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(54) THREE-PHASE ELCTRICITY DISTRIBUTION SWITCHBOARD

(57) A three-phase electricity distribution switchboard comprises:
• at least one switch-disconnector assembly (1; 100) housed in a chamber (13, 113) of a containment body (7) filled with insulating gas; wherein the switch-disconnector assembly (1; 100) comprises three switch devices (5), each of which is provided with a movable contact and a moving device (16) configured to move the movable contact, and a three-pole disconnector device (6) provided with a movable member (30) configured to rotate at least between a disconnecting position and a contact position;
• a control assembly (21) configured to simultaneously operate the moving devices (16) of the three switch devices (5) and comprising a drive rod (24), which passes through a first opening of the containment body (7);
• a disconnection control device configured to operate the movable member (30) of the device and comprising a drive shaft (39), which passes through a second opening of the containment body (7);
• a sealing device (44) configured to perform a gas seal around the first opening and the second opening.

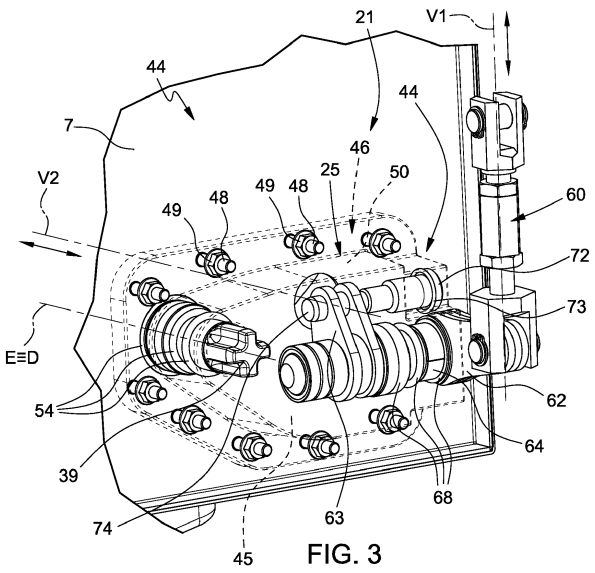

FIG. 3

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102022000006548 filed on April 1st, 2022, and Italian patent application no. 102022000006560 filed on April 1st, 2022, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a three-phase electricity distribution electrical switchboard.

[0003] In particular, the present invention relates to a three-phase electricity distribution electrical switchboard preferably connected to medium/high voltage bars.

BACKGROUND

[0004] Electrical switchboards normally receive voltage from voltage bars and supply current to user systems.

[0005] Electrical switchboards of this type are used in the primary level distribution substations and in the secondary level distribution substations.

[0006] Commonly, an electrical switchboard is defined by a cabinet fixed to the wall or by free-standing structures.

[0007] As is known, some types of electrical switchboards comprise a switch-disconnector assembly comprising three first connectors and three second connectors, a three-pole disconnector device and three switch devices. The three-pole disconnector device, as is known, is configured to selectively disconnect the connection between the first connectors and the three switch devices. In other words, the disconnector device is configured to selectively open the connection between the first connectors and the three switch devices ensuring a prescribed insulation distance, in a physical and visibly evident manner. In this manner, the parts downstream of the three-pole disconnector device are electrically insulated from the upstream circuit and vice versa. This condition is necessary if having to intervene on a component of the power grid downstream of the disconnector device, for example in case of maintenance.

[0008] The switch devices are simultaneously operated by a control assembly, whereas the three-pole disconnector device is operated by a disconnection control device independent of the control assembly.

[0009] The switch-disconnector assemblies of known type are normally housed in containment bodies filled with insulating gas.

[0010] In the electrical switchboards of the gas type, the containment body is defined by a sealed chamber of the electrical switchboard filled with insulating gas.

[0011] In the electrical switchboards of mixed type, inside a chamber of the switchboard which is not made sealed (and in which air circulates) the switch-disconnector assembly is arranged housed in a containment body which wraps it and which is filled with insulating gas.

[0012] In both solutions it is evident that it is necessary to prevent the insulating gas from coming out of the containment body.

[0013] The control assembly of the switch devices and the disconnection control device of the three-pole disconnector device are in part housed on the outside of the containment body. Therefore, it is necessary to provide for openings for the passage of portions of the control assembly and of portions of the disconnection control device. This can entail serious risks of the insulating gas coming out during use.

[0014] Some solutions of this type are illustrated in documents EP2645395 and WO01/33593.

SUMMARY

[0015] An object of the present invention is thus to manufacture a three-phase electricity distribution switchboard which is safe, reliable and which is at the same time easy and cost-effective to manufacture.

[0016] In accordance with such objects, the present invention relates to a three-phase electricity distribution switchboard comprising:

- at least one switch-disconnector assembly housed in a chamber of a containment body filled with insulating gas; wherein the switch-disconnector assembly comprises three switch devices, each of which is provided with a movable contact and a moving device configured to move the movable contact, and a three-pole disconnector device provided with a movable member configured to rotate at least between a disconnecting position and a contact position;
- a control assembly configured to simultaneously operate the moving devices of the three switch devices and comprising a drive rod, which passes through a first opening of the containment body;
- a disconnection control device configured to operate the movable member of the three-pole disconnector device and comprising a drive shaft, which passes through a second opening of the containment body;
- a sealing device configured to perform a gas seal around the first opening and the second opening; wherein the sealing device comprises a main body provided with a perimeter edge configured to be coupled to the containment body and is provided with a perimeter groove made on the face of the main body which, in use, faces the containment body and with a perimeter seal engaging the perimeter groove; the perimeter groove being shaped to surround, in use, the first opening and the second opening.

[0017] Advantageously, the electrical switchboard according to the present invention provides a reliable seal

for the first and the second openings with a single sealing device. This ensures ease of use and quick installation.

