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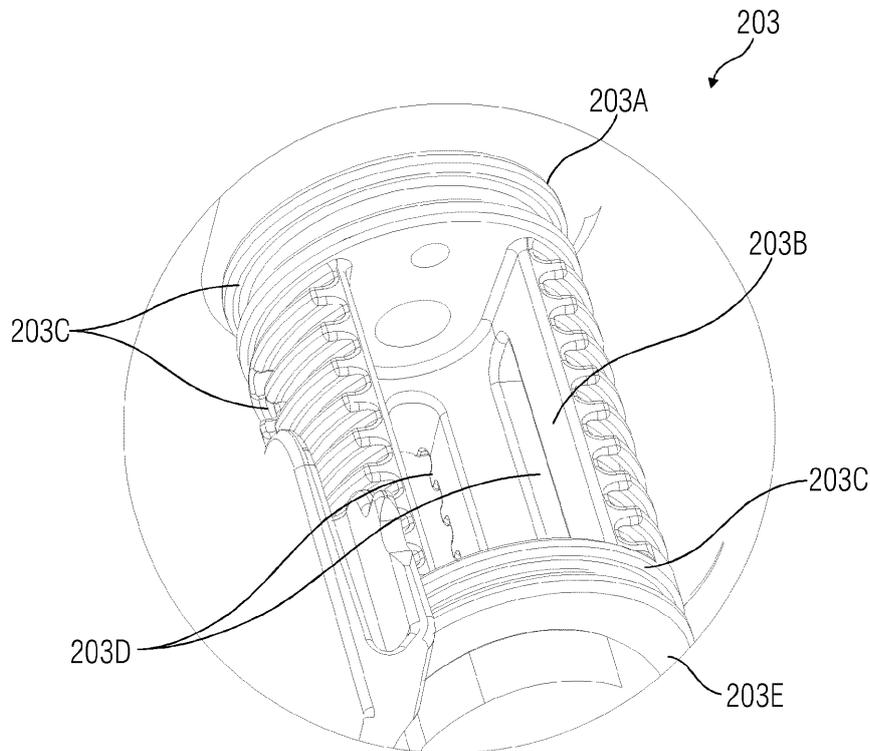
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(54) **VENTILATING CONNECTOR UNIT FOR CIRCUIT BREAKER**

(57) A switching device (200, 300) is provided. The switching device (200, 300) has a contact arm structure (301, 302, or 303) and a pole unit (201, 304A, 304B, or

304C) operably connected to one another by a ventilating connector unit (203) physically disposable there-between.

**FIG 2D**



## Description

**[0001]** The present disclosure relates to switching devices such as circuit breakers. More particularly, the present disclosure relates to a contact structure of a circuit breaker having a ventilating connector unit and at least one contact arm attached to the ventilating connector unit.

**[0002]** Typically, circuit breakers are switches used to protect electrical circuitry connected thereto from damage due to overload and short circuit faults, by their automatic operation leading to an interruption of the current flowing therethrough. Conventionally, a circuit breaker mainly includes a switching module formed from one or more function-oriented units including a base module unit, a pole module unit and a drive module unit. The pole module unit includes an interrupter unit such as a vacuum interrupter comprising a stationary member and a movable member for making and breaking of the contacts, and a pair of contact arms extending out of pole heads of the pole module unit and in connection with the interrupter unit so as to establish contact with busbars.

**[0003]** FIG 1 illustrates a side view of one such circuit breaker unit 100 according to the state of the art. The circuit breaker unit 100 is an air insulated medium voltage circuit breaker typically used in applications including overhead lines, cables, transformers, generators, motors, etc. The circuit breaker unit 100 comprises a breaker 101 mounted on a truck 102 also known as a trolley for facilitating movement of the breaker. The breaker 101 comprises contact arms 101A having a plastic based encapsulation 101B for protection of the contact arms 101A from flashovers at high voltages. The contact arms 101A are connected to an interrupter unit 101C having an upper and a lower interrupter support 101D each of which are connected to post insulators 101E. The breaker 101 is at least partially enclosed within an insulation barrier in a pole 103. D1 denotes a pole center distance in a single pole 103, that is a distance between contact arms 101A. D1, for example, is 550mm. D2 denotes an overhang of each of the contact arms 101A, that is cantilever length of the contact arms. D2, for example, is 469 mm. D3 denotes distance across flats, that is, across the post insulators 101E and/or the upper and lower interrupter supports 101D. D3, for example, is 430mm. Although, the circuit breaker unit 100 disclosed herein is well suited for most industrial applications, it lacks compactness. Moreover, the pole 103 does not have an encapsulation or an insulated coating thereby, inviting pollutants to settle thereon resulting in early corrosion and surface degradation of the equipment when installed in environments prone to have ambient pollution. Furthermore, the dielectric clearance required to be maintained for the poles 103 in a three-phase circuit breaker unit is larger, for example, depth-wise indicated by distance D4 which is, for example, 538 mm. Such a distance is required to ensure no flashovers happen during operation of the circuit breaker unit. This renders the circuit breaker unit 100 to

be inefficient and bulkier in size leading to installation difficulties.

