corresponding to the movement of this drive connection rod 204, stroke of the vacuum interrupter 202 is set to be at a specific distance in the open condition of the vacuum interrupter 202. At step 702, the method configures a stroke adjusting member 201C of the interlink arrangement 201 for varying a physical distance of a moveable member 203A of the interrupter unit 203 with respect to a moveable member 202A of the interrupter unit 202, when the interrupter unit 203 is in an open state and the interrupter unit 202 is in a closed state. According to one embodiment, at step 702, the method includes configuring the stroke adjusting member 201C by selectively removing and adding spacer plates 201C' between connectors 201A and 201B of the interlink arrangement 201, based on a stroke to be maintained for the grounding switch vacuum interrupter 203. According to another embodiment, at step 702, the method includes configuring the stroke adjusting member 201C by selectively rotating the stroke adjusting member 201C with respect to connectors 201A and 201B of the interlink arrangement 201 for aligning the connectors 201A and 201B, with one of multiple extrusions 201E configured on the stroke adjusting member 201C. The method at step 702, includes selecting an extrusion 201E based on a stroke to be maintained for the grounding switch vacuum interrupter 203.

[0023] While the present invention has been described in detail with reference to certain embodiments, it should be appreciated that the present invention is not limited to those embodiments. In view of the present disclosure, many modifications and variations would be present themselves, to those skilled in the art without departing from the scope of the various embodiments of the present invention, as described herein. The scope of the present invention is, therefore, indicated by the following claims rather than by the foregoing description. All changes, modifications, and variations coming within the meaning and range of equivalency of the claims are to be considered within their scope.

Claims

1. A pole assembly (200) of a switching device, comprising:

- a first interrupter unit (202) providing a path for current flow therethrough in a closed state and interrupting the current flow in an open state; and
- a second interrupter unit (203) operably connected to the first interrupter unit (202), wherein the second interrupter unit (203) allows the current flow through the first interrupter unit (202) in an open state and grounds the switching device (106) in a closed state; **characterized by**:
- an interlink arrangement (201) operably connected to a moveable member (202A) of the first interrupter unit (202) and a moveable member (203A) of the second interrupter unit (203).

2. The pole assembly (200) according to claim 1, wherein the interlink arrangement (201) comprises at least one stroke adjusting member (201C) configured to set a stroke of the second vacuum interrupter (203) without affecting a stroke of the first vacuum interrupter (202).

3. The pole assembly (200) according to claim 2, wherein the stroke adjusting member (201C) is configured to vary a distance between the moveable member (203A) and the moveable member (202A).

4. The pole assembly (200) according to claim 2, wherein the stroke adjusting member (201C) is disposed between connectors (201A and 201B) and wherein each of the connectors (201A and 202B) are in operable connection with at least one of the moveable members (202A and 203A).

5. The pole assembly (200) according to claim 4, wherein the stroke adjusting member (201C) comprises one or more spacer plates (201C') removably arranged between the connectors (201A and 201B).

6. The pole assembly (200) according to claim 4, wherein the stroke adjusting member (201C) is configured to have a plurality of extrusions (201E) each having a predefined radius.

7. The pole assembly (200) according to claim 6, wherein the stroke adjusting member (201C) is rotatably disposed against the connectors (201A and 201B) for selectively aligning one of the extrusions (201E) with the connectors (201A and 201B).

8. A switching device comprising at least one pole assembly (200) according to the claims 1-7 in an operable connection with a drive unit (205) via a drive connection rod (204).

9. The switching device according to claim 8, is a medium voltage switchgear having an operational rating of up to 38 kilo Volts and up to 40 kilo Amperes.