[0018] Moreover, according to a preferred embodiment, the sealing device comprises a housing seat configured to house at least a portion of a transmission device of the control assembly of the switch devices.

[0019] Advantageously, part of the transmission device is thus gas-insulated and protected without the need for surface treatments. This determines a reduction in manufacturing costs and an increase in reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Further characteristics and advantages of the present invention will be evident from the following description of a non-limiting example embodiment thereof, with reference to the figures of the accompanying drawings, wherein:

- Figure 1 is a perspective view, with parts removed for clarity, of a switch-disconnector assembly according to the present invention;
- Figure 2A is a sectioned perspective view along plane IIA-IIA of Figure 1, with parts removed for clarity, of the switch assembly of Figure 1;
- Figure 2B is a flat view in section along plane IIB-IIB of Figure 1, with parts removed for clarity, of the switch assembly of Figure 1;

- Figure 3 is a front perspective view, with parts removed for clarity, of a second detail of the switch assembly of Figure 1;
- Figure 4 is a rear perspective view, with parts removed for clarity, of the second detail of Figure 3;
- Figure 5 is a perspective view, with parts removed for clarity, of a switch-disconnector according to an alternative embodiment in accordance with the present invention.

DESCRIPTION OF EMBODIMENTS

[0021] In Figure 1, reference numeral 1 indicates a switch-disconnector assembly for a three-phase electricity distribution switchboard.

[0022] In the embodiment illustrated in Figure 1, the switch-disconnector assembly 1 is for an electrical switchboard of mixed type.

[0023] The switch-disconnector assembly 1, in fact, is housed, in use, in a chamber (not illustrated) of the electrical switchboard in which air is present.

[0024] As it will be specifically apparent in the following with reference to Figure 5, the switch-disconnector assembly according to the present invention can be used also for the electrical switchboards of the gas type.

[0025] With reference to Figures 1, 2A and 2B, the switch-disconnector assembly 1 comprises three first connectors 2 configured to be connected, in use, to a user system (not illustrated in the accompanying figures) and three second connectors 3 configured to be connected, in use, to a medium or high voltage bar (not illustrated in the accompanying figures), three switch devices 5 and a three-pole disconnector device 6.

[0026] The second connectors 3 extend along three respective longitudinal axes A1, A2, A3.

[0027] Each first connector 2 is aligned with or arranged parallel to a respective second connector 3.

[0028] In the non-limiting example described and illustrated herein, the first connectors 2 are arranged parallel to the second connectors 3.

[0029] In the non-limiting example described and illustrated herein, the first connectors 2 and the second connectors 3, the three-pole disconnector device 6 and the three switch devices 5 are housed in a containment body 7.

[0030] The containment body 7, in particular, comprises a watertight box element 10, three first insulating elements 12 configured to wrap at least in part the first connectors 2 and three second insulating elements 11 configured to wrap at least in part the second connectors 3.

[0031] The box element 10 and the three first insulating elements 12 form, when coupled, a chamber 13 filled with insulating gas, in which the three-pole disconnector device 6 and the three switch devices 5 are housed.

[0032] With reference to Figures 2A and 2B, the three switch devices 5 are arranged aligned along a longitudinal axis B.

[0033] Each switch device 5 extends along a respective axis C1, C2, C3 and comprises a vacuum bulb 15 and a moving device 16. The vacuum bulb 15 houses a fixed contact (not illustrated) electrically connected to the respective second connector 3 and a movable contact (not illustrated) electrically connected to the three-pole disconnector device 6.

[0034] The moving device 16 is configured to move the movable contact between a circuit closing position, in which the movable contact is approached to the fixed contact for establishing an electrical connection, and a circuit opening position, in which the movable contact is arranged at a distance from the fixed contact such to ensure the absence of electrical connection and the opening of the circuit.

[0035] The moving device 16 comprises a rod 18 (not completely visible in the accompanying figures), a spring 19 coupled to the rod 18 and a movable supporting frame 20, connected to a control assembly 21 (which will be specifically apparent in the following with reference to Figure 3). The rod 18 is coupled to the movable supporting frame 20 by means of a shaft 22 on which the spring 19 is mounted. The rod 18 is wrapped by an insulating body 23.

[0036] The moving device 16 of each switch device 5 is connected to a single control assembly 21. Therefore, the switch devices 5 are operated simultaneously.

[0037] The control assembly 21 comprises at least one drive rod 24 (visible only in part in Figure 2A), a connect-

ing structure 26 (visible only in part in Figure 2A) which connects the movable supporting frames 20 to the drive rod 24, and a transmission device 25, which is connected to a drive device of the switches (not illustrated).

[0038] With reference to Figure 3, the transmission device 25 is arranged on the outside of the containment body 7.

[0039] In particular, the drive rod 24 passes through an opening of a wall of the box element 10 of the containment body 7.

[0040] In use, the transmission device 25 moves the drive rod 24 connected to the movable supporting frames 20 of each switch device 5 determining a respective movement of the movable contacts.

[0041] With reference to Figure 2A and to Figure 2B, the three-pole disconnector device 6 extends along a longitudinal axis D and comprises three earth contacts 28 connected to the earth, three connecting contacts 29, electrically connected to the movable contact of the respective switch device 5 and a movable conductor member 30, which is provided with three appendixes 32 (only one of which is visible in Figure 2A) connected to the first connectors 2 and three free appendixes 33.

[0042] The movable member 30 is movable between three positions: a connecting position, in which the free appendixes 33 are arranged in contact with the respective connecting contacts 29, a disconnecting position, in which the free appendixes 33 are arranged at a safety distance from the connecting contacts 29 for ensuring the interruption of the connection between the first connectors 2 and the switch devices 5, and an earth position, in which the free appendixes 33 are in contact with the respective earth contacts 28.