**[0004]** To address aforementioned problems, advanced circuit breaker units with air insulated embedded poles are developed and are in use. These advanced circuit breaker units pose several advantages, for example, longer life due to longer operating cycles prior to every maintenance required, capacity to be retrofit thereby, making them an attractive choice in industry and quite compact in size. However, integrating such advanced circuit breaker units in the switchgears designed to accommodate the conventional circuit breaker units 100 becomes a challenge. For example, the distance D3 is lesser in the advanced circuit breaker units as a result of embedded poles resulting in space and assembly constraints for interrupter units which cannot be re-designed to suit the advanced circuit breakers as it would become an overhead. Also, the resulting overhang distance D2 of the contact arms is smaller in the advanced circuit breaker unit thereby, making the short-time withstand fault current test critical and the breaker rack in-out operation risky. Moreover, routing of contact arms 101A having offset bends from pole heads is a challenge due to possible interference with pole shell encapsulation. Furthermore, the current carrying elements in the circuit breaker unit 100, for example the contact arms 101A and the lower and upper interrupter supports 101D are typically exposed to ambient air thereby, resulting in an effective heat dissipation. However, pole heads of embedded poles in the advanced circuit breaker unit restrict heat dissipation due to enclosure/embedding of the current carrying elements in plastic or epoxy shells thereby, causing losses at high current ratings.

**[0005]** Accordingly, it is an object of the present invention, to provide a circuit breaker arrangement having embedded poles, that addresses the aforementioned problems, without changes required to be made in the switchgear modules and/or the interrupter unit while ensuring ease of assembly, adherence to stipulated dielectric clearances, desired heat convection, reduced losses due to skin effect at higher current ratings, reduced criticality in the short time withstand fault current tests and rack in-out operations, etc.

**[0006]** The switching device disclosed herein achieves the aforementioned object by providing a ventilating connector unit physically disposable between an embedded pole unit and a contact arm structure.

**[0007]** Disclosed herein is a switching device. The switching device is a circuit breaker such as a single-pole or a multi-pole circuit breaker, and a low, a medium or a high voltage, and/or a vacuum, an air or a gas circuit breaker. The switching device comprises a contact arm structure and a pole unit detachably connected to the contact arm structure. The switching device may also include an interrupter unit, such as a vacuum interrupter, a base unit such as a mounting truck or a trolley, and a drive unit including kinematics required to provide drive, that is, movement of the contacts of the interrupter unit.

The pole unit refers to an insulated, epoxy coated structure housing there-within the interrupter unit. The pole unit may also be referred to as an embedded pole of the aforementioned advanced circuit breaker units. The contact arm structure refers to a hollow part-insulated or full-insulated structure that houses there-within contact arms for connection to the interrupter unit positioned inside the pole unit. The contact arm structure has an encapsulation member configured of one or more insulating materials including, but not limited to, epoxy, ceramic, porcelain, silicone rubber and elastomers chosen for maximum insulation efficiency and durability. The contact arm structure further includes contact arms configured of current conducting materials such as copper and/or aluminium. The contact arm is at least partially housed inside the encapsulation member.

**[0008]** The switching device disclosed herein includes a ventilating connector unit physically disposable between the pole unit and the contact arm structure. As used herein, the ventilating connector unit refers to a unit detachably connected to the pole unit and the contact arms structure. The ventilating connector unit has two distal ends, one of which is detachably connected to a pole head of the pole unit via one or more fastening means including, but not limited to screws, nuts, bolts, adhesives, etc. The other distal end is detachably connected to the contact arm of the contact arm structure via one or more of the fastening means.

**[0009]** According to an embodiment of the present disclosure, one or more distal ends of the ventilating connector unit are fixedly attached to the pole head and the contact arm via one or more welding, brazing, sintering, etc.

**[0010]** According to one embodiment of the present disclosure, the ventilating connector unit is configured as a hollow structure. According to this embodiment, the ventilating connector unit is configured as a thorough hollow member, for example, a pipe like structure, or a partial hollow member.