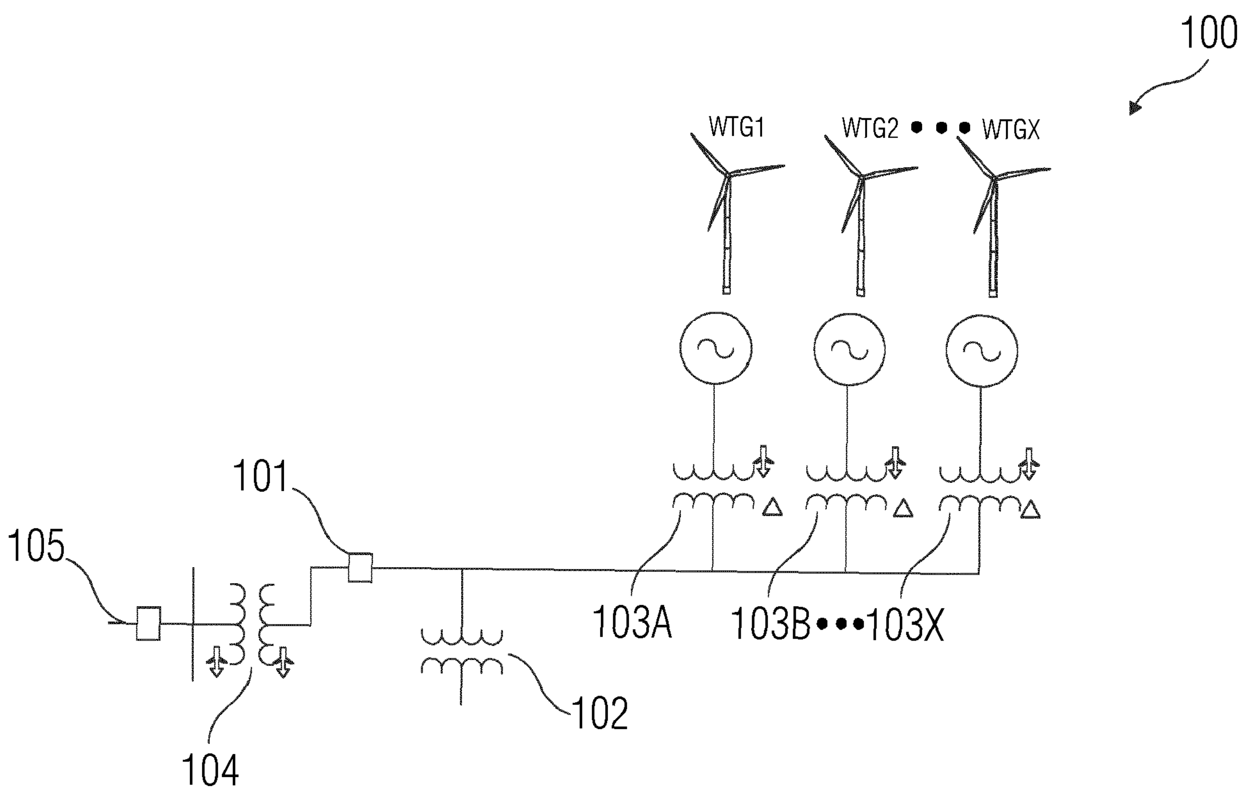
10. A method (700) for operating a switching device according to the claims 8-9 having a pole assembly (200) according to the claims 1-7, comprising:

- displacing (701) a drive connection rod (204) by operating a drive unit (205) connected thereto;
- configuring a stroke adjusting member (201C) of an interlink arrangement (201) of the pole assembly (200) for varying a physical distance of a moveable member (203A) of an interrupter unit (203) with respect to a moveable member (202A) of another interrupter unit (202) when in the interrupter unit (203) is in an open state and the another interrupter unit (202) is in a closed state, wherein the interlink arrangement (201) is operably connected to the moveable members (202A and 203A).

11. The method (700) according to claim 10, wherein configuring the stroke adjusting member (201C) of the interlink arrangement (201) comprises selectively removing and adding spacer plates (201C') between connectors (201A and 201B) of the interlink arrangement (201).