[0043] In Figures 2A 2B illustrated herein, the movable member 30 is in the disconnecting position.

[0044] Preferably, the extension axis D of the three-pole disconnector device 6 is parallel to the alignment axis B of the switch devices 5.

[0045] The movable member 30 is a single body provided with the free appendixes 33 spaced apart from each other and is rotatable around a rotation axis E preferably coinciding with the extension axis D.

[0046] Preferably, the rotation axis E is arranged at a distance d from the longitudinal axes A1, A2, A3 along which the second connectors 3 extend. Such arrangement is particularly compact.

[0047] In accordance with a variation not illustrated, the distance d is zero and the rotation axis E intersects the longitudinal axes A1, A2, A3.

[0048] The moving of the movable member 30 is entrusted to a disconnection control device, which is partly housed on the outside of the containment body 7.

[0049] In particular, the disconnection control device comprises a drive shaft 39 (visible only in part in Figure 3), which passes through one of the walls of the box element 10 of the containment device 7 and a control (not visible) connected to the drive shaft 39.

[0050] The three switch devices 5 and the three-pole disconnector device 6 are separated by at least one insulating barrier 40 and arranged on opposite sides with respect to such insulating barrier 40.

[0051] In the non-limiting example described and illustrated herein, the insulating barrier 40 is a solid insulating barrier and comprises three walls 41 spaced apart from each other, each of which is arranged between the respective switch device 5 and the respective portion of the three-pole disconnector device 6 provided with the free appendix 33.

[0052] The walls 41 are made of insulating material, for example polycarbonate.

[0053] Preferably, the insulating barrier 40 extends along a plane parallel to the extension axis C1, C2, C3 of the switch devices 5.

[0054] Preferably, the three switch devices 5 and the three-pole disconnector device 6 are arranged side by side and separated by the sole insulating barrier 40.

[0055] Preferably, the three switch devices 5 and the three-pole disconnector device 6 are arranged side by side at a distance DIS less than a predefined threshold.

[0056] Preferably, the distance DIS is measured between the rotation axis E of the three-pole disconnector device 6 and one between the extension axes C1, C2, C3 of the three switch devices 5 and is less than 100 mm.

[0057] In the non-limiting example described and illustrated herein, the distance DIS is preferably less than 85 mm and more preferably comprised within the range 75mm - 80 mm.

[0058] In the non-limiting example described and illustrated herein, the three-pole disconnector device 6 is arranged side by side with the moving device 16.

[0059] More preferably, the three-pole disconnector device 6 is substantially arranged side by side with the spring 19 of the moving device 16.

[0060] "Arranged side by side" means here and in the following that at least a portion of the three-pole disconnector device 6 is arranged aligned with at least a portion of the three switch devices 5 along a direction orthogonal to the extension axis E of the three-pole disconnector device 6 and to the extension axis C1, C2, C3 of each switch device 5.

[0061] In the non-limiting example described and illustrated herein, the insulating barrier 40, and specifically the walls 41, also define a portion of a supporting structure of the switch devices 5.

[0062] Figure 3 and Figure 4 illustrate a sealing device 44, which is coupled to the box element 10 of the containment body 7 and is configured to perform a gas seal around the openings dedicated to the passage of the drive shaft 39 of the disconnection control device and around the drive rod 24 of the control assembly 21 configured to drive the switch devices 5.

[0063] Preferably, the sealing device 44 is defined by a main body 45, preferably made of metallic material, and by a plurality of sealing elements which will be specifically described in the following.

[0064] The main body 45 is provided with a perimeter

edge 46 coupled to the box element 10 (preferably by means of pins 48 integral with the box element 10, which are fixed with nuts 49 and possible washers to the perimeter edge 46) and is provided with a perimeter groove 50 made on the face 51 of the main body 45 which, in use, faces the box element 10. The perimeter groove 50 is engaged by a perimeter seal (not visible) preferably made of deformable material.

[0065] The main body 45 is provided with a through hole 53 configured to house the drive shaft 39 of the disconnection control device and with a plurality of sealing rings 54 (visible in part in Figure 3) arranged in respective grooves 55 (visible in part in Figure 4) in the through hole 53 around the drive shaft 39.

[0066] The main body 45 is further provided with a housing seat 58 configured to house respective portions of the transmission device 25 of the control assembly 21 of the switch devices 5.

[0067] In the non-limiting example described and illustrated herein, the transmission device 25 comprises a double crank-rod mechanism configured to transform the rectilinear movement along an axis V1 of a rod 60 connected to the drive device (not illustrated) into a rectilinear movement along an axis V2 of the drive rod 24 connected to the supporting frames 20 of the switch devices 5.

[0068] The axis V1 and the axis V2 are transverse to each other, preferably orthogonal.

[0069] Between the rod 60 and the drive rod 24 a first crank 62 and a second crank 63 are arranged coupled to each other by means of a connecting pin 64. The first crank 62 has an end fixed to the rod 60, whereas the second crank 63 has an end connected to the drive rod 24.

[0070] The housing seat 58 comprises a main cavity 65 (see Figure 4) configured to house the second crank 63 and an accessory cavity 66 (see Figure 4) configured to house the connecting pin 64.

[0071] Preferably, in the accessory cavity 66 various grooves are present (not visible in the accompanying figures) for housing respective sealing rings 68 (Figure 3) and bearings useful for the operation, which in use are arranged around the connecting pin 64.

[0072] The housing seat 58 preferably also comprises a service cavity 70, which allows access to the main cavity 65 so as to be able to fix the drive rod 24 to the second crank 63 by means of a suitable fixing pin 74. The cavity 70 is closed with a cap 72, which presses a sealing ring 73 (visible in Figure 3).