**[0011]** According to another embodiment of the present disclosure, the ventilating connector unit is configured as an integral structure that is cast or forged as a single piece.

**[0012]** According to yet another embodiment of the present disclosure, the ventilating connector unit is configured as a modular structure that has one or two distal members connected by a body extending there-between. Advantageously, the distal members such as discs can be modularly attached and detached from the pole head and/or the contact arm for maintenance and inspection purposes. According to an embodiment, the body is configured of at least one member, for example, a slat extending between the distal members. Advantageously, a quantity of these slats can be defined based on a desired strength of the ventilating connector unit given load of the contact arm. A person skilled in the art may appreciate multiple permutations and combination possible with configuration of each of the components of the modular

ventilating connector unit based on design preferences and operational constraints.

**[0013]** According to yet another embodiment of the present disclosure, the ventilating connector unit is configured with one or more heat dissipation structures including, but not limited to, protrusions, indentations, and/or orifices provided, for example, in forms of ribs, grooves, holes, corrugations, and/or a combination thereof, along an outer surface of the ventilating connector unit so as to allow efficient and effective cooling via heat dissipation in the pole unit.

**[0014]** According to yet another embodiment of the present disclosure, the ventilating connector unit is a generally cylindrical shaped structure. The cylindrical shape enables ease of assembly and connections to the pole head and the contact arm. The shape of the ventilating connector unit may be changed based on a shape of a surface of the pole head and the contact arm such that maximal contact is established with the ventilating connector unit.

**[0015]** The physical dimensions of the ventilating connector unit are defined based on physical dimensions of the pole head, physical dimensions of the contact arm including an offset bend of the contact arm, and/or an operational rating of the switching device. The physical dimensions include, for example, a shape, a size, a weight, a material, etc. For example, a length of the ventilating connector unit is dependent on the operational kV/kA rating of the circuit breaker such that higher the rating, longer is the length to ensure desired dielectric properties. In another example, an outer diameter and a material of the ventilating connector unit is dependent on normal current carrying capacity of the switching device. In this example, up to 1250 Amperes, the material selected is an aluminium alloy and greater than 2000 Amperes, is a copper alloy. Similarly, the outer diameter is about 80 mm for a current carrying capacity of up to 2000 Amperes. Advantageously, a profile of the ventilating connector unit is designed to ensure equal distribution of heat and current there-along thereby, reducing skin effect.

**[0016]** Advantageously, the ventilating connector unit disclosed above enables connection of more than one contact arms thereby providing product suitability to higher rated switching devices. Moreover, the ventilating connector unit allows reduction in the overhang distance of the contact arm thereby, increasing stiffness of the contact arm and ensuring compliance to the short time withstand fault current tests and reliable rack in-out tests. Furthermore, the ventilating connector unit provides flexibility and ease of connection of the contact arm and the pole head by providing an increased surface area for creating a joint there-between. Furthermore, the heat dissipation structures of the ventilating connector unit leverage natural convection and create natural drafts for air circulation thereby, overcoming challenges associated with epoxy coated embedded pole units.

**[0017]** 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.

**[0018]** The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 illustrates a side view of a circuit breaker unit according to the state of the art.

FIG 2A illustrates a perspective view of a circuit breaker, according to an embodiment of the present disclosure.

FIGS 2B-2C illustrate perspective enlarged views of portions marked 'A' and 'B' of the circuit breaker shown in FIG 2A.

FIG 2D illustrates a top perspective view of the ventilating connector unit, according to an embodiment of the present disclosure.

FIG 3 illustrates an exploded view of one of the contact arm structures of a circuit breaker having a ventilating connector unit, according to an embodiment of the present disclosure.

**[0019]** 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.

**[0020]** FIG 2A illustrates a perspective view of a circuit breaker 200, according to an embodiment of the present disclosure. The circuit breaker 200 is mounted on a truck 102 and has three phases, each including an embedded pole 201. A ventilating connector unit 203 is fastened to the embedded pole 201. Contact arms 202 are affixed and extend out from the ventilating connector unit 203.

**[0021]** FIGS 2B-2C illustrate perspective enlarged views of portions marked 'A' and 'B' respectively of the circuit breaker 200 shown in FIG 2A. FIG 2B illustrates a lower pole head 201C having a protrusion 201B. The ventilating connector unit 203 is affixed to the lower pole head 201C such that the protrusion 201B at least partially accommodates the ventilating connector unit 203 there-within. The contact arm 202 is affixed to the ventilating connector unit 203 via fasteners (not shown) inserted through holes 202A punched through the contact arm 202 as well as the ventilating connector unit 203. FIG 2C illustrates an upper pole head 201A having a protrusion 201B. The ventilating connector unit 203 is affixed to the

upper pole head 201A such that the protrusion 201B at least partially accommodates the ventilating connector unit 203 there-within. The contact arm 202 is affixed to the ventilating connector unit 203 via fasteners (not shown) inserted through holes 202A punched through the contact arm 202 as well as the ventilating connector unit 203. Thus, the ventilating connector unit 203 is affixed at each of the pole heads 201A and 201C of each of the embedded poles 201 in each phase of the circuit breaker 200.