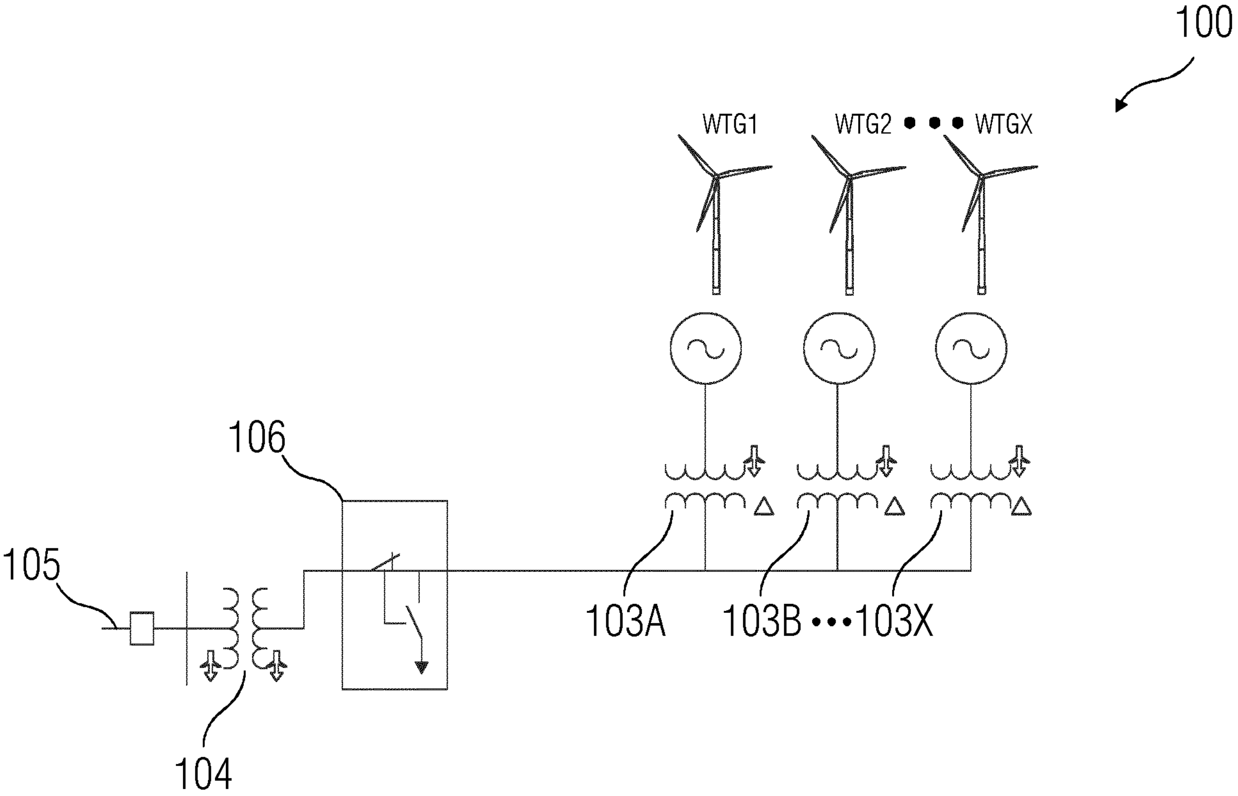
12. The method (700) according to claim 10, wherein configuring the stroke adjusting member (201C) of the interlink arrangement (201) comprises selectively rotating the stroke adjusting member (201C) with respect to connectors (201A and 201B) of the interlink arrangement (201) so as align the connectors (201A and 201B) with one of plurality of extrusions (201E) configured on the stroke adjusting member (201C).

FIG 1A



(PRIOR ART)

FIG 1B



(PRIOR ART)