[0073] In use, the sealing rings 68, the sealing rings 54 and the perimeter seal ensure that the insulating gas does not come out of the chamber 13.

[0074] Figure 5 illustrates a switch-disconnector assembly 100 for an electrical switchboard of gas type.

[0075] The switch-disconnector assembly 100 is housed, in use, in a chamber (not illustrated) of the electrical switchboard in which gas is present.

[0076] The switch-disconnector assembly 100 has only some differences with respect to the switch-disconnector assembly 1. For such reason, the reference numerals used in Figures 1-4 will be utilized for indicating identical or similar parts.

[0077] The switch-disconnector assembly 100 is housed in a containment body (not illustrated) which defines a chamber 113 filled with insulating gas.

[0078] As it is thus possible to note, the switch-disconnector assembly 100 is completely immersed in insulating gas and does not require insulating elements nor the sealing box element.

[0079] However, although not illustrated in Figure 5, the disconnection control device which adjusts the moving of the movable member 30 of the three-pole disconnector device 6, is partly housed on the outside of the containment body. Therefore, the drive shaft 39 has to pass through a wall of the containment body which defines the chamber 113.

[0080] Similarly, also the transmission device 25 of the control assembly 21 which moves the moving devices 16 of each switch device 5 is arranged on the outside of the containment body.

[0081] In particular, the drive rod 24 has to pass through a wall of the containment body which defines the chamber 113.

[0082] On the wall of the containment body which defines the chamber 113, the sealing device 44 described with reference to Figures 3 and 4 will therefore be preferably present.

[0083] The relative arrangement of the three-pole disconnector device 6 and of the switch devices 5 is substantially identical to the one illustrated in Figure 2.

[0084] The sole difference consists in the structure of the insulating barrier 140, which is a solid insulating barrier and comprises a single wall 141 which preferably extends along a plane parallel to the extension axis C1, C2, C3 of the switch devices 5 for separating the three-pole disconnector device 6 from the switch devices 5.

[0085] The wall 141 is made of insulating material, for example polycarbonate.

[0086] Finally, it is evident that modifications and variations can be made to the switch-disconnector assembly and to the switchboard described herein, without departing from the scope of the appended claims.

Claims

1. Three-phase electricity distribution switchboard comprising:

   • at least one switch-disconnector assembly (1; 100) housed in a chamber (13, 113) of a containment body (7) filled with insulating gas; wherein the switch-disconnector assembly (1; 100) comprises three switch devices (5), each of which is provided with a movable contact and a moving device (16) configured to move the movable contact, and a three-pole disconnector

device (6) provided with a movable member (30) configured to rotate at least between a disconnecting position and a contact position;
• a control assembly (21) configured to simultaneously operate the moving devices (16) of the three switch devices (5) and comprising a drive rod (24), which passes through a first opening of the containment body (7);
• a disconnection control device configured to operate the movable member (30) of the three-pole disconnector device (6) and comprising a drive shaft (39), which passes through a second opening of the containment body (7);
• a sealing device (44) configured to perform a gas seal around the first opening and the second opening; wherein the sealing device (44) comprises a main body (45) provided with a perimeter edge (46), configured to be coupled to the containment body (7) and is provided with a perimeter groove (50) made on the face (51) of the main body (45) which, in use, faces the containment body (7) and with a perimeter seal engaging the perimeter groove (50); the perimeter groove (50) being shaped to surround, in use, the first opening and the second opening.

2. Switchboard according to claim 1, wherein the main body (45) is provided with a through hole (53) configured to house the drive shaft (39) of the disconnection control device and provided with at least one groove (55) for housing at least one sealing ring (54).

3. Switchboard according to any one of the preceding claims, wherein the sealing device (44) comprises a main body (45) provided with a housing seat (58) configured to house at least a portion of a transmission device (25) of the control assembly (21) of the switch devices (5).

4. Switchboard according to claim 3, wherein the transmission device (25) comprises a double crank-rod mechanism configured to transform the rectilinear movement along a first axis (V1) of a rod (60) connected to a drive device into a rectilinear movement along a second axis (V2) of the drive rod (24).

5. Switchboard according to claim 4, wherein the first axis (V1) and the second axis (V2) are transverse to each other, preferably orthogonal.

6. Switchboard according to claim 4 or 5, wherein the transmission device (25) comprises a first crank (62) and a second crank (63) coupled to each other by means of a connecting pin (64); the first crank (62) having one end attached to the rod (60) and the second crank (63) having one end attached to the drive rod (24).

7. Switchboard according to claim 6, wherein the housing seat (58) comprises a main cavity (65) configured to house the second crank (63) and an accessory cavity (66) configured to house the connecting pin (64).

8. Switchboard according to claim 7, wherein the accessory cavity (66) is provided with at least one groove for housing at least one respective sealing ring (68).

9. Switchboard according to claim 7 or 8, wherein the housing seat (58) comprises a service cavity (70), which is in communication with the main cavity (65) to allow access to the main cavity (65) and to allow the attachment of the drive rod (24) to the second crank (63).

10. Switchboard according to any one of the preceding claims, wherein the containment body (7) comprises a watertight box element (10), three first insulating elements (12) and three second insulating elements (11); the first opening and the second opening being made on a wall of the box element (10).

11. Switchboard according to any one of the preceding claims, wherein the switch-disconnector assembly comprises:

- three first connectors (2);
- three second connectors (3);
- the three switch devices (5) being arranged between the three first connectors (2) and the three second connectors (3) respectively, and being configured to selectively create an electrical connection between the first connectors (2) and the second connectors (3);
- the three-pole disconnector device (6) being arranged between the three first connectors (2) and the three switch devices (5) and being configured to selectively disconnect the connection between the switch devices (5) and the first connectors (2);

the three switch devices (5) and the three-pole disconnector device (6) being separated by at least one insulating barrier (40; 140) and arranged on opposite sides with respect to such insulating barrier (40; 140).