**[0022]** FIG 2D illustrates a top perspective view of the ventilating connector unit 203, according to an embodiment of the present disclosure. The ventilating connector unit 203 includes a pair of distal members 203A and 203E conjoined via a body 203B extending there-between. The distal members 203A and 203E are generally elliptical discs. One of the distal members 203E is disposed against a pole head 201A or 201B shown in FIGS 2B-2C. The other distal end 203A is in a rigid connection with a contact arm 202 shown in FIGS 2A-2C. The body 203B of the ventilating connector unit 203 is a generally semi-elliptical hollow member, for example, U-shaped or C-shaped member, having multiple grooves 203D extruded therefrom. The body 203B and each of the distal members 203A and 203E have corrugations 203C on their outer surfaces. The grooves 203D and the corrugations 203C provide heat dissipation means thereby, enabling ventilation from the embedded pole 201.

**[0023]** FIG 3 illustrates an exploded view of one of the contact arm structures 301 of a circuit breaker 300 having a ventilating connector unit 203, according to an embodiment of the present disclosure. The circuit breaker 300 has three phases having contact arm structures 301, 302, and 303 each connected to embedded poles 304A, 304B, and 304C respectively, thereby forming three phases of the circuit breaker 300. The circuit breaker 300 is mounted on a truck 102. The contact arm structure 301 is replicated across an upper half that has an upper pole head and a lower half that has a lower pole head. The upper contact arm structure 301 includes a contact arm 301C cantilevered by fastening one the ends or the contact arm 301C to the ventilating connector unit 203 via multiple fasteners 301D. The cantilevered end of the contact arm 301C is terminated with a tulip contact 301B for connection to incoming and outgoing feeders, that is, electrical lines. An epoxy coating 301A at least partially encloses the contact arm 301C and the tulip contact 301B there-within. The ventilating connector member 203 is completely enclosed by the pole head 301E of the embedded pole 304A. The pole head 301E has an epoxy coating extending therefrom for accommodating the ventilating connector member 203.

**[0024]** 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.

List of reference numerals:

Prior art

**[0025]**

100 circuit breaker unit  
 101 circuit breaker  
 101A contact arm  
 101B encapsulation  
 101C interrupter unit/vacuum interrupter  
 101D upper and lower interrupter supports  
 101E post insulators  
 102 truck/trolley  
 103 pole unit/pole

Present Disclosure

**[0026]**

200 circuit breaker  
 201 embedded pole  
 201A upper pole head  
 201B epoxy protrusion from the upper and lower pole heads  
 201C lower pole head  
 202 contact arms  
 202A holes for fasteners  
 203 ventilating connector unit  
 203A, 203E distal members/distal ends  
 203B body  
 203C corrugations  
 203D grooves  
 300 circuit breaker  
 301, 302, 303 contact arm structure  
 301A epoxy coating/encapsulation for contact arm structure  
 301B tulip contact  
 301C contact arm  
 301D fasteners  
 301E pole head (upper) having epoxy coated protrusion therefrom  
 304A, 304B, 304C poles/pole units/embedded poles

**Claims**

1. A switching device (200, 300) comprising at least:  
 - a contact arm structure (301, 302, or 303); and

- a pole unit (201, 304A, 304B, or 304C) operably connected to the contact arm structure (301, 302, or 303);

**characterized by:**

- a ventilating connector unit (203) physically disposable between the pole unit (201, 304A, 304B, or 304C) and the contact arm structure (301, 302, or 303).