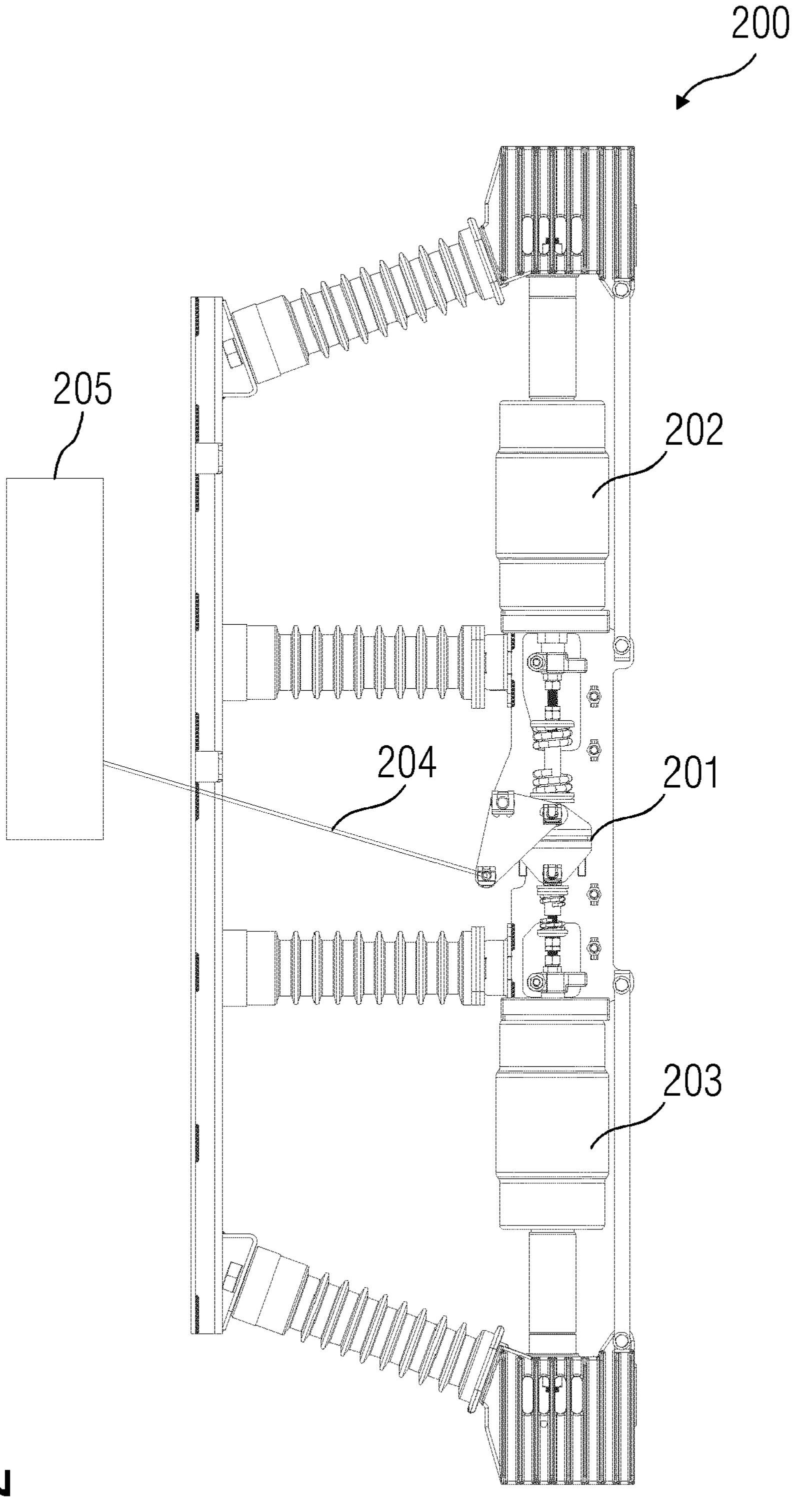


FIG 2

FIG 3A

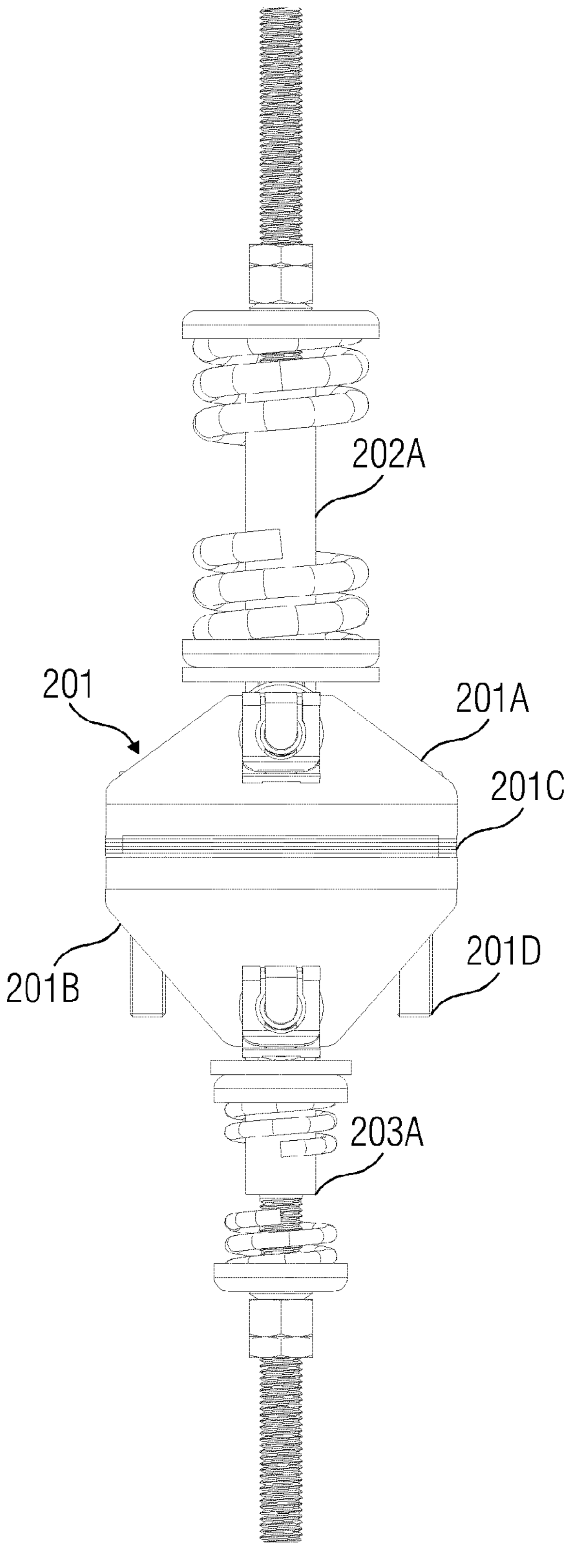


FIG 3B

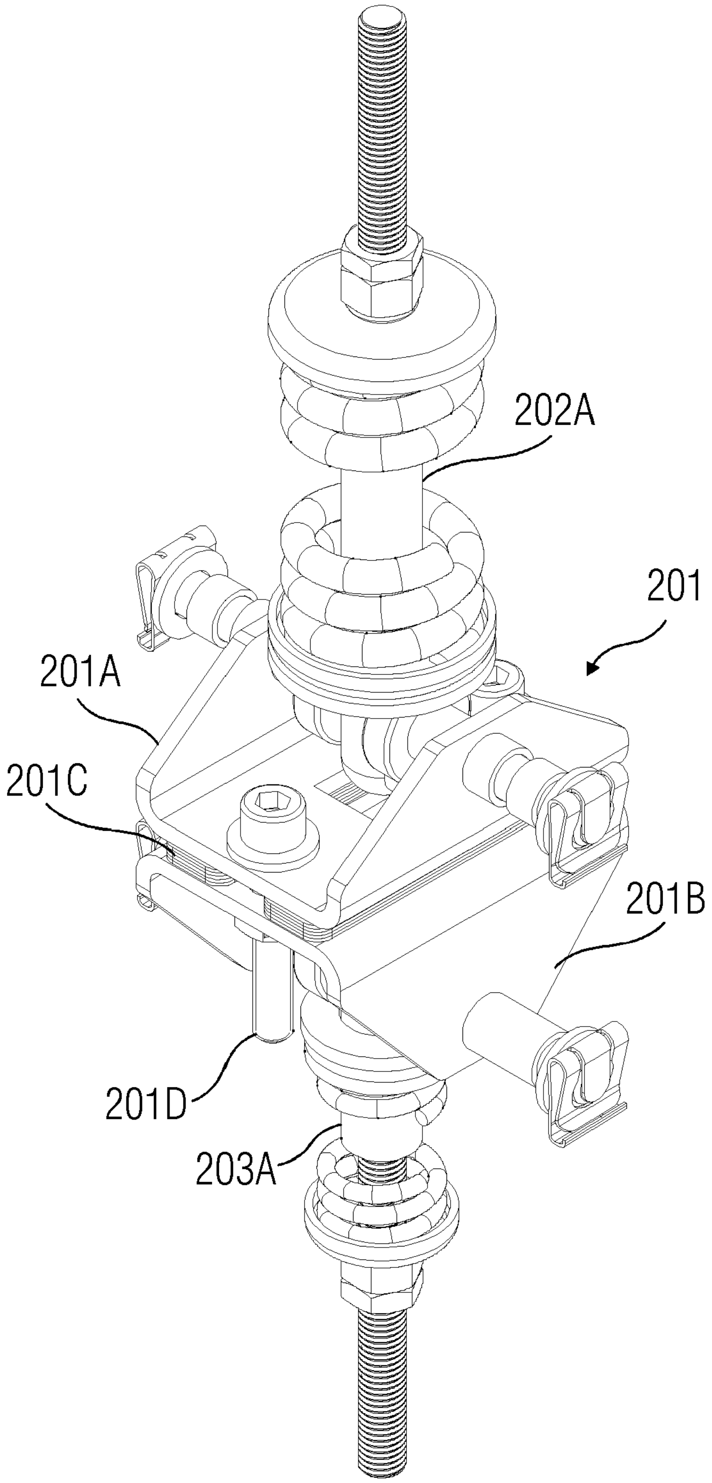


FIG 4