12. Switchboard according to claim 11, wherein the switch devices (5) extend along respective longitudinal axes (C1; C2; C3); the at least one wall (41; 141) extending along a plane parallel to the longitudinal axes (C1; C2; C3).

13. Switchboard according to claim 11 or 12, wherein the three switch devices (5) and the three-pole dis-

connector device (6) are arranged side by side.

14. Switchboard according to claim 13, wherein each switch device (5) comprises a moving device (16), a fixed contact, electrically connected to the respective second connector (3), and a movable contact, moved by the moving device (16); the three-pole disconnector device (6) being arranged side by side with the moving device (16).

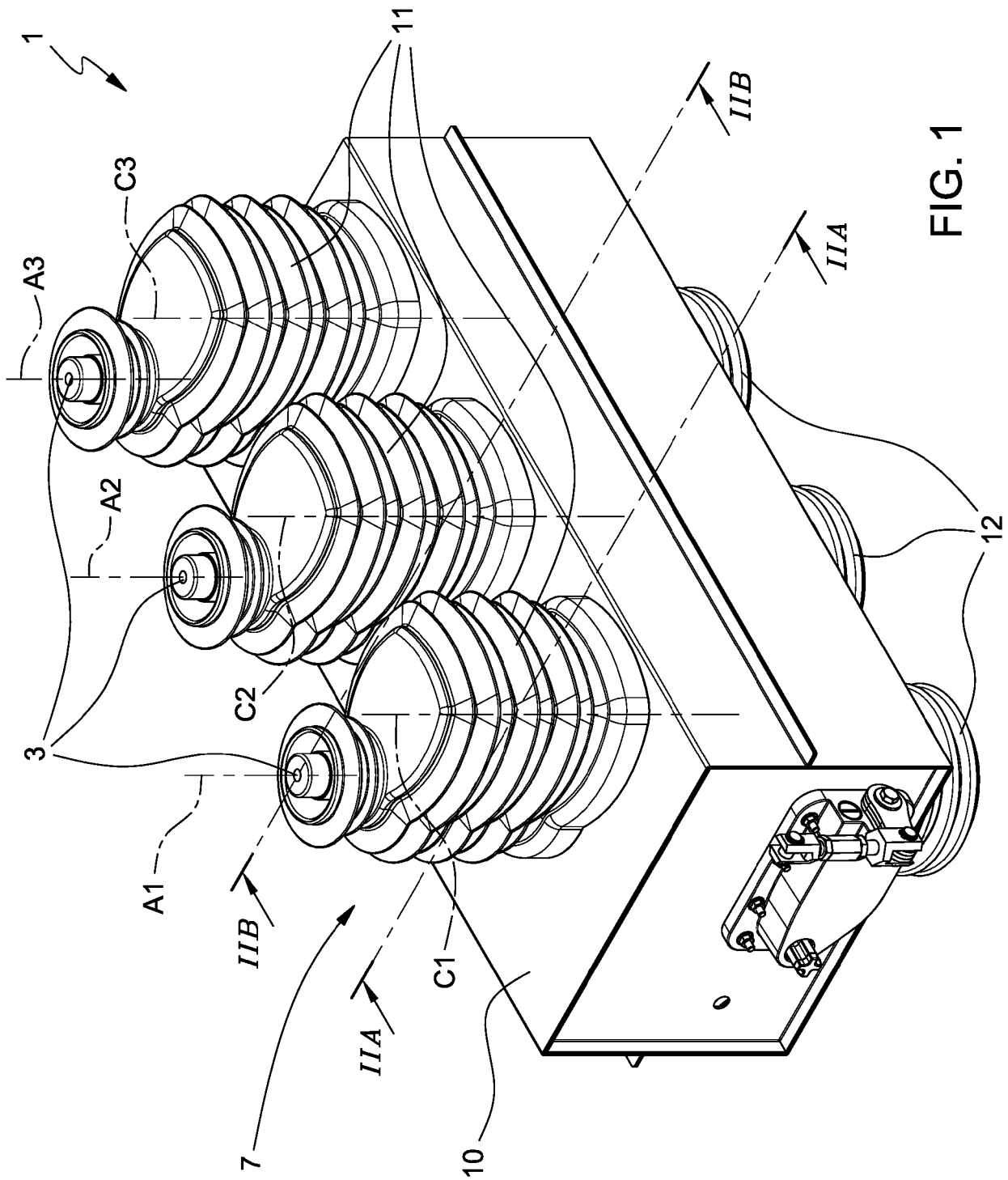
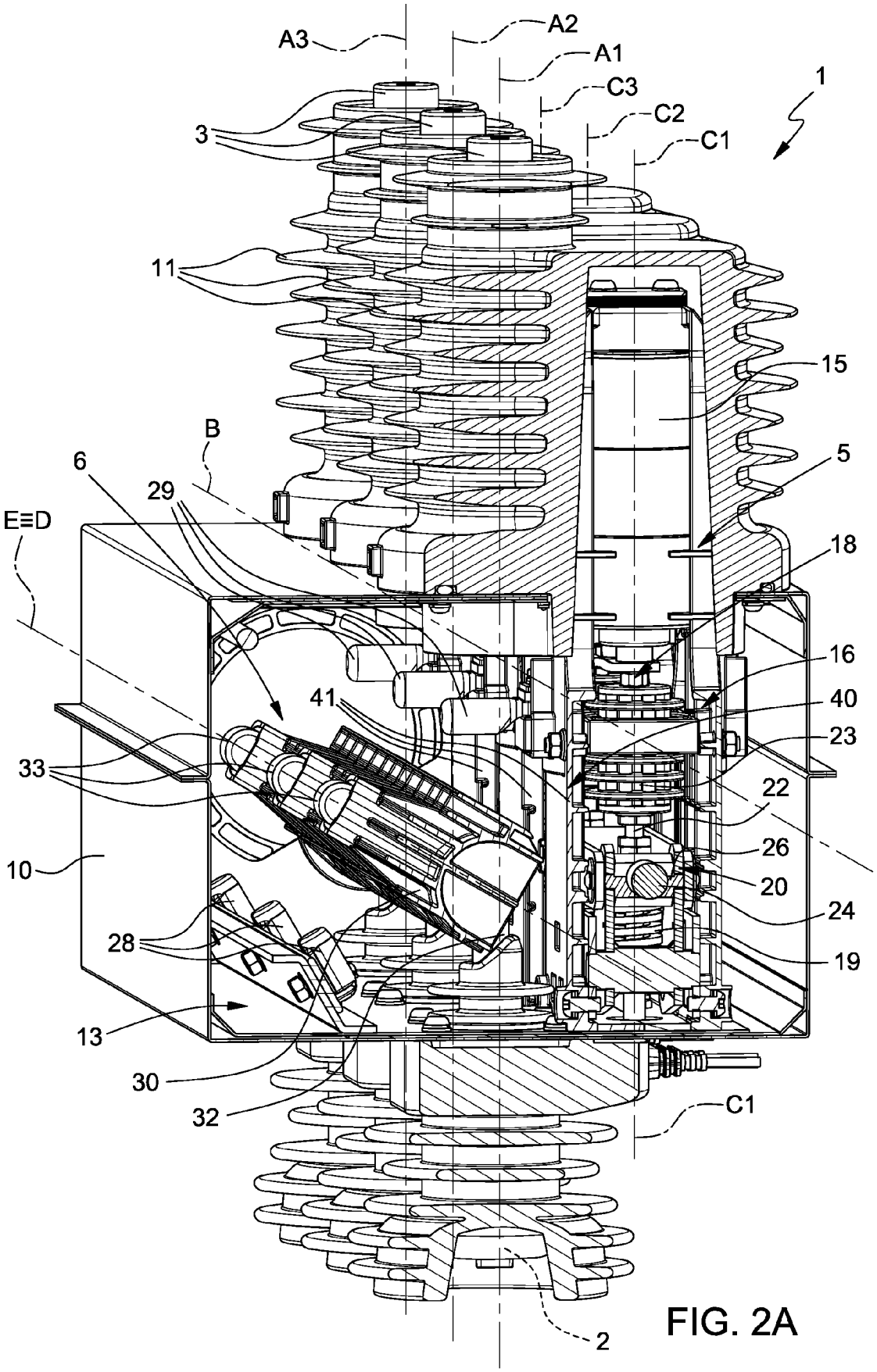