2. The switching device (200, 300) according to claim 1, wherein a distal end (203E) of the ventilating connector unit (203) is detachably connected to a pole head (201A, 201C, or 301E) of the pole unit (201, 304A, 304B or 304C) via one or more fastening means (301D).
3. The switching device (200, 300) according to any one of the claims 1 and 2, wherein a distal end (203A) of the ventilating connector unit (203) is detachably connected to a contact arm (202 or 301C) of the contact arm structure (301, 302, or 303) via one or more fastening means (301D).
4. The switching device (200, 300) according to any one of the previous claims, wherein the ventilating connector unit (203) is configured as a hollow structure.
5. The switching device (200, 300) according to any one of the previous claims, wherein the ventilating connector unit (203) is configured as one of an integral structure and a modular structure.
6. The switching device (200, 300) according to claim 5, wherein the modular structure of the ventilating connector unit (203) comprises distal members (203A and 203E) connected by a body (203B) extending there-between.
7. The switching device (200, 300) according to any one of the previous claims, wherein the ventilating connector unit (203) is configured with one or more heat dissipation structures (203C, 203D).
8. The switching device (200, 300) according to any one of the previous claims, wherein the ventilating connector unit (203) is a generally cylindrical shaped structure.
9. The switching device (200, 300) according to claim 1, wherein physical dimensions of the ventilating connector unit (203) are defined based on one or more of physical dimensions of a pole head (201A, 201C, or 301E) of the pole unit (201, 304A, 304B or 304C), physical dimensions of a contact arm (202 or 301C) of the contact arm structure (301, 302, or 303),

and an operational rating of the switching device (200, 300).

- 10. The switching device (200, 300) according to claim 1 is a circuit breaker. 5
  
- 11. A ventilating connector unit (203) for a switching device (200, 300), physically disposable between a pole unit (201, 304A, 304B, or 304C) of the switching device (200, 300) and a contact arm structure (301, 302, or 303) of the switching device (200, 300), according to claims 1-10. 10

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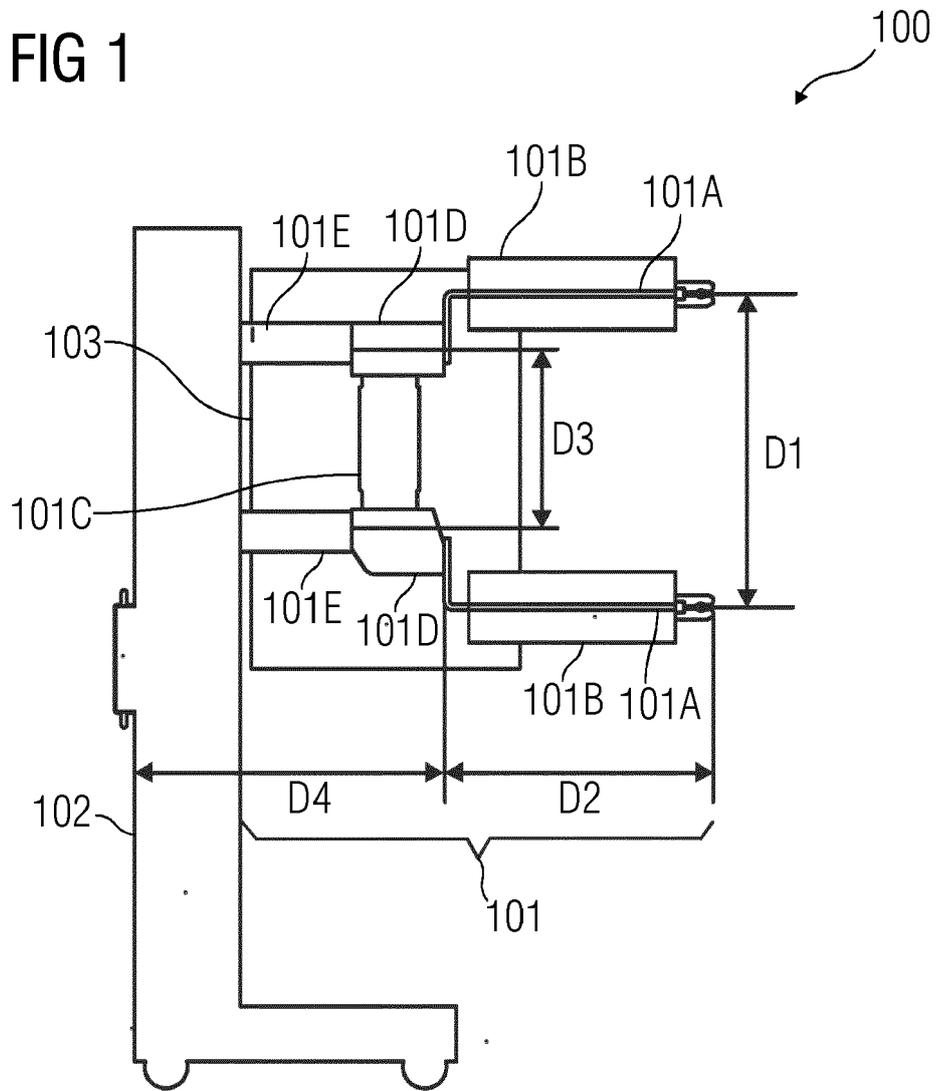
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FIG 1