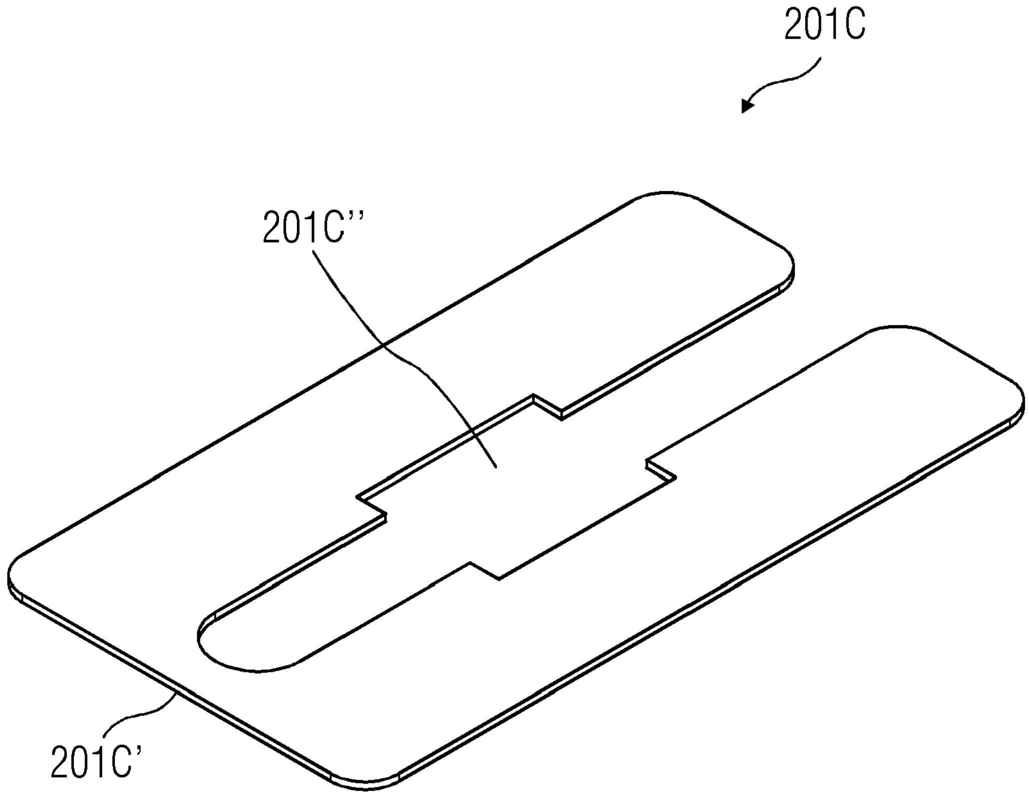


FIG 5A

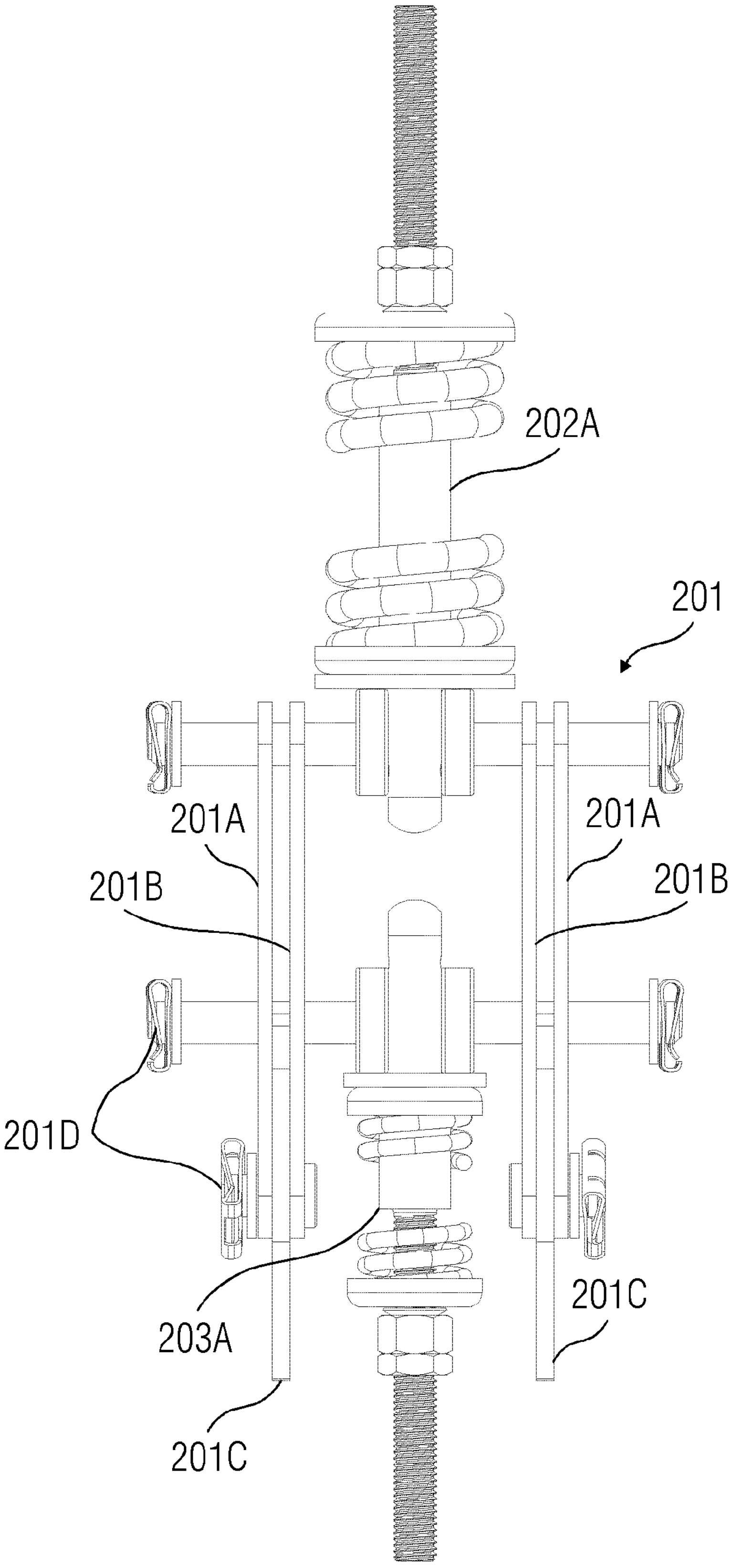


FIG 5B

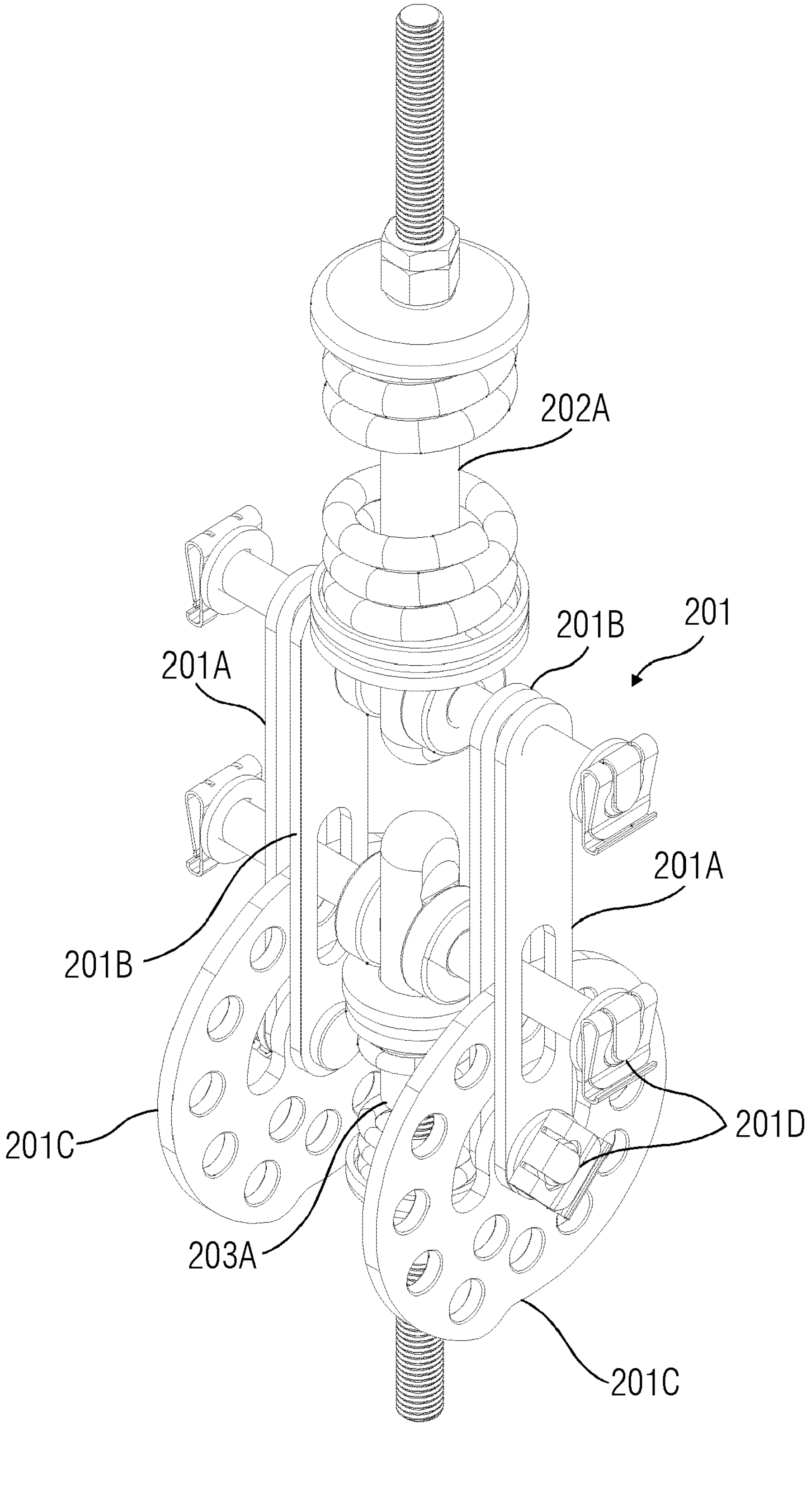


FIG 6

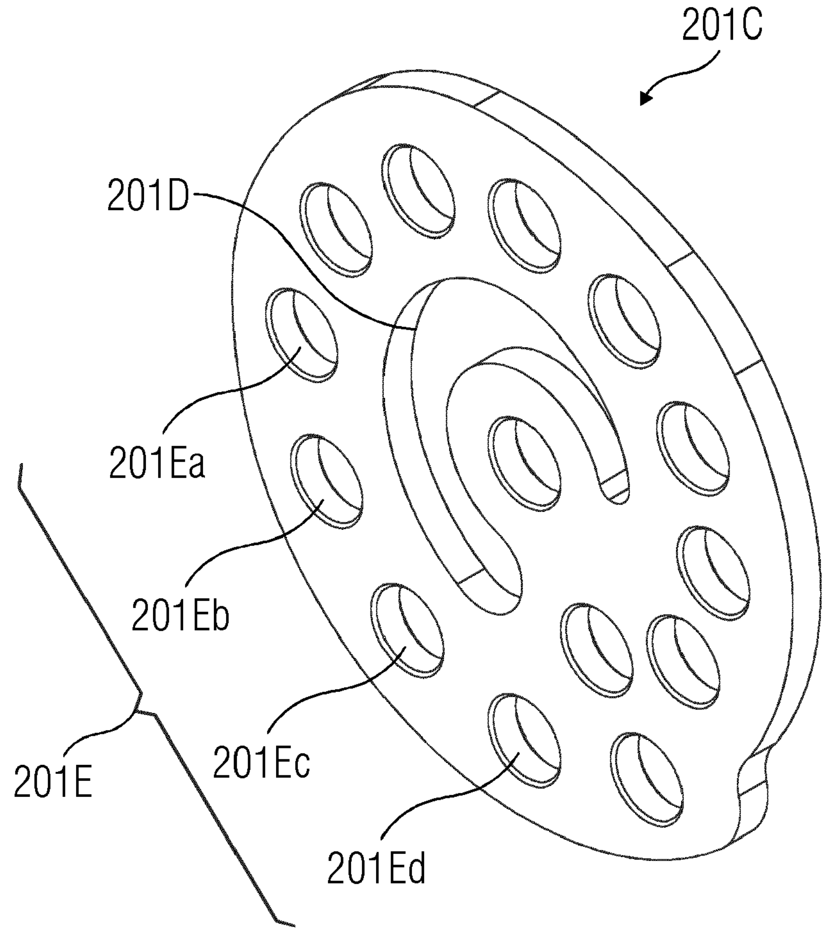
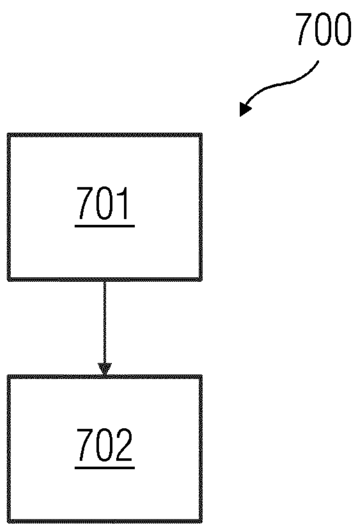


FIG 7



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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 0515

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			TECHNICAL FIELDS SEARCHED (IPC)
			H01H

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	22 March 2021	Fribert, Jan

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 20 0515

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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