FIG. 1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A2
A1
C3
C2
C1
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FIG. 2A

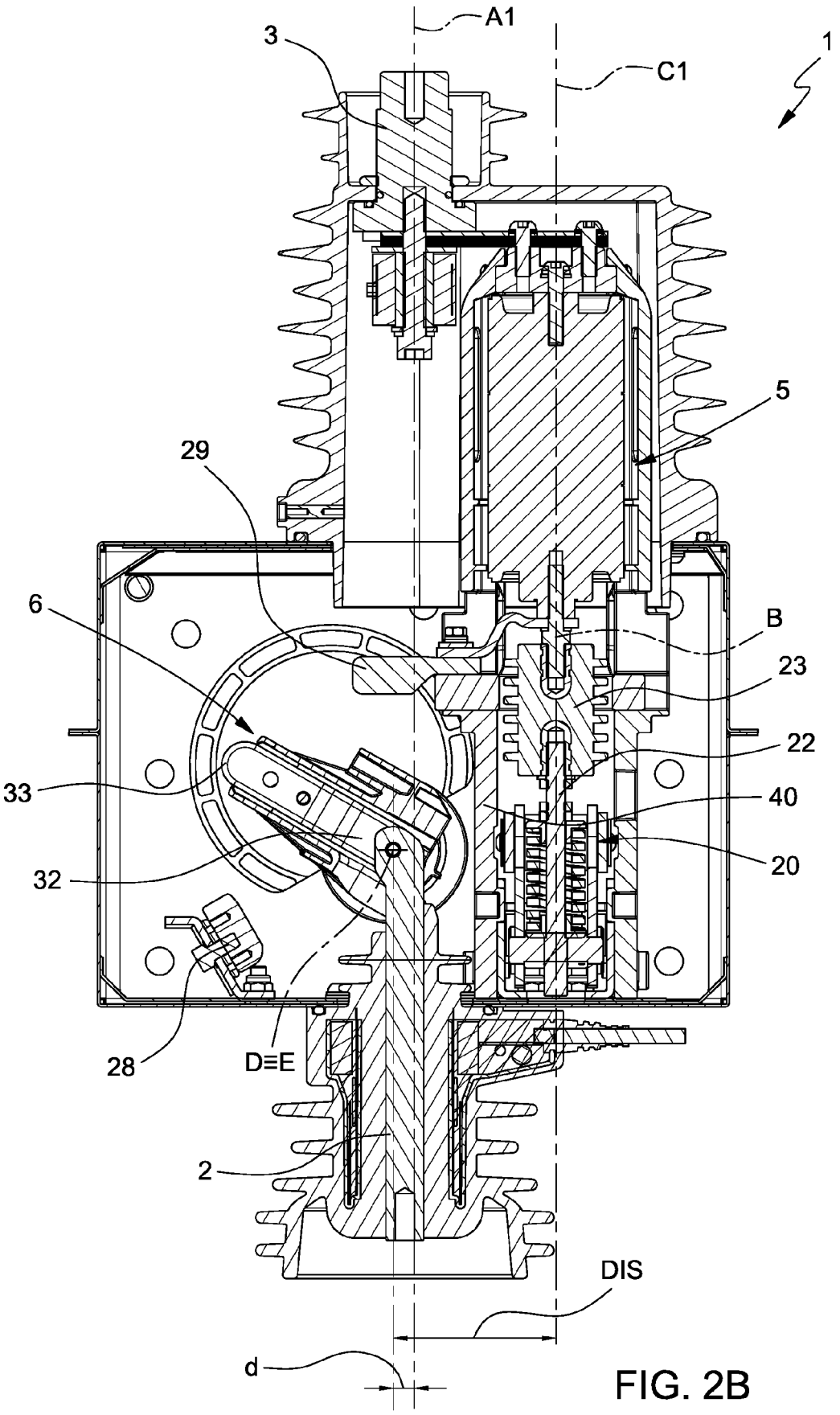
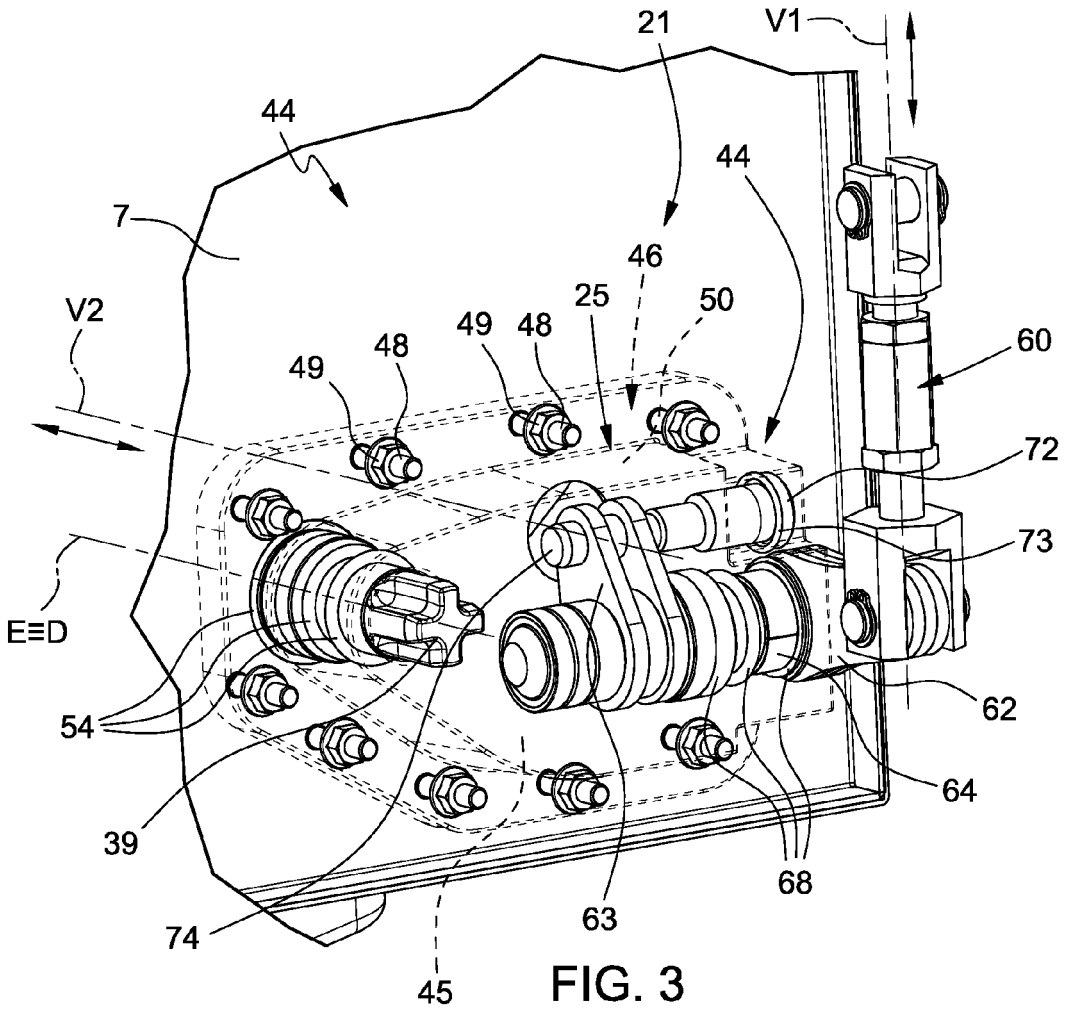


FIG. 2B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V1
44
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7
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25
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V2
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FIG. 3