(STATE OF THE ART)

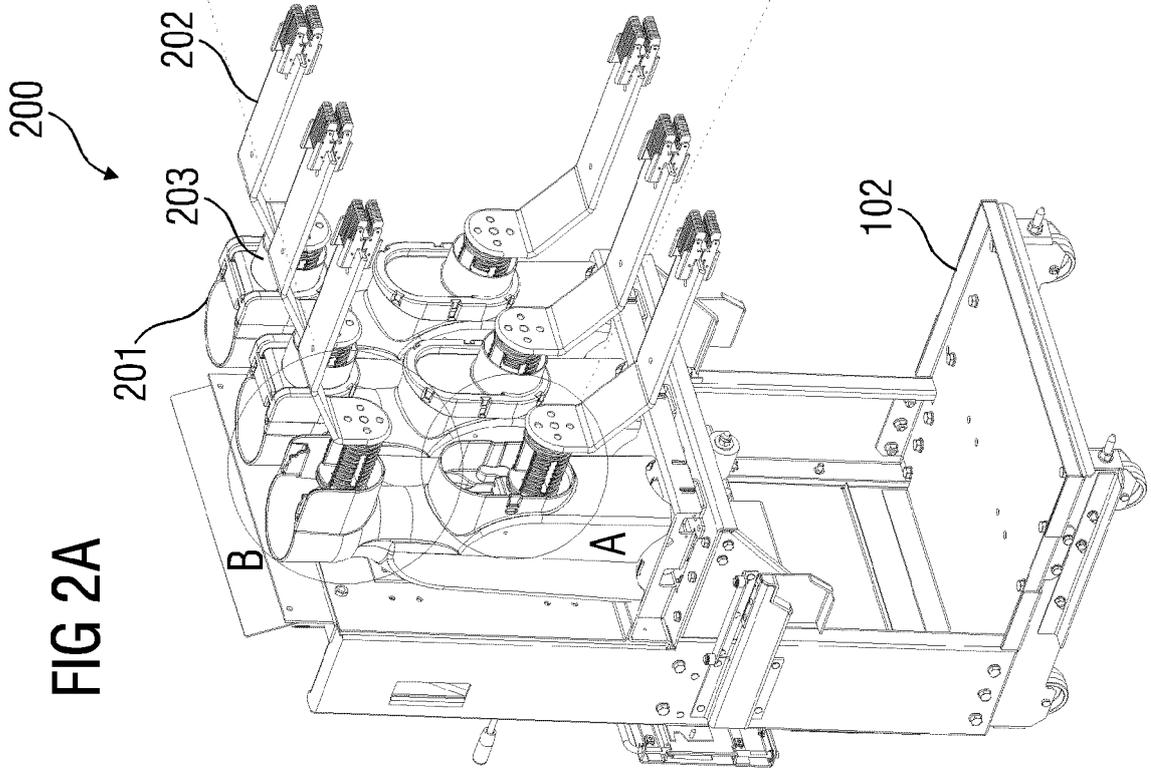
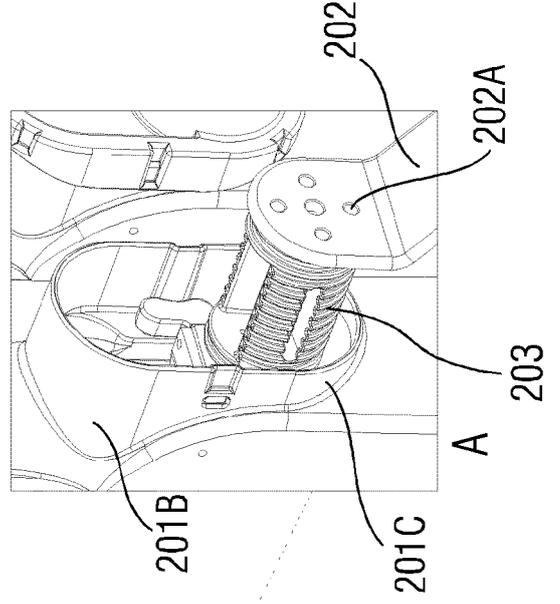
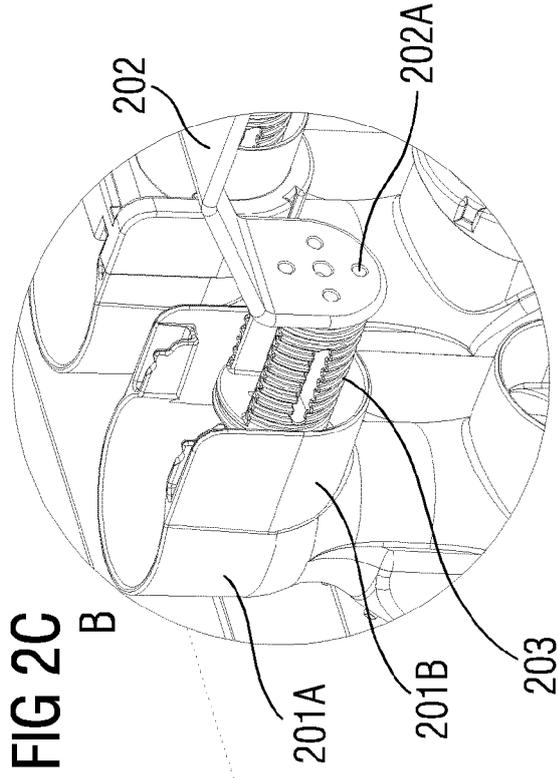
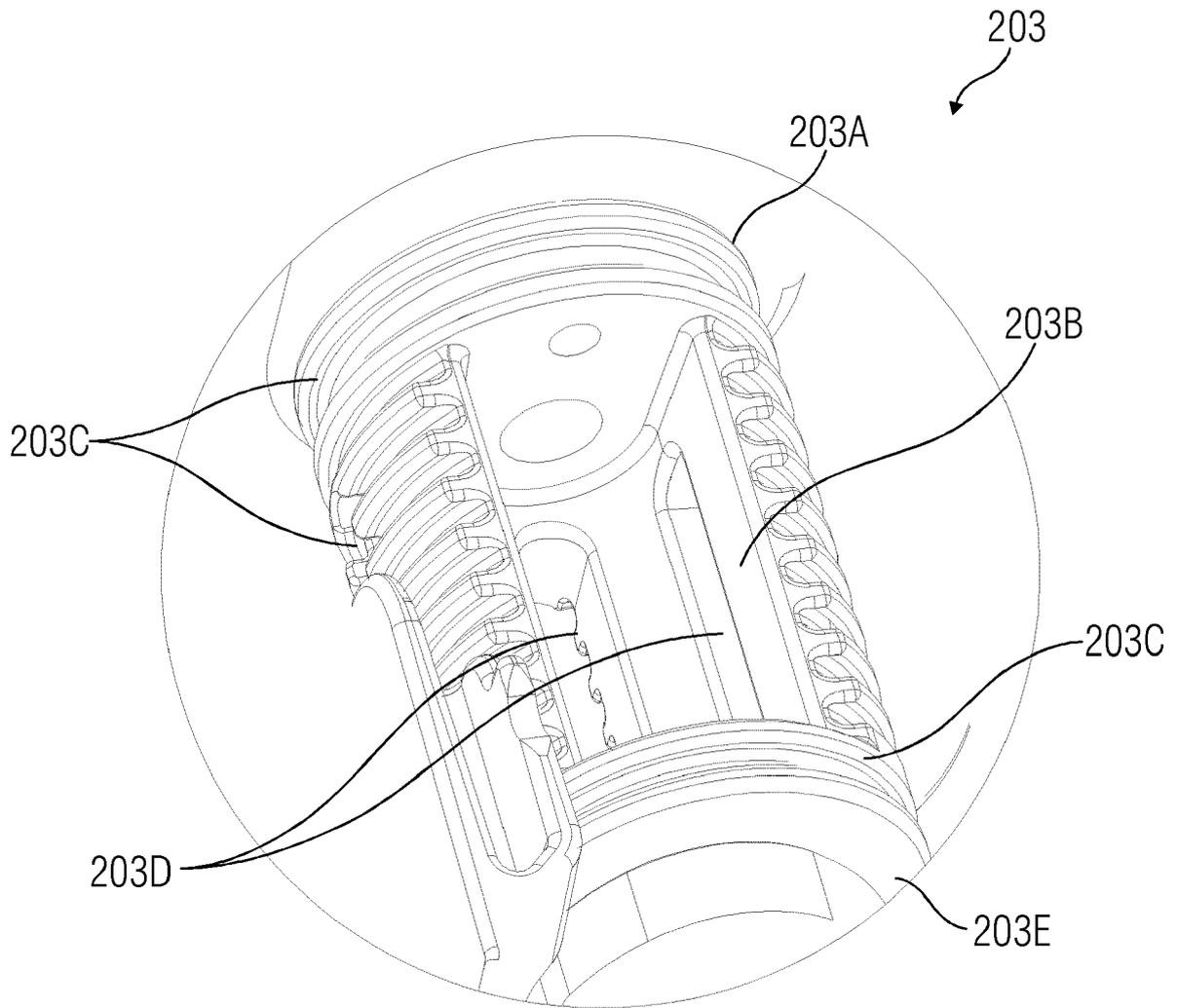
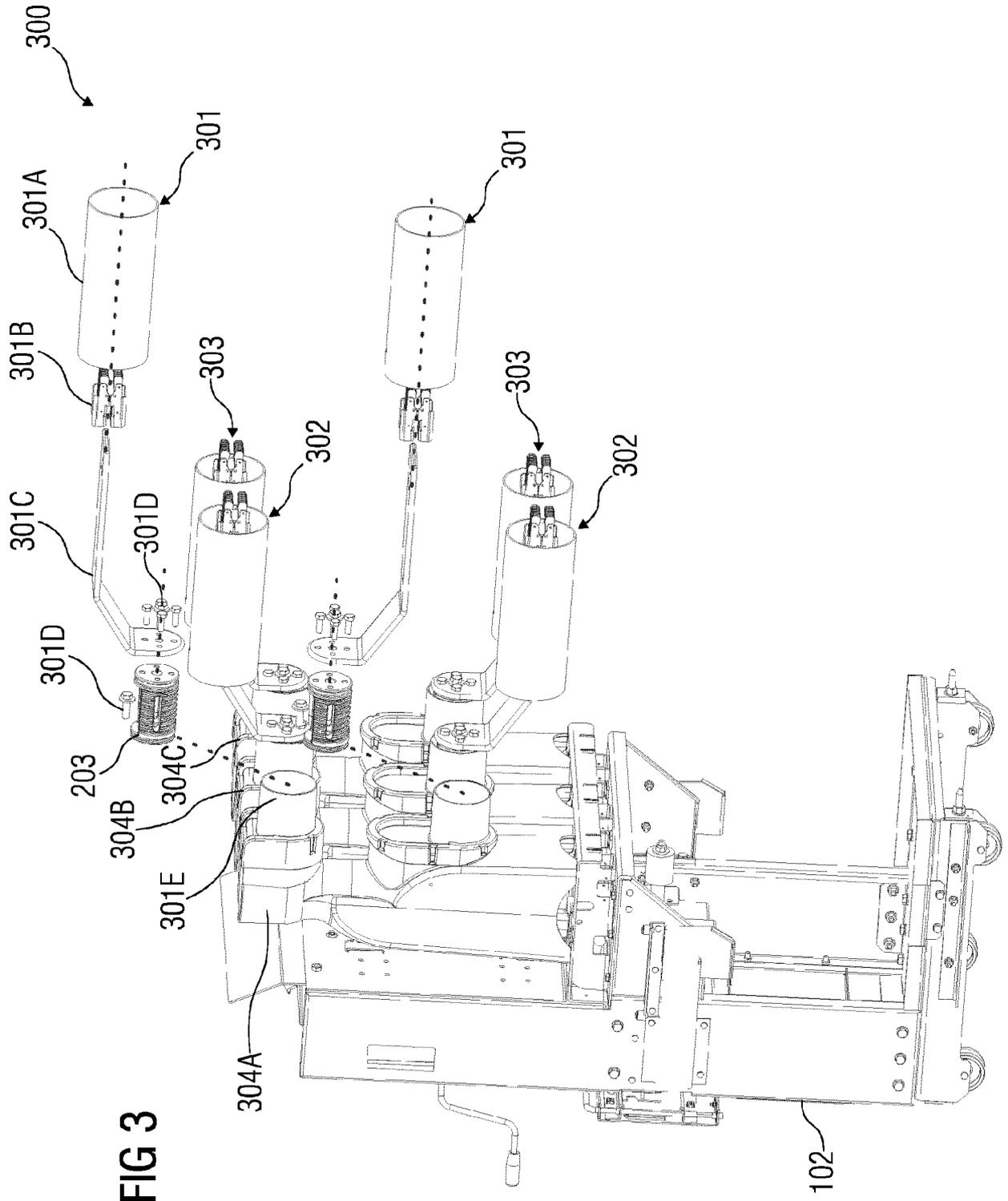


FIG 2D







EUROPEAN SEARCH REPORT

Application Number  
EP 19 21 5099

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search <b>Munich</b>		Date of completion of the search <b>26 February 2020</b>	Examiner <b>Findeli, Luc</b>
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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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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 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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