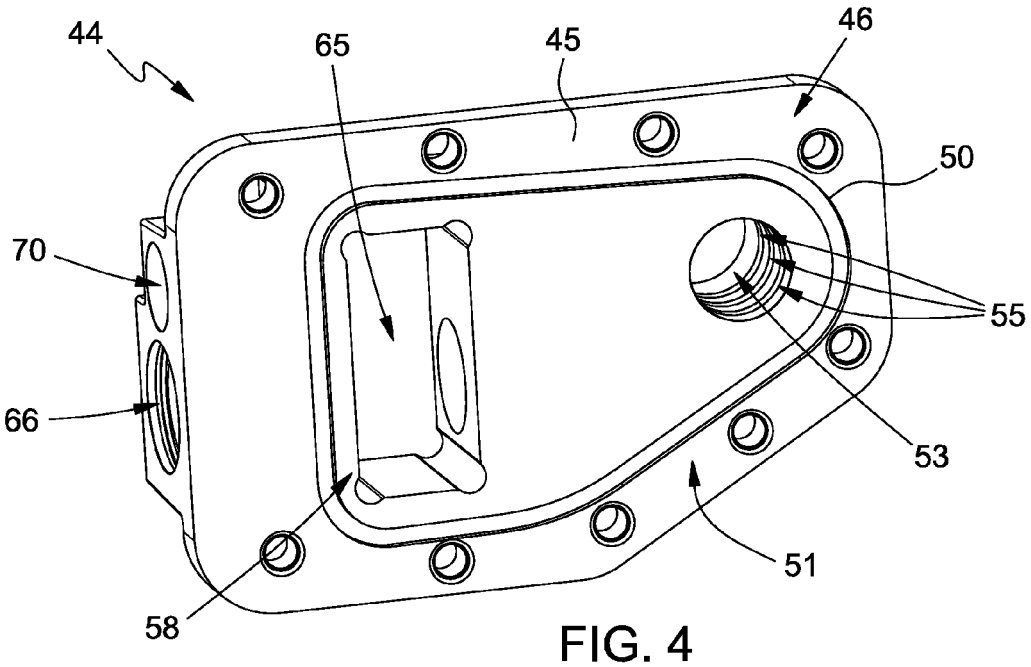
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FIG. 4

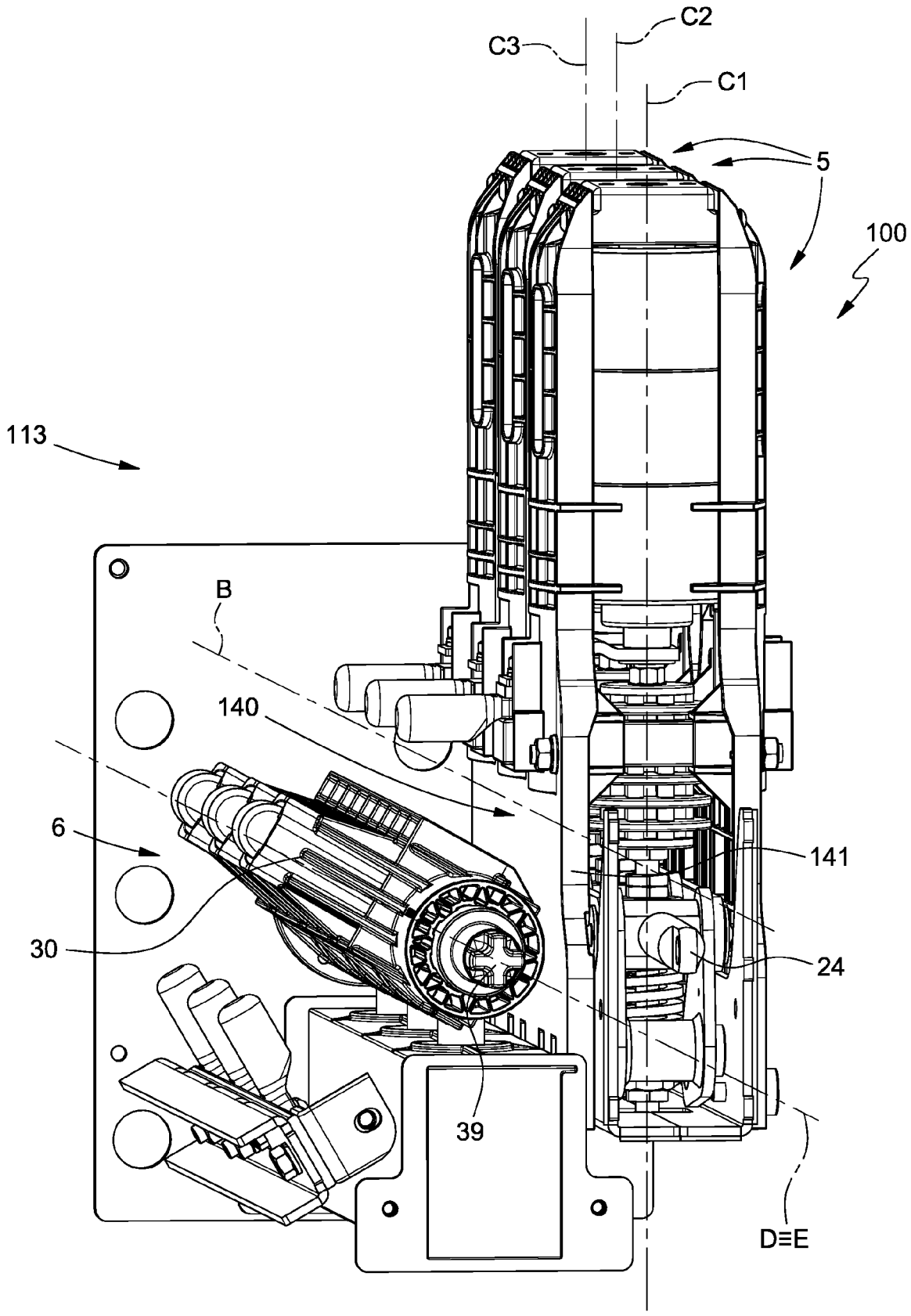

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 5788

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 2 645 395 A1 (ABB TECHNOLOGY AG [CH]) 2 October 2013 (2013-10-02) * paragraphs [0037], [0058], [0064] - [0066]; figures 1-12,16 *	1-14	INV. H01H31/00 H01H33/02 H01H33/12 H01H33/56
A	WO 01/33593 A1 (VEI ELECTRIC SYSTEMS SPA [IT]; VAGHINI ALBERTO [IT]) 10 May 2001 (2001-05-10) * the whole document *	1-14	H01H33/666
A	CN 113 471 011 A (JUNLANG ELECTRIC CO LTD) 1 October 2021 (2021-10-01) * the whole document *	1-14	

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 August 2023	Ramírez Fueyo, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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